File Name: 975.pdf **UNESCO Region:** EUROPE AND THE NORTH AMERICA

SITE NAME: **Zollverein Coal Mine Industrial Complex in Essen**

DATE OF INSCRIPTION: 16th December 2001

STATE PARTY: GERMANY

CRITERIA: C (ii)(iii)

DECISION OF THE WORLD HERITAGE COMMITTEE:
Excerpt from the Report of the 25th Session of the World Heritage Committee

The Committee inscribed the The Zollverein Coal Mine Industrial Complex in Essen on the World Heritage List under criteria (ii) and (iii):

> ***Criterion (ii):*** The Zollverein XII Coal Mine Industrial Complex is an exceptional industrial monument by virtue of the fact that its buildings are outstanding examples of the application of the design concepts of the Modern Movement in architecture in a wholly industrial context.
>
> ***Criterion (iii):*** The technological and other structures of Zollverein XII are representative of a crucial period in the development of traditional heavy industries in Europe, when sympathetic and positive use was made of architectural designs of outstanding quality.

The Observer of Germany informed the Committee that people from all over Europe had worked in the mine and that the recognition of this heritage is important for its future protection.

BRIEF DESCRIPTIONS
The Zollverein industrial landscape in Land Nordrhein- Westfalen consists of the complete infrastructure of a historical coal-mining site, with some 20th-century buildings of outstanding architectural merit. It constitutes remarkable material evidence of the evolution and decline of an essential industry over the past 150 years.

1.b State, Province or Region: Land Nord-Rhein-Westfalen

1.d Exact location: 51°5' N, 7°2' E

The Zollverein Mines in Essen
Pit XII

A Monument Landscape of Universal Significance
in the Heart of Europe

The Zollverein Mines in Essen
Pit XII
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1 Identification of Property

a. Country

Federal Republic of Germany

b. State, Province or Region

North Rhine-Westphalia

c. Name of the Property

The Cultural Industrial Landscape of the "Zollverein Mine“

- The Zollverein Mine underground
- The pits
- The Zollverein central coking plant
- The railways facilities
- Pit heaps, mining damage, changes in the gravitational flow into receiving waters
- Miners´ housing and housing estate development
- The mine consumer facilities and welfare centre

d. Exact Location on map and indication of geographical coordinates to the nearest second

The coordinates of Pit XII:

7✍ 2´ 38" east of Greenwich

51✍ 5´ 8" north of the equator

e. Maps and/or plans showing the boundary of area proposed for inscription and of any buffer zone

See annex, no. 4, no. 5, no. 6

f. Area of property proposed for inscription and proposed buffer zone

See annex, no. 4, no. 5, no. 6

2 Justification for Inscription

a. Statement of significance

The cultural industrial landscape of the Zollverein Mine is a unique witness of complex interrelationships of living and working, dominated by large-scale industry, in the midst of one of the biggest cultural industrial landscapes of the world.
By means of individual monuments, which are located in their relevant structural interrelationships, it symbolises the achievement of man in creating and shaping an industrially defined habitat. Without interference from any other industrial enterprise, and usually without active participation of governmental authorities, Zollverein was able to mark and dominate this landscape. For this reason, the cultural industrial landscape of the Zollverein Mine documents the development of a habitat in a unique manner, which was based on industrial growth through the efficient exploitation of natural resources.

Zollverein Pit XII
The pit of Zollverein XII is an individual monument of outstanding significance in this landscape. In the phase of the highest, never again to be achieved, concentration of groups of heavy-industry companies, Pit XII was built as an investment which was provided with all visionary ambitions of industrial rationalisation. Thus, Pit XII embodies one of the most important fundamental ideas of industrial activity in a globally unique manner.
With an output of 12,000 t of usable coal per day, Pit XII was the most efficient mine in the world. Under the difficult geological conditions of the region, the achievement of this output was a real technological feat. The architects Fritz Schupp and Martin Kremmer developed Pit XII in the graphic language of the Bauhaus to a group of buildings which combined form and function in a masterly way. For more than three decades, the architecture of Pit XII had a model character and marked the cultural industrial landscape along the Ruhr with innumerable imitations.

Zollverein central coking plant
The Zollverein central coking plant was the most modern of its type in Europe when it was completed in 1961. Fritz Schupp designed the plant against the backdrop of his great experience with large industrial plants. Function and form were harmonized with one another and, thus, a masterly work was created.

The technology of large ovens with a height of 6 m, which had been used only once before in 1926 at the Nordstern central coking plant, designed by Fritz Schupp and Martin Kremmer, is a unique witness of the history of technology.

The cultural industrial landscape of the Zollverein Mine is a unique ensemble in the history of forms of human settlement. Zollverein Pit XII and the central coking plant of Zollverein are masterly achievements of technology and industrial architecture. The architectural concept of Pit XII became a model for the region for more than three decades. The headgear of Pit XII has also remained the central landmark of the Ruhr Area even after structural change and, thus, symbolises one of the largest industrial conurbations of the world.

The cultural industrial landscape of the Zollverein Mine fulfills the criteria of the Operational Guidelines of the Convention Concerning the Protection of the World Cultural and Natural Heritage.

The Ruhr Area has contributed a great deal to European industrial history. The basis of the early industrialised communities were the coal and steel industries.

At the end of this millennium, this era of the industrialised community will become history.

The economic and social modernisation has only begun to tentatively understand the cultural importance of the most recent industrial past. The preservation of monuments, which bear witness to the industrial history, is still considered to be an obstacle to modernisation.

The northern districts of the cities of Essen, Stoppenberg and Katernberg developed with the Zollverein mines in the middle of the past century. In 1932, their pits were concentrated on one single working mine, namely Pit XII. In this manner, the world´s biggest colliery developed which was second to none in terms of technology, architectural culture and organisation.

Pit XII is the nowadays probably most important architectural and technological monument of large-scale coal mining. The production facilities and the shells of their buildings are largely in an unimpaired condition and are now in the process of being renovated for a large number of cultural purposes.

In the neighbourhood of Pit XII, the entire history of the mining industry, which now dates back 150 years, and its typical housing estates are still visible in the urban appearance in the form of other pits, mine railways, miners´ housing estates and pit heaps. This unique "monument landscape“ is important to understand the "cathedral“ of Pit XII.

For this reason, it is a matter of universal concern to conserve this entire monument landscape for future generations and, at the same time, to adapt it to future economic and social needs.

The testimonial value given by Pit XII with its surrounding monument landscape on the one hand and the exemplary development strategy, which respect the industrial history and its culture, justify its inscription in the UNESCO World Heritage List. The difficult work on this enormous task, which also gives rise to numerous conflicts, needs, at the same time, the protection and promotion which are associated with the emphasis and commitment resulting from an inscription.

b. Possible comparative analysis

With its architectural ambition and the dimensions of its topographic urban environment, the landscape of Zollverein embodies the built vision of an exemplary mine which is probably unmatched all over the world. See Ganzlewski, Michael / Slotta, Rainer: Die Denkmallandschaft Zollverein, Manuscript, Bochum Oktober 1999 (a copy will be sent in november).

c. Authenticity/Integrity

The cultural industrial landscape of Zollverein is now, 10 years after the closure of the mine, still very well preserved. On the basis of the large number of buildings and other material witnesses it is very comprehensible. The conservation of Zollverein Pit XII by means of repairs and use for new purposes is a universally significant example of the conservation of an outstanding cultural and industrial monument of extremely large dimensions. The conservation of the Zollverein central coking plant by the foundation for the protection of monuments "Stiftung Industriedenkmalpflege und Geschichtskultur" marks a major step to integrate the large industrial facility into the future planning in the field of cultural industrial landscapes.

The concepts of the International Building Exhibition IBA Emscher Park for the careful treatment of residual industrial sites for the area between the black heap between the coking plant and Pit XII has set standards for the conservation of industrially evolved landscape and ecology. Thus, decisive cornerstones have been laid for the conservation of the cultural industrial landscape of the Zollverein Mine.

d. Criteria under which inscription is proposed

When Zollverein Mine XII was completed in 1932, it was considered to be the most modern and beautiful coal mine in the world the output of which was, with 12,000 tons of hard coal extracted per day, four times higher than the normal average figure. It was the same year, that the Bauhaus began to be closed, the most noble objective of which had been to work towards the "new building of the future“ by fusing craft and art. In the opinion of the founder of the Bauhaus, Walter Gropius, the goal of architecture was to create objects and spaces, for the purpose of which a new development of the form had to proceed, in particular, from the works of industry and engineering. Here, the Bauhaus maxime that form must be oriented towards function, is perfectly translated into reality.

Zollverein XII was created at the end of a phase of political and economic upheaval and change in Germany, which was, artistically speaking, aesthetically reflected in the transition from expressionism to cubism and functionalism. At the same time, Zollverein XII embodies this short economic boom between the two world wars, which has gone down in history as the "Roaring Twenties". But Zollverein is also, and not least, a monument of industrial history reflecting an area in which, for the first time, globalization and the world-wide interdependence of economic factors played a vital part.

Cultural Criterion (i): The architects Fritz Schupp and Martin Kremmer developed Pit XII in the graphic language of the Bauhaus to a group of buildings which combined form and function in a masterly way.

Cultural Criterion (ii): The cultural industrial landscape of the Zollverein Mine is a unique witness of complex interrelationships of living and working, dominated by large-scale industry, in the midst of one of the biggest cultural industrial landscapes of the world.

Cultural Criterion (iii): The pit of Zollverein XII is an individual monument of outstanding significance in the landscape. In the phase of the highest, never again to be achieved, concentration of groups of heavy-industry companies, pit XII was built as an investment which was provided with all visionary ambitions of industrial rationalism. Thus, Pit XII embodies one of the most important fundamental ideas of industrial activity in a globally unique manner.

Cultural Criterion (iv): With an output of 12,000 tons of usable coal per day, Pit XII was the most efficient mine in the world. Under the difficult geological conditions of the region, the achievement of this output was a real technological feat.

3 Description

a. Description of Property

North Rhine-Westphalia has a history which dates back more than 2000 years, and the diverse cultural legacies of which are often of international importance. In the centre of the Federal Land, there is the Ruhr Area which has been Europe´s biggest industrial conurbation for one century. This region owes its prominent position at the intersection of the most important central-European traffic routes, in particular to its hard coal deposits, their extraction and the industries dependent upon these.

The tangible expression of the culture of this mining industry with its rich tradition is, in particular, the concrete legacy of excellent achievements of engineering and architecture. From this monument landscape, which is so characteristic of the Ruhr Area, the Zollverein Mine XII in Essen-Katernberg stands out like an architectural revelation. Between 1927 and 1932, the architects Fritz Schupp (1896-1974) and Martin Kremmer (1894-1945) created here a masterpiece in terms of engineering and design, whose function-related grouping of the individual buildings is also extraordinarily impressive with respect to its composition in terms of urban development.

Visible from far away with the perfectly shaped expression of an equally distinct and symbolic landmark, the markedly symmetrical headgear forms a bridge above the pithead building which opens an axis of the complex drawn by buildings at the end of the representative entrance area. It interfaces with the tub roundabout and, at the end of this, to the enormous coal-washing plant and the refuse bin which are arranged crosswise on both sides.

From the generous free space in front of the pithead building, a second axis develops at right angles and towards the right. As a wide path flanked by long workshop halls which, after a crossroad, is laterally continued with slightly higher compressor halls it architecturally finds its arranged point de vue in the stepwise walled boiler house and the slim stack which rises behind it to a height of 109 meters in the centre (which, unfortunately, had to be torn down because of considerable deformations in 1979). Cooling towers installed lateral to this, of which only the eastern one was built, were intended to provide a flanking dignified shape as a plastic, large element, despite all its technological purpose.

The impressive powerfulness of the Zollverein XII colliery is, in particular, based on the conciseness of the architectural language invented and conclusively phrased in form and material by Schupp and Kremmer. With the exception of the double-frame hoisting gear, the individual buildings consist, for the most part, of a uniformly checkered steel framework construction with a uniform brick infill and horizontal wired-glass panels, which are flush with the wall, to admit daylight.

b. History and Developement

The landscape is limited by the boundaries of the former Zollverein Mine. Above ground, this boundary is exceeded in those cases in which the Zollverein Mine had a significant impact on the development of the cultural landscape.
The existence of the Zollverein Mine is limited in time by its consolidation in 1847 and its closure on 23rd December, 1986.

Within this period, the landscape developed from an agrarian, sparsely populated area into an extremely condensed industrial settlement area. It has become a typical core area of one of the biggest industrial conurbations in the world.

The cultural industrial landscape of the Zollverein Mine is a combination of characterising components all of which, in the final analysis, evolved from the industrial requirements of the mine. A complete description of all historic and preserved objets would go beyond the scope of the nomination. To facilitate the understanding of the landscape and to provide a framework, the landscape will be described from the following points of view:

- The Zollverein underground mine

- The pits

- The Zollverein central coking plant

- The railways

- Pit heaps, mining damage, changes of the gravitational flow into receiving waters

- Miners´housing and housing estate developement

- The mine consumer facilities and welfare centre

<u>The Mine Underground</u>

The Zollverein Mine begins with the consolidation of the associated claim areas on 18th December, 1847. The Zollverein mining field covered an area of 13.2 km². At that time, it was the northernmost mine of the region and one of the oldest in the mining district. For many decades, Zollverein had been one of the biggest mines on the Ruhr.

The essential functions of a mine were the mining and extraction of hard coal.

Hard coal was formed in the carboniferous period and needed more than 300 million years to become the fuel hard coal. In 140 years, Zollverein mined more than 200 million tons of hard coal. Approx. 90% of these were gas and fat coals which were valued, in particular, by the steel industry because the coke produced from it was of excellent quality.
In the northern field of the Zollverein, which, from a geological point of view, belongs to the Gelsenkirchen anticline, the seams were steeply stratified. In the southern field situated in the Essen synclines, flat stratification was to be found. The seams had an average thickness of 1.17 m.

The underground "landscape“ had to be constantly developed with a roadway system of a length of 120 km. This was adequate for a major mine in the Ruhr district. The roadway system was always adapted to the different heights of the levels. In 1851, mining began at the first level at a depth of approx. 120 m. It finished at the 14th level at a depth of 1,200 m in 1986.

The technical development was typical for a hard-coal mine in the Ruhr Area. In the course of the 140-year history, mining by means of holing picks, mechanical picks and coal planes was always based on the state of the art.

Reports about a very high productivity per worker per shift are striking, which is said to have been, at times, more than 1.4 t before World War I. Mining was mechanised relatively late by using coal planes. Coal planes were used for the first time around 1960.

Up to the turn of the century, the workforce steadily increased to approx. 5000. In this century, the number of miners employed varied between 5000 and 8000.

The mine suffered no major disasters. The most serious accident in 1941 cost the lives of 27 miners because a longwall had collapsed in a dust explosion.

The pits were developed by means of a total of 12 shafts, distributed over 5 pits. The shafts were used for extraction, man riding, ventilation, and water drainage.

Mining at the colliery was stopped on 23rd December, 1986. The coal deposits which could be mined economically were exhausted.

The Pits

The Zollverein 1/2 Pit

Between 1847 and 1883, Pit 1/2 was the first and only pit of the mine. Above the shafts, the headgears and wash houses, the boiler house, processing plants, a coking plant, and other necessary ancillary plants were built which were continually adapted to the growing dimension of the mine.

The Zollverein 3 Pit

Shaft 3 in the western field of the mine started operation in 1883 and was extended to become an autonomous pit with an annexed coking plant within a few years.

The Zollverein 4/5 Pit

Shafts 4 and 5 in the north of the mining field went into operation in 1893 and were also extended to become autonomous pits with their own coking plants.

The Zollverein 6 Pit

Shaft 6 in the south began its operation in 1893. Up to 1914, the coal extracted here was conveyed to Pit 1/2 by means of a rope bridge and processed there. From 1914 to 1929, Pit 6 was an autonomous pit with its own processing plant.

Because of increasing operational requirements, new shafts had to be sunk which extended the existing pits: Pit 1/2/8, Pit 3/7/10, Pit 4/5/11, and Pit 6/9.

The Zollverein XII Pit

With the construction of the central extraction and processing plant of Zollverein XII in 1932, the old pits lost their autonomy and were reduced to functioning solely as man-riding and materials-supply shafts. Also most of the energy supply was provided by the new central pit.

From 1st February, 1932, Zollverein Pit XII extracted all the coal mined at the Zollverein. As the Zollverein was the biggest mine in the region, the dimensions of the pit had to be correspondingly large. The average output of the pits of the Ruhr district amounted to approx. 2,900 t per day. At the Minister Stein/Furred Hardeners mine in Dortmund, there was the then biggest hoist with a capacity of 5,000 t per day. Zollverein Pit XII ensured an output of 12,000 t per day. Thus, pit XII had the largest capacity in the world.
By using the most modern, almost fully automated equipment, the number of jobs was reduced from 1000 to approx. 500.

By involving architects in all planning stages an almost ideal combination of technology and architecture could be achieved.
Zollverein Pit XII constituted a unique, still unmatched move in industrial rationalisation.

For decades, Pit XII had remained the model for hard-coal mining pits in West Germany.
Until the closure of the mine in 1986, the corporate concept of a division of labour with central extraction in Pit XII and man riding in the other pits worked smoothly.

In 1967, the mine discontinued mining steep-dip deposits because mechanisation was not possible in such cases. The working field and the Zollverein 4/11 Pit were closed.

In 1974, Zollverein began to cooperate with the Holland mine. The coal mined there was hauled underground to Pit XII for preparation.

In 1979, mining in the southern field of Zollverein was stopped and Pit 6/9 was closed.

In 1983, mining at the Holland mine was discontinued.

In 1983, Zollverein started to cooperate with the Nordstern Mine. The coal mined there was hauled to the surface and prepared at Pit XII.

On 23rd December, 1986, the Zollverein Mine was closed down. The coal deposits which could be mined profitably were exhausted.

The Coking Plants

The coal deposits of Zollverein at a depth of 200 to 800 m consisted almost exclusively of fat and gas coals which are particularly suitable for coking. For this reason, as early as 1857, only six years after the first commercial extraction of coal at the mine, three stack-type ovens were built at Zollverein 1/2 to coke the coal.
In 1866, the first chamber coke ovens - 30 flame-heated ovens based on the Smet system - started operation. In 1869, the plant was expanded by another 60 ovens of the same design.
In 1901/02, the coking plant was again expanded by 30 ovens, and the first 30 flame-heated ovens were taken out of service.
In 1905, 60 new waste-heat recovery furnaces from the Dr. Otto company, which were in operation until 1919, replaced the existing 30 ovens.
In 1908, 30 waste-heat recovery furnaces of the Koppers company followed which were taken out of operation in 1928.

In 1914, 60 Koppers regenerative furnaces were built which were in operation until 1930.
In 1917, the construction of a new coking plant began which, however, could be completed only in 1927. With 54 Koppers ovens, it attained a daily

throughput of 500 t of dry coal. In 1932, this coking plant had to be closed down because of the bad economic situation.

In 1936, it resumed operation and worked until 14th November, 1953. One year later, it was demolished.

At Zollverein 3/7/10, coke making began in 1914 with two batteries, each with 60 regenerative furnaces from the Still company. It continued operating until 1930 and was then torn down.

At Zollverein 4/11 the Brunck company built 60 regenerative furnaces, and in 1896, a by-product plant was added. In 1912, the Koppers company modified the ovens to waste-heat recovery furnaces. In 1928, this coking plant was closed down. It was subsequently demolished.

When the Zollverein Mine was taken over by the newly founded steel group Vereinigte Stahlwerke A.-G. in 1926, the operating conditions of the coking plants changed fundamentally. The group combined all its mines in the Gelsenkirchen area to form one single group of mines and built a new, very big central coking plant for these mines, namely the Nordstern coking plant. With a capacity of approx. 2000 t per day in the first phase of the expansion, Zollverein supplied approx. 50 % of the required coking coal.

In 1957/58, the Gelsenkirchen Bergwerks A.-G., the then holding company of numerous mines in the district, was planning a new big central coking plant at Zollverein. Because an increase in the demand for coke was being expected it was intended to supplement the Nordstern coking plant.

The Zollverein central coking plant commenced operation in 1961 with 8 oven batteries of 24 ovens each according to the Still system. The oven chambers are 6 m high, 13.6 m deep and 0.45 m wide. In 1972/73 it was enlarged to a total of 304 ovens. The construction and operation were consciously focussed on environmental protection. The coke-making capacity amounted to 8,600 t per day. The production programme comprised, furthermore, tar, sulphuric acid, crude benzene, ammonium thiocyanate, ammonium sulfate, and gas. Because of the decreasing demand for coke, the coking plant was closed on 30th June, 1993.

The Railways

The Cologne-Minden railway

The layout of this first railway line was decisive for the location of the Zollverein mine. Shafts 1 and 2 were sunk only approx. 500 m from the line. In May, 1847, the line from Oberhausen to Hamm was opened. In a west-easterly direction, it ran directly through the mining field. With a short connecting line, the mine had since been connected to the transport system of the railway.

The first passenger station for the municipality of Katernberg, however, was opened only forty years later. The name of the station was initially "Zollverein Station“. In 1896 the name was changed to "Katernberg South“.

The Bergisch-Märkische railway
The "Emscher Valley Railway" of the Bergisch-Märkische railway company 1847 opened its railway line with a route to the north of the Cologne-Minden line. The line intersected the north-wester corner of the Zollverein mining field.
In 1901, the passenger station Katernberg North was built there.

The mine railways of Zollverein
Pit 1/2
For the connection to the Cologne-Minden line, a 500 m long line was sufficient which was built when the Zollverein Mine was established.

Pit 3/7/10
When shaft 3 was sunk, the mine established a connection line to Pit 1/2. This line went into operation in 1880.

Pit 4/5/11
When the sinking of shaft 4 began in 1891 Zollverein established a connection to the Emscher Valley railway of the Bergisch-Märkische Railway Company.
Pit 6/9
In the first years of operation of the pit, the extracted coal was transported in mine cars with a cable system over a long bridge to Pit 1/2 for preparation. In 1913, Zollverein connected the pit to the internal railway network with a line to Pit 1/2.

The mine subsequently interconnected its lines. In 1922, a new line between Pit 4/5/11 and Pit 1/2 established the formerly missing link for the interconnection of all pits. In 1921, Zollverein entered into a community of interests with the steel group "Phoenix AG für Bergbau und Hüttenbetriebe". The Nordstern mine with a coking plant and port on the Rhine-Herne Canal, situated to the north of Zollverein, was a member of the group. In 1926, a railway established the connection to the Nordstern port.

When, in 1926, Zollverein joined the large steel trust "Vereinigte Stahlwerke A.-G.", the railway network was connected to the neighbouring mine Bonifacius in Essen Kray and, thus, to the eastern network of lines of the group, with a line from pit 3/7/10.

The Pit heaps and Mining Subsidences

The pit heaps of the mine
To the east of Pit 1/2, there is the oldest pit heap of Zollverein, which was formed when the shafts were sunk in 1847. In approx. 1895, this heap was planted with acacias and used as a recreational area for the mine officials who had to live immediately at the entrance to the mine. It was subsequently also called the "Green Heap".

In the west of Pit 1/2, a second heap began to rise at about the same time, for the purpose of spoil management. From 1932, parts of this heap were prepared for pond management. The boiler ash and coal sludges of the Zollverein 12 Pit were dried there. It was called the "Black Heap“.

Another heap was formed next to Pit 3/7/10 after the first shaft had been sunk in 1880. In 1958, it was partially removed to create building sites for miners´ houses.

After the shaft had been sunk, a pit heap formed at Zollverein Pit 4/11. At this pit, coal was mined in a steep dip. Therefore, it was urgently necessary to fill the spaces where the coal had been mined. For this reason, spoil management was performed with particular intensity. After an adjacent airfield became redundant in 1930 Zollverein established a big pit heap on this site. It was also used by other mines.
Furthermore, to ensure national energy reserves, large amounts of coal were stored to the west of heap 4/11. In 1933, this heap was removed.

The Mining Subsidences

The mining of more than 200 million tons of coal in the Zollverein mining field caused the level of the surface of the earth to subside by more than 25 meters in some areas. Above the mining zone, a subsidence trough formed, at the edges of which stretching occurred, and in the centre compression. Houses and streets, as well as large areas in the Zollverein mining field began to move. It was not uncommon that, when houses were damaged due to extreme mining damage, they had to be torn down because they had become uninhabitable. Railway tracks, bridges and other buildings were raised to ensure that they continued to function.

Control of the gravitational flow into receiving waters
The Zollverein mining field is situated within the Emscher zone where many large-surface swampy areas had existed even before mining began. The subsidence of the surface of the earth worsened these gravitational flow conditions significantly.
The main receiving water flooded the land and caused it to become swampy because the water could not run off. Since the hygienic conditions deteriorated accordingly typhoid, cholera and dysentery epidemics occurred in the second half of the 19th century.

At a very early stage, the Zollverein Mine began to control the receiving waters. But at the turn of the century, conditions threatened to become uncontrollable in the Emscher region so that a cross-regional concept was deemed to be urgently necessary. The municipalities, mines and other institutions concerned established the "Emscher Association“. On the Zollverein mining field, the main receiving waters, Schwarzbach, Zollverein-Graben, Stoppenberger Bach, and the Berne have since been systematically developed on the basis of a large-scale concept. When the level of the receiving waters fell below the level of the Emscher river, pumping stations were used for artificial drainage. In 1934, 415 acres in the mining field were drained as a polder zone.

Miners´ Housing and of the Housing Estate Development

1st construction phase from 1847 to 1918
Since the beginning of mining at the Zollverein mine, the workforce had steadily increased. As no other property developers were available, Zollverein itself started to construct miners´ houses. The development of the housing estate was based on operating plans of the mine. Despite a high degree of commitment on the part of the mine with respect to mine colonies, it had hardly been possible for 100 years to build approximately enough houses for the workforce.

The mine acquired large building sites by purchasing farms and cottages in the area around the pits. The Hegemannshof farm with 185.5 morgen (1 morgen = 0.557 acres) was bought on 15th April, 1856, followed by the purchase of the Ottekampskotten with 52 morgen in 1867.

In 1860, 146 flats were ready for occupancy. In that year, the mine employed 710 workers. The first housing estate was continually expanded and soon acquired its own social and urban identity as the "Hegemannshof colony“, which even became a term in official usage. Subsequently, further colonies were built: "Ottekampshof colony, colony 3 and "Beisen" colony.

The urban development concept of the colony was characterised by the choice of the type of house, the size of the garden and the arrangement of the houses in parallel streets.
The four-dwelling residence became the standard. The cross-shaped groundplan of this type of house made it possible to install 4 dwelling units. These had separate entrances with a living area of 50 to 60 m². The walls made of simple bricks made outdoors or bricks from the mine brickworks were typical for the outer appearance of the colony houses.

Approx. 640 m² of land including the space occupied by the house belonged to every housing unit. The large garden was meant to attract miners and increase their loyalty to the mine. This function was of great importance because of the extremely high fluctuation of the workforce at the turn of the century. The mine required a base of experienced miners to ensure smooth working underground. The size of the garden also determined the utilisation of the space of the building site. The distances from the next house and from the next parallel colony street also resulted from this.
As the biggest colony, the Hegemannshof colony grew until the turn of the century to a size of approx. 222.393 acres.

After the turn of the century, the design of the houses was varied by using some of the architectural elements of garden estates. In Roonstrasse and Theobaldstrasse, a number of new houses were built according to these principles.

In 1876, the property owned by the mine was only 36.2009 acres. By World War II, it had grown to 1782.8771 acres. Nevertheless, it became obvious that a use of land as at the Hegemannshof colony would be too generous to provide housing for all miners because the workforce had, in the meantime, grown to 5000.

The development of the centre of Katernberg

Between the Hegemannshof colony and Pit 1/2 along Katernberger Strasse, private business men established themselves. The mine supported the development of the new centre of Katernberg and donated a plot of land to the municipality for use as a marketplace. They also promoted the establishment of the post office, a doctor´s surgery and also of the churches. In a 1.5 km wide belt around this centre, however, Zollverein purchased almost all land.

The old, pre-industrial passageways and streets continued to exist as an urban-development matrix. In the spaces between these streets, the proposed design of the estate planners, working according to the instructions of the mine, determined the configuration of the new passageways and streets.

2nd construction phase from 1918 to 1945

In the harsh post-war period, the building activities could be continued only slowly.

Starting in 1921, the „Trust Agency for Miners´ Housing“ became active in Katernberg. To the west of Viktoriastrasse, it built a housing estate which was very different from the colony concept. The houses were richer in variety and they required much less space because the gardens were markedly smaller.

In 1928, the construction company "Ruhrwohnungsbau AG" built ten pre-fabricated houses with a steel cladding in Dirschstrasse, which attracted much attention as "steel houses".

From the mid-20s, the architects Fritz Schupp and Martin Kremmer had been working as consultants for the mining operations of the "Phoenix AG für Bergbau und Hüttenwesen" and, later, of the "Vereinigte Stahlwerke A.-G." and had influenced the building activities at the Zollverein Mine. In Heinrich-Lersch-Strasse, Gaudenzstrasse and Distelbeckhof, they designed residential dwellings.

In the late 20s, the mine could offer a flat to all salaried employees and officials. But the miners´situation was still characterised by a gross imbalance. For the workforce of approx. 8000 miners , only about 3000 flats were available. In 1933, in the course of the reorganisation of the "Vereinigte Stahlwerke A.-G", the group established its own housing association. The "Rheinisch Westfälische Wohnstätten AG" took over the houses owned by the Zollverein mine. The mine retained the right to allocate housing and to participate in the definition of new construction projects.

3rd construction phase from 1945 to 1986

The housing associations created new estates with multi-storey big blocks of flats in the remaining gaps between buildings on a large scale.

The Kaldekirche estate in Pfeifferstrasse was built in 1951/51 based on the designs by the architect Wilhelm Seidensticker. The two-storey blocks of rented flats are of a relatively lively design in terms of equipment and arrangement in the sense of the architectural intentions of that time. As opposed to the old mine colonies, the tenants do not have gardens any more. Instead, large green spaces were created as a substitute which was to ensure the economical use of the land.

The Westerbruch estate was built in 1951/52. It is characterised by a relatively high design quality of the blocks of flats. It is the only contemporary estate in the area of the cultural industrial landscape of Zollverein which is consistently constructed with brick walls. Thereby, the design of the houses was especially well matched to the appearance of the historic estates and buildings in the area of the cultural industrial landscape Zollverein.

The Kapitelacker estate dating from 1953/54 is at the foot of the Kapitelberg mountain. The two-storey blocks of rented flats with a simple, unpretentious facade design are arranged in such a way that a diverse ensemble of squares, free spaces and streets is created.

Further estates, such as the ECA estate in Schonnebeck, the buildings on the free spaces in the Beisen colony and the early land development in the area of the Hegemannshof and Ottekampshof colonies followed within the framework of the miners´ housing programme.

The small "Glück Auf" estate was built on the basis of neighbourly mutual assistance between 1952 and 1955. From originally approx. 47 homesteads, it grew to the impressive number of 141 homesteads with 282 dwellings. The single-storey houses with pitched gable roofs with the eaves facing the street have two lateral entrances and are designed for two families. Construction was supported by the mine which provided the bricks which had been used in the world war for protection purposes against damage caused by air raids.

The Pestalozzi villages were built to house the apprentices who were systematically recruited because the mine needed more and more new workers. From 1952 to 1955, the first village unit "Im Grund" was built with 30 semi-detached houses for 30 Pestalozzi families. 6 young miners recruited in other regions of Germany and two parents lived in each of these houses. The single-storey houses with pitched gable roofs arranged in quiet winding streets and squares gave the estate a village-like character.
The "Neuhof" was the second Pestalozzi village of Zollverein. Here, the protestant church "Neuhof" and a large community centre were built to provide for the social and religious needs of the village community which consisted of problem youths.

In 1958, 7061 dwellings were available for a workforce of 8000.

The Mine Consumer Facilities and Welfare Services

The mine consumer facilities provided groceries and manufactured goods at low prices. The profit from the sale of the products was returned to the customers in the form of a dividend at the end of each financial year. The amount of the dividend depended on the amount of the purchased goods.

In 1895, the mine already had three points of sale:
- "Konsum 1" in the vicinity of Pit 1/2
- "Konsum 2" at the southern end of the Ottekampshof colony
- "Konsum 3" at the edge of the Hegemannshof colony

In 1914, the number of points of sale had doubled:
- "Konsum 4" next to Pit 4
- "Konsum 5" next to Pit 3
- "Konsum 6" next to Pit 6

In 1928, approx. 5000 mine employees had a participation in the sales of the consumer association. This corresponded to more than 2/3 of the workforce. When the mine was taken over by the "Vereinigte Stahlwerke A.-G.", the consumer facilities became also the property of the group.

When the group was reorganised in 1934, the "Vereinigte Stahlwerke A.-G." established the independent operating company "Westfälische Haushaltsversorgungsgesellschaft" (WEHAG) which took over the consumer facilities at Zollverein. In the 50s, many of the consumer facilities were closed because of the competition of the new self-service shops. In the 70s, the trading company "PLUS Handelsgesellschaft" took over the remaining so-called Wedi markets of the WEHAG.

<u>The Mine Welfare Services</u>

Sine the mid-20s, the mine had been committed to the welfare of its employees and their families. Trained female welfare workers provided support and assistance with respect to economic, health and educational matters. They were directly responsible to the mine management. In 1928, Zollverein established the first welfare centre in a small frame shed at the entry to Pit 1/2. In 1934, the second mine welfare centre was opened next to Pit 3/7/10. In 1938, the first welfare centre could move to a renovated building. The Schulte farm on the Hege had been modified according to designs by Fritz Schupp, and two annexes had been added. In 1953, Zollverein built a new, big welfare centre next to Pit 3/7/10. The brick building was also designed by Fritz Schupp. Around 1955, the heavy-industry companies in the Ruhr Area began to again cut back their welfare activities. The key word of the public discussion about this was "dismantling the social gimmicks". In the early 60s, Zollverein stopped its mine welfare activities.

c. Form and date of most recent records of property

Ganser, Karl / Kania, Hans / Mainzer, Udo: The Zollverein Colliery in Essen, Written Statement of Facts and Nomination for Inscription in the UNESCO World Heritage List, o.O., 1999

Ganzlewski, Michael / Slotta, Rainer: Die Denkmallandschaft Zeche Zollverein. Eine Steinkohlenzeche als Weltkulturerbe, Manuscript, Bochum 1999

Kania, Hans: Industrielle Kulturlandschaft Zollverein, Essen 1999

d. Present state of conservation

With the exception of Pit XII and Pit 2, the underworkings were closed on the 1000 m horizon by walling up the galleries after mining had been stopped. How many galleries are still open behind the walls cannot be stated with certainty. In 1987, the Ruhrkohle company referred to a volume of 155,000 m³ of open underworkings which they could make available for filling with power-station wastes. It is to be assumed that some sections of the approx. 100 km of underworkings at the time of the closure were damaged more or less by the permanent rock pressure.

On the 1000 m horizon, the RAG operates a station of the central water drainage system. Every day, about 1,200 m³ of mine water are pumped to the surface with underground pumps. From the approx. 500 m long cross measure drift between Pit XII and Pit 2, an approx. 8 km long cross measure drift to the former Nordstern and further to the Mathias Stinne mine is open and accessible.

<u>The Pits</u>

Pit 1/2/8
Only the foundations of the Malakow towers remain of the old pit dating back to 1847, which, however, have been built over by the present headgear. Only the urban-development situation with the two pits, their closeness to the former Cologne-Minden railway and the access from the former mine community Katernberg document the beginning of the pit.
The headframe of Pit 1 (1956-1958) and the headgear of Pit 2 (erected in 1950 at the Friedlicher Nachbar mine and relocated at Zollverein Pit 2 in 1965) are landmarks of the mine´s history. Both structures were designed by Fritz Schupp. The appurtenant tub roundabout was also architecturally designed by Schupp.
The winding engine building is a brick hall with a barrel-shaped roof dating from 1903 with an extension (by Schupp) which was added in 1958. The former machine hall built in 1903 is a brick double hall with round-arched windows. The main store dating from 1922 has a reinforced concrete framework with external brick walls and a low-pitch gable roof.

The wash house is a brick hall with a barrel-shaped roof and surrounded by lower two-storey buildings. It stills hands down to us the organisational form of a wash house for 3000 miners.

At the entry to the pit, there is a line of three buildings which complete the ensemble. The administrative building is a large, prestigious brick building dating from 1906, followed by the director´s villa built in 1898 and the mine officials´ residence built in 1878. For the smooth operation of the mine, it was necessary that the responsible mine officials lived and worked directly next to the pit.

Pit 3/7/10

The headgear of Pit 10, as a 33 m high German strut frame structure, is a landmark which is visible from far away. In 1913, it was built by the Gutehoffnungshütte steel works. Only few of the other buildings have been conserved. The machine and transformer building (1913/1920) is a three-aisle brick hall over a pedestal-type storey and has low-pitch gable roofs. The machine hall was built in 1913 and modified in 1917 and 1952 for operational reasons. The gatekeeper´s house (1950) and the bicycle shed (1955) characterise the entrance area of a large pit. Both are single-storey brick buildings with low-pitch hipped roofs.

Pit 4/11

The distinctive headgears of the pit have been demolished.
Of the foundation phase of the pit in the early 1890s, only the machine hall of Pit 4, a forge and a machine hall which was built before 1914 are still in existence. The extension phase of the 1920s is documented by the pithead building of Pit 11 and the appurtenant winding engine house of 1926/27. It was built according to a design by Fritz Schupp. In 1955, a workshop building was taken into operation which had been designed by Fritz Schupp in the graphic language of Pit XII.

Pit 6/9

Parts of the pit wall, the access road from Gelsenkirchener Strasse and a plane-tree alley dating back to the initial period of the pit have been preserved.

Pit XII

The central hoisting unit built in 1932 has been completely preserved apart from a few elements and is almost unchanged. Until his death in 1974, Fritz Schupp could decisively influence repairs and modifications of the industrial halls made of steel frames and non-bearing frame-type facades.
The building axis running parallel to the tracks of the mine railway station is defined by the central energy-supply plants of the mine. The control station in the south and the compressed-air station in the north form the two poles of this axis. The compressed-air station consists of the boiler house and the upstream compressor houses. The stack in the axis of symmetry behind the boiler house was one the essential reference points of the entity. In 1979, it was demolished for safety reasons.
The two hauling-engine houses are to the north and south of the headgear. The one to the south has an annex where a transformer was installed in 1958.

At right angels, the group of buildings of the tub roundabout intersects the tracks of the mine railway station. The cubic buildings are raised on supports to allow passage of the waggons. They are designed for well-defined functional areas and ensure circular movement of the tubs in the interior. On the northern side, the buildings of the screening plant (tipper hall/picking belt hall), the electrostatic precipitator and the refuse bin are annexed. The belt conveyor bridge establishes a functional connection between the refuse bin and the picking belt hall, as well as the coal washing plant.
In 1958, the shift from tub extraction to skip extraction at the pit made large parts of the tub roundabout unnecessary. But in turn, an additional belt bridge and a connecting building had to be built. In connection with this, the facade

on the right of the pithead building was closed because the appearance of the "court of honour" was impaired by the new buildings.

The belt bridge for the raw coal connects the tub roundabout and the washing plant. It is arranged at 90✍ and joins the coal washing plant at a height of 40 m in a corner tower.
As a compact building block, the coal washing plant is clearly arranged. In north-south direction it divides the axis of symmetry in the centre. The building with its length of approx. 90 m is divided into three sections. For coal storage bins, the buildings consist of concrete structures on the north side and in the lower section. The only remarkable change to the set of buildings which was not supervised by Fritz Schupp is on the roof: the roof superstructure with claddings of sectional plate from 1982 provided space to new, big dedusting plants. The washing plant is connected with the coking coal storage bins by a belt bridge. In 1958, when the Zollverein central coking plant was built, a belt conveyor bridge was built from the base of the storage bin to the blending tower of the coking plant.

The Zollverein pits are visible surface landmarks of the industrial work of the mine. Pits 1 and 2 are industrially evolved, technological and architectural units which stand as an example for hard-coal mines in the Ruhr Area. After it was opened, Pit XII was considered to be the model plant of the mining industry. With the fundamental concept of industrial streamlining, the ensemble focusses on an essential motivation of action of the industry in a globally unique manner.

With their headgears and mine gates, the pits are social places and landmarks of outstanding value. Compressors, hoisting engines and steam boilers are interconnected examples of paramount significance in terms of the history of technology within the ensemble of the cultural industrial landscape of the Zollverein Mine.
In particular the architectural design of Pit XII is one of the globally most important witnesses of the history of architecture.

As determining elements of the landscape, the Zollverein pits are of outstanding universal value in terms of cultural history.

The Coking Plants

The coking plants at the Zollverein mines have been demolished.

The Zollverein central coking plant
Since its closure in 1993, the coking plant has been completely conserved. Over a distance of approx. 1 km parallel to the former Cologne-Minden railway line, there are the oven chambers with their technical equipment. The route of the coking coal from the blending tower to the charging tower has been preserved in all detail. The ovens with their pusher machines, the coke quenching station, the screening plant and the loading station are all fully preserved.

The complete gas treatment unit with all pipelines and technical equipment, on the scale of one of the largest European coking plants, is still in existence as the so-called "White Side".
The pre-cooling/pre-cleaning units, tar production unit, phenol production unit, ammonia factory, sulphuric-acid wet catalysis, fine gas cleaning unit all document a complete coking plant.

All ancillary buildings, ranging from the administrative building to the compressed-air generating plant, the workshops and the laboratory complete the picture of the fully conserved large-scale plant.

In a globally unique manner, the central coking plant illustrates the almost perfect large-scale processing of the raw material coal. Technological, industrial and architectural functions are united in a globally unique set of buildings which is an essential element of the cultural industrial landscape of Zollverein.

The Railways

The former Cologne-Minden railway line is now part of the railway line network of the German railway company Bahn AG. It is used for long-distance rail traffic, the urban railway and freight transportation. The connection is one the most important east-west line through the Ruhr Area and has a high traffic load.

Road traffic is separated from the tracks by means of underpasses and overpasses. When this traffic separation concept was translated into practice in the 50s and 60s the mining subsidences could be used to advantage. The former Katernberg South railway station has been replaced by an urban-railway station.

The former Bergisch-Märkische railway line is used by the Bahn AG for freight transportation.

The mine railways

The railway connection from the former Cologne-Minden railway line via Pit 1, Pit 2 to the Rhine-Herne Canal has been preserved. Three signal boxes and two level crossings and 10 bridges are part of it. The railway line from Pit 1 via Pit 2 to the Bonifacius Mine with 4 bridges has been preserved without the tracks and is to be converted into a bicycle path.

As far as the train stations of the pits and the coking plant are concerned, only some tracks have been preserved in some sectors of the Zollverein XII Mine.

The railway was an essential pre-condition for the development of industry. Zollverein with its decision in favour of the location for the establishment of the mine in 1847 on the grounds of the line arrangement of the former Cologne-Minden railway line is an ideal example of this fundamental connection.

According to industrial requirements, the railway lines intersect the landscape. They link the industries and separate the housing estate areas. This essential characteristic of cultural industrial landscapes is still readily visible as an example at Zollverein.
The railway is a decisive structural feature of the cultural industrial landscape of Zollverein.

The Pit Heaps and the Mining Subsidences

The heaps
The oldest heap of Zollverein in the west of Pit 1 has been preserved. The acacias planted at the end of the 19^{th} century are overaged. When in 1992 the heap burned, small parts of the southern slope had to be removed.

The pit heap west of Pit XII has been preserved without any changes in its form which evolved on the basis of the industrial pond management for boiler house ash and coal sludge. Since approx. 1970, the cultivation of the area has been tolerated and, to a lesser extent, been promoted by planting trees. The area is now a project with respect to the careful development of the ecological, aesthetic and industrial-history potential within the framework of the International Building Exhibition IBA Emscher Park.

At Pit 3, the eastern slope of the heap has been preserved and, with the adjacent subsidence area of Beisen, forms a landscape of hills shaped by industry.

The heap at Pit 4 is now a big table mountain. It is used as a local recreational area, and hiking trails have been established. The adjacent trotting-race course operates a training course on the heap.

The mining subsidences
The mining subsidences are most obvious if buildings on them are inclined. When coal was mined a subsidence trough develops above the mining field. At the edges of the trough, the surface is inclined towards the trough centre and causes the inclination of buildings.
On both sides of Schlägelstrasse, there are colony houses. In the central area, the street and the houses built there are inclined towards the south.
Because of intensive mining around Pit 3, the surface level in the district of Beisen has sunk by markedly more than 20 m. In Kraspothstrasse and Auf der Reihe, the older houses have an extreme inclination. The inclination of Kraspothstrasse towards the east, seen from Pit 3, marks the edge of a subsidence trough around Pit 3/7/10.

The gravitational flow conditions
The Emschergenossenschaft operates three pumping stations to drain the polder areas caused by industry.

The "Essen-Schonnebeck" pumping station built in 1977 drains a catchment area of 294.061 acres with 4 pumps. The water is discharged through the small river "Katernberger Bach" to the Schwarzbach which flows into the Emscher river.

"Essen-Beisen" drains 432.443 acres with 5 pumps. The pumping station was also built in 1977. The maximum pump output is 5300 l/s and is conveyed with a pressure line to the pumping station "Gelsenkirchen-Zollvereingraben" 500 m further north.

The "Gelsenkirchen-Zollvereingraben" pumping station was completed in 1968 for a catchment area of 850.058 acres. The planning was based on the consequences of the mining of the Pit Zollverein 4/11 which, however, was closed down in 1967. The current catchment area is 328.656 acres. A pressure line is used for drainage into the Schwarzbach.

The buildings of the pumping stations are standardised functional buildings. On a deep concrete trough for pipes and pumps, there is a small protective building with a flat roof.
At the Essen-Schonnebeck pumping station, a 500 m long section of a developed bricklined drainage canal has been preserved. It documents the mine´s activities relating to the control of the gravitational flow into receiving waters before the establishment of the Emscher Association.

The changes in the level of the surface have modified the character of the cultural industrial landscape. The pit heaps are artificial, industrial mountains. In addition, subsidences formed which are nothing but small industrial valleys. In some areas, the landscape would be uninhabitable without artificial drainage.
As the oldest pit heap of the Ruhr Area, the heap next to Pit 1 deserves special attention. The subsidences in the quarter of Katernberg-Beisen are among the most extreme in the mining district.
The topographic changes illustrate in an extreme manner the industrial deformation of the landscape which has become almost uninhabitable. They are essential components of the cultural industrial landscape of the Zollverein Mine.

The Miners´ Housing and Housing Estate Development

1st construction phase from 1847 to 1918
In the area of the former Hegemannshof colony, the houses in Meerbruchstrasse, the eastern side of Bolsterbaum, Schalker Strasse, Termeerhöfe, parts of Viktoriastrasse, and Zollvereinstrasse have been preserved and are, as a rule, in their almost original state but badly in need of repair.
The same applies to the preserved colony houses of Ottekampshof in Drokamp, Nienhauser Busch and part of Josef Oertgen Weg.

The colony houses in Röckenstrasse and Kraspothstrasse next to Pit 3 were redeveloped in 1995 according to the principles of the protection of monuments.

Estate 3 in Schlägelstrasse, Eisenstrasse and Ückendorfer Strasse has been conserved with its original appearance.

The Theobaldstrasse and Stiftsdamenwaldstrasse estates were redeveloped, while losing only some facade elements.

Within in the framework of large-scale redevelopment measures in the 50s and 60s, the western part of the Hegemannshof colony was demolished and replaced with multi-storey blocks of flats. The same happened to the core area of the Ottekampshof colony.

Development of the centre of Katernberg
Along Katernberger Strasse and in the area of the catholic church, almost all residential and commercial buildings are still in existence. The facades of the upper floors have been largely preserved with their decorative details. The appearance of the rooms used for business purposes has been strongly changed.
The marketplace with its characteristic adjacent buildings of the post office, the protestant church and the former town hall has been preserved with its appearance as land which was donated to the community by the mine.
The network of streets with its pre-industrial determination is still completely visible. Only the underpassage of Katernberger Straße under the former Cologne-Minden railway line next to the train station Katernberg South is a major modification.

2nd construction phase from 1918 to 1945
The houses which were built in the period between the wars west of Viktoriastrasse, also called Distelbeckshof, have been conserved. Only at few places, have facades and details been lost because of redevelopment after privatisation.

3rd construction phase from 1945 to 1986
The Glück-Auf estate west of Distelbeckshof was built by the miners themselves by means of organised neighbourly assistance. From the beginning, the houses had been private property. They have been preserved, but, to some extent, they have been strongly modified according to the taste and financial means of the estate´s inhabitants.

The Pestalozzi villages
In Pestalozzistrasse and Neuhof, single-storey houses with red, low-pitch tile roofs were built in the 50s.
Both estates have been conserved in all detail. The architects´ urban-development concept still creates a special atmosphere of almost village-like security.

Construction of multi-storey houses
In order to satisfy the demand for housing on limited space, the housing associations built housing estate complexes with multi-storey blocks of flats. The tenants did not have any gardens, instead the blocks were erected in green areas which were supposed to convey an atmosphere of living in the country. The estate at Kapitelacker has been preserved in its original form. It is badly in

need of repair.
The Kaldekirche estate west of Pit XII has gained professional recognition because of the decorative character of its clinker brick facades. It has been conserved and is in need of repair.
In Westernbruch, the facades of the blocks of flats with their clinker brickwork and the quiet design of details have remarkable qualities.
The estate at Kapitelacker, which does not have any outstanding features, is badly in need of repair.
The ECA housing estate has been privatised and has changed its original appearance.
The estates consisting of blocks of flats in the former Hegemannshof, Ottekampshof and Beisen colonies are still in their original state.

In the area of the Zollverein Mine, an historical, 140- year period of miners´ housing is uniquely visible. The changing social living conditions are significantly documented by the housing situation of people. This illustrates the diversity of aspects of ordinary life as opposed to occupational life. The housing estates in the area of the Zollverein mining field are monuments of outstanding universal value in terms of social and cultural history. The completeness of the evolved ensemble of the miners´ housing estates of Zollverein causes these to rank among the internationally outstanding monuments and is a central element of the cultural industrial landscape of the Zollverein mine.

The Mine Consumer Facilities and Welfare Centre

The consumer facilities

Consumer facility 4 was built in 1900 in Josef Oertgen Weg. In the three-storey brick building at the corner of Katernberger Strasse, the consumer facility was initially on the left side. Having been destroyed in the war, the house was rebuilt in 1948. From that time, the consumer facility used the entire basement.
Nowadays, the rooms are used by a carpet company as a sales warehouse. The appearance of the building has been preserved in all detail.

Consumer facility 6 is a two-storey building with a symmetrical facade design. The facade is plastered, and the window and door apertures are bordered with red clinkers.
The rooms of the consumer facility are now used by an electrical appliances store.

The mine welfare centres

Today, the former welfare centre 1 in Viktoriastrasse is used for similar purposes. Medical and law group practices are located here. When the building complex was modified under private initiative for the new use the appearance and details were preserved in an exemplary manner.

The buildings of the mine welfare centre 2 in Karl-Meyer-Strasse are being used as accommodation for asylum seekers. The two-storey brick building of 1953 has been largely conserved but it is currently in a bad state of conservation.

The Zollverein Mine influenced the local community life directly and indirectly. The consumer facility and the mine welfare centres are special historic examples of this, all in all, much more complex history. As examples of the intervention of industry in community life with the intention to promote a well-run and mine-friendly municipality, the mine welfare services and the consumer facility are particularly clear examples of the industrial promotion of communal life and, therefore, of central importance to the cultural industrial landscape of the Zollverein mine.

e. Policies and programmes related to the presentation and promotion of the property

Pit XII has a ten years tradition of guided tours. It started with only one tour a month, organised by former miners. Today more than 25 000 people are guided on the "Track of Coal" from the shaft to the washery. This "Museum Zollverein" has become a well known institution. (Stiftung Zollverein, Gelsenkirchener Straße 181,45309 Essen)

Former Miners started nine years ago a non profit organisation to preseve and collect a "Zollverein Archiv". Today more than 4000 Fotos, 4500 Drawings and a 100m² room full of historical papers are forming an outstanding archive of Zollverein. (Zeche Zollverein e.V., Verein zur Förderung der Geschichte des Bergwerks, Gelsenkirchener Straße 181, 45309 Essen)

The cokery is preserved and opened for the public. In 1999 a lot of events, performances and a big exibition about the story of energy have been big attractions. More than 200 000 visitors walked inside the formerly "forbidden city". In addition to this, guided tours are offered. (Stiftung Industriedenkmalpflege und Geschichtskultur, Emscherallee 111, 44369 Dortmund).

The industrial landscape , spreading out over the 13 km² large mining field can be discovered by a guided bicycle tour. Tours are offered since 1999 and a broschüre is giving detailed information concerning the history of the places. Following the very successful start with 30 guided tours in two month, the tours will be organised professionally next year. (Verkehrsverein Kulturlandschaft Zollverein, Lauenbüschken 22, 45141 Essen).

4 Management

a. Ownership

Landesentwicklungsgesellschaft Nordrhein Westfalen
Roßstrasse 120
40476 Düsseldorf

Ruhrkohle AG
Rellinghauser Strasse 1-11

45128 Essen

Kommunalverband Ruhrgebiet KVR
Kronprinzenstrasse 35
45128 Essen

VEBA Immobilien
Gladbecker Strasse 431
45329 Essen

b. Legal status

After the termination of mining at the Zollverein colliery, the borders of the mining field, which are deemed to be the essential definition of the cultural landscape, are of no more legal relevance. The greater portion of the former mining field is situated in the area of the city of Essen and belongs to the Düsseldorf administrative district of the Federal Land. Town district VI with the three suburbs Katernberg, Stoppenberg and Schonnebeck form the main portion of the area.
The corner in the North-East of the mining field belongs to the city of Gelsenkirchen.

c. Protective measures and means of implementing them

Constitution of the Federal Land of North Rhine-Westphalia
Article 18
28th June, 1950

Law Governing the Protection and Conservation of Monuments in the Federal Land of North Rhine-Westphalia, Law on the Protection of Monuments
11th March, 1980

Law Governing the Consideration of the Protection of Monuments in Federal Legislation
1st June, 1980

See annex, no. 14

d. Agency/agencies with management authority

Ministerium für Arbeit, Soziales und Stadtentwicklung,
Kultur und Sport des Landes Nordrhein-Westfalen
Breite Strasse 31
40213 Düsseldorf

Regierungspräsidium Düsseldorf
Cäcilienallee 2
40474 Düsseldorf

Stadt Essen
Rathaus
45127 Essen

e. Level at which management is excercised and name and address of responsible person for contact purposes

Stiftung Industriedenkmalpflege und Geschichtskultur
Hans Kania
Emscherallee 111
44369 Dortmund

Stiftung Zollverein
Gelsenkirchener Straße 181
45309 Essen

f. Agreed plans related to property

To protect and preserve the cultural industrial landscape of the Zollverein mine, a "National Park of Industrial Culture" is to be established. In regard to this a plan is prepared to protect the complete area of all former industrial sites of Zollverein. This would also include a special form of protection of the complete industrial landsape.

g. Sources and levels of finance

More than 100 million Deutschmarks have been invested only to restore Pit XII. This was possible only because the combination of the most diverse promotional programmes of the Federal Land and of the European Union was successful and because, in this process, the bodies engaged in the promotion of economic development discovered their interest in a location for culture, cultural management and tourism for the future.

h. Sources and expertise and training in conservation and management techniques

In the last ten years authorities and management got experienced in protecting the large scale industrial heritage of Zollverein.
In the area of the cultural industrial landscape of the Zollverein mine, important, characteristic areas have been conserved for the future.

Pit 1/2/8
The oldest pit of Zollverein has been largely preserved. The headframe of Pit 1

and the headgear of Pit 2 will continue to represent as landmarks the beginning of mining operations of the Zollverein mine. The buildings existing at the time of the closure are being used for new purposes and will be conserved.
The former administrative building of the mine at the entrance to Pit 1/2/8 has been renovated. The building is used by the "Asien Stiftung" foundation.

Pit 3/7/10
The headgear of Pit 10 was renovated in 1998. The machine houses and the gatekeeper´s house have been modernised for new purposes since the closure and have been renovated on a large scale.

Pit 4/11
The buildings of the former pit have been developed as a start-up centre for new businesses after the closure of Zollverein. The old administrative building was completely modernised. The start-up centre is expanding, and further buildings are being prepared.

Pit XII
Pit XII is a listed monument and will be conserved completely and largely in its original state as an industrial monument of outstanding universal value on the basis of a monument-related concept of rehabilitation and re-use.

Since 1990, a large-scale rehabilitation programme has been performed to preserve the outer appearance of the ensemble. So far, rehabilitation costs have amounted to approx. 90 million DM. The steel frame facades of all buildings were badly dilapidated. They have been secured for the future, and in most halls thermal insulation has been added to allow re-use.
In the tub roundabout, where a monument trail along the route of the coal is being prepared, the facade will be preserved in its original state. Here, the monument is to remain unchanged as a central exhibit of a historic presentation.
The interrelationship of buildings and machinery in the design of the architects, which was developed jointly with the engineers, is a central reference point of the ensemble of Zollverein XII. Within the framework of a multi-stage concept for the rehabilitation and re-use of the monument, this interrelationship has been observed. With the exception of the former workshop 2 (hall 6), at least one important technical plant of importance has been conserved in each hall.
In this context, the stoker´s station in the boiler room, as well as the tipper hall in the tub roundabout, the jigging machine hall in the preparation plant, and the switch room of the control station are the four most important rooms where the machines and building form an especially close interrelationship. When the boiler house was renovated the room of the stoker´s station was largely preserved. The design of the interior of the boiler house was developed by the architectural office Sir Norman Foster and Partners. The remaining mentioned interiors were also preserved after renovation. In the tub roundabout, no measures whatsoever will be taken which would change the appearance of the rooms. The industrial work with tubs, machines and plants will remain completely legible and will be intentionally presented to the public as an exhibit within the framework of the monument trail.

In 1998, the renovation and re-use of the buildings, with the exception of the washing plant and the coking coal tower, will be completed.
The re-use is based on the three foci art, design and industrial history.

With the maximum participation of former workers of the Zollverein mine, the history is intensively managed. This includes maintaining the buildings of the tub roundabout and the preparation plant, the processing of the mine archive with 120m of files, photos and drawings. Furthermore, exhibitions and books are being developed, and guided tours of the industrial monument are offered (approx. 20,000 visitors per year).

Zollverein central coking plant
The inclusion of the coke oven battery with the appurtenant technical facilities in the foundation for the protection of industrial monuments "Stiftung für Industriedenkmalpflege und Industriekultur" prevented the demolition of the large industrial plant. This was the first step necessary for the conservation of the coking plant. The foundation has the task of preventing the dilapidation of the structures, protecting the coking plant from destruction and of finding a new use in line with the protection of monuments.
At present, a large exhibition about the history of energy, called "Sun, Moon and Stars" at the coking plant is being prepared for 1999. This also includes a large restoration programme for the coke oven battery, storage bins and belt conveyor bridges. With the ambition to attract 200,000 visitors to the coking plant in 1999, the exhibition is creating awareness for the coking plant. This is intended to create general support of its future conservation.

The pit heaps
The landscape of pit heaps in their industrially evolved form is largely protected for the future within the framework of the cultural industrial landscape of Zollverein.
The concept for the treatment of residual industrial sites which was developed within the framework of the International Building Exhibition IBA Emscherpark may be deemed to be exemplary for conservation in the sense of the Nomination.
The former pit heap, with pond management, between Pit XII and the coking plant will be conserved in its topographical form. The nature developing on it should develop without any interference. Because of the special, unique location, a new ecological area has evolved which will be preserved and protected as industrial nature.

The heap of the former pit Zollverein 4/11 has been opened as a recreational area for the general public.

Housing estate colony Röckenstrasse/Kraspothstrasse
The colony houses were renovated by the owner VEBA Wohnen AG in 1994. Within the meaning of the Nomination, this measure may be considered to be a good example of the conservation of an important detail of the cultural industrial landscape.

The mine welfare centre 1
Under private initiative, the building complex has been renovated according to

appreciable aspects in compliance with the principles of the protection of monuments. The new use is ideally matched to the old function. The good state of conservation may be designated as exemplary private commitment.

i. Visitor facilities and statistics

See Annex, no. 13 (Tourismuskarte).
Since ten years the number of visitors has steadily been growing; in 1999 more than 350.000 people visited the industrial landscape Zollverein.

j. Property management plan and statement of objectives

On 31st December, 1986, Pit XII of Zollverein was shut down. From then on, no coal was extracted from a mine within the communal district of Essen.

In accordance with Essen local government policy, most of the buildings which deserve protection as monuments should be torn down to provide "land unobstructed by monuments“ for the establishment of commercial enterprises.

Being aware of the conflict with the conservation of monuments, the property fund of the Federal Land of North Rhine-Westphalia then took over the Pit XII premises within a few days. Thus, some time had temporarily been gained.

The property fund was now responsible for developing the land. An expert commission appointed by the fund was asked to develop proposals for the utilisation of the premises and, at the same time, to determine the cost of conservation.

After two years, the objective was defined: A forum for the industrial culture of the 20th century was to be created. History, culture, art, and design are to reanimate Pit XII. The individual building sections of the Pit are to be prepared only then when the new use has been specified.

In analogy to the great cathedrals, a "Craftsmen´s Guild“ under the responsibility of the City of Essen and the Regional Development Company was established to demonstrate that conservation, repair and preparation for new purposes, as well as future maintenance are permanent tasks.

With the exception of the coal washing plant, all buildings and production facilities at Pit XII have now found new purposes: The rehearsal stage of the Aalto Theatre, the meeting centre of the town district, the design centre of North Rhine-Westphalia, offices for design-oriented companies, a private art gallery, an exhibition hall for sculptures, the workshops of a qualification centre for the long-term unemployed, the production centre for media art, a large cultural-gastronomy facility, the rooms of the Craftmen´s Guild itself and a coal-fired heating station at the location of a former cooling tower form the new set of buildings at Zollverein XII.

A museum trail is being built where the route of the coal from the pit through the various processing plants can be followed.

With respect to the immense coal washing plant, it has been planned to move the design department of the Comprehensive College/University of Essen to the location of Zollverein.

From the beginning, the development and building activities at Zollverein were accompanied by great public interest. Very soon, events of very different types and even major congresses were organised at Zollverein, although the conditions there were "as on a construction site“.

Persons engaged in all cultural sectors, ranging from the visual arts to dancing, discovered this great stage, created impressive installations and lasting works of art. One of the first to come to Zollverein was Ulriech Rückriem with his contribution to the 1992 Documenta.

The great appeal of Pit XII is probably one of the reasons why even the adjacent pits and the coking plant are undergoing a development which has its roots in the industrial culture-related past. Pit 3/7/10 will be a citizens´ and artisans´ park. The headgear, the winding engine hall, the control station, as well as the two gate houses and the unmistakable position on an elevation will be preserved.

Pit 4/11 has just begun to serve as a start-up centre for young companies which are provided with rooms in the buildings of the former pit facilities.

Unfortunately, Pit 6/9 was demolished at a very early stage so that only the access road in the form of a plane-tree alley and the pit wall mark the former colliery location. There, immediately adjacent to the centre of the Stoppenberg town district, a new housing estate is being built, in the ground plan of which we can still at least read the past.

Pit 1/2, in the immediate vicinity of Pit XII, has just been bought by the property fund of the Federal Land of North Rhine-Westphalia to launch new developments undisturbedly. The prospects here are that culture, commercial enterprises and design-oriented companies will grow into this location in the course of time. For this development, the surface buildings including the headgears are being kept in readiness by the property fund.

See annex, no. 11 (Industriedenkmal Zollverein. Die neue Nutzung).

k. Staffing levels

Stiftung Industriedenkmalpflege und Geschichtskultur: professional: 10; technical: 5; maintenance: 30

Stiftung Zollverein: professional: 3; , technical: 5; maintenance: 20; volunteers: 10

Verkehrsverein Kulturlandschaft Zollverein: volunteers: 20

5 Factors affecting the Property

a. Developement Pressures

Within the meaning of Document WHC/2 of UNESCO, the evolved ensemble of the Zollverein Mine is at risk of losing its cultural significance, although the conservation of Pit XII and the coking plant, which required major efforts, has been crowned with success. The changes in the industrial conurbation are proceeding at high speed after structural change. For example, the demolition of the railway engine shed of the mine railway has been approved to improve access to the large industrial monument Pit XII. Or the housing associations are planning to private their houses which, usually, leads to large-scale, uncontrollable changes as a result of modernisation.
The landscape outside the former mine premises is at risk of losing its significance in terms of cultural history because of uncontrolled modernisation.

b. Environmental Pressures

No risk.

c. Natural disasters and preparedness

No risk.

d. Visitor/tourism pressures

No problems.

e. Number of inhabitants within property, buffer zone

50.000

f. Other

Nothing to indicate.

6 Monitoring

a. Key indicators for measuring state of conservation

The protection plans will be realised at the end of the year 2000, see 4 f. The complete restoration of Pit XII, including the coal washery, will be finished 2001.

b. Administrative arrangements for monitoring property

A permanent commission of experts in the field of preserving the industrial and architectural heritage will be appointed in 2000 by the Ministerium für Arbeit, Soziales und Stadtentwicklung, Kultur und Sport for monitoring the property Zollverein.

b. Results of previous reporting exercises

The preservation of big monuments inside the industrial landscape Zollverein was part of the International Building Exhibition Emscher Park. The IBA Emscher Park didn´t make masterplans and preferred a wide communication to prepare decisions. The preservation of large scale monuments as Zollverein XII and the cokery Zollverein is a result of the concept "work in progress".

7 Documentation

a. Photographs, slides and video

See annex, no 7, 8, 9; 10.

b. Copies of property management plans and extracts of other plans relevant to the property

See annex, no. 11.

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Manuscript Bochum 1999

d. Address where inventory, records and archives are held

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45309 Essen

8 Signature on behalf of the State Party

Essen, im Oktober 1999

Hans Kania
(Stiftung Industriedenkmalpflege
und Geschichtskultur)

10 Annex: Table of Contents

1. Map, Detail: Ruhr District
2. Map: Steinkohlenbergwerks Zollverein
3. Map: Zeche Zollverein
4. Map: Zeche Zollverein - Betriebsbedingte Veränderungen der Eroberfläche
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10. Publikation: "Die Zeche Zollverein"
11. Publikation "Die neue Nutzung" (management plan)
12. Publikation: "Die Halde Zollverein"
13. Map: Tourismuskarte
14. Publikation: Denkmalschutz und Denkmalpflege: Gesetz, Organisation, Verfahren, S. 53 - 63 (Text of the laws concerned)

The "Zeche Zollverein" Landscape of Monuments - A Coal Mine as Part of the World Cultural Heritage?!

Michael Ganzelewski / Rainer Slotta

commissioned by
IBA International Building Exhibition Emscher Park
in connection with TICCIH

Bochum
1999

The address and application for inclusion of the "Zeche Zollverein" Landscape of Monuments in UNESCO's world cultural inheritance list were published in 1999[1]. The attention of the specialists in this sector has once again recently been drawn to the special significance of this coal-mining installation[2].

The present report has been prepared by Bochum's German Mining Museum at the request of the IBA International Building Exhibition Emscher Park, Gelsenkirchen. It demonstrates that the "Zeche Zollverein" Landscape of Monuments is ranked on a worldwide scale and should be considered as one of the outstanding cultural achievements of humanity. This report is further justification of the application for inclusion of the "Zeche Zollverein" Landscape of Monuments in UNESCO's world cultural inheritance list.

Michael Ganzelewski / Rainer Slotta

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[2] Mainzer, Udo: Eine Architekturleistung von Weltrang: Zeche Zollverein XII in Essen, in: Die Denkmalpflege 57, 1999, No. 1, p. 28 - 35.

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The "Zeche Zollverein" Landscape of Monuments - A Coal Mine as Part of our World Cultural Heritage?!

The "Zeche Zollverein" Landscape of Monuments -
A Coal Mine as Part of the World Cultural Heritage?!

Introduction

The Ruhr created an important part of history for both Europe and humanity. Although mining once formed the basis of earlier industrial societies, this chapter of industrial society will have become history by the end of the millennium.

The economic and social advancement of our time has only made initial attempts at comprehending the cultural significance of the most recent of our industrial history.

The Ruhr, the largest settlement area created and shaped by man in Europe, is located on an extensive deposit of glance coal: the Ruhr owes its very emergence and development to this fact. The northern districts of the city of Essen, i.e. Stoppenberg and Katernberg, grew up with the Zollverein mines in the middle of the previous century. In 1932 their shafts were concentrated on a single hauling pit, shaft 12. This was the background for the emergence of what was at the time the world's largest coal-mining installation as an outstanding technical, constructional and organisational achievement of the German glance-coal mining industry.

Today shaft 12 is the most important structural and technical monument of modern large-scale glance-coal mining. The production equipment and surrounding buildings remain by and large unscathed and have been adapted to accommodate a wide range of new cultural activities. In the region around shaft 12 the urban and rural landscape still bear the traces of the complex 150-year history of mining and its various settlements in the form of further pits, works railways, worker housing or pit tips. This unique landscape of monuments is not only essential if we are to comprehend the monument "Zollverein Shaft 12" but also acts as a paradigm to elucidate the conditions of life and the environment existing today in the Ruhr - representing every coal-mining district.

It is therefore a justified concern to preserve this unique landscape of monuments created by man for the generations to come but nevertheless to bring it into line with the economic and social requirements of the future.

1. Glance Coal (Hard Coal) - A Special Material for Man

Of the minerals available as raw materials in the world, coal, and glance coal (Hard coal) in particular, assumes special importance in a number of regards. On the one hand, it is its formation which distinguishes glance coal from most other raw materials in mineral form, and on the other hand, its significance as a raw material and fossil fuel which has allowed glance coal to become important to man.

Glance coal was extracted by man over 2000 years ago. In the 19th century coal (in particular glance coal) became the key fuel for the production of iron and steel, thus representing a basic prerequisite for the industrial revolution in Europe and the rest of the world. Even today coal mining clearly leaves its stamp on the cultural and economic development of entire regions and countries as was previously the case in Europe: their "development" is lastly influenced by the existence of coal deposits.

However, glance coal is not just a fuel but also provides a number of valuable key substances such as coke oven gas, crude tar and crude benzol for upgrading at the coking plant. It was not just at times of crisis that the processes for coal upgrading, gasification and liquefaction assumed prime importance; glance coal was investigated in extensive research. Still a strategic material, glance coal is now in fierce competition with hydrocarbons, nuclear power and increasingly, alternative sources of energy as well. Although its importance for metal smelting still remains, it has meanwhile declined where the chemicals industry is concerned. With the exception of Europe there has been an increase in the production of glance coal in all coal regions of the world; today coal only takes second place to mineral oil for worldwide consumption of primary energy. In the power generation sector it is still in first place ahead of mineral oil.

1.1 Formation of Glance Coal

The formation of coal in the earth's crust has been taking place for around 400 million years. Coal is a combustible organogenic rock which is created from deposits of enormous quantities of vegetable substance. They are the usable fossil-based product of a fundamental process which also played a major role in the development of life on earth: photosynthesis.

Coal occurs as layers in numerous sedimentation basins on the earth. The formation of glance coal depended on the occurrence of certain climate conditions for a prolific growth of vegetation and the necessity of the dead vegetable matter in areas of subsidence being protected from decay by the exclusion of oxygen. These conditions frequently occurred on peat moors at flat coastal regions (paralic formation) and less often in basins in continental regions (limnic formation) when the vegetation died off and slipped below the water surface due to subsidence. The continued alternation between subsidence and cessation of subsidence allowed the glance coal forest to repeatedly grow up and die off again. The washing-in of clastic sediments resulted in the formation of coal series in some cases several thousand metres in depth.

Coal formation per se, i.e. carbonisation, involves a complicated process which starts with a biochemical phase. Peat and soft brown coal forms from the vegetable material. As the cover increases, the layers of coal are compressed with ever greater force; during the geochemical carbonisation phase this produces glance brown coal, glance coal and anthracite in conjunction with subsidence at lower levels and at increased pressure and temperature. In the case of glance coal the carbonisation process ranges from highly gassy glance coal to increasingly low-gas types from bright-burning and gas-flame coal through gas, fat and forge coal to lean coal and ultimately anthracite.

In economic terms two key characteristics are important for coal: the energy content (thermal value) and the cokability.

The **energy content** (kJ/kg) increases with the degree of carbonisation as volatile constituents (water and gas) are replaced by solid carbons. Glance coal has a much higher energy content than brown coal. Irrespective of the degree of carbonisation raw coal is contaminated by varying levels on non-combustible mineral substances which bring about a proportionate reduction in usable energy.

Power station or boiler coal is evaluated for the heat and power generating industry according to its energy content and includes both glance and brown coal.

Coke is used for the reduction process and power generation during the extraction of pig iron at the blast furnace. Fat coal is particularly suitable for coking while other types of coal can be used as blending components. High-quality coking and boiler coals sold on the international market offer moisture and ash contents under 10% and sulphur levels under 1%.

1.2 Mining of Glance Coal

The possible scope and type of mining activities depends on the existing geology, i.e. glance coal can only be extracted where provided for by the geology. The geological conditions decide whether and where mining can be carried out and whether a raw material such as glance coal can be extracted. Here it is not only the mere existence of the raw material which permits mining but also the geological conditions which may vary on a regional basis, and even within the deposit itself. If glance coal is present in the subsurface, it can be extracted using mining methods if there is a favourable disposition of the mass. This generally results in a regional proliferation of mining operations working the coal deposits where permitted by the economic and technical conditions. The mining of glance coal often started with the help of relatively simple equipment at the place where the coal seams appeared at the surface. As the coal was mined, the working level sank further and further (underground working), resulting in the progressive development of the techniques necessary for the extraction and transportation of the coal and rock. The deeper the works went, the greater the technical requirements became on the transport systems and the safety infrastructure to cope with the rock thrust, presence of water and ventilation at ever increasing temperatures. Today the technical limit on extraction is 1,500 m.

Depending on the deposit conditions glance coal can either be extracted by underground working (below ground) or open cut mining (above ground).

With open cut mining the coal seam is exposed by removing the covering layers and then extracted in a second work stage. When calculating the economic efficiency of this process a number of factors are significant, such as the consistency of the rock, the drainage and the stability of the embankments, the ratio of excavated material to coal and many other elements. For open cut coal mining the absolute deepness limit is approx. 600 m. Open cut coal can generally be extracted at much lower hauling costs than for underground working as the costly pits with their subsidiary facilities used in underground mining are not required. High investment costs for hauling equipment do not have a major impact due to high hauling capacities. In addition the productivity per man and shift is considerably higher than for underground working.

As open cut mining also offers a better utilisation of reserves, greater flexibility in adapting to fluctuations in demand and higher levels of safety, there is a worldwide trend towards open cut mining at the expense of underground working.

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2. The "Zeche Zollverein" Landscape of Monuments - The Mine

2.1 History of Zeche Zollverein

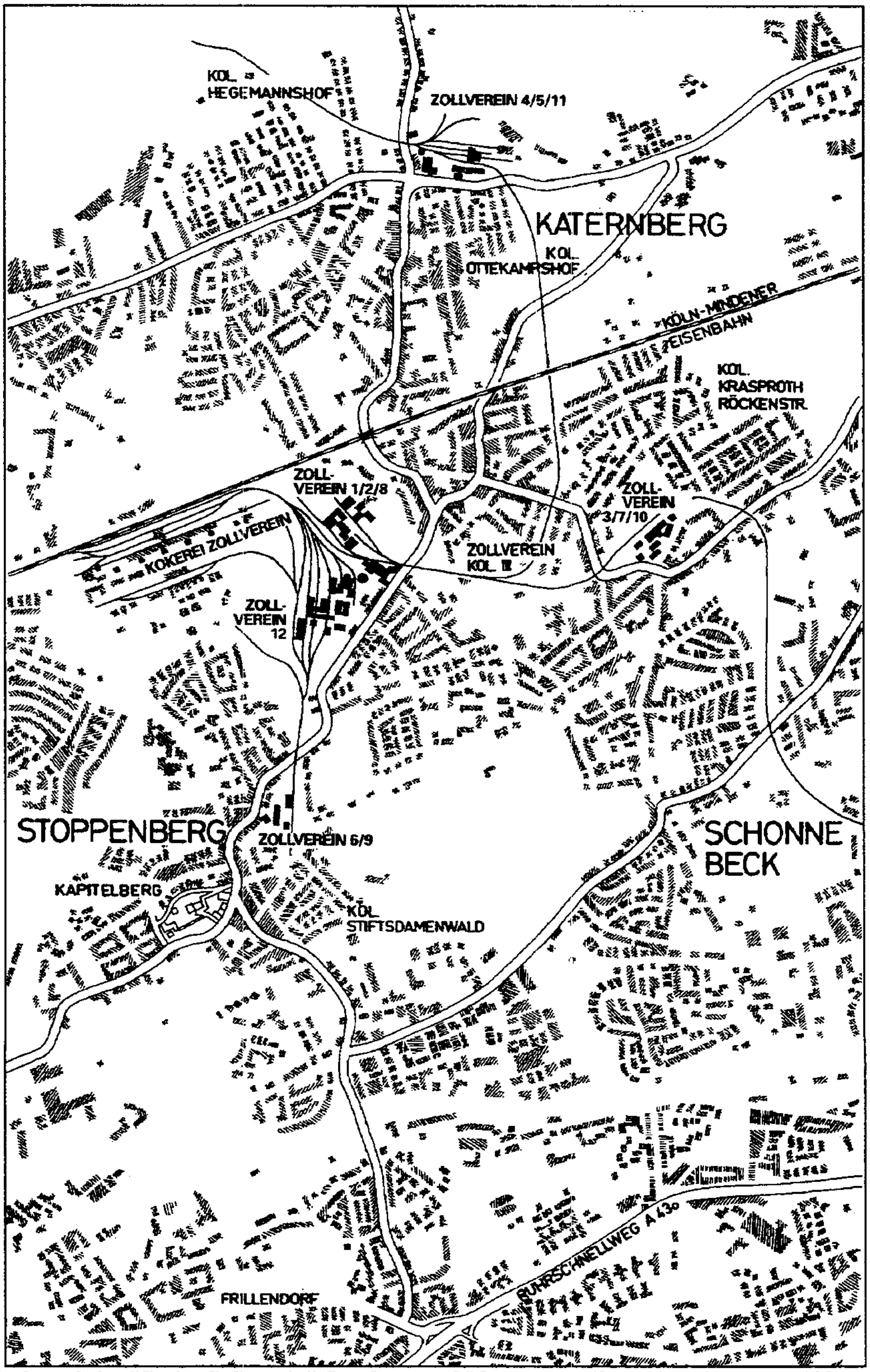
Essen's glance coal mine Zeche Zollverein ranked as one of the most important mines in the Ruhr Mining District at all stages of its development and history. Alone the technology and architecture of the foundation installation constructed between 1848 and 1852 was outstanding for Ruhr mining of the time. The construction and development of the fully preserved central shaft Zollverein 12 in the years between 1928 - 1930 represented a remarkable achievement on a worldwide scale including its exceptional architecture. The expansion phase of the mine after the Second World War with the coking plant built between 1958 and 1961 finally demonstrated the high level reached by the German mining industry in the post-war period before the structural crisis already emerging in 1959 brought about the decline which continues to the present day.

Soon after Franz Haniel used the mines Franz and Kronprinz in the northwest of Essen in 1834 and 1837 to prove that shafts could be sunk in the thick layer of marl above the carbon using the technical equipment available at the time, the search for the "black gold" started up around 1840 in the boroughs to the northeast of Essen, making Franz Haniel here into a key figure of mining history.

On 20 June 1840 Franz Haniel founded a drilling company with friends, acquaintances and his children and applied for concessions for fields in the boroughs of Schonnebeck, Stoppenberg, Katernberg, Rotthausen and Altenessen. In 1845 he discovered a seam at a depth of approx. 120 m which was then given the name "Zollverein". In January 1847 all applications for mining concessions were consolidated, and in the same year Haniel bought up the shares of the drilling company, kept 76 shares of the 128-share mining company for himself and divided up the remainder between his children. This meant that the "Zollverein Project" had became a purely family business, and remained so until 1920.

The motives behind the commitment shown by Haniel was clearly to secure a supply of coal for his iron-producing and metalworking companies in Oberhausen. As early as 1845 he expressed his idea for a smelting mine in a letter addressed to Mining Officer von Beust: "For ourselves likewise, the expansion of our ironworks creates a strong need to have our own coal fields, as is the case with almost all major ironworks in Belgium and England, which is why I have been engaged for some time, now after many geognostic findings have been obtained for coal, with a good likelihood of success in the vicinity of the Cologne/Minden railway in Essen, in preparations for a new enterprise by means of drilling, and was delighted to discover a rich seam."

The starting point for the shaft was positioned with regard to the sale of coal as close as possible to the railway line and at the same time, at a location where it was hoped to reach the bottom of the Stoppenberger Mulde with the shaft. In 1851 Franz Haniel, who had meanwhile attained the age of 72, handed over management of the mine to his eldest son Hugo Haniel (1810 - 1893), who had also played an outstanding role in the development of the Rheinpreußen mine. In 1858 the fields were consolidated to a size of 13.8 km^2. This meant that Zeche Zollverein was about the same size as the neighbouring Cölner-Bergwerks-Verein with 16.6 km^2 or Anna, which at 14.9 km^2 was once the largest pit of the Aachen Mining District.



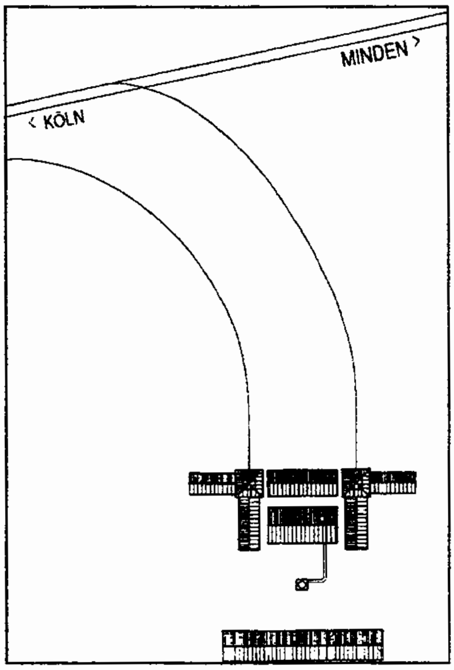
General plan of the "Zeche Zollverein" Landscape of Monuments (from: Buschmann (1998), p. 416, Fig. 433).
Köln-Mindener Eisenbahn = Cologne/Minden railway; Kokerei Zollverein = coking plant; Ruhrschnellweg = Ruhr expressway

The new mine in the northeast of Essen was named after the German customs and trading union (*Zollverein*) which was created in 1834 under Prussian hegemony and was constantly expanded in the following decades. Given the political circumstances of the time with the tendencies just emerging in the failed revolution of 1848/1849 towards the founding a German nation-state, the adoption of this name demonstrated the hopes of the progressive bourgeoisie for economic and political unity.

Construction history of foundation installations

In 1847 work started on the driving of shaft 1; the Malakow tower was erected and a steam engine put in place. The installation was completed by two boilers and the "*Zechenhaus*" or pit house. The work had to be stopped in 1848 due a strong influx of water. Construction of the shaft was then delayed by the political unrest of the revolution occurring in March 1848. And even after the installation of a second steam engine in May 1848, work could not be resumed until the beginning of 1849. In November of this year the shaft reached the glance coal ground at a depth of 114 m. The open cut installation was completed in 1849 by the addition of a forge, engineering shop and joiner's workshop.

In derogation from the previous plans, apparently due to the strong influx of water, the decision was then taken to create a second shaft, which was to be solely used for drainage purposes. shaft 2 was sunk at a distance of 50 metres from shaft 1; by February 1850 a second Malakow tower had been built complete with a 12 hp steam engine. The glance coal ground was already reached in December 1850 and extraction started in 1851. Following the installation of two more steam engines the extraction of glance coal could start as scheduled in 1852.



General plan of the Zollverein pits 1 / 2 with both Malakow towers (from: Buschmann (1998), p. 419, Fig. 435).
Köln = Cologne

Architecture and technology of foundation installations

The foundation installations, which have completely disappeared today, consisted of the two striking Malakow towers of identical architectural design which were positioned on the nearby Cologne/Minden railway line. Archive pictures show how the coal tubs left the towers at ground level so that they could be drawn to pitmouth level. The two hoisting engines were housed in two wings set at an angle to the tower of shaft 1; the first boiler house with initially two boilers (in 1847) and later on four (in 1849) was added to one of the hoisting engine houses. The fireplace also stood there later on.

The Malakow tower above shaft 2 was also provided with side and rear wings; initially a double-action 12 hp steam engine was installed here during sinking of the shaft. In 1852 the shaft was equipped with its final drainage machine as well as a hoisting engine in the side wing. Double-level mine cages each with two tubs side by side were used for hauling.

The elongated pit house with offices was located between the two towers. The coe was integrated in the side wing of shaft 2 which was partly occupied by the hoisting engine. A second boiler house with five boilers and an axially positioned fireplace was built in 1854 parallel to the pit house at the rear.

The pit Zollverein 1 / 2 was not only an early Malakow installation but also the first double-tower installation. The experience gained here was not only useful in the subsequent Haniel mines in Oberhausen (1854 - 1857) and Rheinpreußen (concept 1857) but also for similar installations during this development stage.

In the years following the start of extraction in 1851 it took another three years until both shafts were sunk to the second floor (= 202 m). In 1855 Zollverein only mined 91,651 tonnes of coal but managed to step up output to over 400,000 tonnes (1880) in the following two decades and thus had one of the highest capacities in the Ruhr. When three charcoal kilns were taken into service for the production of coke in 1857, Haniel was getting nearer to his original objectives and was able to supply Zollverein coke to the GHH ironworks Gute Hoffnung Eisenhütte, which was built in Oberhausen on the Cologne/Minden railway around the same time and had completed its first blast furnace in 1855.

However, very high levels of coke production were not probably reached until the 1870s. After the first battery of 30 chamber ovens was installed in 1866, another 60 were added in 1869. Both shafts were then extended to the third floor (= 265 m) (1870/1871) while shaft 2 was equipped with a new hoisting engine once the engine of shaft 1 had already been replaced in 1866. The construction of a coal washing station (1874) brought about a significant improvement in the quality of the coal and coke.

Expansion phase between 1880 and 1914

The construction of three new double-shaft pits during the years which followed resulted in major changes in the conditions at Zeche Zollverein. This phase of expansion started in 1880 with the sinking of shaft 3 and ended towards 1914 with the completion of the new administrative building located on the access road to pit 1 / 2. Pit 3 / 7, 4 / 5 and 6 / 9 were built according to the technical designs of an engineer named Dreyer. In 1900 he was replaced by an architect called

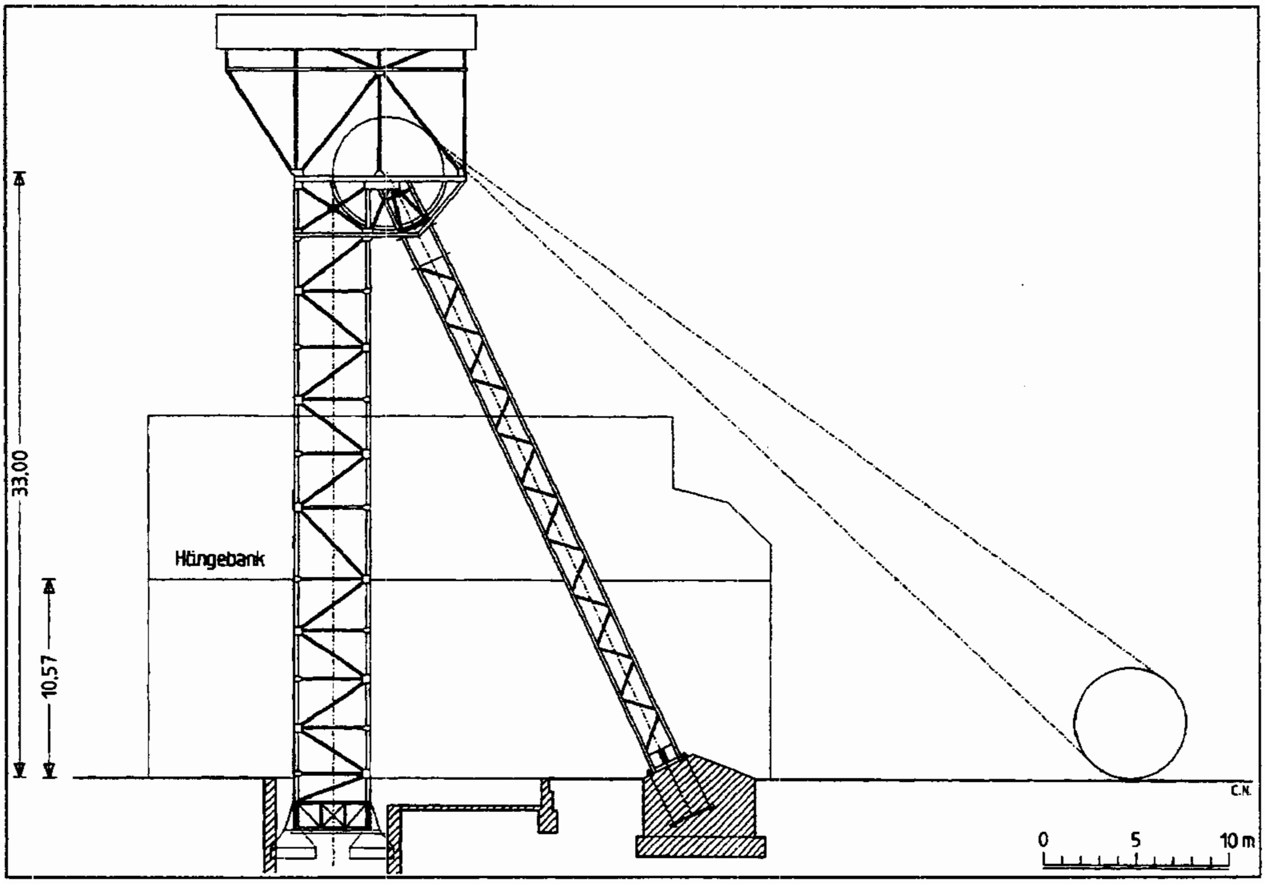
Stolze, who played an important role in planning the conversion of pit 1 / 2 involved in this phase of development.

The building activities were sparked off by extension of the underworkings. The construction of a new external pit at some distance from the foundation shafts was intended to improve the ventilation conditions and reduce the hauling distances. Initially designed as a single-shaft pit and then sunk to the third floor between 1880 and 1882 (extended to the 6th and 7th floor in 1890) shaft 3 was to be extended to form a double-shaft pit with shaft 7 built between 1897 and 1899 due to the problematic ventilation conditions below ground. To take advantage of the favourable economic conditions emerging at the beginning of the 1890's the decision was taken in 1891 to build another pit in the northern part of the field, which was planned as a double-shaft pit with ventilation and hauling shaft from the outset. Shaft 4 was sunk to the 4th floor between 1891 and 1894 while shaft 5 was built from 1894 to 1896 (to the third floor) and was used solely for ventilation.

From 1895 shafts 6 and 9 were then constructed as the fourth pit in the southwest of the field. Initially this pit was planned as a subsidiary facility with a cableway connecting it to shafts 1 / 2 and without its own processing station and coking plant. Shaft 6 was sunk to the third floor between 1895 and 1897 and then equipped with a remarkable double strut frame in 1896. To improve the ventilation conditions the ventilation shaft 9 was added to shaft 6; shaft 9 had been in operation to the third floor from 1903 to 1905. With the extension of shafts 6 / 9 to form an independent hauling system it was not until 1914 that shaft 9 was provided with a hoist frame and a steam hoisting engine manufactured one year previously.

The years between 1899 and 1906 were characterised by the replacement and extension of the foundation pit. As the external pits apparently did not fulfil the expectations regarding an improvement in ventilation of the old underworkings either, shaft 8 was sunk between 1899 and 1902 with a connection to the two fans located at shaft 2 in a localised/functional link with shafts 1 and 2. Shaft 8 was not provided with its own hoist frame. The processing equipment was replaced: in 1901/1902 a fat coal washing station was built and a gas-flame coal washing station added in 1904. However, the most extensive construction project involved shaft 1 with demolition of the Malakow tower in 1903 and the installation of a hoist frame including a shaft house, screening and loading station, hoisting engine house and a new steam hoisting engine. At the same time construction took place of the machine house with a steam turbine, compressor and fan which replaced the old Guibal fan of shaft 2. In 1906/1907 this was followed by the construction of a new coe for 3000 miners and the administrative building. At the same time the coking plant was extended and a by-product station taken into service.

In the last few years before the First World War the new main shaft 10 was added to pit 3 / 7: the decision to build this shaft had already been taken in 1907. Once shaft 3 had been extended to the 12th floor (= 659 m) in 1908/1909, shaft 10 was brought to the same depth between 1911 and 1914 and equipped with a hoist frame, hoisting engine, screening and loading station. A large coking plant with 120 ovens, by-product station and central gas engine station was constructed to the north of pit 3 / 7 / 10. Following completion of shaft 3 the output of Zeche Zollverein increased sharply from approx. 400,000 tonnes in 1880 to 663,803 tonnes in 1885: Zeche Zollverein took the leading position in the mining district. In 1890 it extracted over 1 million tonnes of coal for the first time and managed to boost its output to 1.8 million tonnes before the First World War (in 1910). At the time the output of Zeche Zollverein was only surpassed in the Rhineland by the mines Zeche Gewerkschaft Deutscher Kaiser in Duisburg, which had been the Ruhr's largest mine since 1901, and Rheinpreußen in Moers. With its four pits Zollverein was one of the largest and most productive mines in the district.



Zeche Zollverein, pit 10, hoist frame: panel tipping for application for building permit, 1913 (from: Buschmann (1998), p. 442, Fig. 457)
Hängebank = Pitmouth

Junction lines

With the construction and extension of the four pits Zeche Zollverein now encompassed the three boroughs of Katernberg, Stoppenberg and Schonnebeck above ground as well: the pits were served by a network of pit railways. A junction line was already constructed between pits 1 / 2 and 3 in 1879/1880; this was replaced in 1898 with the construction of shafts 7 and 10 and equipped with two new bridges in 1912. A pit railway was also built in 1891 to serve shafts 1 / 2 also directly linked to pit 4 / 5 in the north. Pit 6 / 9 located in the southwest was initially only connected to the foundation shafts via a cableway and was equipped with a siding track in 1913/14. The mine's railway network was completed after the First World War by the addition of tracks serving Hafen Nordstern on the Rhine/Herne Canal (1924 to 1926) and a junction line between the mines Bonifacius and Zollverein (1934).

Workers' housing
The tremendous expansion taking place at Zeche Zollverein could also be seen in the development of staffing levels and outputs. Production at the mine rose from approx. 1 million tonnes in 1890 to approx. 2.3 million tonnes in 1913; over the same period the workforce increased from around 2000 to 6526 people. Housing had already been built before the expansion phase to provide accommodation for the miners; this building activity was vigorously stepped up around 1900. By 1914 greenland had been used to build 543 houses for miners and office workers, six sales centres operated by the mine and a central goods warehouse. The largest colonies were Hegemannshof, Otkampshof and Kolonie III created at the same time as shaft 3. Plans by the engineer Herr Dreyer and the architect Herr Stolze from the mine's design office were also used for the workers' housing.

Interest group Zollverein - Phoenix
If the close link of a mine the size of Zeche Zollverein with the Haniel family had been an anachronism in previous years, the circumstances prevailing after 1918 urgently called for a change in ownership. The trend towards socialisation aimed at the mining industry occurring in the early period of the Weimar Republic prompted the family to search for a suitable partner in a different industrial sector; the obvious step was a link with a company in the steel industry who used coal as its basic form of energy. As the company Phoenix AG had been looking for a mine for mining and smelting operations at the same time and its attempts to extend its own coal supplies had remained fruitless, it was logical for Zeche Zollverein and Phoenix to link up. Zollverein was interested in this proposition as it was hoping to escape from imminent socialisation of a "pure" coal mine in a mixed organisation but in fact surrendered its independence with this step. It was taken over entirely by Phoenix, albeit subject to the obligation to operate, equip and maintain the mine in a proper manner.

Apart from shaft 10 which had been taken into service just before the outbreak of war, Zeche Zollverein was in need of modernisation due to the intensive usage during the war and a failure to carry out repairs and replacement: this particularly applied to the processing station as well as the steam, compressed air and power generation equipment, and also the installations of shaft 4 / 5 which were in particular need of replacement. From 1922 shaft 11 had been sunk as a new main shaft and completed to the 5th floor in 1926. The associated above-ground installations such as the hoist frame, shaft house, screening and loading station and the hoisting engine house with two steam hoisting engines were not provided until 1927; extraction followed in 1928. In 1927/1928 the pit was equipped with a large administrative and coe building.

At the same time as the installation of shaft 11, the hauling plant at shaft 2, which dated back to the foundation period, was also provided with new buildings. The Malakow tower was demolished and equipped with a two-level strut frame with a hoisting engine house between 1922 and 1924. Shaft 8 was also provided with a small-scale hoist frame for inspection work and repairs in 1926. The key importance of the foundation pit was reinforced by the construction of a main magazine.

During the Phoenix era a second hoisting engine for shaft 10 was also procured for pit 3 / 7 / 10, and the above-ground installations were improved by the addition of new workshops and virtual complete replacement of the coe.

Central pit 12

With the founding of Vereinigte Stahlwerke AG in 1926, Europe's largest mining complex in the 1920s, the mining entrepreneurs of Zollverein took advantage of their right to exchange Zollverein shares into Phoenix stocks: Phoenix and likewise Zollverein thus became part of Vereinigte Stahlwerke AG. Within Vereinigte Stahlwerke AG Zeche Zollverein then belonged to the group Bergwerksgruppe Gelsenkirchen, which was managed by Friedrich Wilhelm Schulze Buxloh. Albert Vögler acted as chairman of the board of Vereinigte Stahlwerke AG.

The rationalisation programmes developed for Vereinigte Stahlwerke AG called for closure of the small unprofitable pits and to concentrate extraction and processing on the small number of mines with high outputs. In the case of Zeche Zollverein the processing and compressed air generation installations were examined to start with; it was concluded that partial replacement would involve high costs without providing an optimum result. Although shaft 11 was just about to be completed, it was decided to construct an entirely new pit, shaft 12, at a new location. This decision was based on the realisation that it would only be possible to create a functional mine in the long term through radical rationalisation and the discarding of unprofitable parts of the business. This was the background to the concept drawn up for central pit 12, which was designed for the enormous output of 12,000 tonnes per day including processing at this level. The generation of compressed air, power distribution and the workshops were also to be concentrated at the central pit.

The well-known industrial architects of the time Fritz Schupp and Martin Kremmer were commissioned with construction of this installation. Both of them had already been responsible for the planning of mines, including the Phoenix mines under the management of Schulze Buxloh. The pit Zollverein 12 built between 1928 and 1932 represented a highlight in the architectural designs of Schupp and Kremmer and was named after Albert Vögler, the Client's chairman of the board. With the commissioning of shaft 12 Zeche Zollverein once again became the most productive mine in the Ruhr (1932 and from 1934 to 1949). In 1935 the output in tonnes with 6,057 miners exceeded the 3 million mark for the first time while a maximum extraction level of 3,588 million tonnes of glance coal was achieved in 1937.

Expansion of Zeche Zollverein after the Second World War

After Zeche Zollverein still managed to produce an impressive 868,937 tonnes of coal with a workforce of 5,046 in 1945, its output rose once again to 2,275 million tonnes by 1950. In 1955 output had increased to 2.6 million tonnes with a workforce of 8,074. By the end of the 1950's the Zollverein mine had become one of the Ruhr's largest building sites in the post-war era. A major factor was the aim to increase the production of coke at the mine and to improve the output of shaft 12 by changing over from frame to skip winding. This was the only way to maintain the productivity of the plant with an increasing waste percentage. To enable the expansion of pit 12 shaft 1 first underwent modernisation between 1956 to 1958 to relieve shaft 12. It was extended from the 6th to the 12th floor and was provided with a new hoist frame including a shaft house and tub circulation. Conversion at the shaft Zollverein 12 was carried out in 1957/1958. At the same time work started on construction of the Zollverein coking plant, thus implementing by 1960/1961 a project which dated back to the original period of central pit 12. The final large-scale building project was the installation of a new winding tower complete with shaft house and tub circulation at shaft 2 between 1964 and 1966: in 1966 shaft 2 was deepened to the 14th floor (= 1005 m) and by 1972 shafts 10 and 12 had also been brought down to this depth.

Although the plan was to operate the mine well into the 21st century, the rationalisation programme of Ruhrkohle AG resulted in the shutdown of the Zollverein mine on 23 January 1986. The coking plant remained in operation until June 1993: this date witnessed the cessation of all production activities at the Zollverein mine in Essen - apart from the pumping of the drainage system at shaft 12.

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2.1.1 Historical Dates

1842-46	Submission of applications for concessions for 13 fields
1845	Seam discovered by businessman Conrad Engels and named "Zollverein"
1847	18 February, applications for concessions consolidated: Nonnenwerth Godesberg (first of all Prinz von Preußen), Hermanus, Stolzenfels, Industrie, Rolandseck, Borussia, Zollverein, Drachenfels, Rheinstein, Germania, Rheinland und Heinrich zu Zollverein, and founding of mining company (main shareholder Franz Haniel), start of sinking operations for shaft 1 (500 m to west of Katernberg): sinking with hammer and wedge
1848	Sinking work interrupted at 26 m due to water. December: resumed following commissioning of a drainage steam engine
1849	Carbon found at 114 m
1850	Shaft 1: setting of a ventilating course = 148 m (-99 m, later on 1st floor new) and 1st floor = 170 m (-120 m), start of sinking work for shaft 2 (next to shaft 1), applications for concessions for fields Germania, Germania Nos. 2 and 3
1851	Shaft 1: start of extraction, shaft 2 used as a drainage shaft, railway connection, applications for concessions for fields Germania Nos. 4 to 6, 24 June: granting of concessions for fields Germania, Germania Nos. 2 and 3, 13152 t, 256 staff (ST) (the mine virtually always operated at a profit right from the start)
1852	7 January, granting of concessions for fields Germania Nos. 4 to 6

1853	Extension of shaft 1, 16 August and 29 September: granting of concessions for Zollverein fields (Heinrich, Rheinland, Hermanus, Godesberg, Rolandseck, Industrie (including Überschaar, granted 1855) and Drachenfels)
1854	Shaft 1: setting of 2nd floor = 202 m (- 152 m)
1855	Ventilation shaft 2 to 2nd floor, 412470 Prussian tonnes (PrT) (91651 t), 498 ST
1857	Shaft 1: commissioning of Fahrkunst to 2nd floor, commissioning of coking plant
1858	11 April, granting of concession for field Borussia, 12 July and 9/22 February 1859: consolidation of all fields into Zollverein = 13.2 km^2, 760 ST
1860	622846 PrT (138396 t), 720 ST
1865	873019 PrT (193984 t), 804 ST
1866	24 October, accident at staple pit (4 dead)
1870	Extension of shaft 2, 236647 t, 983 ST
1871	Ventilation shaft 2: setting of 3rd floor = 265 m (-216 m), shaft 1 to 3rd floor
1875	303035 t, 1365 ST
1878	Introduction of man-riding, shaft 1: Fahrkunst extended
1880	Sinking of shaft 3 started (1200 m to east of pit 1 / 2), 408453 t, 1237 ST
1881	Shaft 3: carbon at 117 m, intersection with 1st floor = 146 m (- 89 m) and 2nd floor 173 m (- 116 m, driven from pit 1 / 2)
1882	Shaft 3: start of extraction and setting of 3rd floor = 200 m (- 143 m, = 2nd floor of pit 1 / 2)
1883	Shaft 3: setting of 4th floor = 274 m (- 217 m) and 5th floor = 301 m (- 244 m)
1884	Extension of shaft 1
1885	Shaft 1: setting of 4th floor = 330 m (- 280 m), 663803 t, 1790 ST
1886	Pit 1 / 2: commissioning of briquetting plant: subsequently only in production for a few months, exchange of fields with Königin Elisabeth: acquisition of northern part of Längenfeld Wilhelmsthal and surrender of another part of field (0.34 km^2), concession size: 13.8 km^2
1888	Closure and demolition of briquetting plant as gas fine coal produced unsuitable for briquetting, 879887 t, 1987 ST, output 1.48 t/MS (1888 - 1901, 1932, 1934 - 1938 and 1945: largest mine in Ruhr Mining District)
1890	Extension of shaft 3 and setting of 6th floor = 326 m (- 269 m = 4th floor of pit 1 / 2) and 7th floor = 351 m (- 294 m); 1,048162 t, 2488 ST
1891	Extension of ventilation shaft 2 to 4th floor, sinking of shaft 4 started in northeast field (Katernberg, Karstraße)
1892	Carbon found in shaft 4 at 129 m
1893	Pit 1 / 2: extension of shaft 1 and setting of 5th floor = 395 m (- 345 m); shaft 4: setting of 1st floor = north ventilating course = 172 m (- 122 m), 2nd floor = south ventilating course = 199 m (- 149 m), 3rd floor = 253 m (- 202 m) and start of extraction, intersection of 2nd floor with pit 1 / 2
1894	Pit 1 / 2: shaft 1: setting of 6th floor = 476 m (- 426 m); shaft 4: setting of

	4th floor = 391 m (- 341 m), sinking of ventilation shaft 5 started (next to shaft 4)
1895	Pit 1 / 2: shaft 1: setting of 7th floor = 559 m (- 510 m); pit 4 / 5: ventilation shaft 5 finds carbon at 129 m, commissioning of coking plant 4 / 5; sinking of shaft 6 started (Stoppenberg, Hallostraße); 1,188195 t, 3085 ST
1896	Pit 4 / 5: ventilation shaft 5 to 3rd floor in operation; shaft 6: carbon = 109 m. Setting of 1st floor = 129 m (- 69 m) and 2nd floor = 225 m (- 166 m)
1897	Pit 1 / 2: sinking of ventilation shaft 8 started (next to shaft 1 / 2), but soon after cessation of sinking work; shaft 3: sinking of ventilation shaft 7 started (next to shaft 3); shaft 6: setting of 3rd floor = 267 m (- 208 m) and start of extraction, above-ground cableway from shaft 6 to pit 1 / 2
1899	Pit 1 / 2 / 8: resumption of sinking work in ventilation shaft 8, extension of shaft 2; pit 3 / 7: ventilation shaft 7 to depth of 493 m and only setting of 5th, 6th and 7th floor; pit 4 / 5: extension of ventilation shaft 5; sale of part of field to Victoria Mathias, 6 January: takeover of Längenfeld Zollverein 1 from Hagenback
1900	Pit 1 / 2 / 8: ventilation shaft 8 in operation to 4th floor, shaft 2 to 6th floor and changeover to intake shaft; pit 4 / 5: ventilation shaft 5 to 4th floor; 1,752946 t, 5355 ST
1901	Pit 4 / 5: ventilation shaft 5: setting of 5th floor = 495 m (- 445 m), extension of shaft 4 to 5th floor; extension of shaft 6
1902	Shaft 6: setting of 4th floor = 321 m (- 261 m)
1903	Pit 1 / 2 / 8: ventilation shaft 8 in operation to 5th floor; pit 3 / 7: extension of shaft 3 and setting of 8th floor = 377 m (- 320 m) and 9th floor = 413 m (- 356 m); pit 4 / 5: extension of shaft 4 and setting of 6th floor = 606 m (-556 m); June: sinking of ventilation shaft 9 (next to shaft 6) started
1904	Pit 1 / 2 / 8: ventilation shaft 8 to 6th floor (depth of 613 m): pit 3 / 7: shaft 3: setting of 10th floor = 471 m (- 414 m); pit 6 / 9: ventilation shaft 9 in operation to 1st floor
1905	Pit 6 / 9: ventilation shaft 9 to 3rd floor; 1,713313 t, 5768 ST
1906	Pit 3 / 7: extension of ventilation shaft 7
1907	Pit 3 / 7: ventilation shaft 7: setting of 11th floor = 541 m (- 484 m) and 12th floor = 611 m (- 554 m, depth of 659 m)
1908	Pit 3 / 7: extension of shaft 3
1909	Pit 3 / 7: shaft 3 to 12th floor (depth of 659 m)
1910	Pit 6 / 9: extension of ventilation shaft 9; 1,855453 t, 5700 ST
1911	Pit 3 / 7: sinking of main shaft 10 started (next to pit 3 / 7); pit 6 / 9: ventilation shaft 9: setting of 5th floor = 354 m (- 295 m)
1912	Pit 6 / 9: ventilation shaft 9: setting of 6th floor = 456 m (- 397 m) and 7th floor = 659 m (- 509 m)
1913	Pit 6 / 9: railway connection; 2,322689 t, 6526 ST
1914	Pit 3 / 7 /10: main shaft 10 to 12th floor and start of extraction, shaft 3 becomes ventilation shaft, commissioning of coking plant 3 / 7 / 10
1915	1,574884 t, 5024 ST
1916	Pit 6 / 9: upraising of shaft 6 from 7th floor
1918	Pit 6 / 9: shaft 6 to 7th floor (depth of 601 m)

1919	Pit 1 / 2 / 8: extension of shaft 2; 1 April mining explosion (3 dead)
1920	Pit 1 / 2 / 8: shaft 2 to 7th floor; 1,492866 t, 7014 ST
1921	Pit 1 / 2 / 8: shaft 2: sinking work stopped at 644 m
1922	Pit 4 / 5: upraising of new main shaft 11 from 5th floor (next to pit 4 / 5)
1925	Pit 3 / 7 / 10: shafts 3 and 7: setting of sump floor = 659 m (- 602 m); 2,078305 t, 8295 ST
1926	Pit 4 / 5 / 11: main shaft 11 between 1st and 5th floor completed
1927	Pit 4 / 5 / 11: main shaft 11 from surface to 1st floor breakable
1928	Pit 4 / 5 / 11: start of extraction in shaft 11, 13 April: shutdown of coking plant pit 4 / 5 / 11
1929	Pit 1 / 2 / 8: sinking of central main shaft 12 started (Albert Vögler; 200 m south of pit 1 / 2 / 8; pit 6 / 9: 1 March, extraction stopped, coal underground to pit 1 / 2 / 8
1930	Pit 1 / 2 / 8 / 12: shaft 12: carbon at 112 m; pit 3 / 7 / 10: 30 September, shutdown of coking plant; 2,568540 t, 7682 ST
1931	Pit 1 / 2 / 8 / 12: shaft 12 to depth of 640 m, only setting of 12th floor central main floor 605 m (- 555 m) and intersection with pit 1 / 2 / 8; intersection of pit 1 / 2 / 8 and pit 3 / 7 / 10 at 12th floor
1932	Pit 1 / 2 / 8 / 12: 1 February, start of extraction in central main shaft 12 and simultaneous cessation of extraction at pit 1 / 2 / 8, pit 3 / 7 / 10 and pit 4 / 5 / 11, coal underground to pit 12; pit 4 / 5 / 11: filling of ventilation shaft 5; pit 1 / 2 / 8 / 12: 6 February, coking plant shut down
1934	Pit 1 / 2 / 8 / 12: shafts 2 and 8 to 12th floor
1935	3,046390 t, 6057 ST
1936	Pit 1 / 2 / 8 / 12: February: coking plant started up again, pit 6 / 9: shaft 9: setting of 12th floor 613 m (- 554 m), concession size: 13.8 km^2
1937	Pit 4 / 11: shaft 11: setting of 6th floor = 606 m (- 556 m), pit 6/9: extension of shaft 6 to 12th floor, max. extraction: 3,588000 t, 6835 ST
1940	3,394200 t, 6624 ST
1941	Pit 6 / 9: 26 February, mining explosion (29 dead) and 4 November man-riding accident (3 dead)
1945	868937 t, 5046 ST
1946	Pits 1 / 2 / 8 / 12, 3 / 7 / 10, 4 / 11 and 6 / 9 using main gangway floor of 12th floor for extraction (= 610 m), concession size: 13.8 km^2
1950	2,275330 t, 7673 ST
1951	Pit 1 / 2 / 8 / 12: shaft 1: setting of 13th floor = 756 m (- 706 m)
1953	Pit 1 / 2 / 8 / 12: 14 November, closure of coking plant
1954	Pit 3 / 7 / 10: extension of shaft 10; pit 4 / 11: shaft 11: setting of 13th floor = 756 m (- 706 m)
1955	Pit 3 / 7 / 10: shaft 10: setting of 13th floor = 756 m (- 699 m); 2,628830 t, 8074 ST
1956	Pit 1 / 2 / 8 / 12: upraising of central main shaft 12 from 13th to 12th floor and extension
1957	Pit 1 / 2 / 8 / 12: upraising of central main shaft 12 from 13th floor = 756 m (- 706, 760 m F) in operation, construction of new coking plant at pit 1 / 2 / 8 / 12

1958	13th floor becomes main gangway floor
1960	2,129790 t, 6650 ST
1961	Pit 1 / 2 / 8 / 12: by end of year commissioning of central coking plant
1963	Closure of working field, pit 1 / 2 / 8 (pits 3 / 7 / 10 and 6 / 9), intersection of pit 1 / 2 / 8 / 12 with pit 4 / 11 on 13th floor
1964	Pit 1 / 2 / 8 / 12: extension of shaft 2 from 12th floor, pit 4 / 11: cessation of production and shutdown of above-ground working, coal underground to central main shaft 12
1965	Pit 1 / 2 / 8 / 12: shaft 2 to 13th floor and extension; 2,354300 t, 5354 ST
1966	Pit 1 / 2 / 8 / 12: shaft 2: setting of 14th floor = 1005 m (- 955 m) and start of exploration
1967	Pit 4 / 11: 30 June, closure, working field f. 6 / 9
1968	Pit 4 / 11: filling of shaft 4; 10 shafts in operation: pit 1 / 2 / 8 / 12, pit 3 / 7 / 10; pit 6 / 9 / 11
1969	Pit 1 / 2 / 8 / 12: extension of central main shaft 12
1970	1,963200 t, 3693 ST
1971	Pit 3 / 7 / 10: extension of shaft 10
1972	Shaft 10 and central main shaft 12 to 14th floor
1973	Intersection of 14th floor with 10th floor, pit Holland (in Bochum-Wattenscheid)
1974	15 January: takeover of Holland mine after cessation of extraction there (pits: Holland 4 / 6, Rheinelbe 4, Rheinelbe 5, Rheinelbe 6, Alma 5, Bonifacius 1 / 2, Bonifacius 5); total of 17 shafts; 14th floor becomes main gangway floor; working field Holland/Bonifacius: coal on 10th / 14th floor to central main shaft 12
1975	Filling of pits Zollverein 6, Rheinelbe 4, Rheinelbe 5, Rheinelbe 6, Bonifacius 2; available at pits: Zollverein 1 / 2 / 8 / 12, Zollverein 3 / 7 / 10, Zollverein 9, Zollverein 11, Holland 4 / 6, Alma 5, Bonifacius 1, Bonifacius 5; 3,027850 t, 5149 ST
1976	Holland 4 / 6: installation of central drainage system on 10th floor for former mining fields Katharina, Friedrich Joachim, Victoria Mathias, Friedrich Ernestine and Dahlbusch including the working fields Bonifacius and Holland still in operation. Filling of shaft Holland 6
1977	Working fields: Zollverein 6 / 9, Zollverein 3 / 7 / 10 and Holland, 3 / 7 / 10: exploration 15th floor = 1150 m (- 1100 m F) via a floor connection, extension of shaft 10
1978	Pit 3 / 7 / 10: shaft 10 to 15th floor = 1150 m (- 1093 m)
1979	30 November, closure of part of working field shaft 9 and eastern mining field of Holland after extraction of stocks, filling of shaft Alma 5
1980	Pit 1 / 2 / 8 / 12: shutdown of shaft 1; pit 3 / 7 / 10: shutdown of shafts 3 and 7; 2,133565 t, 3619 ST
1982	Intersection with Zeche Nordstern at - 955 m F/- 1000 mF with cross cut 4800 m long, filling of shaft 9, pits: Zollverein 2 / 8 / 12, Zollverein 10, Zollverein 11, Holland 4 / 6; shafts Bonifacius 1 and 5 shutdown; 2,263206 t, 3560 ST
1983	1 January, amalgamation to form mine Nordstern-Zollverein

1987	1 January, name Nordstern-Zollverein changed back, Zollverein closed down on 23 December 1986 (except central coking plant), above-ground installations of shaft 12 classified as a historical monument, filling of shaft 10 (hoist frame left standing), pit 2 / 12: installation of central drainage system
1988	Holland: 26 February, shutdown of central drainage system, April/May: filling of shafts Holland 4/6, followed by closure of shafts and underworkings no longer required
1991	Filling of shafts 1 and 11
1993	30 June, shutdown of central coking plant for pit 1 / 2 / 8 / 12

Bibliography:

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2.2 Description of Zeche Zollverein

2.2.1 Pit Zollverein 1 / 2 / 8

All that remains of the foundation installation is the municipal design with the two pits at a distance of 50 m which are parallel to the Cologne/Minden railway and form a line running from outside the mine gates along the approach road planted with trees including the administrative buildings and the director's house. The architectural design of the installation is dominated by the steel and steel framework buildings from the years between 1956 and 1964 and the brickwork buildings dating from the expansion phase between 1899 and 1906.

Hoist frame of shaft 1

The first hoist frame was built over shaft 1 in 1903 and replaced the Malakow tower dating from 1847. The first hoist frame became necessary as the shaft was deepened to the 13th floor (= 750 m). Today it extends to the 14th floor (= 1005 m).

The hoist frame over shaft 1 in existence today was built by Fritz Schupp between 1956 and 1958 as a single-strut frame designed as a plate girder structure for single extraction (type Dörnen 2). The height to the headwheel girders is 39.5 m and the two headwheels have a diameter of 5.5 m. The structure is mainly welded, with riveting in places; the guide frame was constructed without diagonal rods and its simple design is only relieved by the external stairs. The struts are reinforced with K-trusses (plate girder sections). This type of design and the harmonious variation of the plate girder sections are clearly based on the design of the hoist frame above pit Zollverein **12**. It is obvious that the design of the frame was not solely determined by the technical requirements but also the ideas of the architect.

Shaft house for shaft 1
The steel framework house resembling a tower was also built by Fritz Schupp between 1956 and 1958; it consists of a rectangular floor plan with a primary structure made of bolted and welded I-sections joined to form a frame. This was clad with steel framework walls including horizontal lengthways rectangular infill sections. The long sides are provided with high vertical windows, to the east they still have metal glazing bars.

Three of the original four shaft gates with their decking and offtake systems are still to be seen. The upper shaft gates include two platforms above the pitmouth, providing the miners with access to the four-level mine cages: each man-ride transported 64 to 68 men. At the pitmouth there was the hitcher, with the automatic decking system on the decking side and a hinged platform to secure the mine cages below pitmouth level.

Tub circulation at shaft 1
The tub circulation system built by Fritz Schupp between 1956 and 1958 consists of a steel structure mainly mounted on supports which was developed on the floor plan of an longitudinal rectangle from the shaft house. Located next to the shaft house and the narrow sides, the tub circulation system is designed as a closed structure with the supports including a structural framework as the primary structure and clad with steel framework facades. The west leg takes the form of an open rail bridge which leads to the junction bridge for shaft 12, with a right-angled bend in it, and is connected to the timber and materials stockyard via an angled endless chain transporter system. This transporter system was used to take the empty tubs arriving from the offtake side of the shaft to the stockyard. For the loaded tubs Schupp had provided an angled endless chain transporter system upstream of the north leg of the tub circulation system. The angled bridge was provided with an extensive glazed steel framework facade and ends in a structure with a triangular floor plan which, like the tub circulation system, is designed as a mounted closed rail bridge. All rail bridges are equipped with horizontal rows of windows. Under the west leg of the tub circulation system an apron extends from the bottom edge of the tub circulation system to ground level.

On the decking side two tracks lead to the shaft. They are each equipped with two braking systems arranged in series. On the offtake side the tub circulation system continues with a track. At the north leg of the tub circulation system the tracks of the junction bridge for shaft 12 merge with the tracks for the transport of material and run on a slope to pitmouth level via three angled endless chain transporter system. A control unit is positioned on the slope.

Hoisting engine house at shaft 1
The hoisting engine house built in 1903 and converted between 1956 and 1958 is a brickwork building with a basement floor and a barrel-shaped roof. Round-arch windows are positioned between wall projections; the basement floor features small windows with segmental arches. The wall projections, which are more massive at the corners, are designed as small corner towers which run above the eaves; round windows are positioned in the gable bays. The south annex was added in 1956/1957 according to plans by Fritz Schupp with an identical design.

The hall is spanned by segmental-arch steel trusses (strut framework) which are riveted together. The equipment includes a double bridge crane with a traveller made by J. Becker (1957) and the electric hoisting engine with a 2860 kW engine made by the Siemens-Schuckert-Werke which was installed in the same year.

Winding tower of shaft 2

The winding tower built by Fritz Schupp in 1950 and 1965 over the shaft extending to the 14th floor (= 1005 m) was the third headwheel support structure after the Malakow tower of 1850 and the hoist frame of 1923. The tower had been built in 1950 at the mine Friedlicher Nachbar in Bochum and was relocated to shaft Zollverein 2 in 1964. It consists of a steel framework tower with a flat roof and a rectangular floor plan, 51.56 m in height. Four massive corner trusses, which are stiffened by numerous diagonal struts, rise up from a substructure made of reinforced concrete. At the head of the tower this primary structure supports 3 platforms made of reinforced concrete: the machine platform, the machine cellar platform and the converter and guide pulley platform. The pitmouth is designed as another reinforced concrete platform. The tower head is made up of a welded steel frames which give the hoisting engine house the characteristic appearance of Fritz Schupp's architecture. An erection shaft with a somewhat weaker primary structure tower is attached to one narrow side of the tower over an entire infill section.

The tower is enveloped in a steel framework facade of uniform design which does not reflect the different function areas of the tower but with its dominant horizontal infill sections is oriented in terms of form to the downstream the tub circulation system. The hauling plant is lit by one row of vertical windows on each of the narrow sides and three rows on each of the long sides; these are interrupted in the vicinity of the machine platform by closed infill sections, which means that at least the head of the tower is perceived externally as an independent function area with the hoisting engine. The narrower infill section widths of the rows of windows correspond to the corner infill sections. The equipment found in the head of the tower includes the 2000 kW electric hoisting engine made by Siemens-Schuckert-Werke installed in 1950 with a drive wheel for bicable hauling which was brought into line with new requirements in 1966/1967. Above the hall there is a double bridge crane with a plate girder structure (made by Rheinstahl Union AG, carrying capacity 30000 kg / 7500 kg, 1950). A converter made by Siemens-Schuckert-Werke with a rating of 2140 kW is installed on the converter and guide pulley platform. At pitmouth level there are pit gates on 3 levels which are accessible from the pitmouth using two platforms.

Tub circulation at shaft 2

The tub circulation system built by Fritz Schupp in 1964 is located in a structure which runs between the winding tower and the tub circulation system of shaft 1 based on a U-shaped floor plan design. The two legs immediately adjacent to the tower consist of two-level structures with flat roofs; double-jointed frames clad with steel framework facades function as the primary structure. The south leg with its steel framework passes through the upper floor of the coe while the north leg is designed as a closed transport bridge consisting of a steel framework on steel supports. At the southeast corner the tub circulation system is joined by a closed crew gallery which ends in a staircase tower. All steel framework facades include horizontal infill section bays and horizontal rows of windows.

At pitmouth level two tracks lead to the pit on the decking side with braking and decking equipment; one branches off via points just before the shaft which it bypasses to the side and is equipped with a braking system level with the shaft. The two tracks leading out of the shaft and the side track then merge back into one on the offtake side. This track extends to the tub circulation system of shaft 1 in the south leg with an endless chain transporter.

Machine house

The machine house built in 1903 by the architect Herr Fuller is designed as a double brickwork structure featuring round-arch windows and barrel-shaped roofs and is symmetrically aligned with the axis of the hoisting engine house of shaft 1. On the south side the two halls are preceded by two narrow barrel roof-wings with a single-storey intermediate tract. The roofs of the halls include riveted steel girders with a strut framework, with the girders between the two halves of the halls resting on a row of supports. A transverse framework girder is positioned between the supports and the roof trusses.

The hall originally contained a steam turbine to generate power, a compressor and a fan while the switchgear was installed in the wing structures and the transformers in the single-storey intermediate tract. On completion of the shaft Zollverein 12 this equipment was no longer required and was therefore removed. In 1956 the south section was modified to accommodate a 5 kV system.

Fan building at shaft 8

The fan building constructed by the architect Stolze in 1917 takes the form of a single-storey brickwork structure with a slightly sloping gable roof. Wall projections bear a cornice resembling an architrave while the large rectangular windows are provided with metal glazing bars. The fan building is connected to the machine house via a narrow passageway.

The original fan with its diffuser installed to one side of the building is no longer present. Today's diffuser, which is made of sheet metal plates bolted together, extends above the roof of the building and was installed along with the axial electric fan in 1964.

Engine shed

The engine shed is also the work of the architect Stolze. The brickwork building constructed in 1921 includes a gable roof and a floor plan consisting of a circular segment. The facade facing the road has large upright rectangular windows with glazing bars while there are seven wooden gates on the side towards the pit. The roof rests on a wooden structure with wooden supports which trace the circular floor plan in two rows.

Main magazine

The main magazine with a storage area of 12,000 m^2 built by Stolze in 1922 was used to perform incoming goods checks and for the storage and issue of operating materials for all Zollverein installations. The reinforced-concrete framed structure is equipped with brickwork outside walls and a slightly sloping gable roof. The facades are broken up by discreet wall projections. The wall bays include triplet windows. A double-gate installation with a canopy can be found on the side facing the mine.

Coe

The coe built by Stolze in 1906 and renovated in 1964 is a brickwork building with a barrel-shaped roof which is surrounded on 3½ sides by lower two-level structures. The original segmental-arch windows combined in pairs by relieving arches have been converted today into rectangular formats. The hall gables were subdivided by a system of blind niches, each blind niche in the centre being designed as a round arch. The wall projections at the corners of the building are finished off with corner towers.

In the south part the hall spanned by steel girders forming a strut framework incorporates the hook-lined coe with washing facilities and WCs in the added lower-level building wings. In the north part of the building the wages room can be found in the basement and above the lamp room with access to the two shafts.

The building underwent modification in 1965 in conjunction with the building of shaft 2: the tub circulation system of shaft 2 was routed through the upper floor of the building and the previously mixed coe reorganised into a dirty/clean coe each with 966 hooks. At the same time there was a coe for the youngest miners with 200 hooks and a foremen's coe for 90 men.

Despite major changes the structure which remains still conveys the type of coe organisation used for a pit worked by 3000 miners: it can be categorised as belonging to the early period of wash coes which started to emerge from the 1880s and in its architectural design it shows the differentiation between the hall-like changing rooms and separate showers, offices and arrangements. The impressive style of the separate administrative building constructed at the same time was the reason for the relatively plain design used for the coe building, which is based on the contemporaneous works buildings of the mine (e.g. the neighbouring hoisting engine house of shaft 1).

Former administrative building / office workers' housing

The cube-shaped brickwork building constructed in 1878 was designed as a 2½-floor structure with a hip roof, five-axis front facade with an added centre entrance and segmental-arch door and window openings in recessed wall bays. The upper floor takes the form of a mezzanine. In 1898 a gatehouse with a mine gateway (which has not survived) was added to the east on the same building line. The former administrative building was probably converted into housing for the office workers when the new administrative building was constructed (1906).

The former administrative building is the oldest building of the Zollverein complex to survive and even today displays the seldom preserved classical architectural style which was also used for the Malakow towers located on the same building line.

Director's villa

The villa, which was built in 1889, consists of a cube-shaped two-storey brickwork building with a hip roof and a projecting two-storey structure with a flat roof. The facades have a similar design to the neighbouring administrative building, featuring segmental-arch window and door-openings in recessed wall bays.

This villa must also be considered as an example of a director's house located in the immediate vicinity of the pit which had already become rare. This solution, which had normally been the case in the past, ensured that responsible persons with the required skills were directly on hand in the event of accidents or malfunctions. A second director's villa diagonally opposite to the magazine was demolished with the conversion of shaft 2 (1920 to 1923).

Administration

The two-storey brickwork structure of the administrative building constructed by Stolze in 1906 was covered by a mansard roof in the neo-baroque style. In the single-axis front facade the three centre axis lines are highlighted by a projection under a gable while the rear facade is accentuated by a more slender projection. The brickwork facades are subdivided by pilasters, lintel, window-sill and eaves cornices made of ashlar; the portal with an oval oculi above the two-leaf door is framed by pilasters made of natural stone. This oval window was originally repeated in the curved gable above the projection. The interior is lit by large rectangular windows on the ground floor and twin windows divided by ashlar pillars on the upper floor. The windows in the mansard roof were modified at a later stage; the roof is crowned by a lantern covered with slate.

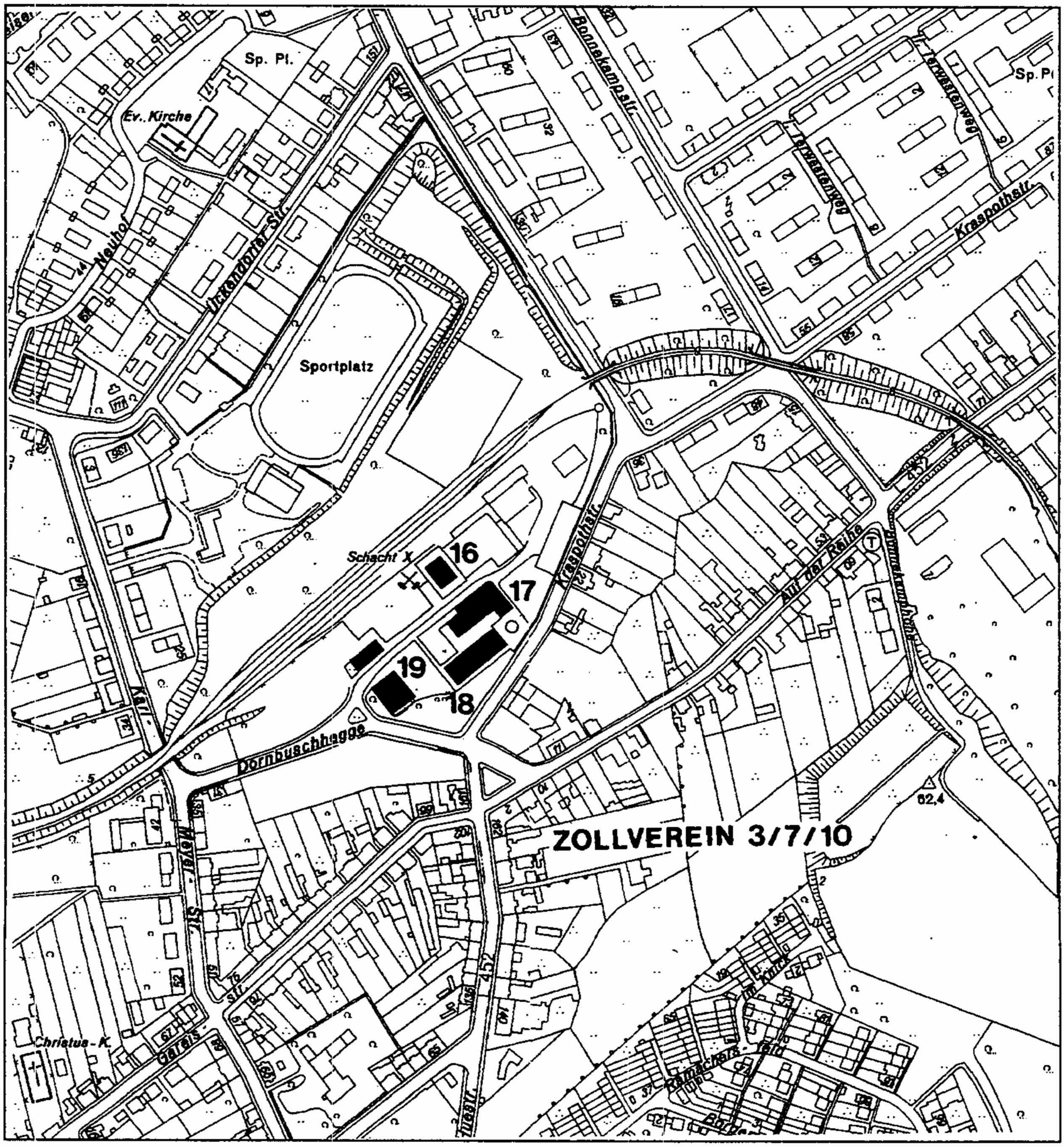
In the interior the initial floor plan design with its opulent three-flight stairway can still be seen although all other original fittings have meanwhile disappeared without trace.

Tip

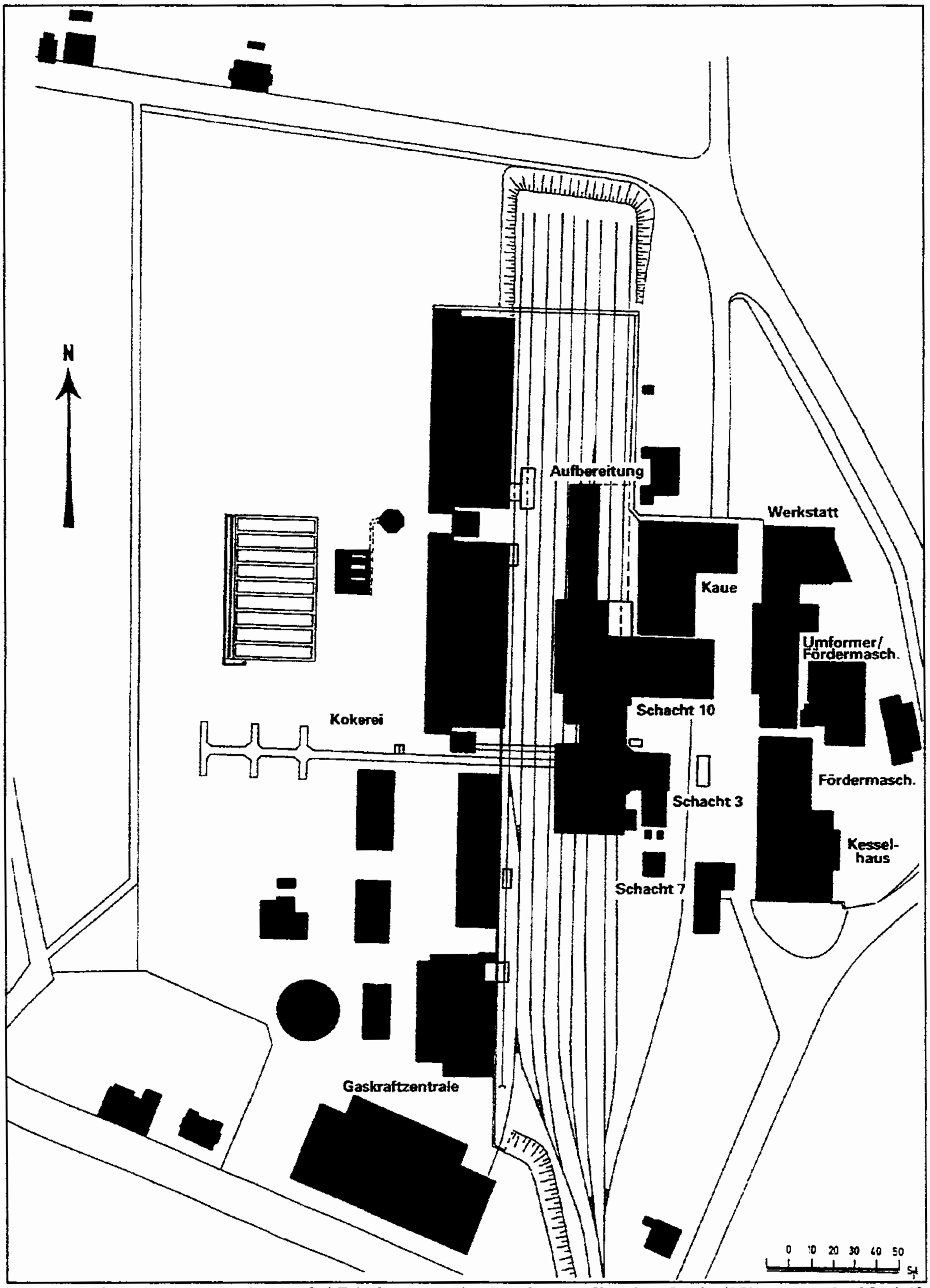
The cone-shaped tip, used from 1848 to store waste since founding of the mine, lies in the triangular area between Haldenstraße and Gelsenkirchner Straße.

2.2.2 Pit Zollverein 3 / 7 / 10

The plan for the pit Zollverein 3 / 7 drawn up by the engineer Dreyer and submitted in 1881 for the building permit was characterised by great simplicity and clarity in terms of the overall installation and architectural design. Together with the coe the shaft with the shaft house and hoist frame formed a row of buildings positioned immediately adjacent to the tracks of the junction line. Opposite a second row of structures, consisting of all other buildings for the above-ground installation, was arranged along a carefully maintained building line: workshops, office and magazine, double hoisting engine house, boiler house and stables for 40 horses.



General plan of Zeche Zollverein, pit 3 / 7 / 10 (from: Buschmann (1998), p. 441, Fig. 455). 16 Hoist frame of shaft 1; 17 Hoisting engine and converter building; 18 Machine house; 19 Gatehouse and cycle sheds; Schacht X = Shaft X.



General plan of Zeche Zollverein, pit 3 / 7 / 10: panel tipping for application for building permit, 1914 (from: Buschmann (1998), p. 438, Fig. 454).
Aufbereitung = Processing; Werkstatt = Workshop; Kaue = Coe; Schacht 10 = Shaft 10; Umformer/Fördermasch. = Converter/hoisting eng.; Schacht 3 = Shaft 3; Fördermaschine = Hoisting engine; Kokerei = Coking plant; Schacht 7 = Shaft 7; Kesselhaus = Boiler house; Gaskraftzentrale = Central gas power station.

The two rows formed the boundary for a pit yard approx. 33 m in width with a longitudinal orientation. All buildings including the shaft house up to the pitmouth level, were built of solid brickwork and provided with barrel-shaped roofs covered with corrugated sheeting, oriented towards the pit yard in close rows.

With consistent development of this design shafts 7 (1897 to 1899) and 10 (1911 to 1913) were positioned to the east and west of shaft 3 so that all three hoist frames were aligned with each other. However, the shaft house of shaft 10 projected a good way into the elongated pit yard, forming its easternmost boundary from this time. On the other side of the tracks of the mine station with its coking ovens and by-product station the coking plant built with the main shaft 10 formed a third row to which further functional areas of the coking plant were attached.

After the pit was considerably scaled down by the demolition of buildings following commissioning of the central main shaft 12 around 1932, more recent demolition work reduced the complex to a state where its original general arrangement can hardly be imagined. Still visible today is the topographical dominance of the pit with the hoist frame of shaft 10 which, from its position on a flat hill crown, towers over the houses of Schonnebeck.

Hoist frame of shaft 10

The single-storey German strut frame (type Promnitz 2) was built in 1913 by the Gutehoffnungshütte as a riveted framework structure for double extraction using four headwheels arranged side by side. The height of the headwheel platform is 33.0 m. The two box-shaped struts are connected under the headwheel girders by plate girders; the headwheel platform is supported by three headwheel girders designed as a steel framework structure which simultaneously connect the struts and guide frame. Of the four headwheels with a diameter of 6.0 m one is still in place while the other three headwheels were replaced by welded models. A craneway with a manual traveller is positioned above the headwheels.

The guide frame contains shaft gates on four levels above the former pitmouth. Three platforms above the pitmouth allow miners to simultaneously enter and exit the four-level mine cages; the wooden guide rods, bumpers and drop latches can still be seen. Following demolition of the shaft house designed as a steel framework structure the cable feed winch has been preserved.

Hoisting engine machine and converter building

The hoisting engine machine and converter building constructed by Stolze in 1913/1920 as a three-aisle brickwork structure over a high basement floor with slightly sloping gable roofs. Facing Zechenstraße the gabled halls are positioned on a single building line. At the rear the converter building projects from the building line of the hoisting engine houses by two axes. The converter hall and the hoisting engine house to the east were built in 1913 while the hoisting engine house to the west was added in 1920.

The homogenous architecture of the halls is characterised by pilasters, cornices, large rectangular windows with metal glazing bars on the main floors and small segmental-arch windows in the basement. The bases and capitals of the pilasters are incorporated in panel`strips made of artificial stone. The pilasters include another cornice which is integrated in the eaves facades. The east facade covered with trapezoidal sheeting does not fully match this design in terms of form and mainly consisted of the west gable of the older magazine building. Facing the pit road there are two building entrances in the style of portals, including one portal with two double doors.

Behind the doors the original stairways with metal baluster railings can be seen. On the basement floor of the halls the dark-brown wall tiling is mostly still present, in addition to the floor covering with white tiles and smaller black tiles in the corners. In the halls the craneways for the double bridge cranes designed as plate girder structures with manual operation are supported by thick pilasters with finely profiled capitals while the roofs rest on plate-type steel girders.

Of the machinery that has remained the electric hoisting engine made by Siemens-Schuckert-Werke in 1920 located on the western side is of interest. The engine with an output of 741 kW was equipped after the Second World War with a new drive wheel 6.5 m in diameter and a new driving governor with a depth level display. In the converter building there is still the 700 kW converter (Ward-Leonard system) with its electric engine made by Siemens-Schuckert-Werke.

Machine house

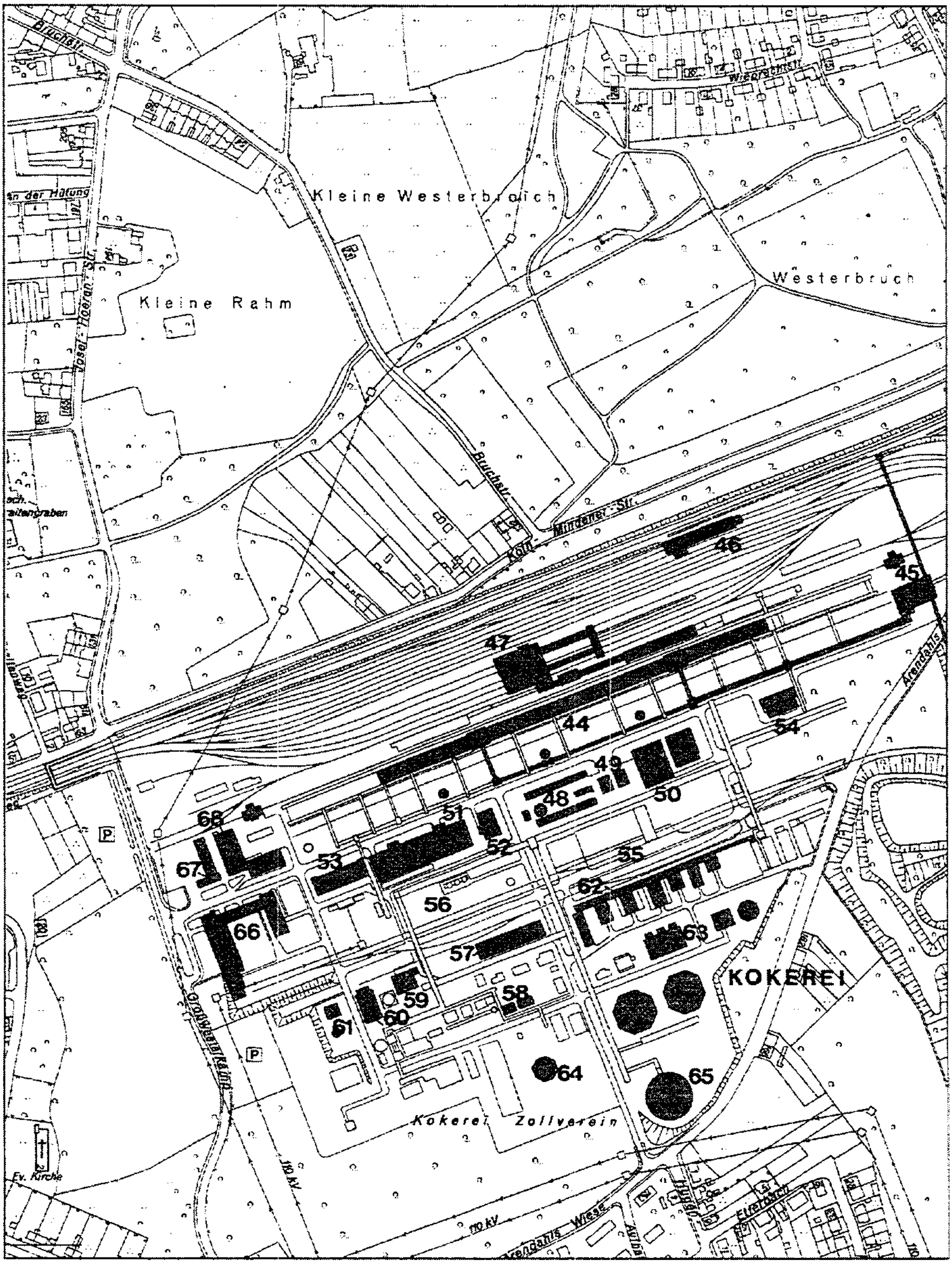
This machine house with its elongated hall with brickwork walls on the ground floor, a steel framework superstructure and a slightly sloping gable roof dates back to 1913 with the fabric of the ground-floor walls. In 1917 it was enlarged by the addition of the steel framework superstructure with riveted steel girders and extended on the western side. In 1952 following partial demolition the building acquired its longitudinal rectangular form, the windows on the ground floor became rectangle in shape and the ground floor was provided with a new facing. The remaining turbo compressor (with an output of 50,000 m^3/h) was installed in the hall in 1952 while the crane dates back to 1918 during the first extension phase.

Gatehouse and cycle sheds

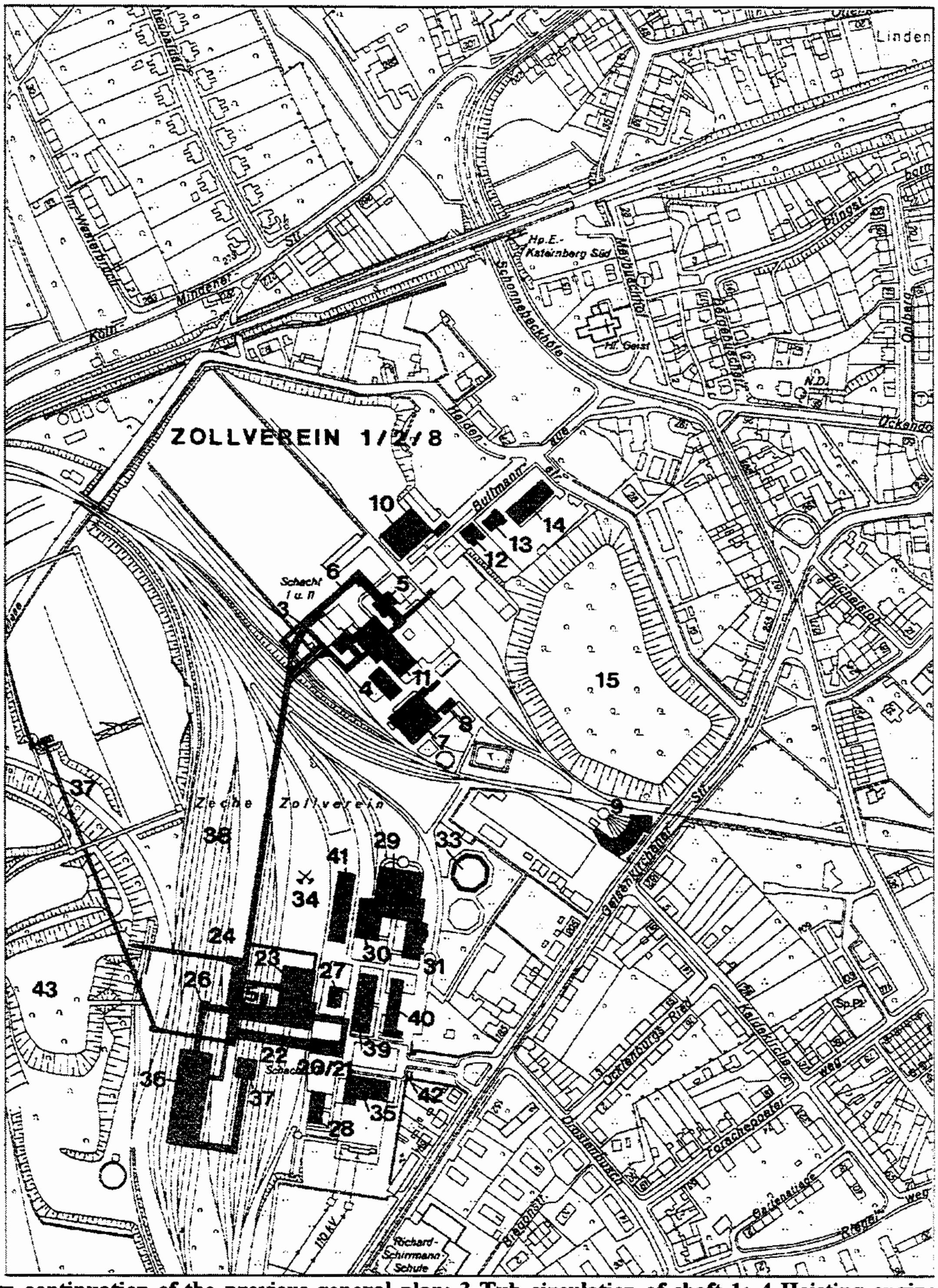
The gatehouse, which was created during conversion of a joiner's workshop (1950), and the cycle sheds (ca. 1955) are brickwork buildings with slightly sloping hip roofs and form the western boundary of the site.

2.2.3 Pit Zollverein 12

The architecture of the installation as a whole is dominated by two lines which cross each other, with an area of grass at their intersection. The hoist frame 55 m in height faces the main axis which starts at Gelsenkirchener Straße and is initially defined by the short approach road and two gatehouses of identical size. The second axis, which starts at two workshop buildings forming a narrow passageway, is oriented towards the boiler house and used to face the 106.25 chimney which is no longer in place.



Zeche Zollverein, pit 1 / 2 / 8 and 12: General plan (from: Buschmann (1998), p. 428/429, Fig. 445). 44 Coking oven batteries 1 - 8; 45 Mixing station; 46 Unloading station and underground hopper; 47 Coarse and fine coke screening; Precooling/precleansing; 49 Tar extraction; 50 Phenol extraction; 51 Suction and compressor house; 52 Control station; 53 Switching station 1; 54 Switching station 2; Ammonia plant 56 Tar loading; 57 Compressed gas treatment; 58 Sulphuric acid wet catalysis; 59 Fine gas purification; 60 Measuring station; 61 Hydrometric and distribution station; 62 Operating materials building, so-called Comb Building; 63 Fan cooler/cooling towers; 64 Gas flare; 65 Gas tank; 66 Administrative and coe building; 67 First-aid station; 68 Workshop and magazine; Kokerei = Coking plant



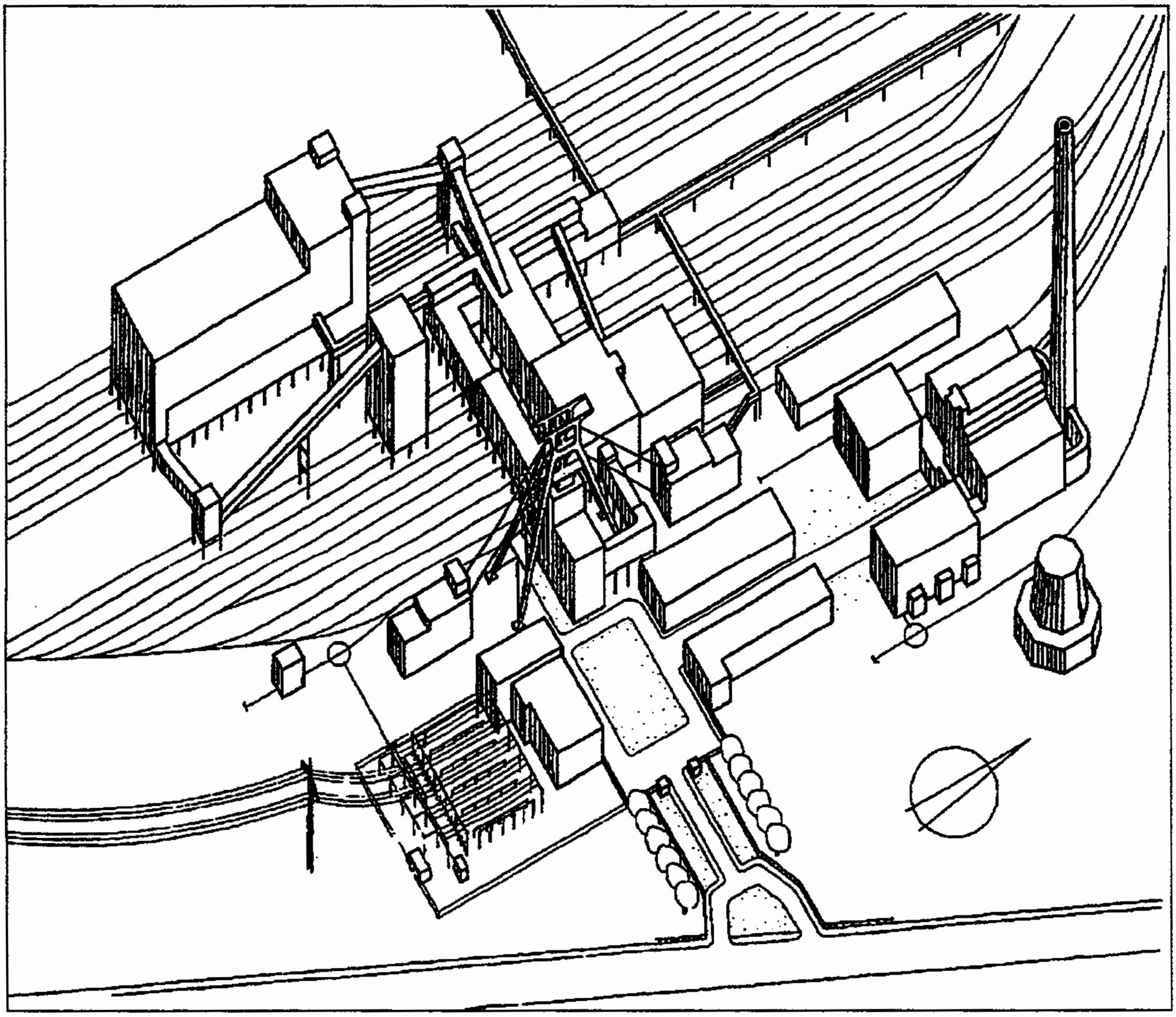
Eastern continuation of the previous general plan: 3 Tub circulation of shaft 1; 4 Hoisting engine house of shaft 1; 5 Winding tower of shaft 2; 6 Tub circulation of shaft 2; 7 Machine house; 8 Fan building of shaft 8; 9 Engine shed; 10 Main magazine; 11 Coe; 12 Former administrative building / office workers' housing; 13 Director's villa; 14 Administration; 15 Tip; 20 Hoist frame of shaft 12; 21 Shaft house of shaft 12: 22 Tub circulation; 23 Tipper hall / screening station; 24 Waste bunker; 25 Electrostatic filter building; 26 Transport bridges, raw coal conveyors/return coal conveyors with corner tower; 27 Hoisting engine house / north; 28 Hoisting engine house / south; 29 Boiler house; 30 High-pressure compressor house; 31 Low-pressure compressor house; 33 Cooling tower; 34 Ash bunker; 35 Converter and switching station; 36 Washing station; 37 Coking coal tower with transport bridges; 38 Mine station; 39 Mechanical workshop; 40 Electrical engineering workshop; 41 Warehouse/mech. workshop; 42 Gatehouses and mine wall; 43 Tip; Schacht I u. II = Shaft I and II.

The regular structure of the double-strut frame positioned in the centre of the overall installation provided the inspiration for a building design based on symmetry and the impact of the axes. Discretion in implementing the principles of "symmetry" and "axiality" means that exciting design features can already be seen in the buildings in the entrance zone: the superelevation of the converter building to the left of the central yard mirrors the leg of the tub circulation system joining at the shaft house on the right. This part of the tub circulation system, which was initially open at ground floor level, was then equipped on this side of the yard with a closed wall panel in 1957 with the changeover to skip winding, thus allowing the hoist frame to become completely visible only with the left-hand side. Where the other axis is concerned, its severity is somewhat relieved by the different sizes of the two compressor houses which precede the boiler house as wing structures. The variation of the motif used in the entrance area is even more noticeable at the rear. Strong accents are set by the washing station and the coking coal tower to the left of the hoist frame. Both buildings have a strong impact on the appearance of the entrance area and are important additions to the switching station, converter building and shaft house in terms of a balanced distribution of building masses. The accentuation of the installation as a whole by the cubic building design of the tipper hall/separation station and the waste bunker on the other side of the tub circulation system does not make such a strong impression.

The aesthetic appeal of this building complex is due to the uniform subdivision of the facades whose regularity is further enhanced by the grid of the steel framework structure: All infill sections are 2 m in height and generally feature extremely longitudinal rectangular formats. Only the corner bays and in places, the infill sections next to the windows are designed with upright rectangular formats. Diverging from the norm, vertical rows of windows have been used for the shaft house in the style of a tower and the boiler house, probably to emphasise the special situation of these building sections lying on the main lines of sight. Although large windows have sometimes been included in the facades to illuminate the sizeable halls for the aggregates of compressors, converters, hoisting engines and the sorting belts at the separation station, the windows are always divided into slender upright rectangular formats to create an interesting contrast between the different shapes of the windows and infill sections.

As regards the selection of the mainly crosswise rectangular formats for windows and infill sections, little notice was taken of the structural forces acting on the facades. Where the sections of the steel framework structure had been reduced to the barest minimum, the large spans between the columns, particularly above the windows, could only be realised using interior reinforcement. These rather problematic solutions in structural terms were accepted in the desire to create a graphic effect of breaking up the building masses with the lightweight steel sections. The lightness of the facade structure is an illusion which demonstrates the refusal of this design to exploit the possibilities of the material in a provocative manner - a feature of constructivism.

The free design of the facades was made possible by the general separation of the internal primary structure from the dividing facade elements with external facing. The primary structures generally consist of double-jointed frames designed as plate girder structures - a type of structure which is also able to absorb horizontal wind pressure forces. The architects Schupp and Kremmer thus managed to reduce the number of diagonal reinforcing struts or so-called St Andrew's crosses which would have marred the clarity of the interiors and the arrangement of the windows. The cross bracing, which could generally not be omitted, was integrated in the wall structure of the double-shell walls with flat steel so that it was not visible either from the inside or outside. With single-shell walls the St Andrew's crosses are positioned underneath the roof so as not to disturb the harmony of the structure of the inside walls.



Zeche Zollverein, pit 12: Isometric drawing of complete installation (from: Buschmann (1998), p. 445, Fig. 462).

One point of interest is the extensive use of welded connections: columns and rigid corners were generally prefabricated as welded components while the frame beams were riveted in place on site. The increased welding costs - of the 9,700 tonnes of structural steel used 2,000 tonnes was welded at the workshop - were offset by a weight saving of 15%. The pit Zollverein 12 can probably justifiably claim to have been Europe's largest overall welded installation of its time.

The cubic design of the building structures were a logical development of the orthogonal system used for the facade structure; the roofs were not significant in terms of the appearance of the installation. The steel framework facades extend far beyond the structural girders and are finished off at the top with a U-section. The cubic design is also emphasised by the windows with opaque wire glazing set in the facades flush with the exterior and the steel framework parts painted in the same colour as the brickwork.

All buildings including the hoist frame were designed between 1928 and 1932 by the architects **Fritz Schupp** and **Martin Kremmer**. After the death of Martin Kremmer in 1945, Fritz Schupp was solely responsible for the second major building phase of Zollverein 12 which occurred when the mine changed over to skip winding in 1957/1958 and 1966/1967.

Hoist frame

The hoist frame manufactured by Dortmunder Union in 1931 towers over shaft 12 which was completed to the 12th floor (= 640 m) in 1931 and was extended to a depth of 1005 m in 1957 and 1972; its diameter is 7.2 m. The double strut frame designed as a riveted plate girders was 55 m in height. The designers had initially provided for complete welding of all frame connections but lacked the courage to use this modern connection technique in view of the dynamic loads to which the welds would be subjected.

The four strut feet are supported on four isolated foundations via joints; K trusses consisting of plate girders were inserted between the struts as bracing. The struts, which steadily increase in size in the flange thicknesses from the base, extend to the upper headwheel platform, where they turn into massive top headwheel girders via rigid corner elements. The generously dimensioned craneway structure also starts from these corner connections. The lower headwheel platform is positioned between the strut legs and thus blends in with the background. The four headwheels have a diameter of 6.5 m

The guide frame starts underneath the lower headwheel platform and is almost entirely surrounded by the shaft house. On the upper pitmouth platform the four shaft gates dating from the frame winding period can still be seen.

Shaft house

The shaft house constructed in 1931 is a cuboid building which stands out from the structures of the tub circulation system in terms of width and height. Under the hoist frame the shaft house extends in the form of a tower to just below the lower headwheels. The facades facing the yard before the hoist frame include vertical rows of windows, likewise at the rear of the towerlike superstructure; in the south facade at the top there are two rows of windows to let in the light for the upper and lower pitmouth level and underneath three large upright rectangular windows to illuminate the pitmouth; of these one is now combined with a double door following the removal of the parapet bay.

The shaft house initially bore the insignia "Zollverein" in raised lettering above the large window bay of the front facade, flanked by the "hammer and wedge" emblem of the mining industry and the logo of Vereinigte Stahlwerke AG. When the shaft was renamed, the inscription "Schacht Albert Vögler" written in Gothic script was mounted in more or less the same place as well as the word "Zollverein" in the same script directly under the eaves (still in place today). However, due to Albert Vögler's association with the Third Reich, the lower insignia was removed after the end of the Second World War although the holes in the facade where it was attached still remain.

Of the double pitmouth for simultaneous loading and unloading of two floors of the four-level mine cages the two floor slabs can still be seen. The shaft gates at the upper pitmouth level date back to the time when frame winding was replaced by skip winding as well as remnants of the tracks on both levels; the latter was levelled off with concrete in certain areas at a later stage. On the lower pitmouth level the control station for the skip winding system is positioned directly next to the guide frame; underneath there are the two sheet-metal unloading pockets into which the conveyed material was poured from the skip containers. The southwest corner of the hall contains a materials lift and the south east corner an electrostatic filter.

Tub circulation

The tub circulation system built in 1931 is a functional unit in the form of a closed ring which diverges from the norm by its relatively independent design consisting of a constructional breakdown into the individual functions of tipper hall/screening station and waste bunker for Zollverein 12. The legs of the tub circulation system which is mostly mounted on supports are designed as two or three-storey buildings which extend from east to west in the shape of an elongated rectangular circle. Daylight is provided by rows of windows which are today partly bricked up The building is then developed towards the rear and the side from the shaft house and ends with the northern legs in the tipper hall. Although the shaft house and tipper hall are relatively independent structures, they are integrated in the tub circulation system in functional terms.

The main function of the tub circulation system was to supply the tipper hall with the filled coal tubs from the shaft, empty them there and then return the empty tubs to the shaft on a round circuit. The tubs were propelled by chains which were driven by electric motors: the endless chain transporters and their drive units are still mostly present. As the coal tubs had to be discharged centrally at one level in the tipper hall, two slopes (so-called chain hills) were used to connect the two pitmouth levels. One of these chain hills can still be seen in the northern part of the tub circulation system shortly before the tipper hall while the second one, which redistributed the tubs to the two pitmouth levels in the south part of the tub circulation system just before the shaft, was removed. A third chain hill, which was used to feed the waste and material tubs to the tub circulation system in the west wing, has been preserved (cf. waste bunker).

A workshop with storage rooms is integrated in the west wing of the tub circulation building.

A tub cleaner made by Demag in 1930 can be seen in the northern part of the tub circulation system next to the tipper hall.

Tipper hall/screening station
With a span of 30 m the frames of the tipper hall built in 1931 extend across one of the largest rooms in the pit to be seen without any crosswise division. Separated by two floor slabs, the top floor of the building contained eight head tippers which discharged the conveyed material from the coal tubs onto the roller bar grizzlies and vibrating screens of the screening station. The sorting belt hall located upstream of the tipper hall was designed as an independent building in terms of structure and building dimensions: the five sorting belts each with a length of 15 m which used to stand there have disappeared from this work area like the other technical equipment dating back to the time of founding.

The tipper and sorting belt hall were mounted above ground like the tub circulation system so that railway cars could pass underneath to load lump coal and waste. Both halls were equipped with wall aprons at the side which were added on the ground floor at a later stage to screen off the clouds of coal dust produced during loading. After sorting ceased in 1960, the hall was also walled up at the front faces on the ground floor.

The constructional state of this part of the pit is characterised by installations and additions which resulted from the changeover from frame to skip winding. In 1958 an angled belt bridge for raw coal belt section 2 was installed in the yard between the wings of the tub circulation system: the belts (still in place), which were used to replace the tub circulation system, conveyed the raw coal from the shaft house to the screens of the screening station, which were installed in a new annex extending the angled belt bridge at the side of the tipper hall.

One of the Wedag screens installed in 1984 can still be seen next to the two raw coal belts. A short sorting belt is joined to the screen to sort out the waste. A double-roll crusher made by Wedag in 1976 was used for further processing of the lump coal. The crushed and screened material was then removed on raw coal belt sections 2 and 3 leading to the washing station. The transfer station of the return coal belts is positioned in the vicinity of the screens and roll crushers.

The tipper hall and screening station were modified on the upper floor (former sorting belt hall) and the ground floor in 1992/1993. The glass panels at the front of the ground floor are intended to show that railway cars originally passed under the building for loading. On the upper floor the sorting belt hall was divided off from the tub circulation system by two new walls running crosswise.

Waste bunker
The waste bunker built in 1931 as a cuboid structure was joined to the northwest end of the tub circulation system parallel to the tipper hall and is connected to the sorting belt hall via an angled transport bridge. The sorting waste was conveyed to the waste bunker (capacity 110 t) via this transport bridge with rubber belts while the washing waste was also passed from the washing station to the waste bunker with rubber belts. The belts are housed in a mounted structure which extends over the entire east wing of the tub circulation system up to the end of the waste bunker building and end above the bunker building: there they discharge the washing waste onto an oscillating resonance screen.

The waste bunker made of concrete is positioned inside the building where it is surrounded by a structure typical of Zollverein, consisting of structural double-jointed frames clad with steel framework facades.

Two open transport bridges are connected to the waste bunker building. One bridge leads to the tip: the sorting waste which could not be used for underground stowage was disposed of here. In the opposite direction this bridge could also be used to transport waste from the tip to the shaft. On the other side of the mine station the bridge is equipped with a rotary tipper, which allowed the waste to be loaded on railway cars. The second bridge leads to pit 1 / 2 / 8. It was initially still used to transport the coal extracted at shafts 1 and 2 to the central processing station of pit 12 and, until the changeover to skip winding, was required to convey the wood and materials tubs arriving from pits 1 / 2 to the central shaft.

Of this equipment some track installations, electrically operated endless chain transporter systems and two control units still remain today. The empty tubs from the tipper hall were conveyed by an angled endless chain transporter system to the lower-level offtake platform under the bunkers and were filled with waste by offtake slides. They could then leave the waste bunker building for the tip via the transport bridge or were returned to the tub circulation system from the offtake platform using an angled chain transporter so that the waste could be taken through the shaft to the underground stowage location.

A separate angled chain transporter was available for the tubs arriving from pit 1 / 2. This system conveyed the tubs past the waste bunkers to the tipper hall. A third angled chain transporter at the tub circulation system was used to convey empty tubs from the tipper hall directly to the tip bridge. The equipment dating back to 1931 for conveying tubs at the waste bunker area can mostly still be seen and only underwent slight modification with the installation of another waste bunker following the discontinuation of frame winding in the southern part. The more recent waste bunker with its associated equipment dates back to 1942.

The complexity of the waste bunker system at pit Zollverein 12 can be attributed to the evenly balanced waste management system maintained until 1960, i.e. the waste taken above ground was largely returned to the pit as stowage material. It was only the trend towards mechanisation in the 1950's with its marked increase in the volume of waste (from 10,000 t to 12,000 t per day) that made it impossible to keep to the stowage system previously maintained. From that time the waste was increasingly disposed of on the tip or loaded onto trucks or railway cars.

Electrostatic filter building

Between the waste bunker and the tipper hall there stands the electrostatic filter building constructed in 1931 as a steel framework structure based on the design of the tub circulation system. Its equipment includes a three-chamber electrostatic filter made by Siemens-Schuckert-Werke with a transformer, converter, synchronmeter and switchboard. The dust produced at all coal discharge points (tipper, grates, belt heads) was removed by an extractor fan, passed to the electrostatic filter via pipework, deposited there in the three-chamber filter between the electrodes (77 kV) and then pumped to the washing station. Every day between 12 t and 15 t of filter dust was recovered using this method; the tipper hall and the screening station were virtually dustfree thanks to this installation.

Transport bridges, raw coal and return coal belts with corner tower

Band belts, which were designed as closed transport bridges directly next to the tub circulation system and installed in 1931, were used to connect the screening and washing station. The change in direction was effected by a corner tower positioned near the track installations of the mine station. The angled belts were used to convey the raw coal from the screening station to the head of the washing station where it could be stored in the raw coal bunkers in the event of any malfunction at the washing station. From these bunkers the coal was conveyed back to the screening station via the corner tower using so-called return coal belts installed in horizontally positioned transport bridges. With the help of a transfer station the coal was returned to the washing station using the raw coal belts once the malfunction had been rectified.

Hoisting engine house / north

The building constructed in 1931 to house the hoisting engine for extraction at the north is designed as a steel framework structure with a flat roof and a roof bulkhead to accommodate the hoisting cable leading to the upper headwheel. At the rear there is a large window area extending over three infill sections around the corners of the building. The basement level is illuminated via partly bricked-up horizontal rows of windows.

Behind the door set to one side the hoisting machine platform is accessed via a stone stairway with a square stairwell. This is the location for the electric hoisting machine made by Siemens-Schuckert-Werke in 1931 with its drive wheel 7 m in diameter, driving governor, depth display and other operating controls used by the engine man which were probably replaced in 1967.

Hoisting engine house / south

The design of the hoisting engine house in the south also built in 1931 corresponds to its counterpart in the north. With the changeover from frame to skip winding at shaft 12 and the replacement of the hoisting machine in 1959 a converter based on plans by Fritz Schupp was added to the rear of the original building which was almost cubic in shape.

The interior was fitted out as for the machine house in the north. The building contains the hoisting engine built in 1959. The electrical system with its 4000 kW electric motor was supplied by BBC and the mechanical installation by Demag. The hoisting engine is one of the most powerful aggregates ever installed. The control station with its housing dating back to 1959 can still be seen.

Boiler house

As the replacement and amalgamation of the steam and compressed air generation system had a major impact on the concept used for the central shaft, the "power system" was installed with four boilers in 1928/1929 during the first construction phase of the central shaft. This was followed in 1935 by extension of the building at the rear and the installation of a fifth boiler.

The boiler house, which is flanked on both sides by the associated compressor houses, forms the core of a three-wing installation axially aligned to the 106.25 m high chimney which is no longer present. A lower intermediate tract positioned before the boiler house divides the complex into three relatively independent structures.

The boiler house is a three-aisle framework structure. The narrow centre aisle extends above the side aisles and is accentuated at the front by a stair tower before the hall. The flights of stairs which can be made out through the glass of the vertical row of windows emphasise the function of this building. At the side the elevated section of the centre aisle is accompanied by half-size narrow mountings above the side aisles which extend the entire depth of the hall and give the gables of the boiler house a stepped appearance. The side walls of these structures are completely covered with adjustable sheet metal louvres used to ventilate the hall above the boilers. The superelevated section of the centre aisle framed by them houses the coaling platform above the coal bunkers.

The boiler house is lit in the front and rear gables by six high window areas each extending vertically over three infill sections; small horizontal windows positioned above which continue in the eaves sides as rows of windows are used to illuminate the zone above the boilers. On the centre axis the high vertical row of windows of the stair tower is repeated in the rear facade. Under the upper row of windows the side facades are lit by additional rows the height of two infill sections.

The lower intermediate tract positioned before the boiler house, which draws a line between the boiler house and the two compressor houses, forms a direct part of the boiler house in functional terms. This intermediate tract equipped with horizontal rows of windows housing pumps in the left-hand section and water cleansing equipment in the right takes up the architectural concept of a slightly recessed central entrance to the boiler house with a double door once again. The steel framework superstructure of the 45 t underground hopper joins the boiler house hall at the side. Here railway cars used to discharge the fuel used for firing.

Internal primary structures and definitive functional sequences are reflected in the forms of the buildings. The high centre aisle is created by massive portal frames which simultaneously support the sheet-metal bunkers at the top and the coaling platform installed above. The coaling platform engaged with two rubber conveyor belts positioned above the bunkers used to convey the fuel to the bunkers. The conveyor belts were connected to the underground hopper via a bucket conveyor 44 m in length. The fuel was separated into the categories of coal, middlings and coking duff and distributed among the bunkers via the conveyor belts and double chutes.

The side aisles which housed the boilers are spanned by angled trusses which each connect to the portal frames of the centre aisle with one leg. The four boilers manufactured in 1929 with more or less the same design are vertical tube boilers with zone wall grates 21.5 m^2 in size; two were supplied by the company Walther and two by Steinmüller. The fifth boiler with a grate area over double the size (57 m^2) was installed in 1935. The sixth boiler originally planned was never installed, and the resulting space inside was walled off from the hall and used as a storage area. All boilers rest on massive reinforced concrete pillars which serve as an ash pit at the same time. Here impact pulverisers were set up underneath the boilers to crush the ash which was mixed with water and transported to the tip, and later on also to the ash bunker.

Along the eaves wall smoke flues were installed behind the boilers but only fragments remain today. They originally continued outside as mounted structures up to the chimney. Each boiler was equipped with fans on the smoke flues. They produced the under-grate blast previously heated to 180° C which was channelled into the combustion chambers. Stairways and operating platforms with gratings are positioned between the steel framework linings of the boilers.

Of the installations used to supply the boilers with feed water there still remains the water cleansing system using the Permutit process with three riveted sheet-metal boilers. Later on a laboratory was added for continuous checking of the water quality. The more recent feed water pumps were used to convey the water to a tank installation located above the boilers.

In 1995/1996 the boiler house was converted into an exhibition room and part of the equipment was lost during the work. Four of the five boilers were removed and the surrounding walls turned into exhibition bays. However, one boiler dating back to 1929 has been preserved more or intact.

High-pressure compressor house

The cuboid steel framework hall built between 1928 and 1930 is illuminated on the main storey by large window areas extending vertically over three infill sections and horizontal rows of windows at basement level. A stone stairway with a square stairwell can be found behind the entrance at the side. The hall provided space for two high-pressure steam compressors manufactured by Demag, of which only one was installed to start with, with the second following later on in 1955/1956. Neither of the high-pressure steam compressors are still to be seen.

Low-pressure compressor house

The elongated steel framework hall built in 1928/1929 is provided with high window areas extending vertically over three infill sections which have been combined with rows of windows for the main storey and basement floor. The interior fitout is a mirror image of the high-pressure compressor house. Of the three low-pressure compressors originally installed here Compressor 1 can still be seen; the 6,650 hp full steam turbine, the turbo compressor with an output of 55,000 m^3/h and the condensation station installed at basement level were supplied by AEG in 1929. Steam-driven pumps were used to incorporate the water recovered from the condensation station in a circuit which passed the water via pit 1 / 2 for preliminary heating and ended by feeding it to the boilers. One of these pumps, positioned upstream of the condensation station of compressor 1, is still in place.

Cooling tower

To the east of the boiler house there stood a cooling tower until 1997. This tower was built by the company Wedag in 1928/1929 for recooling of the cooling water required for condensation. A riveted iron structure rose up over a reinforced concrete foundation usèd as a drip basin; the wooden facing and the dripper system made of wood are no longer present. The cooling tower which covered a floor area of 720 m^2 offered a normal cooling capacity of 1900 m^3 water/h.

Ash bunker

The ash bunker built in 1960/1961 is a tower structure with a concrete bunker mounted on supports which was faced with brickwork. To the side a stairway projects slightly from the building line. In the bunker ash was blown from the boiler house through pipework and could then be loaded onto railway cars.

Converter and switching station

The converter and switching station built in 1931/1932 consists of steel framework halls joined together at right angles with a hall for the switchgear parallel to the central entrance area and a higher-level crosswise hall for the converters. The two-storey switching station is illuminated by rows of windows, large windows in the converter hall, which are vertical in the two narrow sides and fill the bays between the posts of the primary structure in the longitudinal facade. The converter hall was extended in 1951 to accommodate the second converter.

Both buildings are jointly accessed from the yard with a stone stairway around a square stairwell. At the switching station the current converted from 100 kV to 5 kV at the outdoor installation was distributed to the individual Zollverein shafts; today the building still contains four control cabinets and the switching room with its instrument panel clad in marble and the large control desk. In the converter hall there is the 2200 kW control power converter manufactured by Siemens-Schuckert-Werke in 1931 and the associated converter also made by Siemens-Schuckert-Werke dating back to the 1950's to supply the north hoisting engine with direct current.

In 1990/1991 the switching station was converted into administration offices for Bauhütte Zeche Zollverein GmbH and a large function room while the converter house is used for exhibition purposes.

Washing station

The washing station was built between 1930 and 1932. Originally designed solely as a steel framework structure, the enormous building (91 m in length, 34 m in width and 37 m in height) was developed by Schupp and Kremmer as a combination of concrete components for the bunkers and steel framework for the floors with machinery. The decision to leave the concrete components unlined allowed another building material to be integrated to ensure the harmonious overall impression desired for the installation: this design objective was realised in a particularly felicitous and exemplary manner in the case of the washing station of Zollverein 12.

The entire structure extends over six rows each with 16 reinforced concrete supports so that it was completely accessible to railway cars running underneath on five tracks. The supports bear reinforced concrete bunkers which are designed as unlined substructures rising under the machinery floors up to a height of 17.3 m. In the case of the raw coal bunkers in the north of the building, which performed a buffer function in the event of malfunctions at the washing station, the concrete components tower upwards in the air. The upper centre bay of the north elevation was designed as steel framework to ensure a proper transition to the angled steel framework transport bridge of the raw coal belts and probably also to tone down the dominant impression made by the concrete components. The gable side to the north thus presents itself as an elegant frontage featuring two towers while the two external pockets of the raw coal bunker extend beyond the roof. This was essentially a design feature as the two "high-level containers" 31.3 m in height only played a minor role as water tanks for the roof drainage system. Both containers are incorporated in the clearly superelevated building section housing the charging unit and the fore-screening station beside the coal bunkers.

Similar to the integration of the concrete components in the north part of the building, the steel framework also extends downwards in the south. This firstly again results in a smooth transition to the transport bridge which leads to the coking coal tower via a corner tower and secondly, consistently takes up the theme of the multiform interlacing of concrete and steel framework components.

To illuminate the washing station horizontal rectangular windows have been incorporated in the concrete components (so-called 6 m platform for the sizing and loading of nuts and the small coal belts under the bunkers) and rows of windows in the steel structure components for the floors with machinery. Access is provided by an open bridge positioned between the washing station and the tub circulation system and leading to a two-flight stairway with lift. Two other stairways with generously dimensioned stairwells (used simultaneously as installation openings) are located on the side of the building diagonally opposite.

The design objective of dividing up the colossal building structure, which is already recognisable from the outside, is taken up in the interior by its functional subdivision. The 91 m long building is divided up into three 30 m sections of more or less identical length. The first section in the north, which in the external elevation already stands out from the other buildings by its height, exceeding them by approx. 8 m, has a primary structure consisting of frames set crosswise to the main axis. The hall made up of these frames with a span of 25 m mainly houses charging units and the fore-screening station, in addition to a number of dedusting units.

The second centre section is spanned by frames arranged parallel to the main axis extending over a distance of 30 m. Next to the tipper hall it is the widest room in the pit although it is subdivided in the interior by a second centrally positioned frame structure designed to accommodate the jigging machines. With these jigging machines this centre section of the building can be considered as the heart of the entire processing station.

The third and final building section is characterised on the inside by a number of slender frame structures which are used to support the load for the agitators located on the roof. This third section mainly houses the sludge washing station with its agitators, the flotation station and the disk dryers as well as all associated auxiliary equipment.

A fourth equipment section extends underneath the bunkers at the 6 m level below the entire building structure.

The technical and mechanical equipment still to be seen is considered according to these three functional / building sections.

Where the charging units, the fore-screening station and the dust separation system are concerned, the raw coal was transported by the conveyor belts of the raw coal belt to two reinforced concrete charging bunkers each with a capacity of 60 t. If the coal exceeded a certain level in the charging bunkers, it slid into the raw coal bunkers via closed ducts. Underneath the raw coal bunkers two band belts were used for connection to the return coal belt. The raw coal destined for further processing was taken to two screening drums manufactured by the Dortmund company SKB Schüchtermann & Kremmer-Baum in 1930 using two metering belt weighers which have not survived. These drums were used for fore-screening of the coal into raw smalls (0 mm to 10 mm) and raw lump coal (10 mm to 80 mm, and 10 to 120 mm from the 1960's). The lump coal was transported to the jigging machines by band conveyor belts.

The small coal was transported by three bucket conveyors to a processing level above the jigging machines. The bucket conveyors were provided with upstream and downstream dust separation systems, two of which can still be seen today. Dust separation was performed above the jigging machines so that the dedusted small coal could slide into the jigging machines under the effect of gravity.

The dust recovered in the sifters was deposited in a single-chamber electrostatic filter manufactured by Siemens-Schuckert-Werke in 1932 and then passed to the dust hopper. A second adjacent electrostatic filter made by the same company in 1930 was used to recover the dust produced at the transfer points of the conveyor belts and the general room dust separation system.

A double bridge crane designed as a riveted framework with an electric traveller was positioned above the screening drums and bucket conveyors.

The main sorting work of the processing station was performed in the jigging machines. The jigs were arranged in two parallel rows; to support the extremely heavy weights they were mounted in a separate framework which was supported by the concrete structure of the bunkers. Each of the two rows started with the open grain jigging machines which were directly connected to the fore-screening drums via the above-mentioned band belts. This was followed by the fine coal jigs, which delivered the material to the sifters via ducts. A rewash jig was connected to the row at the west for further processing of the middlings.

Despite improvements and minor modifications the five jigging machines operated with compressed air to generate the wavelike motion of the water largely correspond to the original state of the washing station around 1955.

To the side of the jigging machines there are twelve bucket elevators for the waste produced by the jigging machines and for the middlings: this involved drainage bucket elevators which drained off most of the water from the conveyed material using the perforated buckets. The waste was deposited on waste belts arranged in a parallel position behind the jigging machines. The original route taken by the washed waste on the crosswise band belt to the transport bridge leading to the waste bunker building can still be made out although it has not been used since the 1960's. From that time the waste was taken to the rededicated small coal bunker; it was removed on the 6 m platform with band belts to connect with the old route to the waste bunker building via an open transport bridge.

The middlings recovered from the open grain jigging machines were broken up in double-roll crushers (no longer in place) and passed with the middlings from the fine coal jig via drag belts to the rewash jig where they underwent further processing. The middlings resulting from this washing process could then be stored in the four middlings bunkers after preliminary drainage and were then taken to the boiler house by railway cars.

All jigging machines produced coal as a finished product in various grain sizes: the nuts resulting from the open grain jigging machines slid via ducts to the nut sizing screens provided for each row of the jigging machines. These were oscillating resonance screens manufactured by Krupp in 1955 which could be used to sort the lump coal into six grain sizes. These two screens stood to one side underneath the jigging machine platform; they were thus positioned immediately above the bunkers for the nuts.

On the same level there were the slotted hole screens built by the company Siebtechnik in 1960 for preliminary drainage of the small coal. From there the small coal was passed to a charging belt and was distributed between the eleven small coal bunkers via a mobile throw-off car. These bunkers also performed drainage at the same time to extract additional water from the damp small coal. From the 1960's the drainage function of the small coal bunkers was taken over by drainage centrifuges on the 6 m platform; two screen trays were positioned upstream for preliminary drainage. The small coal bunkers which had now lost their function were used to store waste. The jigging machine washing station also included a control station and a laboratory.

The washing water soiled with remnants of coal underwent treatment at the sludge washing station: the water collected from two washing water tanks was pumped to the three Dörr agitators installed on the roof of the washing station by three main wash water pumps manufactured by SKB, of which two were constantly in operation. The sludge was deposited in these three round concrete basins made by Westfalia-Dinnendahl-Gröppel AG. The fine sludge was passed to three Hardinge agitators (two still present) while separation of the coal and waste was carried out at the flotation station, of which two recent installations can still be seen. The coal sludge from the flotation station was dried in rotary disk filters built by SKB in 1941 and from there fell into bunkers positioned underneath. A social room and a foreman's office were also located at the sludge washing station.

All installations used to prepare the finished products for loading and further transportation were housed on a floor which extended virtually over the entire floor area of the building underneath the bunkers. In 1955 Krupp had installed nut loading screens under the nut bunkers; these were used to ensure that the open grain processing station only produced the size of grain actually required by the consumer. Under the small coal bunkers there were two rows of conveyor belts which ran through the entire building in a crosswise direction. At the northern end the dust recovered there and in the middle the small coal could be discharged; at the southern end dust and small coal was unloaded onto the coking coal belts positioned crosswise there. Parallel to this there was an Erko mixer built in 1987 which broke up the dried sludge from the sludge washing station into the finest particles, also discharged it onto the coking coal belts. Transport belt bridges were used to convey the coking coal to the coking coal tower. Also on this level there were two shunting winches built in 1930, which were used for the controlled conveying of the railway cars, in addition to weighing systems.

Coking coal tower and transport bridges

The 39 m high tower with its capacity of 3,500 t was built in 1930/1931 and rests on reinforced concrete supports positioned below the bunker subdivided into six pockets; the charging floor is designed as a mounted steel framework structure. Like the washing station, the platform under the bunkers is illuminated by horizontal rectangular windows while rows of windows are provided for the charging floor.

This installation is connected to the washing station by angled transport bridges positioned at right angles to each other and also a corner tower. The transport bridges and the corner tower are designed as steel framework structures with rows of windows. The corner tower rises up above riveted and welded steel frames.

Until construction of the coking plant the coal stored in the tower was loaded onto railway cars which ran underneath the tower on three tracks. 1959/1960 saw the construction of a coaling bridge which extended from the coking coal tower to the coal mixing station of the coking plant via two corner towers. The bridges and corner towers were designed as steel framework structures typical of Zollverein 12. A forebuilding used to house shunting winches was also added at the south side of the tower at a later stage.

The charging floor of the coking coal tower contains a revolving distribution bench with a stripper. This was used to mix the different material category of small coal, coarse sludge and dust arriving on the conveyor belts in three layers. On the floor below the bunkers there are band belts which lead to the coking plant via the transport bridges and corner towers, changing direction several times.

Mine station

The mine station built between 1928 and 1932 originally included 21 main tracks running north and south, which in the south merge to form a return track via points and lead to an inbound and an exit track in the north. The four tracks to the west adjacent to the washing station, of which three can still be seen, were used to line up loaded cars. They are followed by the five tracks under the washing station and five for the loading of coking coal, including three directly under the coking coal tower. South of the washing station the reversing equipment for the shunting cables is still in place. The next six tracks originally ran underneath the screening station but were terminated following the changeover from frame to skip winding and now end in front of the south leg of the tub circulation system. Secondary tracks lead to the outdoor converter and the boiler and compressor house. The points were operated from a control unit designed as a steel framework structure located at the northern part of the station. The tracks were lit by three 30 m floodlight masts, of which two have survived. The rolling stock of the mine included 141 railway cars and seven steam engines.

Mechanical workshop
The elongated building designed as a steel framework structure with two rows of rectangular windows one over the other was used as a mechanical workshop. The rows of windows are separated from each other by narrow upright rectangular brickwork bays at the interior frame trusses. Two large gates in the middle of the two longitudinal facades were used for the entry and exit of the workpieces. The narrow gauge tracks leading into the hall for transportation of the workpieces have since disappeared.

In the south of the hall a wall was added in a crosswise direction at a later stage to partition off offices and staff rooms. Later on, the fitting shop and the mechanical workshop were housed in the hall and the forge in the northern part. A double-bridge travelling crane with three electric motors and a lifting capacity of 10 t can still be seen.

The mechanical workshop was converted into an exhibition hall in 1990.

Electrical engineering workshop
The electrical engineering workshop built in 1931 is an elongated steel framework hall with a header structure set at an angle to the central yard. Horizontal rectangular windows are interspersed with narrow upright rectangular wall bays in front of the inside frame trusses. Two large gates in the longitudinal side facades provided for the delivery and removal of workpieces.

The electrical engineering workshop, plumber's workshop and welding shop were located in the north part. A hand travelling crane manufactured by Demag with a lifting capacity of 3 t was at the disposal of the electrical engineering workshop. The header structure housed the works offices, a visitors' coe and a dining room; behind the entrance centred to the yard side a two-flight stairway led to the offices on the upper floor. This workshop building also contained the fire station with the equipment room, with its rooms being incorporated in the electrical engineering workshop at a later stage. An art gallery was set up in the electrical engineering workshop in 1992/1993.

Warehouse/mechanical workshop
This elongated steel framework hall was positioned to the east of the boiler house and was lit by two rows of horizontal rectangular windows. At the south gable a centre window is flanked by two side gates. Tracks used for the delivery and removal of workpieces lead to these gates. At the north gable the entire lower zone could be opened using gates. The building, which was constructed in two phases (in 1931 to the internal crosswise wall and 1936/1937), was initially used as a warehouse and was converted into a mechanical workshop at a later date.

Since 1990 the warehouse has been used with newly added rooms (house in a house) as a workshop building with offices, classrooms and trainee workshops.

Gatehouses and mine wall
Two small cubic steel framework houses mark the end of the approach road planted with trees and simultaneously "preface" the central yard. To the right and left there are walls the height of a man

enclosing the pit which, like the steel framework architecture of the buildings are designed with beams and posts made of steel sections. Between the gatehouses there still stands the original gate installation which has been largely preserved.

Outside installations/tip

The buildings in front of and adjacent to the hoist frame over shaft 12 are mostly incorporated in a system of grassed areas which are framed with bricks set upright as curbs. The roads are paved with blue basalt stone (small stone set paving) and the footways with brickwork paving. Illumination is provided by lanterns specially designed for the pit.

The traffic routes of the pit are formed by a network of narrow-gauge tracks set into the paving. These tracks extend from the shaft to the individual workshops and were used to transport all kinds of workpieces. To the north of the sorting belt hall the tracks once leading out of the screening station are spanned by a long footbridge, providing direct access to the sorting belt hall, the waste bunker and also pit 1 / 2 / 8 via the junction bridge.

The outside installations also include the tip at the east which was already created from the waste produced by pit 1 / 2 around the turn of the century and was limited in terms of space in 1927 so that the central shaft installations could be built. From 1932 the tip was used for the storage and drainage of the waste and coal sludge via the open transport bridge from the waste bunker building and from pit 12.

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2.3 Architects of Surface Installations at Shaft 12 of Zeche Zollverein

The surface installations to be found at shaft 12 of Zeche Zollverein are the work of probably the most renowned German industrial and mine architects: Fritz Schupp and Martin Kremmer.

Fritz Schupp (1896 - 1974) was born in Ürdingen as the son of a manager employed in the local chemicals industry. He first went to school in Cologne and continued his schooling in 1905 in Essen at a classical grammar school. As he was not deemed fit for military service, he was able to start his studies at the Technical University of Karlsruhe in the winter semester of 1914. In the summer semester he made the acquaintance of Martin Kremmer from Berlin, who was likewise starting his study of architecture.

After successfully completing the first part of his degree Schupp transferred to Munich where he met Theodor Fischer, although this period of his life seems to have left little impression on him. In

1918 he continued his studies at the Technical University of Stuttgart, finishing his degree in 1919. In Stuttgart he made the acquaintance of Paul Bonatz.

After completing his degree he started his career as a professional architect. He drew up designs of mine workers' colonies for his father's company, took part in his first tenders and encountered Schulze Buxloh as a client and then as a sponsor over many years. His first industrial commission was to design a wash coe for 300 miners for the coking plant of the mine Holland 3 / 4 in Bochum Wattenscheid. In 1921 Martin Kremmer became his first employee and just one year later the two architects set up the associate partnership Schupp/Kremmer, Essen - Berlin. Both had an additional office in Berlin. They managed to keep their heads above water by performing design work for well-known architects before being confronted with new tasks following the founding of Vereinigte Stahlwerke AG.

During the economic crisis all types of commissions were performed. After 1934, when industry was experiencing dynamic growth in the framework of the Third Reich's strivings towards autarky, Schupp left his home in Berlin to handle the business from Essen. Martin Kremmer continued to run the office in Berlin. The partnership Schupp/Kremmer remained in place but the geographical division of work - Schupp was in the west and Kremmer in the east - naturally resulted in a loss of business contacts.

In the period immediately after the war industrial commissions were scarce. Instead Schupp was invited in 1949 to become a lecturer at the Technical University of Hanover but he devoted hardly any time to this. Contracts resulting from the economic development of the Federal Republic of Germany started to increase; numerous honours and awards testify to the high standing in which Fritz Schupp was held. He was awarded an honorary doctorate in engineering from the Technical University of Brunswick "in recognition of the characteristic influences he has managed to leave on design as an architect in the field of industrial construction".

Fritz Schupp died in 1974; beforehand he had entrusted his practice to his long-serving employees Patschul and Winkhaus.

Martin Kremmer (1894 - 1945), the somewhat neglected partner of Fritz Schupp, was born in Posen in 1894 as the son of the headmaster Dr. Kremmer. After going to school in Wilda (near Posen), Frauenstadt and taking his school-leaving certificate in Berlin he started his studies as an architect in Karlsruhe in 1915 but was then obliged to report for military service. After the end of the war he resumed his studies at Karlsruhe, Stuttgart and Berlin, where he was a student of Peter Behrens. After successfully completing his degree in summer 1921 he started his practical training at the Schupp offices in Essen.

The venture Schupp/Kremmer launched in 1922 was the start of a successful and mutually complementary partnership. Fritz Schupp, who was undoubtedly the more talented partner in terms of artistic ability, found Kremmer to be an able technician who ensured that it was possible to implement the aesthetic ideas developed jointly down to the last detail. At the start of their cooperation Kremmer was also responsible for project management, a task never undertaken by Schupp.

For the partnership Schupp/Kremmer the economic crisis occurring at the beginning of the 1930's resulted in a brief period of intensive cooperation in Berlin before the flood of commissions after 1933 brought about a gradual separation. The scope of the installations planned by the Berlin office was in all likelihood little smaller than those built in the west. However, following the destruction of the Berlin office and the seizure of Kremmer's own house following the arrival of the Allied forces there are now very few documents which put Kremmer's contribution in the proper light.

Martin Kremmer did not take part in realising the partnership's shared objectives with Fritz Schupp after 1945; he lost his life with the entry of the Russian forces in Berlin.

Between 1920 and 1974 Fritz Schupp was responsible for planning a total of 69 industrial installations, including such well-known buildings and installations as Zeche Zollverein in Essen, the Rammelsberg ore mine near Goslar, the zinc works at Harlingerode (from 1940), the steel works (1957 - 1959) and the continuous casting plant (1967 - 1968) in Duisburg-Ruhrort, the Horst power station in Gelsenkirchen-Horst (1937 - 1942) and the central coking plant of Zeche Zollverein in Essen-Katernberg (1957 - 1962). 33 of these installations were designed by Fritz Schupp together with his partner Martin Kremmer. Fritz Schupp's work can be divided into two phases, separated by the early death of Kremmer: the period of business partnership with Martin Kremmer (up to 1945) and the following period until 1974. During their period of cooperation Schupp and Kremmer built 22 mines together, including the mine Graf Moltke in Gladbeck (1920 - 1955), Zeche Zollverein 4 / 11 and 12 in Essen-Katernberg (both 1927 - 1932), Bonifacius in Essen-Kray (1929 - 1954) and Minster Stein und Hardenberg in Dortmund-Eving (1937). After 1945 Fritz Schupp planned another 18 mines without his former partner, including the mine Grimberg 1 / 2 in Bergkamen (1948 - 1952), Haus Aden in Lünen (1954) and Zeche Katharina in Essen-Kray (1955 - 1959). In all their work the two architects Schupp and Kremmer were a major influence on industrial and mining architecture in Germany. The above-ground installations of pit 12 of Zeche Zollverein were realised at the height of their creative ability and represented the culmination of their work: the expressionist style based on solid brick architecture characterising the work of Schupp and Kremmer until the end of the 1920's resulted in basically functional designs which reached their peak with Zeche Zollverein 12 in Essen-Katernberg between 1928 - 1932. The architectural forms of their constructivist functionalism were dominated by steel skeleton construction, steel framework walls clad with brickwork infill and rows of windows integrated in the framework grid. The design principle of axis and symmetry running through their entire work like a thread was consistently applied by the two architects both at Zeche Zollverein and Rammelsberg. Today the two installations are model examples of the attempts of Schupp and Kremmer to always come up with an expressive style capable of endowing an industrial installation with a representative character.

Thanks to the topographical circumstances both architects were virtually almost always able to plan their industrial projects without having to take the existing environment into consideration, "on the green meadow" so to speak, and seek the harmony of an installation in its own interior. The procedure was different for installations to be built in attractive landscapes. Here the architects looked towards regional building traditions, which they nevertheless did not copy but translated into a new architectural language, with functional and constructional prerequisites playing an important role. They made use of local building materials not only as a way of harking back to the environment but also due to the problems with the transportation of materials.

The post-war architecture created by Schupp without his partner Kremmer was almost exclusively functionalist in style. In emulation of the surface installations at pit Zollverein 12 he repeatedly varied the basic principle of a balanced arrangement of cubic structures, which were mostly designed as steel framework structures with brickwork infill and horizontal and vertical rows of windows.

Beside architects such as Peter Behrens, Hans Poelzig and Walter Gropius, Fritz Schupp is considered as one of the most important representatives of German industrial construction in the 20th century.

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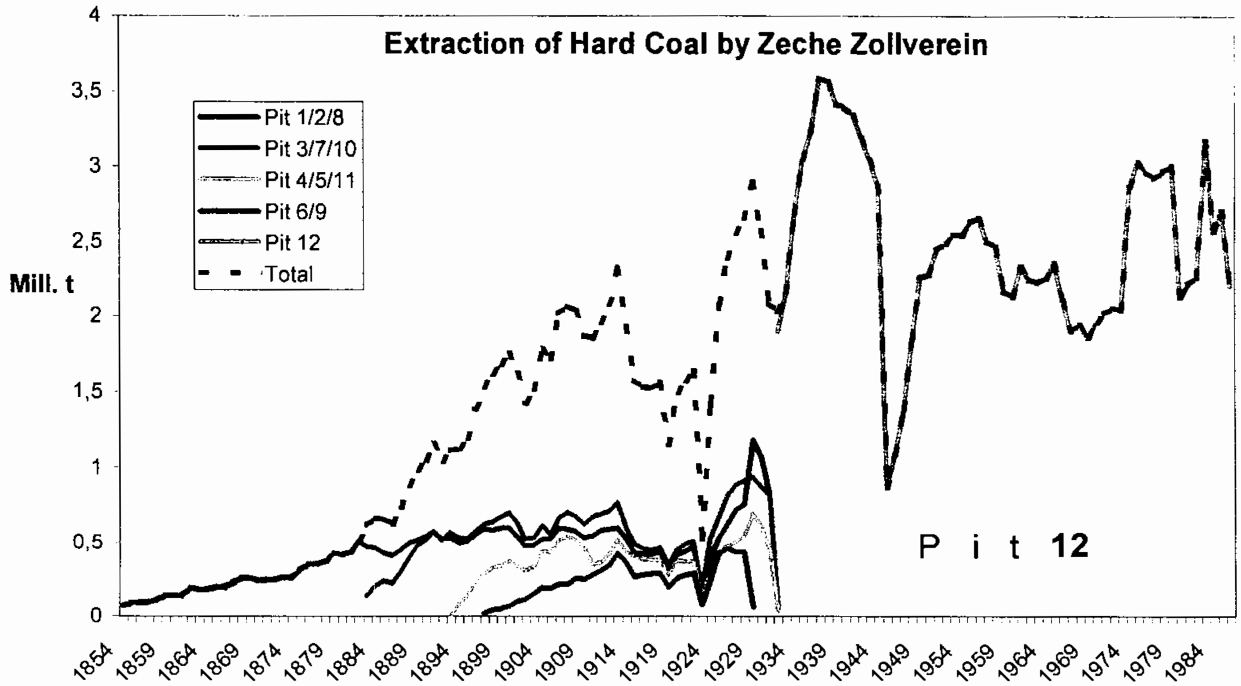
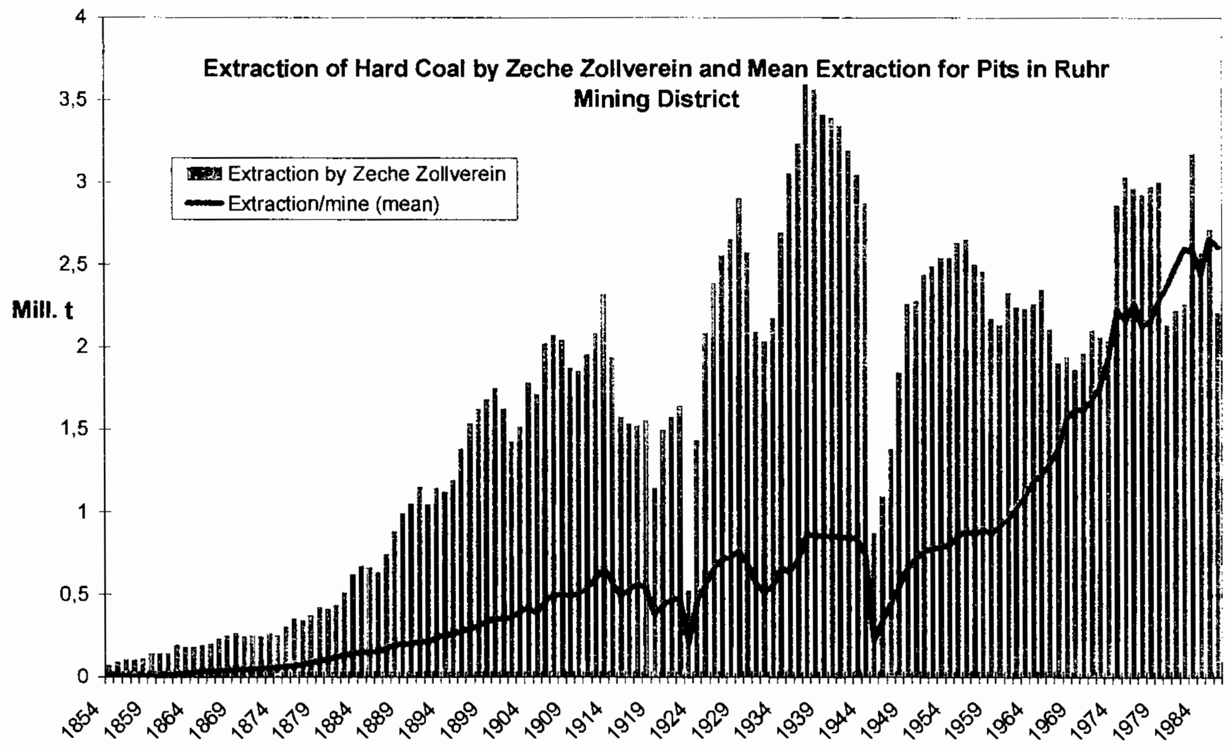
Roseneck, Reinhard: Der Rammelsberg, Hamelin 1992, p 31 f.

2.4 Economic Significance of Zeche Zollverein

The extraction of glance coal at pit Zollverein 1 / 2 / 8 started on 1 March 1851 with production at shaft 1; output figures are not available until December 1853. In the period from 1854 to 1882 the annual output of just under 71,000 tonnes was increased to over 500,000 tonnes of glance coal. On 1 June 1882 extraction started at pit 3 / 7 / 10. The output of the new pit until December 1882 is not known as it was included in the figure for pit 1 / 2 / 8 in 1882. After a swift increase in production over 1 million tonnes of glance coal was already extracted at both pits of Zeche Zollverein in 1890. With the start of extraction at pit 4 / 5 / 11 in November 1893 and pit 6 / 9 in June 1897 production rose to over 2 million tonnes by 1906 even if the production of the last two pits did not reach the output levels of the first two. At over 2.3 million tonnes in 1913 the mine reached its highest ever output. During the First World War output sank to 1.14 million t in 1919 but was increased again only to fall by over 1 million tonnes to around 500,000 t / year due to the political unrest in the Ruhr. By 1929 production had then risen again to almost 2.9 million tonnes. After the closure of pit 6 / 9 at the end of February 1929 and the other 3 pits on 31 January 1932 extraction started at pit 12 as the central shaft of the entire working field of Zeche Zollverein on 1 February 1932. In 1932 the output from shaft 12 had already reached the 2 million mark, and this rose to 3.5 million tonnes of glance coal before the Second World War (1937).

Following a sharp fall in production output was increased to over 2.6 million tonnes in both 1955 and 1956 despite the imponderability of the post-war years. By the end of the 1960's production had fallen to below 1.9 million tonnes per year due to the general development of the German glance coal mining, apart from brief increases in output. Until 1973 shaft 12 managed to maintain a production level of approx. 2 million tonnes per year. With the takeover of Zeche Holland in Wattenscheid shaft 12 also become the central main shaft of the working field Holland/Bonifacius in 1974 and boosted production to around 3 million tonnes per year. This production level was maintained until 1979. This year saw the closure of parts of the mining field which had been exhausted so that production fell to around 2.2 million tonnes in the following years.

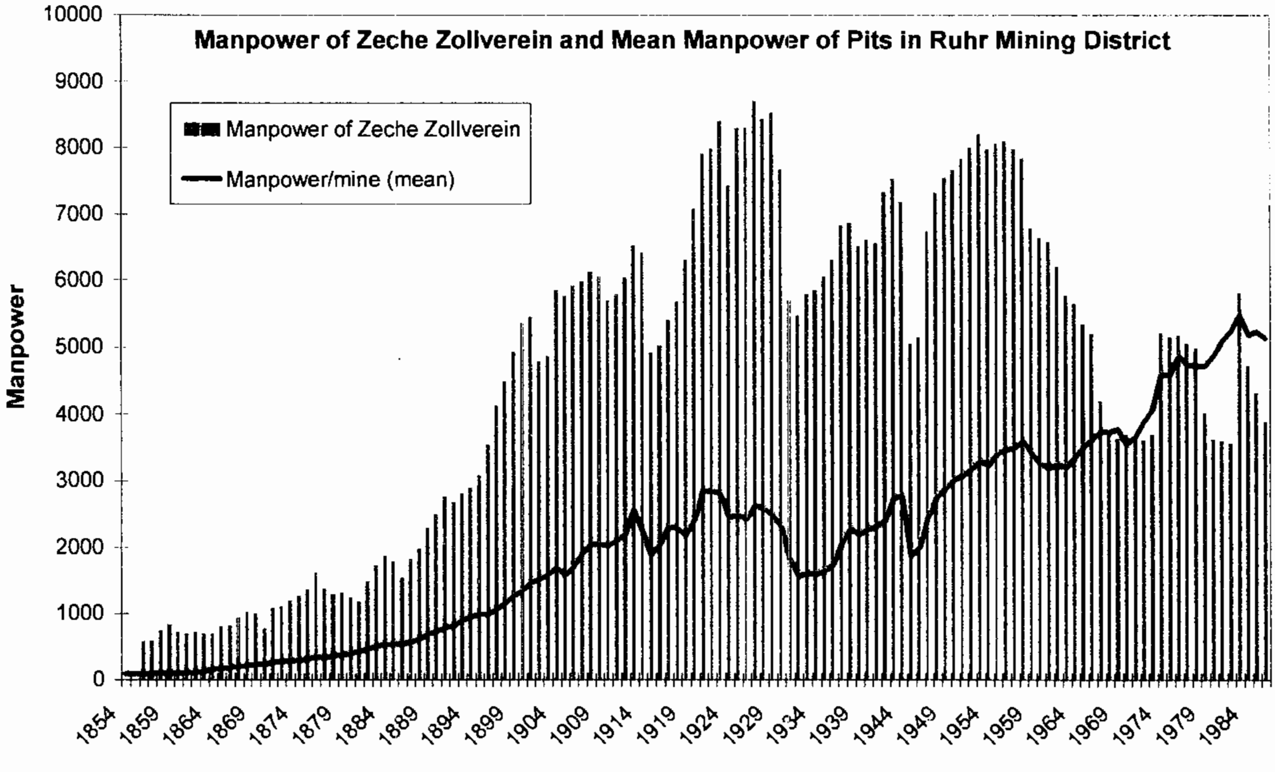




In the framework of further production restrictions in Ruhr mining a production amalgamation was formed with the mine Nordstern in Gelsenkirchen: intersection was carried out in 1982 and the entire production of both mines was brought to the surface via the more productive pit Zollverein 12 until closure of the working field Zollverein on 23 December 1986.

From the start of extraction in 1851 Zeche Zollverein was one of the most productive pits in the Ruhr Mining District. In over 130 years of operation the output levels were not only way above average but were some of the highest for the pits in the Ruhr Mining District. In the years 1888 to 1901, 1933 to 1938 and in 1945 Zeche Zollverein produced the highest volumes of glance coal of all pits in the Ruhr Mining District.

The staffing levels at Zeche Zollverein showed a similar development as the production levels. With a workforce of over 8000 employees at times the staffing levels at the mine were also way above the average for the other pits in the Ruhr Mining District; the mine thus acquired outstanding importance for the region, something which also went far beyond the mere function of an employer.



The closure of Zeche Zollverein on 23 December 1986 bid farewell to Europe's glance coal mine with the greatest economic significance.

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Data included in graphs (see also tables in appendix): Haack: Die Steinkohlenbergwerke der Vereinigte Stahlwerk AG - Zollverein Volume 1, Essen 1934, Huske, Joachim: Die Steinkohlenzechen im Ruhrrevier, Bochum 1998, annals for Superior Mining District Dortmund 26 - 29, Essen 1928 - 1931; annals for Ruhr Coal District 30 - 37, Essen 1932 - 1939; annal of coal mining 1949, Essen 1949; annals of German mining 1950 - 1966, Essen 1950 - 1966; annals of mining, energy, mineral oil and chemicals 1960 - 1964, 1972 - 1975, 1976/1977 - 1983/1984, Essen 1967 - 1983/1984, annals of mining, oil and gas, electricity and chemicals, 1985/1986 and 1987/1988, Essen 1985 and 1987.

The data for Zeche Zollverein between 1939 - 1946 was kindly provided by Joachim Huske (Dipl.-Ing.) and originates from internal statistics of the Gesamtverband des Deutschen Steinkohlenbergbau [parent association of German glance coal mining] in Essen.

Extraction and Manpower of Zeche Zollverein

Year	Total extraction (t)	Extraction (t) Pit 1/2/8	Extraction (t) Pit 3/7/10	Extraction (t) Pit 4/5/11	Extraction (t) Pit 6/9	Extraction (t) Pit 12	Manpower
1854	71384	71384					
1855	91651	91651					
1856	95169	95169					579
1857	95934	95934					585
1858	111960	111960					740
1859	140300	140300					833
1860	138396	138396					720
1861	142078	142078					695
1862	191756	191756					719
1863	178436	178436					697
1864	182819	182819					690
1865	193984	193984					804
1866	197874	197874					817
1867	225798	225798					938
1868	252620	252620					1023
1869	256018	256018					1001
1870	236647	236647					773
1871	246463	246463					1088
1872	244623	244623					1106
1873	260170	260170					1185
1874	254123	254123					1272
1875	303035	303035					1365
1876	345556	345556					1618
1877	344666	344666					1378
1878	366343	366343					1287
1879	419340	419340					1313
1880	408453	408453					1237
1881	426507	426507					1177
1882	508154	508154					1481
1883	617476	472414	145062				1729
1884	666666	464539	202127				1866
1885	663803	426946	236857				1790
1886	625750	404400	221350				1540
1887	740439	446535	293904				1821
1888	879887	496889	382998				1987
1889	985346	516539	468807				2282
1890	1048162	541548	506614				2488
1891	1155507	579652	575855				2768
1892	1039673	526857	512816				2676
1893	1114375	534835	573973	5567			2815
1894	1122337	496568	536720	89049			2906
1895	1188195	510487	531790	145918			3085
1896	1378375	562318	581771	234286			3539
1897	1532311	597127	628336	281720	25128		4124
1898	1616270	591835	646755	324228	53452		4504
1899	1680558	609772	677237	333015	60534		4933
1900	1752946	607166	704684	365684	75412		5355
1901	1619869	542752	637605	330746	108766		5451
1902	1423358	475046	525319	300573	122420		4789
1903	1511443	485393	535602	331442	159006		4870

Year	Total extraction (t)	Extraction (t) Pit 1/2/8	Extraction (t) Pit 3/7/10	Extraction (t) Pit 4/5/11	Extraction (t) Pit 6/9	Extraction (t) Pit 12	Manpower
1904	1780631	524698	620810	434037	201086		5851
1905	1713313	531480	563156	424533	194144		5768
1906	2017904	608986	673332	513896	221690		5918
1907	2065728	596170	710775	538718	220065		5985
1908	2037237	582658	677245	517013	260321		6124
1909	1869906	536188	629432	452680	251606		6052
1910	1855453	553277	678006	345195	278975		5700
1911	1950550	589121	694685	356182	310562		5793
1912	2076650	599689	716397	415208	345356		6045
1913	2322689	607054	773075	517586	424974		6526
1914	1927430	526034	612869	428914	359613		6414
1915	1574884	423470	487454	396090	267870		4921
1916	1526758	421235	453680	373110	278733		5019
1917	1519918	415767	443668	373435	287048		5399
1918	1555222	432973	461643	371466	289140		5683
1919	1144609	324931	336589	276482	206607		6302
1920	1492866	413688	446404	370714	262060		7083
1921	1570336	439023	488141	361466	281706		7919
1922	1635628	474264	510401	361197	289766		7996
1923	522748	157169	167793	112535	85251		8402
1924	1426201	379379	527860	277768	241194		7431
1925	2078305	542536	677754	432387	425628		8295
1926	2385368	634755	820975	471982	457656		8310
1927	2552566	731334	885594	501060	434578		8716
1928	2651140	762350	914990	541490	432310		8442
1929	2896070	1188830	939050	697510	70680		8526
1930	2568740	1075760	872080	620900			7682
1931	2087300	828080	818580	440640			5704
1932	2033950	54380	49030	33770		1896770	5471
1933	2166360					2166360	5800
1934	2686540					2686540	5855
1935	3046390					3046390	6057
1936	3230000					3230000	6309
1937	3588000					3588000	6835
1938	3564040					3564040	6874
1939	3415620					3415620	6514
1940	3394200					3394200	6624
1941	3343900					3343900	6564
1942	3190920					3190920	7331
1943	3042440					3042440	7528
1944	2868780					2868780	7187
1945	868937					868937	5046
1946	1088060					1088060	5155
1947	1384520					1384520	6748
1948	1844530					1844530	7322
1949	2258950					2258950	7549
1950	2275330					2275330	7673
1951	2439600					2439600	7848
1952	2486290					2486290	8010
1953	2540600					2540600	8218
1954	2542520					2542520	7998
1955	2628830					2628830	8074

Year	Total extraction (t)	Extraction (t) Pit 1/2/8	Extraction (t) Pit 3/7/10	Extraction (t) Pit 4/5/11	Extraction (t) Pit 6/9	Extraction (t) Pit 12	Manpower
1956	2654640					2654640	8103
1957	2502610					2502610	7993
1958	2465040					2465040	7852
1959	2171170					2171170	6788
1960	2129790					2129790	6650
1961	2331830					2331830	6587
1962	2245070					2245070	6204
1963	2225700					2225700	5783
1964	2256810					2256810	5651
1965	2354300					2354300	5345
1966	2113660					2113660	5204
1967	1902750					1902750	4196
1968	1943200					1943200	3711
1969	1864888					1864888	3628
1970	1963200					1963200	3693
1971	2019600					2019600	3668
1972	2058200					2058200	3606
1973	2042800					2042800	3695
1974	2863319					2863319	5210
1975	3027850					3027850	5149
1976	2965239					2965239	5177
1977	2921687					2921687	5053
1978	2966048					2966048	4988
1979	3003074					3003074	4022
1980	2133565					2133565	3619
1981	2216386					2216386	3600
1982	2263206					2263206	3560
1983	3173297					3173297	5815
1984	2569528					2569528	4733
1985	2706529					2706529	4319
1986	2207429					2207429	3885

Figures for Glance Coal Mining in Ruhr Mining District

Year	Mines	Extraction Ruhr Mining District (million t)	Manpower in Hard Coal Mining	Manpower /Mine (mean)	Extraction t/Mine (mean)
1854	199	2,94	19327	97	14759
1855	234	3,25	23235	99	13897
1856	278	3,51	27666	100	12629
1857	296	3,64	29644	100	12280
1858	287	3,90	31572	110	13585
1859	282	3,79	29236	104	13450
1860	277	4,28	28487	103	15437
1861	267	4,97	30681	115	18595
1862	257	5,70	32048	125	22183
1863	236	6,30	32560	138	26695
1864	231	7,48	37899	164	32368
1865	234	8,53	42306	181	36436
1866	231	8,58	43143	187	37121
1867	230	9,78	47746	208	42530
1868	224	10,44	48907	218	46620
1869	214	11,25	51670	241	52570
1870	215	11,57	50499	235	53819
1871	227	12,46	62384	275	54899
1872	240	14,15	66538	277	58975
1873	262	16,13	78343	299	61553
1874	268	15,25	81241	303	56910
1875	259	16,70	81822	316	64474
1876	231	17,64	81671	354	76372
1877	216	17,51	72399	335	81069
1878	203	19,02	73060	360	93670
1879	198	20,21	75425	381	102066
1880	193	22,36	78240	405	115876
1881	190	23,58	82239	433	124089
1882	187	25,76	88718	474	137738
1883	190	27,72	96845	510	145874
1884	186	28,26	99874	537	151930
1885	186	28,87	100557	541	155188
1886	179	28,44	98796	552	158877
1887	171	30,09	98463	576	175953
1888	170	33,16	104337	614	195082
1889	164	33,87	115018	701	206506
1890	175	35,51	127534	729	202954
1891	173	37,48	138467	800	216746
1892	174	36,97	141997	816	212471
1893	161	38,70	146193	908	240391
1894	161	40,73	152597	948	253006
1895	155	41,28	154796	999	266310
1896	162	45,01	161965	1000	277833
1897	164	48,52	176192	1074	295854
1898	166	51,31	192235	1158	309072
1899	162	55,07	206616	1275	339951
1900	170	60,12	228693	1345	353641
1901	166	59,01	246175	1483	355452
1902	163	58,63	246396	1512	359675

Year	Mines	Extraction Ruhr Mining District (million t)	Manpower in Hard Coal Mining	Manpower /Mine (mean)	Extraction t/Mine (mean)
1903	164	65,43	258981	1579	398982
1904	162	68,53	274603	1695	423000
1905	172	66,70	273183	1588	387813
1906	168	78,72	285685	1701	468583
1907	163	82,19	311385	1910	504245
1908	167	84,84	343767	2058	508048
1909	170	84,90	348809	2052	499388
1910	174	89,09	353347	2031	512011
1911	172	93,58	360908	2098	544047
1912	170	102,82	374041	2200	604812
1913	173	114,18	444406	2569	660017
1914	170	98,08	385737	2269	576941
1915	174	86,50	329993	1897	497126
1916	175	94,27	360371	2059	538703
1917	174	99,03	400645	2303	569138
1918	176	95,71	403347	2292	543835
1919	185	70,90	402819	2177	383249
1920	196	88,09	473968	2418	449439
1921	199	93,83	568729	2858	471673
1922	202	96,68	576644	2855	478589
1923	200	41,43	563283	2816	207130
1924	201	94,11	490852	2442	468214
1925	185	104,12	459876	2486	562832
1926	168	112,13	407858	2428	667446
1927	163	117,99	430120	2639	723890
1928	157	114,56	405351	2582	729701
1929	160	123,59	398552	2491	772437
1930	155	107,17	358738	2314	691439
1931	149	85,63	272373	1828	574685
1932	141	73,27	221069	1568	519681
1933	140	77,80	224300	1602	555721
1934	148	99,39	237380	1604	671541
1935	153	97,67	249465	1630	638353
1936	151	107,48	263526	1745	711775
1937	148	127,75	307299	2076	863189
1938	147	127,28	335084	2279	865878
1939	151	130,18	330510	2189	862139
1940	151	129,19	342830	2270	855556
1941	152	129,97	351218	2311	855072
1942	152	128,49	365946	2408	845329
1943	150	127,52	411536	2744	850100
1944	149	110,86	414657	2783	744000
1945	148	33,39	276192	1866	225581
1946	147	50,45	296340	2016	343211
1947	146	66,34	358400	2455	454363
1948	146	81,11	401671	2751	555521
1949	145	96,29	419733	2895	664062
1950	143	103,33	433359	3030	722580
1951	144	110,63	444934	3090	768264
1952	146	114,42	462715	3169	783685

Year	Mines	Extraction Ruhr Mining District (million t)	Manpower in Hard Coal Mining	Manpower /Mine (mean)	Extraction t/Mine (mean)
1953	146	115,55	480806	3293	791445
1954	148	118,71	479788	3242	802108
1955	140	121,11	479182	3423	864043
1956	140	124,63	484986	3464	890193
1957	141	123,21	494181	3505	873823
1958	136	122,30	488941	3595	899279
1959	132	115,39	451332	3419	874159
1960	125	115,44	408049	3264	923528
1961	121	116,08	387637	3204	959364
1962	112	115,90	363593	3246	1034803
1963	107	117,16	343977	3215	1094916
1964	99	117,57	331313	3347	1187525
1965	90	110,90	316114	3512	1232267
1966	79	102,91	287004	3633	1302633
1967	65	90,40	243525	3747	1390769
1968	58	91,05	216113	3726	1569827
1969	56	91,19	205965	3778	1628464
1970	56	91,07	198943	3553	1626303
1971	54	90,73	197790	3663	1680204
1972	47	83,28	182719	3888	1771936
1973	41	79,88	167152	4077	1948366
1974	35	78,17	160926	4598	2233457
1975	35	75,86	161113	4603	2167314
1976	32	72,79	156424	4888	2274812
1977	32	68,14	152109	4753	2129281
1978	31	67,11	146625	4730	2164871
1979	30	68,73	141983	4733	2291000
1980	29	69,13	141808	4890	2383931
1981	28	69,98	142987	5107	2499250
1982	27	70,24	141308	5234	2601481
1983	25	64,58	137211	5488	2583080
1984	25	61,22	129685	5187	2448680
1985	24	63,98	125842	5243	2665792
1986	24	62,76	123430	5143	2615000
1987	23	58,20	119633	5201	
1988	22	56,38	113736	5170	
1989	21	55,71	107869	5137	
1990	19	54,56	100949	5313	
1991	19	51,42	95359	5019	
1992	17	51,26	89770	5281	
1993	14	45,69	83953	5997	
1994	14	40,25	77773	5555	
1995	14	41,66	72483	5177	
1996	14	37,99	67354	4811	
1997	13	37,25	62534	4810	

2.5 Current Usage of Monument

The surface installations of Zeche Zollverein can be considered as model examples for changes of purpose in many regards: in particular the fields of art and design have been adopted as new functions for the historic buildings, sometimes employing a creative and pioneering approach but at least in an original way. At the same time this demonstrates how versatile technical monuments and historic fabric can be in terms of conversion; in the Ruhr Mining District the Zollverein pit has now become a symbol for the worthwhile preservation of buildings bearing witness to industrial culture.

Let us refrain from listing all changes in purpose and just consider a number of particularly successful examples. The "Kunstschacht Katernberg" or Katernberg Arts Pit has taken up residence in the machine house opposite **pits 1 and 2** and with its exhibitions has now become an important centre of communications.

Through an open planning procedure for the site of the former **pits Zollverein 3 / 7 / 10** involving intensive consultation consensus has been possible for investors regarding urban planning and architectural design and the requirements for the protection of historical monuments for example in the form of a so-called Handwerkerpark or Tradesmen's Park. In, addition project-related campaigns continue to provide for identification in an urban district in particular need of renewal and with complex social structures, e.g. through the creative measures for the long retaining wall and traffic areas in the framework of traffic-calming.

Particular importance was attached to the development of a citizens' and craftsmen's park, with the historic building fabric being given new functions compatible with its character. The gatehouse was converted into an advice and job centre for unemployed youngsters from the district; the cycle sheds are to be used as a base for social welfare activities or commercial purposes. The plans for the switching house provide for conversion into a day nursery for 130 children within the framework of a German/Turkish model project, while the former hoisting engine house and the yard in front of the renovated hoist frame are to be turned into an "Experience for the Senses" or a forum for socio-cultural events relating to the district. For this purpose the hoist frame is to be converted into an observation tower and a care centre for older people to be added to the historic building. It is planned to open the site and landscape it to form a park.

Where the surface installations of **pit Zollverein 12** are concerned, restoration of the entire complex has always been carried out under the stipulation that the site with its many different parts is to be maintained as an outstanding cultural monument of the 20th century, with work being performed in careful stages and preserving its historic structures and styles to the greatest possible extent. Following renovation or restoration of the building fabric the premises on the site will be allocated new functions with the aim of developing an active centre in particular for culture, design and industrial history; a special foundation has been set up to protect the interests of the complex and its users. One highlight in the history of the conversion of historic buildings is the move of the Design-Zentrum Nordrhein-Westfalen to the former boiler house, which was modified by Sir Norman Foster for this new role. The mechanical and electrical engineering workshops now house studios; the lower floor of the low-pressure compressor house is home to an exclusive and popular catering establishment while the upper floor is used as an exhibition area for modern art. Visitors can enter the premises of the once "forbidden pit" following a museum trail and trace the path taken by the coal through the building.

In the shadow of the impressive surface installations there lies a industrial wasteland: although Nature has already reconquered parts of this site, a number of areas still bear witness to the days of mining. On this wasteland Ulrich Rückriem has put up stone sculptures as a place of peace and contemplation. The central sculpture in a "clearing" consists of massive granite cubes which form an enclosed space. Inside the sculpture, which can be entered by visitors, there is a place of meditation; however the visitors' eye is drawn outside through the opening and reminding them of the history of the locality and the mine.

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2.6 Glance Coal on the Earth and Industrial Monuments

We will now proceed with an attempt to identify as accurately as possible the position of Zeche Zollverein on the international scale by looking at the other mines existing in the world and comparing them with Zeche Zollverein.

To decide whether a mining complex or a "landscape of monuments" possesses the historic character required by a monument to form part of the world's cultural inheritance the following qualities were taken into consideration: the mine should firstly have been of special significance for the people and should secondly have outstanding "technical" characteristics. The monument should then offer qualities which can be used to document significant stages in the development of the people and finally it should provide important information about economic and social trends, which should be recognised as being exemplary on the international scale. Above it has become clear that the landscape of monuments of Zeche Zollverein can fulfil these criteria for evaluation.

A comparison between the landscape of monuments of Zeche Zollverein with mines in other locations and mining districts is naturally difficult as not only the people on the earth each think and act in a specific way as individuals but because the history of formation for each mine and mining district also has its own qualities peculiar to that locality and country. However, their deposits are something all mines have in common: the desire for a sufficient output of glance coal for the benefit of the individual and the community forms the basis of all exploration and extraction activities. For this reason it has been decided to describe below the glance coal deposits important in mining terms and any existing monuments which possibly comply with the socio-cultural evaluation criteria mentioned above.

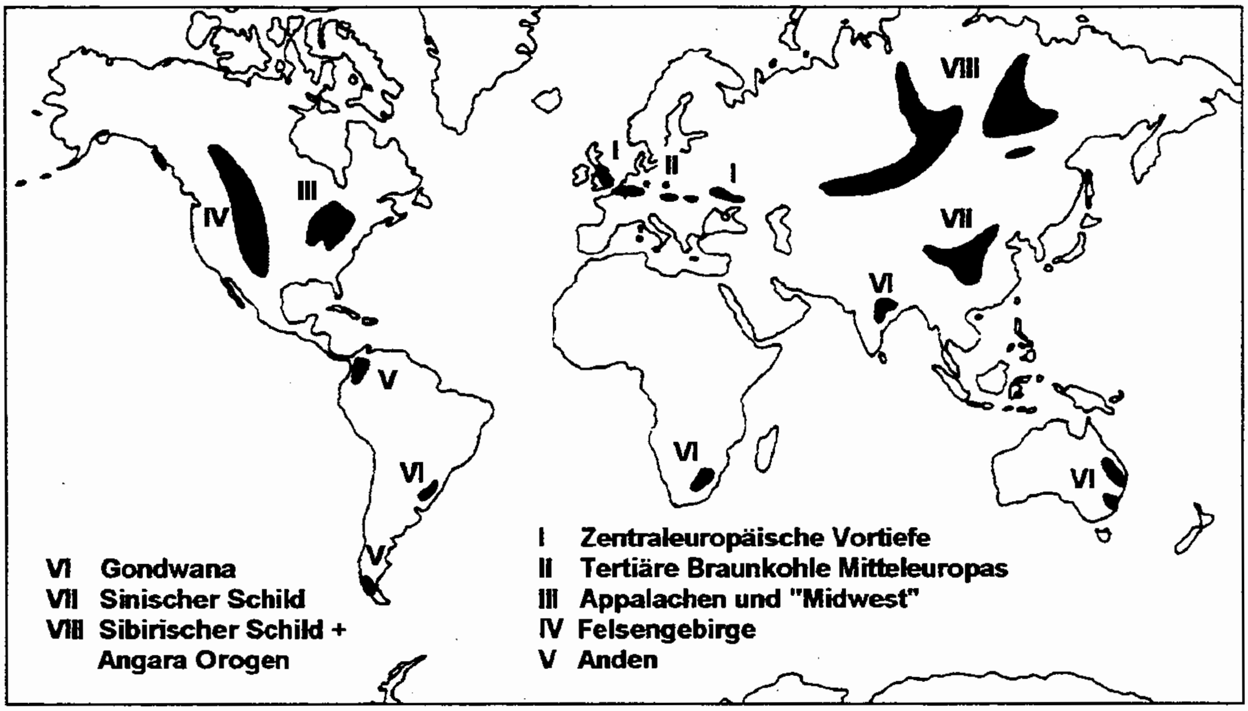
To date there has been major variation in the extent of the research performed by persons interested in the protection of historic monuments into individual monuments and glance coal mining complexes occurring with the earth's deposits: Western and Central Europe is better than Eastern Europe and Europe better than America and Asia. Due to the lack of research data our "evaluation" will contain gaps - but on the other hand it would be most surprising if in over 50 years of industrial archaeological research a "model mine" had been overlooked. And yet, although this study is characterised by certain shortcomings due to the lack of knowledge about existing monuments, particularly in the case of non-European countries, we will be entitled to claim that it offers a basic level of knowledge - going beyond the historical development of the individual mining districts.

However, the significance of the lack of information about such monuments can be minimised in so far as the geological data about the world's glance coal deposits can be considered as extremely good, for it is the deposits which shaped the type or size of the mining installations and thus consequently the economic, political, infrastructure and socio-cultural developments and phenomena of individual countries and regions, the mines and industrial landscapes. For example, the appearance of the surface installations mainly depends on the deepness of a deposit: this understanding is an important help for the comparison and evaluation of individual mines. The geological literature available not only generally includes the specific geological parameters but also certain information on the exploratory history of the deposit so it can be understood whether mines such as Zeche Zollverein could have developed on a deposit at the same time. The output and manpower statistics provide further indications about the productivity of the individual pits so that both mining and social "rankings" can be established. The geomorphological conditions of the glance coal mining districts also provide important indications whether comparable mines can be expected: hilly landscapes and narrow valleys obviously contain mines of a different quality to flatter areas with large "stocks of space".

It can be assumed that pits and mines cannot be expected on all glance coal deposits and in all districts, and certainly not with the character of a historic monument. As the stocks of individual countries are generally distributed between a large number of deposits of varying sizes (mining districts), this description will concentrate on the development of glance coal mining in the countries and districts with the greatest importance for mining but also on those where mining no longer takes place today. This will provide for a better understanding and evaluation of the Zollverein's landscape of monuments shaped by industry and their significance as part of the world's cultural inheritance.

Overview of the Deposits of Glance Coal on the Earth

On the earth glance coal mainly occurs in associated clans. They can be distinguished according to the conditions of formation and the formation period. Over half of the world's stocks of coal were formed many many years ago in the Carboniferous period (350 - 285 million years ago) and Permian period (285 - 225 million years ago). The remaining stocks are more recent formations: Jurassic (195 - 140 million years ago), Cretaceous (140 - 65 million years ago) and Tertiary (65 - 2 million years ago).



The Earth's Major Clans of Coal (from Kelter 1995)

I	**Central European syncline**	**V**	**Andes**
II	**Tertiary brown coal deposits of Central Europe**	**VI**	**Gondwana**
III	**Appalachians and "Midwest"**	**VII**	**Tibetan Plateau**
IV	**Rock ground**	**VIII**	**Siberian Plateau + Angara Orogeny**

The major deposit clans known to exist on the earth are:

I. The Central European syncline of the Varistikum: a belt of Upper Carboniferous glance coal deposits extending from England through Northern France, Belgium, Germany (Ruhr), Poland (Upper Silesia) to the Donets Basin in the Ukraine.

II. Tertiary brown coal deposits of Central Europe, in the Rhineland, Central Germany and Poland.

III Appalachians in the east of the USA, with deposits of Upper Carboniferous glance coal and anthracites in the synclines of the variscan ground. To the west there is the glance coal of the "Midwest clan" dating from a similar age in platform-type basins.

IV. Jurassic-Cretaceous-Tertiary coal deposits in a belt running north/south from Canada through the USA to Mexico and containing rich deposits of horizontally positioned brown coal and steeply dipping glance coal deposits.

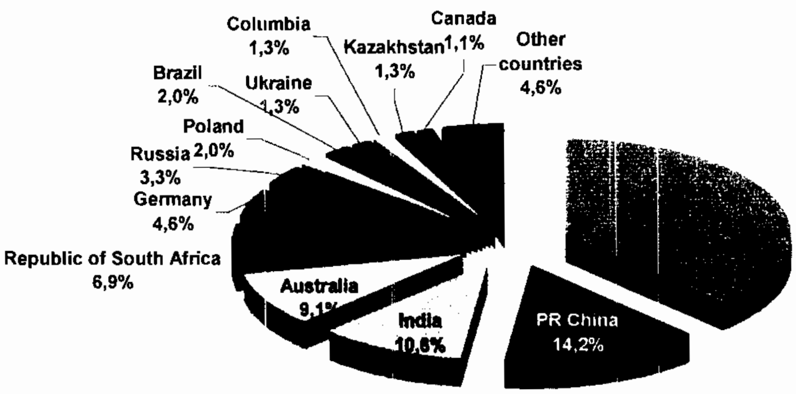
V. The Andes in South America contain rich horizontally positioned brown coal and glance coal deposits dating from the Cretaceous-Tertiary periods in the north of Columbia and the south of Chile.

VI. The Gondwana clan of the southern continent includes Permo-Carboniferous platform-type glance coal which occurs for example in Brazil, South Africa and India. The glance coal dating from a similar age in Eastern Australia is located at the transition to Tasman-Orogeny.

VII. Most of the coal deposits in the PR of China are located in platform-type basins in the Tibetan Plateau in the north and northeast of the country; they were mainly formed during the Jurassic and Permo-Carboniferous period.

VIII. In the Asiatic part of the former Soviet Union there are two major clans: firstly, the synclines and the internal sinks of the variscan Angara-Orogeny from the Carboniferous and Permian period (Karaganda, Kusnetsk) and secondly in platform-type basins on the Siberian Plateau, mainly from the Jurassic and Cretaceous periods.

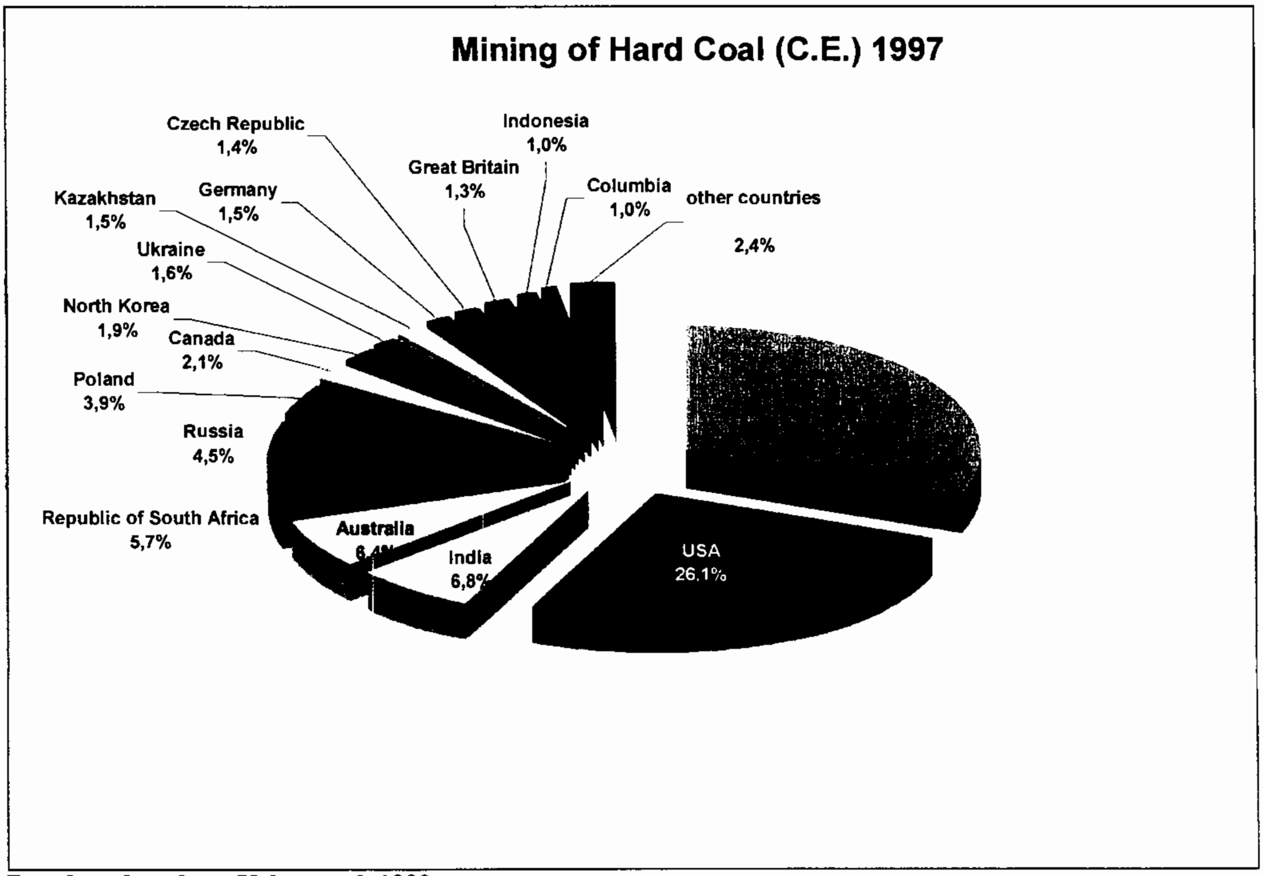
International Percentages of Extractable Paying Reserves of Glance Coal (C.E.) 1997



Based on data from Kelter et al. 1999

The horizontally positioned unfolded deposits, which account for 60% of the world's stocks, are increasingly acquiring greater economic significance. They often include rich seams of an even thickness. Flat unfaulted stratification at reduced depths facilitates extraction using open cut mining. This mainly involves recent deposits of brown coal but most of the glance coal deposits from the Gondwana period (Permo-Carboniferous coal) on the southern continents are also of this type.

The coal deposits positioned diagonally to steeply dipping are characterised by a large number of irregularly formed seams in series of strata often thousands of meters thick. The seams occur at varying deepnesses and often with a complicated folded and faulted stratification. Extraction therefore usually has to be carried out using underground mining. The carbonisation level of the coal is generally high. High-quality coking coals such as lean coal and anthracite are often associated with this type of deposit.



Based on data from Kelter et al. 1999

The major deposits of coal are concentrated on the Northern Hemisphere of the earth. In 1997 the world's total resources of hard coal[1] and soft brown coal was put at 6,668 billion coal equivalent (C.E.) tonnes [2]. Of this quantity 558 billion C.E. tonnes is identified as extractable paying reserves (487 billion C.E. tonnes of hard coal and 71 billion C.E. tonnes of brown coal). The worldwide stocks of coal (total resources) are divided up between 96 countries, of which 85 are identified as having extractable paying reserves (see table). North America alone holds 37% of these reserves, with Asia accounting for 31%, Europe 12%, Australia 10%, Africa 7% and Latin America 3%. The USA, China, India, Australia, South Africa and Germany, which are among the

[1] Glance coal, anthracite and hard brown coal have been summarised under the term "hard coal".

[2] As the different types of coal and also identical types of coal from different deposits have different energy contents, the so-called "coal equivalent unit" (C.E.; germ. = SKE) is used to permit comparison. One C.E. tonne (C.E. tonne) is based on a heat quantity of 29.3 GJ. This corresponds to the gross calorific value of 1 tonne of good-quality glance coal or 3 tonnes of an inferior soft brown coal. To determine the quantity in C.E. tonnes quantities of coal in metric tonnes were multiplied by conversion factors specific to each country. These conversion factors for hard / glance coal range from 0.60 (Czech Republic, Czechoslovakia, Slovak Republic) to 0.94 (Germany, Columbia). The quantities in C.E. tonnes for the individual countries are therefore lower than the respective quantity in metric tonnes. A list of the country-specific conversion factors can be found in Kelter et al. 1999.

14 major coal-producing countries, hold well over 80% of the total extractable paying reserves of hard coal.

Development of Coal Production in the Main Coal-Producing Countries in Million C.E. Tonnes between 1965 - 1997 (from: Kelter 1995 and Kelter et al. 1999)

Pos.	Country	1965	1970	1975	1980	1985	1990
01	PR China	216	259	338	437	598	763
02	USA	410	476	504	639	669	773
03	USSR	328	356	402	414	423	407
04	Poland	108	129	158	175	180	146
05	India	49	54	69	79	109	155
06	Rep. of South Africa	41	46	59	98	147	149
07	Australia	36	52	70	76	118	162
08	Czechoslovakia	60	66	68	73	77	n.v.
09	Great Britain	156	119	105	105	77	77
10	FR of Germany	185	135	128	125	117	174
11	GDR	77	79	74	77	94	n.v.
12	Canada	9	13	22	32	52	61
13	Columbia	3	3	3	5	9	20
14	Indonesia	<1	<1	<1	1<	1	7
	Top 14	1677	1787	2001	2336	2670	2894
	World	1944	2020	2177	2558	2930	3156

Pos.	Country	1992	1993	1994	1995	1996	1997
01	PR China	787	833	897	984	991	953
02	USA	752	709	778	778	801	825
03	Russia	225	205	185	181	175	168
04	Australia	175	178	180	191	199	209
05	Indiea	171	175	181	187	192	213
06	Rep. of South Africa	148	160	166	175	175	172
07	Poland	132	131	134	136	136	136
08	Germany	137	119	109	106	100	95
09	Ukraine	84	75	70	56	52	49
10	Kazakhstan	82	72	67	54	49	47
11	Canada	58	61	64	66	67	70
12	Great Britain	70	56	40	43	41	40
13	Columbia	22	20	21	24	28	30
14	Indonesia	15	19	19	27	31	31
	Top 14	2866	2814	2913	3008	3039	3038
	World	3133	3071	3174	3260	3293	3304

The **development of coal mining**[3] must be seen in the context of the overall worldwide consumption of energy. Until 1990 the worldwide consumption of energy for commercially traded sources of energy (hydrodynamic power, nuclear energy, natural gas, mineral oil and coal) showed a steady increase. 1991 saw the start of a period of stagnation which continued until 1993 due to the worldwide economic downturn. At the end of the 1980's the international coal mining maintained the growth of the previous decades and at 3,187 million C.E. tonnes reached a peak in 1989. The stagnation in output occurring in 1990 lasted until 1993 or there was even a fall in production. The decline in output was more noticeable in the case of soft brown coal than hard coal. In some cases the development of output in individual countries and mining regions diverged greatly from the international situation. While there has been a marked fall in production in the "classical" coal-mining countries of Europe since the 1980's, the reverse has been seen in Asia, Australia, Latin America and Africa. Between 1993 and 1997 the world output of coal of 3,071 million C.E. tonnes rose to a total of 3,304 million C.E. tonnes. In particular, the output of hard coal increased from 256 million C.E. tonnes to 3,009 million C.E. tonnes while the

[3] The extraction quantities are generally based on the usable output. The figures vary depending on the source used but remain within the same dimension.

production of soft brown coal fell 23 million C.E. tonnes to 295 million C.E. tonnes. Following the closure of unprofitable mines in Europe, the output of coal there fell a total of 49 million C.E. tonnes to 417 million C.E. tonnes. During the same period the production of hard coal in Europe fell 38 million C.E. tonnes to 270 million C.E. tonnes. The production of hard coal of individual countries in 1997 is shown in the following table. In recent years a major contribution to the positive worldwide trend for production was made by North America, followed by Asia, Australia, Latin America and Africa.

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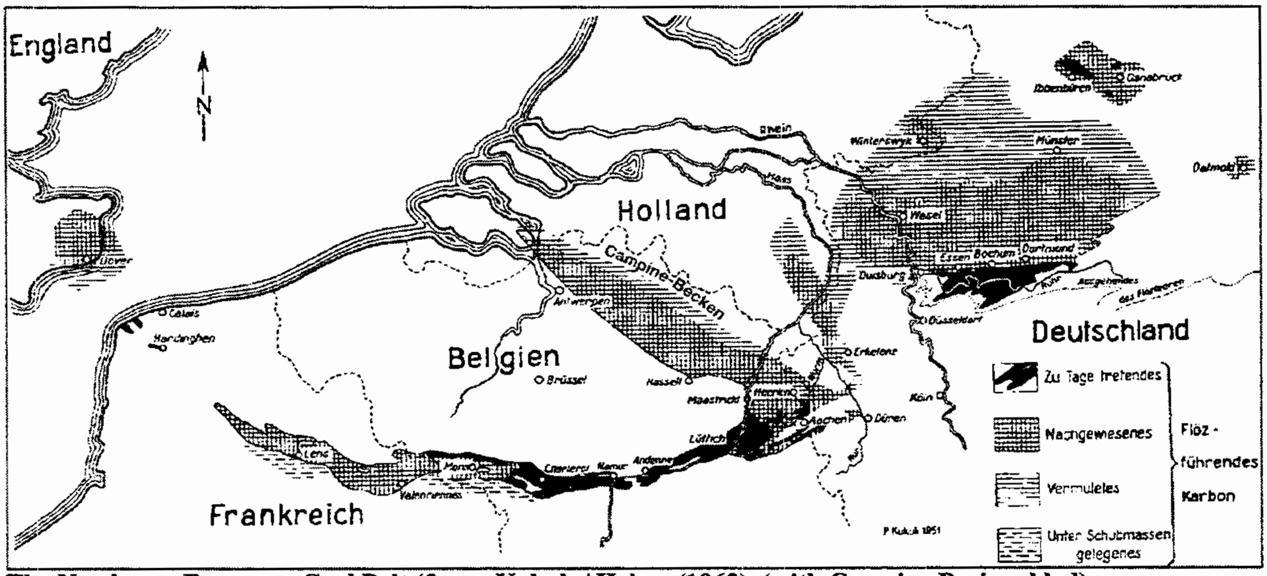
Stocks of Coal and Production of Countries in C.E. Tonnes (1997) from Kelter et al. 1999

Country	Hard Coal Total Resources C.E. Tonnes Mio	Extractable Paying Hard Coal Reserves C.E. Tonnes Mio	Hard Coal Production 1997 C.E. tonnes 1000 t
Russia	2962640,0	16000,0	136000
USA	809973,0	183451,8	785591
PR China	487440,0	69048,0	926554
Germany	197400,0	22560,0	43973
Australia	181080,0	44280,0	192600
Botswana	167652,8	3450,4	704
Great Britain	156620,0	820,0	40295
India	112762,9	51640,4	205190
Poland	106240,7	9935,7	116535
Ukraine	61248,0	6534,0	47916
Canada	52821,0	5506,2	63687
Rep. of South Africa	37854,8	33604,8	172486
Kazakhstan	27217,1	6209,3	46284
Pakistan	23466,1	2049,6	2470
Brazil	21815,2	9560,0	4155
Columbia	21712,1	6344,1	29610
Czech Republic	9577,2	3618,6	41400
Zimbabwe	9387,2	587,2	1728
Indonesia	7514,0	1404,0	30810
Chile	4414,2	826,7	1117
Korea, North	4400,0	480,0	57200
Mongolia	4263,2	81,6	1200
Venezuela	4005,6	383,2	3793
Spain	3696,0	462,0	14694
Hungary	3385,6	1262,4	749
Vietnam	2944,8	451,2	6960
New Zealand	2683,2	114,4	2918
Mexiko	2578,4	928,0	7118
Netherlands	2200,0	none	production stopped
Kirghizia	1452,0	92,4	330
Bangladesh	1424,0	18,4	none
Yugoslavia (Serbia and Montenegro)	1361,9	1149,1	97
Tanzania	1360,0	160,0	80
Iran	1194,4	154,4	1400
Bulgaria	1188,0	196,8	149
Nigeria	944,6	148,2	39
Romania	905,3	648,5	3034
Swaziland	727,2	92,8	144
Mozambique	672,0	192,0	32
Zaire	646,9	70,4	none
Turkey	635,2	408,6	1876
Japan	612,3	612,3	3554
Georgia	528,0	29,7	3
Turkmenistan	528,0	none	none
Argentina	412,0	104,0	278
Afghanistan	372,8	52,8	176
Belgium	352,6	none	production stopped
Malaysia	309,6	3,2	84

Country	Hard Coal Total Resources C.E. Tonnes Mio	Extractable Paying Hard Coal Reserves C.E. Tonnes Mio	Hard Coal Production 1997 C.E. tonnes 1000 t
(Greenland) Denmark	306,4	146,4	none
Korea, Rep.	283,2	65,6	3696
Slovakia	279,6	130,2	1080
France	268,6	98,6	4852
Uzbekistan	254,1	37,6	62
Italy	245,6	21,6	none
Thailand	243,2	136,0	none
Philippines	202,4	168,8	880
Tajikistan	171,6	26,4	none
Algeria	154,4	32,0	16
Peru	133,6	28,8	87
Myanmar (Burma)	99,7	3,7	18
Albania	98,8	17,2	none
Madagascar	89,6	none	none
Taiwan	79,2	79,2	400
Niger	65,1	9,1	120
Egypt	59,2	17,6	280
Zambia	58,4	44,0	304
Slovenia	50,4	31,2	600
Marocco	44,0	4,0	416
Norway (Spitzbergen)	40,8	4,8	241
Laos	36,8	0,8	none
Oman	34,0	2,0	none
Ireland	32,0	11,2	none
Moldavia, Rep	30,4	8,0	none
Ethiopia	22,4	none	none
Austria	22,4	20,0	916
Croatia	17,7	4,8	none
Costa Rica	17,6	none	none
Honduras	16,8	none	none
Sweden	14,7	0,7	none
New Caledonia	8,0	1,6	none
Cambodia	5,6	none	none
Malawi	4,0	1,6	50
Portugal	2,4	0,8	none
Bhutan	2,0	0,1	none
Nepal	1,6	1,6	none
Greece	1,2	0,4	none
Cameroon	1,1	0,4	none
Bolivia	0,8	none	none
Bosnia-Herzegovina	n.v.	n.v.	none
Dominican Republic	n.v.	n.v.	none
Ecuador	n.v.	n.v.	none
Haiti	n.v.	n.v.	none
Mali	n.v.	n.v.	none
Macedonia	n.v.	n.v.	none
Sierra Leone	n.v.	n.v.	none
Central African	n.v.	n.v.	none
World	**5508119**	**486884**	**3009031**

2.6.1 Europe

The deposits which formed during the Upper Carboniferous period (320 - 285 million years ago) on the edge of the so-called variscan ground between England and Poland had the greatest importance for glance coal mining in Central Europe. This mainly involves deposits of paralic coal e.g. in the Ruhr/Emscher/Lippe district (Ruhr Mining District), the Aachen/Erkelenz Mining District or in the Campine Basin and the Belgian/French carboniferous channel which like a number of limnic deposits (e.g. in the Saar region) were once important or still are today.



The Northwest European Coal Belt (from: Kukuk / Hahne (1962), (with Campine Basin added)

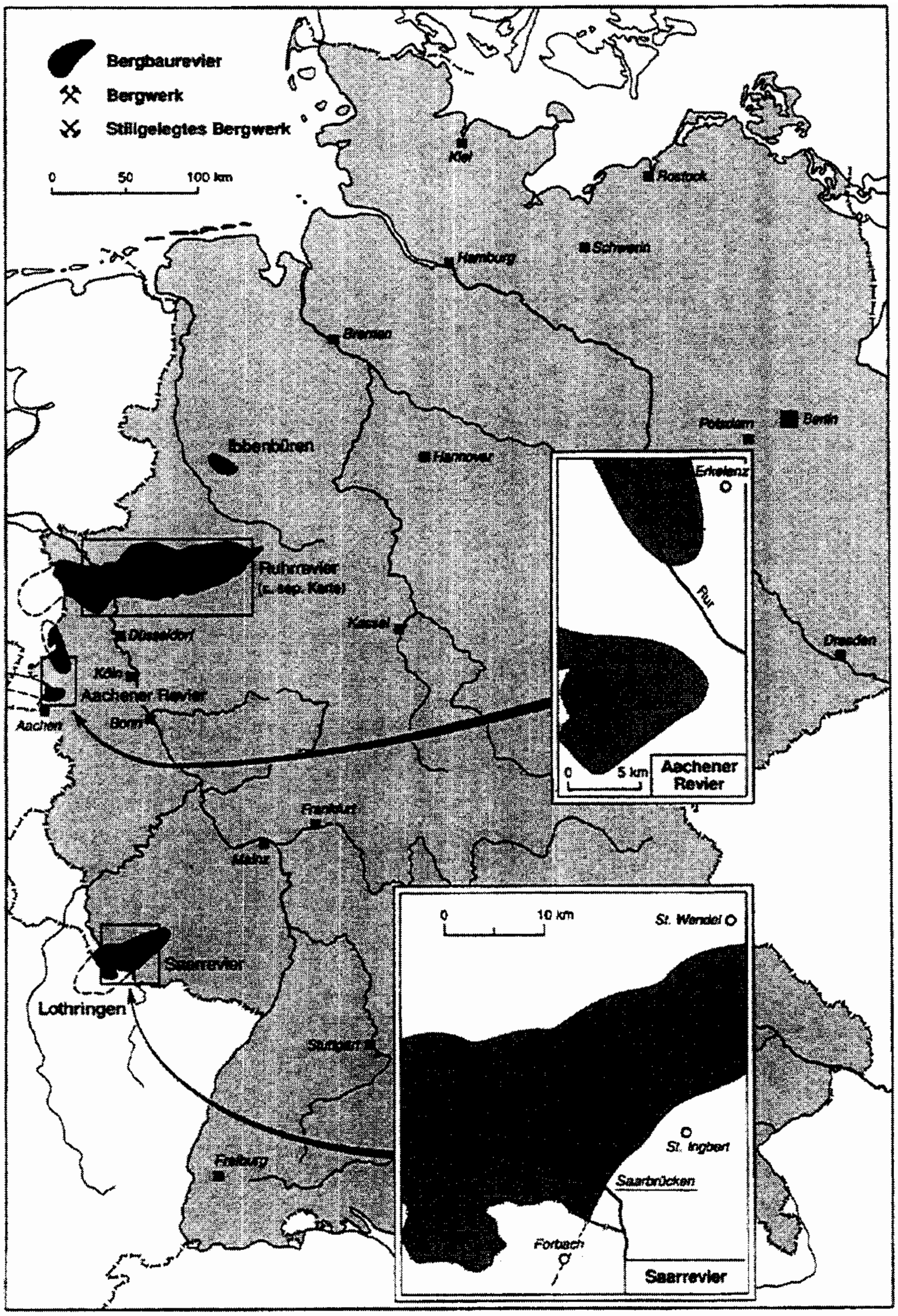
Caption:
- cropping out
- proven
- assumed
- under nappes

stratified carbon containing coal seam formations

2.6.1.1 Germany

Despite the intensive glance coal mining activities lasting many centuries in Germany, the country is still in possession of sizeable reserves. In 1997 the stocks of extractable paying hard coal were in excess of 22.5 billion C.E. tonnes. This figure puts the Federal Republic in 6th position in the world although the mining of glance coal in Germany is not financially viable under the present conditions and imported coal is becoming increasingly important.

The above-mentioned reserves of hard coal consist solely of glance coal from the Upper Carboniferous period and can be found in West Germany in the mining districts of the Ruhr, Aachen, Ibbenbühren and the Saar. Today mining is only carried out in the Ruhr, Ibbenbühren and the Saar Mining Districts after the cessation of production at the last pit in the Aachen Mining District in 1997.

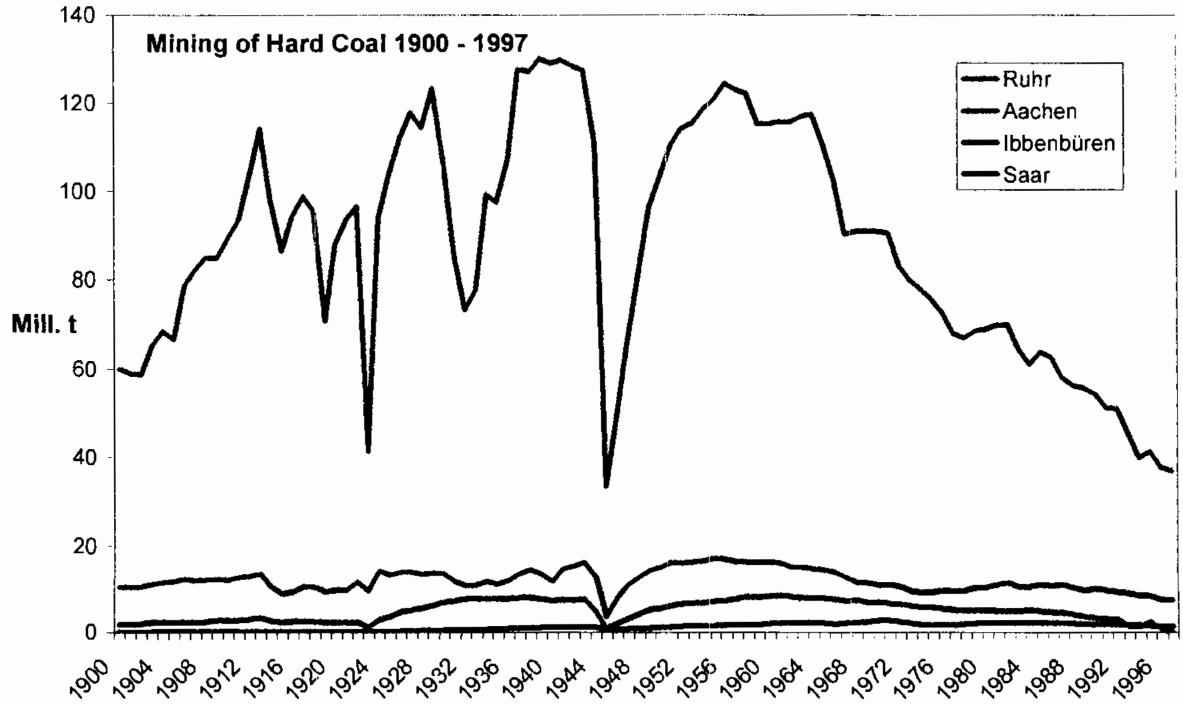


Glance Coal Mining Districts and Glance Coal Mines (from: annal of mining, mineral oil and natural gas, petrochemicals, electricity and environmental protection 1994, p. 40 (supplemented)

- Caption:
- Mining district
- Mine
- Closed mine

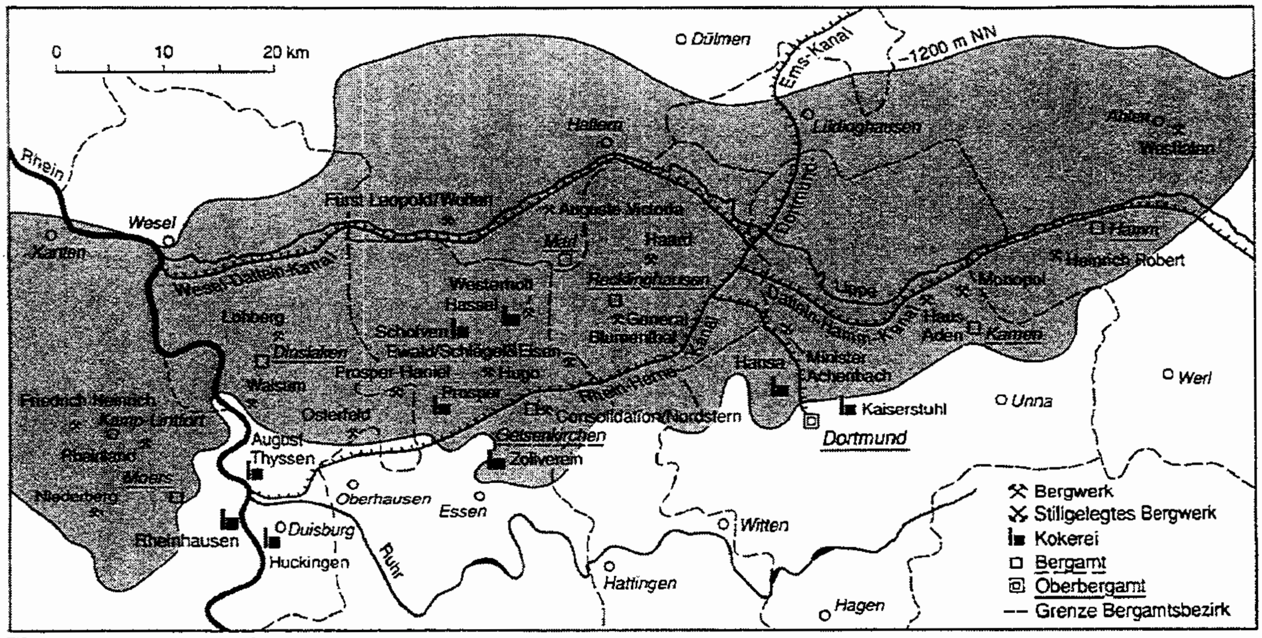
The first three districts with paralic coal deposits form part of the so-called "Central European Coal Belt" which lies under large areas of the North-German plain and the southern part of the North Sea. At the northern edge of the Rhenish slate ground the stratified layers crop out at the surface in the Ruhr and Aachen Mining Districts. Towards the north the layers of carbon disappear and are covered by increasingly thick cap rock further northwards. At Ibbenbühren and Osnabrück the carbon with its seams of glance coal crops out again in places due to the elevation of the strata.

The Saar Basin we can find Europe's largest intramontanous deposit of glance coal containing carbonic and limnic glance coal. The Federal Republic of Germany also contains further deposits of glance coal from the Carboniferous period and more recent times, of which only the Saxon Lugau/Oelsnitz Mining District for glance coal in Saxony is of any great importance in this context given its historical development and significance for glance coal mining in the former GDR.



2.6.1.1.1 Ruhr Mining District

The mining region of the Ruhr Mining District, the centre of German glance coal mining, extends from Moers in the west to Hamm/Westphalia in the east. Towards the south it reaches to the area between Velbert and Wuppertal and in the north to the south of the Münsterland. Covering an area of 5,261 km^2 and accounting for over 85% of the reserves and approx. 80% of German glance coal mining (46.49 mio. tonnes in 1997) the Ruhr Mining District is Germany's largest glance coal mining district. For over 200 years this deposit has been mined on a large scale. In this time over 9 billion tonnes of glance coal has been extracted. Of the around 3,000 m of stratified series of Ruhr carbon seams only account for around 1.5%. The thickest seams have a depth of 3.5 m; less than 50 are workable. As the carboniferous strata crop out in the south of the district and disappear under increasingly thick cap rock sediments in the north, the northern boundary of the district is marked by a cap rock deepness of 1,000 m. However the stratified layers continue towards the north at greater depths.



Glance Coal Mining Operations and Mining Authorities in the Ruhr Mining District (from: annal of mining, mineral oil and natural gas, petrochemicals, electricity and environmental protection 1994, p. 41)

Caption:
- **Mine**
- **Closed mine**
- **Coking plant**
- **Mining anthority**
- **Board of Mines**
- **Boundary of mining authority district**

According to the most recent calculations on 1 January 1995 the remaining stocks amounted to 20.7 billion tonnes (referred to the part of the deposit to the 1,000 m line of the carbon depth position and up to a deepness of 1500 m) in seams with max. 35% waste and a minimum coal depth of 60 cm. Of this the workable quantity is put at 7.16 billion tonnes with a deposit utilisation level of 34.6% (data according to Daul & Juch 1999). With high calorific values (27.6 MJ/kg - 31.5 MJ/kg) and low sulphur contents (< 1%) the coal from the Ruhr is of very good quality. Over 50% of the reserves consist of high-quality coking coal.

Development of Glance Coal Mining in the Ruhr Mining District

In the south of the district glance coal crops out near the Ruhr over an area of approx. 500 km^2. It was here that glance coal was first mined, with the earliest documentary proof dating back to the 13th century. However, it is probable that mining of coal goes back even further south of Dortmund, in Witten, in the Schlebusch Mining District, at Sprockhövel, Hattingen or the vicinity of Essen-Burgaltendorf and Essen-Werden. Glance coal acquired great importance for the forge fire as early as the 14th century. For a long time glance coal mining, which at that time was generally carried out using the gallery method, only played a insignificant role. With the steam engine at the start of the 19th century it was possible to mine at greater depths once the seams had been largely exhausted via the floors of the galleries. The introduction of steam power was one of the greatest technical innovations in the mining of glance coal. The use of steam-driven pumps in the mines to remove the copious quantities of pit water and efficient hauling systems were the basic technical prerequisites for underground working which from around 1850 allowed glance coal to become a bulk commodity.

Initially the River Ruhr was the most important mode of transport and in the middle of the previous century Germany's most frequented waterway. Industrialisation then started with the construction of the railways which allowed coal to be transported over wide distances. Other prerequisites were the development of an output and profit-oriented class of entrepreneurs with a liberal economic approach (e.g. Stinnes or Haniel), the greater availability of capital and lastly, revision of the mining laws.

With its General Mining Act in 1865 the Prussian state, which held the most important German deposits of glance coal, sparked off an economic and social trend for the Prussian states, releasing it from direct economic responsibility and subsequently surrendering the development of glance coal mining to the free interplay of market forces and the economy. In the following years this step represented an important economic benefit in terms of industrial growth.

With the replacement of the principle of direction by the principle of inspection as the result of the new mining act the pit owners then assumed personal responsibility for their own mines although they were still subject to state control particularly as regards safety measures (e.g. submission of operation schedules) - control which was unknown in any other business sector. For example, the state could even compel a mine owner to operate if this was in the public interest.

After the brief boom in glance coal mining at the beginning of the 1850's the first worldwide economic crisis of 1857 featured all typical difficulties of subsequent years, above all the problem that glance coal mining is particularly susceptible to economic crises due to the given natural geological imponderables, i.e. it is unable to respond immediately to the market. One major factor is the fact that even today glance coal and in particular, coke products depend on the ups and downs of the steel industry and also on the general economic development through power consumption

The breakthrough of glance coal mining to become a large-scale industry in the 1860's and 1870's naturally resulted in an enormous demand for manpower. The Prussian act dated 1861 governing the free movement of workers provided the legal basis for the mobility and migration of the population. Where the mines in the Ruhr were concerned, the additional manpower was mainly provided by Poland, East and West Prussia and Lower and Upper Silesia.

The merger of businesses in the glance coal mining districts could already be observed at an early stage. The Verein für die bergbaulichen Interessen in the Dortmund Board of Mines district took this step ahead of everyone else in 1858.

The amalgamation of technology, capital and labour had provided for the breakthrough of glance coal mining in the framework of high-level industrialisation in Germany. The concentration of mining operations and the increase in manpower resulted in a rise in worker productivity between 1855 and 1885.

To cope with the increasing volumes of glance coal and waste for underground transportation it was essential to develop methods of underground hauling. After the use of pit ponies on the main gangways around the middle of the 19th century, and the importance of cable and endless chain transporter systems from the 1880's locomotive transportation in glance coal mining only came into general usage in the first decade of the 20th century.

Despite the introduction of electricity in the form of the electric motor for the control of ventilation (underworkings) in the final third of the 19th century, the hoisting engines remained steam-driven until the turn of the century. The world's first electric hoisting engine did not make its appearance until 1902 at the pit Zollern 2 / 4 in Dortmund-Bövinghausen.

Other milestones on the path towards the creation of large-scale concerns were the improvement of employment and working conditions. This included steps such as the restrictions on blasting and the usage of safety explosive materials (following the invention of dynamite by Nobel in 1867), the introduction of mining lamps and many other measures.

The epoch-making changes occurring since the start of industrialisation undoubtedly involved the actual extraction of the coal. During the whole of the 19th century the coal was worked by hand using the wedge pick and blasting. Purely manual methods of working finally disappeared after the First World War with the introduction of the compressed-air hammer.

Until recent times the structure of German heavy industry has been influenced by the amalgamation between coal and iron initiated in the second half of the 19th century. Up to 1914 it was undertaken in the Ruhr by families of industrialists (Haniel, Grillo, Stinnes) and by companies operating solely in the mining sector, such as Gelsenkirchener Bergwerk AG, which developed into mixed concerns after the turn of the century.

The development of German glance coal mining as a primary commodity industry was accompanied by economic "by-products" which subsequently acquired major importance. The sometimes circuitous development of all waste and by-products of glance coal took place under the slogan "From a by-product to a valuable material". The benzol produced during the coking process was used as a fuel as early as 1904.

The conversion of coal into energy was so far advanced in 1910 that Germany was the world leader in terms of production. In 1913 28% of the German output of glance coal underwent coking.

During the period between the two world wars the development of German glance coal mining was subject to in a national, political and military disruptions, economic instability and finally the politicisation of mineral-based products and their scarcity. This multilayered network of relationships was not only exposed to major intervention in the economic process but also the reorganisation of business for political reasons and also the concentration of mining on central pits before and after the worldwide economic crisis of 1929.

Until 1945 technical development was characterised by the changeover from stall to longwall face working, progress in the mechanisation of extraction and underground hauling of the coal (in 1939 glance coal mining in the Ruhr Mining District reached its peak at over 130 million tonnes), coal processing and carbonaceous chemistry, which chalked up major successes. Once again mining in the Ruhr proved to be a leader among German mines.

1945 heralded an entirely new start for all branches of industry as well as glance coal mining in terms of capacity, economy and business organisation. The external difficulties, resulting from the destruction during the war and "drowned" pits, were compounded by the initial restrictions imposed by the administration of the Allied forces who trying to disentangle the amalgamation between coal and iron ("concentration of economic power").

When the European Coal and Steel Community was founded including Germany in 1952, the production figures for German glance coal mining were the highest among all contractual members.

Between 1959 and 1980 the number of working mines fell from 163 to 40 in the Federal Republic as a result of poor sales of glance coal due to oil and natural gas being sold at dumping prices. In the Ruhr Mining District the number of working pits (without small pits) shrank from 132 to 29. In the same period the manpower levels for glance coal mining (above and below ground) in the Ruhr Mining District fell from 451,332 to 141,808. On the other hand, the output of glance coal only fell from just under 115.5 million tonnes to 69 million tonnes.

The fall in sales in the highly capital-intensive glance coal mining sector also led to the radical concentration of business, resulting in the merger of 26 mining companies with 52 mines in the Ruhr Mining District into Ruhrkohle AG in 1968/69. Since its founding Ruhrkohle AG strove to bring its mines into line with the change in circumstances: repeated reductions in output and surrendering of capacity caused by factors such as the fall in specific energy consumption, declining sales to the steel industry as the main purchaser of Ruhr coke and also due to the much lower world price for imported coal and the cut in subsidies for glance coal paid by the federal government. The consequences: pit closures and mergers, reduction in production quotas and manpower levels.

Following the marked increase in output volumes and expansion of the glance coal mining sector in the 19th century the mines were constantly pressing forward into the north due to the situation with deposits. The easily accessible deposits with limited capping by intervening strata are mostly depleted and today the mining industry has reached the area to the north of the Lippe. With the overlying rock already exceeding 1000 m in the north of the Ruhr the coal has to be extracted from deeper levels. The mean extraction deepness stands at 900 m and the mean worked seam thickness 1.5 m. The maximum extraction deepness for conventional mining has more or less been reached. In 1997 a total of 37,245,000 tonnes of glance coal (usable product) was extracted by 13 modern large-scale mines (in some cases amalgamations) operated by Ruhrkohle AG each with a daily output of over 10,000 t raw coal. The annual mean manpower level for mining in the Ruhr was 62,534.

The political controversy of recent years about coal subsidies ended after lengthy and sometimes heated debate with the Coal Compromise of 13 March 1997. To date this compromise represents the most painful intervention in German glance coal mining: by the year 2005 six or seven of the in all 17 mines still in operation must be closed down; by that date over half of the jobs in mining will have disappeared and production reduced from 50 million tonnes to 30 million. One condition for conclusion of the Coal Compromise in March 1997 was the founding of a new company Deutsche Steinkohle AG (DSK) with its registered office in Herne on 1 October 1998. This company unites all German glance coal operations under the aegis of RAG AG (Ruhrkohle). This involves the mines and coking plants of Ruhrkohle AG and those of Saarbergwerke AG. Preussag Anthrazit GmbH, which operates a glance coal mine in Ibbenbüren (North Rhine-Westphalia), joined the new company in January 1999.

Industrial Monuments

In order to assess the position of the surface installations of Zeche Zollverein 12 among the monuments existing in the Ruhr in terms of quality, an overview of the most important mining monuments will be required. To prevent this list from becoming too long, numerous individual monuments have been disregarded.

Today we can justifiably claim that the Ruhr has the largest number of preserved and converted (mining) monuments in the world. Since the coal crises and radical restructuring taking place since the 1970's (if not before) particular importance has been attached in North Rhine-Westphalia to the monuments of industrial progress as the testimony of social development and special care taken to preserve this type of monument. By 1985 at the latest with the opening of the IBA International Building Exhibition Emscher Park industrial monuments had acquired particular importance in the public consciousness: meaningful examples of this type of monument are utilised as the culmination of social and tourism activities, major monuments have been incorporated in the "Route of Industrial Culture", the overall picture is completed by other monuments and museums. It is not incorrect to assume that the Ruhr is breaking new ground in its aim of using industrial monuments to shape the identity of a region and attribute a special role to its monuments in the present and future: the reutilization of historic building fabric and the desire to preserve the past as a document for the future by also packing economic initiatives in "historic wrappings" acts as a model for other regions and districts. The basic idea of the Route is to allow visitors to experience the development of the mining district through its monuments, with art playing a key role as a design element in conversion of the monuments.

The selection of the monuments was carried out accordingly. The early stages of Ruhr mining - as was carried out around 1800 initially on deposits near the surface and in gallery mines at the outcrop of the coal seams - is clearly documented by **Muttental** at Witten. The "prayer house of the miners" founded there around 1825 records the initial measures taken by the Prussian mining treasury to obtain administrative control over the numerous small pits and peasants' workings in a district. The move towards underground mining is shown by the mine "Vereinigte Nachtigall Tiefbau" in Witten and the impressive **Malakow towers** - brickwork shaft towers reminiscent of fortifications and serving as prime examples of the hoist frames made of iron and steel. These

Malakow towers document the building methods previously used for future-oriented hauling plants in the third quarter of the 19th century - around a dozen can still be seen in the Ruhr Mining District, more than anywhere else in the world. Examples of these are:
- **pit Brockhauser Tiefbau** in Bochum (1876)
- **pit Hannover** in Bochum-Hordel. This former double-tower hoisting installation was built in from 1856 and was developed to become a model pit. The mine has been the scene of a number of technical innovations, e.g. initial introduction of a steam engine as a tower hoisting engine or the endless cable (so-called Koepe winding). Closed down in 1973, the mine has been preserved with one Malakow tower, the machine house still containing a steam-driven hoisting engine dating from 1893 and the fan building which is now a branch of the Westphalian Museum of Industry.

- pit **Holland 1 / 2** in Gelsenkirchen-Ueckendorf. This pit is the only one in the Ruhr to still possess two Malakow towers with a machine house in between (around the middle of the 19th century).

- **Zeche Carl** in Essen-Altenessen. This hauling plant, which was built in 1855/1856 and remained in operation until 1973, is now used by theatre groups and for exhibitions, discussion forums and all kinds of events. The Malakow tower itself is to house a children's and environmental museum.

- pit **Prosper II** in Bottrop. This is one of the most interesting Malakow towers in the district: a steel framework protrudes from the tower erected in 1871. Following closure of the main shaft in 1984 renovation is currently underway on the tower to set up a museum documenting the history of Bottrop inside its walls.

- **Zeche Alte Haase** in Sprockhövel. This Malakow tower was not built until 1897 and is thus the youngest example of such a hauling plant. Closed down in 1966 a craftsman's business has taken up residence in the surface installations.

The more recent monuments of hauling plants include the so-called **hammer-head winding tower over shaft 3 at Zeche Erin** in Castrop-Rauxel built between 1918 and 1921. This pit founded by the Irishman Thomas Mulvany in 1867 was closed down in 1983. Around the monument and as a reminder of the Celtic origin of the mine the site has been planted with a ring of trees which divides up the year into 36 and 4 sections as a sort of "calendar".

Another **hammer-head winding tower at Zeche Minister Stein** can be found as monument at Dortmund-Eving. Built in 1925/1926 it now forms the centre of the Minister Stein business park approx. 30 hectares in size. The coe building adjacent to the hauling plant has been turned in a culture centre with catering facilities while the mine buildings still in existence have been successfully incorporated in the "Neue Evinger Mitte". The modern hoist frame built in 1953 and now to be found in the centre of Castrop-Rauxel forms the focus of a new landscaped park for the service sector and commerce which was set up in the framework of an IBA project.

Another important example of winding towers designed in the style of the new functionalism is the **winding tower over shaft 3/4 at Zeche Königsborn** built by the architect Alfred Fischer in Bönen-Altenbögge in 1928. This tower became a model for many modern hoisting plants and is an important record documenting the development of industrial architecture during the 1920's:

following closure of the pit the winding tower is a monument and symbol testifying to the history of local mining. Such a reminder is also provided by the **winding tower over shaft Rossenray** at the mine Rheinland in Kamp-Lintfort.

Two special monuments should also be mentioned in this context: the former **coal washing station** at the Freizeitpark Maximilian in **Hamm** had to be closed down in 1914 together with the pit which never properly took up operations. In 1984 North Rhine-Westphalia's first Regional Garden Show was staged at this wasteland site. The focus of the show was the coal washing station which was transformed into a "glass elephant": the trunk contains a lift, the viewing platform and the restaurant offer a first-class view of the site which was left in this state once the show had finished. The so-called Colani Egg, an elliptical office made of plastic which created a sensation when it was mounted on the **hoist frame over shaft 4 of the mine Minister Achenbach in Lünen** in 1992, is one of the "special" possibilities for the conversion of mining monuments. A technology centre took up residence in the mine complex which includes coe and administrative buildings.

Special significance is assumed by the **waste tips** of the glance coal mines which are visible far and wide in the otherwise flat landscape of the Ruhr. They are particularly important as landmarks and orientation points in this scenery; for this reason a number of them have been converted into observation sites accessible to visitors and decorated with works of art of special merit. For example, the **waste tip Prosper-Haniel** in Bottrop has been provided with a Path of the Cross inaugurated in 1995, topped with an enormous cruciform structure made of guide rods which was built when the Pope visited the district in 1987. The waste tip has been accepted by the population as an "Adventure Mountain". The **tip landscape of Hoppenbruch-Hoheward** near Herten is still being extended with waste from the mine Ewald / Schlägel und Eisen: by the year 2005 it will probably have reached a height of 150 m. There is already access to the tip today: the tipping operations can be seen as well as the flora and fauna in the biotopes. During the extension of the miners' colony Schüngelberg in Gelsenkirchen the **Rungenberg waste tip** on the edge of Zeche Hugo has also been incorporated in an artistic concept: it owes its striking shape to an aesthetically oriented discharge of waste in the form of a double pyramid which identifies the tip structure as a landscape element created by man. Another example of the creative superelevation of a waste tip by adding "sight elements" which attracted considerable attention was the triangular pyramid on the **Beckstraße tip** in Bottrop: the architect Wolfgang Christ designed a pyramid as a monumental observation tower accessible to visitors on this "artificial mountain". As a result the tip has become a landmark for the inhabitants of the region. Another prominent landmark was created by the American artist Richard Serra with his "Bramme für das Ruhrgebiet" (Slab for the Ruhr) on the crown of the tip **Schurenbachhalde** in Essen.

If we now ask about other preserved **mine complexes** for the purpose of direct comparison, the Ruhr contains an impressively large number which are used for varying purpose. The turbulent development of mining in the 1890's with over 70 new installations resulted in consideration being given to the functional design of the entire complex, i.e. rationalisation of the operation were to also to make themselves felt in the external appearance and the layout, with major importance being attributed firstly to the hauling route from the shaft to the loading facility and secondly, to the route taken by the miners from the pit entrance to the shaft and back. The initial solution was a general longitudinal orientation of the work areas divided up into rows, with the coe and administration building arranged crosswise, in between the mine entrance and the shaft. This model involving the perpendicular intersection of the two axes for the route taken by the coal and the miners was taken as the basis for the design of a whole series of installations while other mines did not depart from the traditional principle of longitudinal orientation. After 1900 the central pit yard acquired new purpose as the "order factor" of the entire complex; new prestigious buildings were supposed to emphasise the economic importance of the mine. The best-know example of this almost "urban" configuration of a mine is the pit Zollern 2 / 4 in Dortmund and also Bonifacius in Essen. In 1912 this design was taken as the model for the truly magnificent mine Zeche Jacobi in Oberhausen which has unfortunately not survived. The period after the First World War saw the formation of amalgamated mines; here the objective was to combine the extraction of a mine on one main shaft. Important examples of this were the pits Minister Stein in Dortmund and above all Zeche Zollverein in Essen.

1. Monument Complexes between 1900 and the First World War

Dortmund's glance coal mine Zollern 2 / 4 is a model example of a pit with a complex and prestigious design created around 1900. It was the intention of Emil Kirdorf, the then director-general of Gelsenkirchener Bergwerks AG, to create a "model mine" which would show the way for others, being unprecedented at that time of German mining. The layout and concept were clearly based on palatial-style buildings with three or four wings and installations reminiscent of the Baroque era including a "cour d'honneur" which were adapted according to the contemporary ideas and concepts of historicism and Art Nouveau.

The mine complex was designed with both prestigious and functional aspects in mind. An approach road in the form of an avenue of trees leads axially from the workers' colony to the mine; a spacious yard, which includes trees and grassed areas, is reached by passing through an entrance framed by two brickwork buildings dating back to1902, the gatehouse and the first-aid station. To the side of the entrance buildings there are single-storey wing buildings leading in the north to the workshop tract with the joiner's workshop, forge, fitting shop and the stable buildings with the stables, outbuildings, sheds and rooms for the coachman and the fire-fighting equipment. Arranged parallel in the south we have the former wages room with the wash coe, magazines, the lamp room and rooms for the caretaker, shift foreman and the young miners all within a single spacious building.

Opposite the entrance and continuing the axis of the approach road the yard ends so to speak in an administrative building positioned crosswise, including a central hall and the foremen's offices on the ground floor and rooms and baths for the management of the mine on the upper floors; the two storeys are joined by a prestigious stairway featuring an extremely complicated design.

To the east of this yard, which was used for reception and access purposes, there are the mine's industrial installations; the axial/symmetrical arrangement of the individual buildings to each other has also been followed in this area. The heart of the mine, the machine house, lies on the axis formed by the approach road and the administrative building. This longitudinal axis was extended with the former boiler house and the trainee workshop with the adjoining classrooms.

The original hoist frames of the ventilation and main shaft were once to be found to the north and south of the machine house: both frames were demolished along with the shaft house of the hauling pit following closure of the Zollern mine but have been meanwhile replaced by relocated frames of the same design and reconstructions. The original condition of the mine around 1900 has thus been recreated here. To the north of the machine house the walled site 385 m in length and 225 m wide used to contain four cooling towers and another new boiler house; in the south there was once a separation station, coal washing station and a coking plant but they have all been demolished.

The mine was constructed in two stages. All buildings in the yard area were built in red brickwork by the architect Paul Knobbe between 1900 and 1904: these buildings, which are dedicated to the spirit of historicism, are characterised by pediments and crenellated acroterions with corner towers and imperial roofs, portals with openwork gablets, lisene framing and the alternation in colour between whitewashed and untreated red walls.

However the architectural and technical focus of both the mine and the monument is the machine house: Paul Knobbe had also submitted an architectural design based on historicism for this building. However, Kirdorf was greatly impressed by the pavilions built by the structural engineer Reinhold Krohn and the architect Bruno Möhring of Gutehoffnungshütte at the Düsseldorf Exhibition for Industry, Commerce and Art held in 1902 and changed the architectural concept without further ado, commissioning Möhring and Krohn to build a machine house with a steel framework incorporating glass and brickwork. This sudden decision was influenced by the entrepreneur's wish to present his mine of the Gelsenkirchener Bergwerks-AG as a leading force in German mining and the Ruhr. This resulted in one of the most sensational machine houses equipped with the latest machinery available in the world. Great importance was attached to the exclusive architectural design: Möhring designed the main portal in the form of a shell on the outside and on the inside as a vine arbour. The preserved glass paintings with their violet, green and blue panes cast a characteristic light on an era which allowed an industrial complex to be provided with such luxury. Another Art Nouveau portal on the narrow side of the hall features discreet forms. The highly "exclusive" fixtures can also be seen in the electrotechnical control centre with a brass clock hanging from the ceiling while the fittings themselves were inset in the marble walls between Egyptian-style Art Nouveau portals and pilasters featuring in a symmetrical and ornamental design. Möhring took his inspiration for the bright green external paintwork used on the steel framework of the machine house with its "signal function" from the entrances to the Paris underground system designed by the French architect Hector Guimard.

The original machinery installed in the Dortmund machine house has mostly survived: of key importance is the world's oldest electric hoisting engine to remain in place which dates back to 1904. But the existing generators and compressors, converters and loading aggregates also testify to the conceptual "show of strength" that for the first time in the history of mine architecture a central machine house was designed as the centre of a mine to provide energy for all machines. The construction of this machine house should thus also be considered as an outstanding achievement in terms of plant organisation.

The pit Zollern 2 / 4 is a prime example of a large-scale pit around 1900: built according to exacting architectural and mechanical standards it is an industrial monument of international significance. The retrospective design oriented towards axially symmetrical complexes resulted in the creation of a prestigious model mine which had not been seen before in Germany or the rest of the world at the turn of the century. The design objective was functionality and modernity combined with high architectural quality; this was achieved - alone the change in plan for the design of the machine hall firstly prevented complete stylistic unity of the complex, while at the same time still allowing the machine house to become one of the "icons" of Ruhr mining.

Comparison with Zeche Zollverein meanwhile shows that the pit Zollern 2 / 4 does not have the stylistic unity of the installations of Zeche Zollverein which was built around 25 years later, with its design being implemented in a uniform and thus consistent way. It must also be borne in mind that, although the two hoist frames displayed in Dortmund are originals, they have been relocated from other historic sites in the Ruhr Mining District or (in the case of the shaft house of the main shaft) are replicas which at least impair the character of the monument. In this regard the monument "Zeche Zollern 2 / 4" cannot fully measure up with the complex of Zeche Zollverein, even if the documentary significance of the Dortmund mine as a milestone in the development of mine installations cannot be set high enough.

The pit **Zeche Friedrich Heinrich** founded in Kamp-Lintfort in 1906 was the result of French investment lasting until 1913 in the form of a massive brickwork structure erected along an avenue to great visual effect. This glance coal mine, which is still in operation, is characterised by a large number of buildings dating from its founding period and its position between extensive colonies built between 1907 and 1930 which are considered as being worthy of a monument. The mine started operations in 1912; a coking plant with five batteries and a by-product station also went into production in 1913/14. The mine was designed for the high output of 5000 tonnes per day, a figure which it almost achieved as early as 1914 and increased to 8000 tonnes per day by 1931. The mine suffered extensive damage in the Second World War, and the coking plant had to be renovated between 1947 to 1954. In 1955/1956 the hoist frame at shaft 1 was replaced by a winding tower, the coe by a new building, and the washing station also extended; work has continued up to the present day. The current appearance of the pit Friedrich Heinrich still allows the impressive monumental design principle applied on founding of the mine to be identified in its original form.

Another example of impressive mines from this period until the First World War is the pit **Rheinpreussen 4**. Encouraged by the boom in mining which occurred around the turn of the century this pit was built in Duisburg between 1904 and 1907 and includes surface installations which can be considered exemplary in terms of arrangement. A double strut frame (the oldest example of its type in the Ruhr dating back to 1904) was built right next to the mine station together with the two hoisting engine houses. The coe and workshop were housed in large-scale building complexes close to the shaft and parallel to the station. The separation and washing station were positioned above the tracks; on the other side of the tracks there was the coking plant with its batteries of coking ovens and by-product station. Apart from one hoisting engine houses the surface installations have been completely preserved; attention should be paid to the special quality of the hoist frame and the administrative and coe building with the wages room. The historical stylistics forms are reminiscent of the Zollern pit - how conformity can be observed in general, e.g. in the administrative and coe building. The Rheinpreussen 4 pit is dimensioned on a smaller scale than the mine in Dortmund. The Duisburg pit also includes an extensive workers' colony, which was built from 1903 into the 1920's and was one of the largest in Ruhr mining.

Between 1903 and 1906 the Prussian state built in Waltrop a mine of the same name (**Zeche Waltrop**). Its production was destined for the imperial navy. 1979 saw the closure of this mine with its exacting and complex architectural design conceived according to the principles of historicism. The surface installations have been preserved except for the two hoist frames and have undergone extensive restoration. These installations, which today are home to a business park, still contain two large steam-driven hoisting engines dating back to 1906 and 1908 in the machine house. However, given the loss of its hoist frames Zeche Waltrop as a monument can only compare with the mine in Dortmund or Duisburg to a very limited extent.

The same restriction also applies to **Zeche Bonifacius**: since 1906 this mine in Essen, which was founded in 1857, has been more or less rebuilt including its surface installations. The hoisting engine houses, the wash coe and the machine house date from this time. Of particular note is the former wages room with its neo-Gothic stylistic forms based on feudal and religious architecture according to the principles of historicism. The magnificent hoist frame was set up in 1899 while the workers' supply building (behind the wages room) was built by Schupp and Kremmer in 1940.

The small pit **Oberschuir** was built as shaft 8 of the mine Consolidation in the town centre of Gelsenkirchen using very attractive Art Nouveau forms. Consisting of the hoist frame, machine house with electrical hoisting engine, wash coe, wages room and gatehouse, a modern cubic structure made of concrete, steel and glass was added in 1996 and is home to the "Galerie Architektur und Arbeit". With its exhibitions on architecture, construction and industrial culture this fine complex attracts both people with a professional interest and laymen.

The pit **Teutoburgia** in Herne only remained in operation between 1911 and 1925. Of the surface installations only the hoist frame and the machine house have survived: both were "discovered" by artists towards the end of the 1980's and incorporated in a "Forest of Art" (Kunstwald). Visitors can see objects and installations dealing with the topic of "Change" and "Transitoriness"; at the entrance path to the mine they come across the large display entitled "Pedestrian" which has now become overgrown by a wild vine: Nature is gradually claiming back the mine for herself. Near the "Forest of Art" there is the colony of the garden town Teutoburgia, which was built between 1909 and 1923, with 136 residential houses carefully restored down to the last detail. It is one of the most impressive miners' colonies in the Ruhr.

The mine **Arenberg-Fortsetzung**, which was built in Bottrop around 1910, was once considered as a "model pit". Closed down in 1930, the surface installations then fell into disrepair until the remaining buildings (machine house with wages room, engine sheds, lamp room and part of wall around mine) were turned into a business park by the IBA. At the centre of the "park" there is the wages room / machine house built using Art Nouveau forms which has now become a cultural meeting point as well as a centre for the founding of businesses and technology.

2. Monument Complexes between the First and Second World War

The surface installations of pit **Holland 3 / 4 / 6 in Bochum-Wattenscheid** dates back to the period after the First World War when such installations started to take on unprecedented dimensions at the mines of the Ruhr. With their extremely aesthetic forms these buildings mark the move away from historicism to designs based on the new functionalism. The buildings grouped around a central yard were the first project of the young team of architects Fritz Schupp and Martin Kremmer and were built in red brickwork between 1920 and 1931. The hoist frame, which can still be seen from far and wide, originally stood at shaft 4 of Zeche Zollverein in Essen and was relocated to Wattenscheid at the beginning of the 1960's. In the meantime the surface installations have been restored in the framework of the IBA project "Holland Business and Residential Park" and are a splendid example of how historic buildings can be reused today.

In this context we should not forget the former Oberhausen mine **Zeche Nordstern**, including the central coking plant: It was built by Fritz Schupp and Martin Kremmer between 1927 and 1938 as one of the largest, most modern, practical and innovative mines in the style of new functionalism based on cubic structures providing a rhythm of their own. The remaining surface installations were allocated a new function in 1977 on the occasion of the National Garden Show: in the former coal bunker artists such as Dani Karavan and Hans Ulrich Humpert have created acoustic displays which have attracted considerable attention. At the present Zeche Nordstern is the venue for the Regional Garden Show.

3. Conclusion

If we search the Ruhr for existing mines which, like Zeche Zollverein, offer a complex of well-preserved mining installations including the following features:

- generous dimensions
- methodically oriented towards axially symmetrical designs in terms of layout
- uniform and representative stylistic forms
- innovative and future-oriented machinery and equipment
- importance in terms of mining and
- create a meaningful impression of size and significance in a setting characterised by mining

we must first of all mention Dortmund's glance coal mine Zollern 2 / 4 which is today the headquarters of the Westphalian Museum of Industry. It alone can measure up with Essen's pit Zollverein 12, even if it ultimately has to take second place behind Essen. We can thus justifiably claim that the surface installations of Zeche Zollverein 12 should be considered as the most outstanding complex of all the monuments in the Ruhr in terms of industrial mining design.

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2.6.1.1.2 Aachen/Erkelenz Mining District

Until the reduction in output in 1992 the Aachen/Erkelenz Mining District for hard coal had been the most important region next to the Ruhr and Saar Mining Districts.

Movement of strata resulted in major tectonic faults in the series of strata in the Aachen/Erkelenz Mining District, causing the deposits in the three subdistricts to be broken up and making the extraction of hard coal considerably more difficult.

The Aachen/Erkelenz Mining District for hard coal is subdivided by the arching of the Aachener Großsattel (large anticline) into the Inde-Mulde (syncline named after the river passing through it) in the south and the wider Wurm-Mulde in the north. In the south and west the stratified carbon crops out at many locations, in particular on the slopes of the Wurm Valley. Glance coal mining in this district first took place here. The cap rock becomes increasingly thick from the west to the east, even reaching the 500 m mark. The richest seams of coal correspond to those in the Ruhr Mining District and have been mostly exhausted.

The Erkelenz Mining District is located around 40 km north of Aachen. The workable stocks can be found on the elevated massif of the so-called Erkelenzer Horst. The Erkelenz Mining District is separated from the Aachen Mining District by the 12 km wide sink zone of the Ruhr trench in which the stratified carbon has sunk approx. 1,300 m. The coal seams of the Erkelenz Mining District virtually solely consist of anthracite. The higher carbonisation degree is attributed to an intrusion body in the depths. The surface of the carbon dips slightly to the north and northeast. Due to numerous faults the overlying cap rock in the Erkelenz Mining District is between 170 and 550 m thick. Compared with the adjacent district and other German coal mining districts, glance coal mining is recent here and has been carried out at the glance coal mine Sophia-Jacoba since 1914.

Development of Glance Coal Mining in Aachen/Erkelenz Mining District

The history of Aachen's glance coal mining dates back to the 12th century. The annals of the Abbey Klosterrath Rolduc indicate that coal was dug up as early as 1113 in the vicinity of Herzogenrath. Even if this coal was probably only used to cover the requirements of the monastery, we know from Aachen's municipal accounts can that glance coal was used to heat public buildings in 1333, if not before. The oldest document recording the granting of a concession for a glance coalfield dates back to the 14th century: on 28 December 1394 Herzog Wilhelm VII. von Jülich gave his mother permission to mine at the Eschweiler Kohlberg. Mining then apparently started there at the outcrop of the coal seams using small-scale above-ground installations while the changeover to underground mining with sloping shafts in the area between

Stolberg and Eschweiler-Pumpe was probably first carried out in the late Middle Ages or the Early Modern Times. This was followed by the age of gallery mining and in the course of further development, also by underground working using water power.

Eschweiler Bergwerks-Verein is the company which has shaped mining at Aachen for two centuries and is inseparably linked to the Eschweiler Kohlberg. In 1814 Christine Englerth become the sole owner of the extensive mining assets of the Wültgens family: in just a few years she managed to acquire not only the entire Eschweiler Kohlberg but also the Weisweiler Kohlberg. This paved the way for the creation of a mining company which was founded on 2 August 1834 and 4 May 1838 under the name of "Anonyme Gesellschaft des Eschweiler Bergwerks-Verein". This firm is the **oldest** mining joint stock company to still exist in Germany.

Eschweiler Bergwerks-Verein primarily supplied coal to the region on the left bank of the Rhine; after commissioning of the Rheinbrücke bridge in 1859 the competition from Ruhr coal became noticeable. This situation was compounded by the competition with local mines. Previously the mine Grube Zentrum (near Eschweiler) in the Inde district had been the only pit around Aachen to mine the fat coal so indispensable to industry so that Eschweiler Bergwerks-Verein had held a monopoly on the supply of this type of coal. However, in 1846/1847 fat coal was also discovered in the Wurm-Mulde which until this time had only produced lean coal. Eschweiler Bergwerks-Verein was thus obliged to share the sales of fat coal with the new pits Anna, Maria, Merkstein and Nordstern (near Alsdorf and Herzogenrath) until it managed to buy up the mines Anna and Merkstein in 1863. From this time the focus of coal mining increasingly shifted to the Wurm Mining District as output at Grube Zentrum was in continuous decline and was shut down entirely in 1891. Instead the pit Eschweiler-Reserve (near Eschweiler) in the Inde district had been put into service.

In 1873 the metallurgical plant Concordia-Hütte near Eschweiler, which had previously been the only blast furnace in the Aachen district, was added to Eschweiler Bergwerks-Verein, thus creating the basis for the ownership of an ironworks. Also of great importance to Eschweiler Bergwerks-Verein was the merger in 1907 with the company "Vereinigungs Gesellschaft für Steinkohlenbergbau im Wurmrevier" founded in 1836. This company owned a large number of fields as well as the pits Laurweg, Gouley and Maria (near Kohlscheid and Alsdorf). With such expansion Eschweiler Bergwerks-Verein was assured of its supremacy in the Aachen Mining District: three-quarters of all granted fields were owned by the company at that time. In 1910 the company merged with Eschweiler-Köln-Eisenwerke AG to form Eschweiler Pümpchen.

The working agreement concluded with Vereinigte Hüttenwerke Burbach-Esch-Düdelingen (ARBED) in 1913 was of great economic importance. The main aim of this link was to secure sales and to supply the ironworks with glance coal, coke and by-products. The installation of equipment for coal distillation and other by-products in 1902/1903 resulted in the creation of a new branch of the mining company: this acquired increasing importance for the economy of the Aachen Mining District. The expansion of the company continued in 1924 with the acquisition of the majority of shares in the anthracite mine Carl-Friedrich (near Richterich), which however had to be shut down just one year later (1925) In the same year Eschweiler Bergwerks-Verein took possession of the rolling mill Walzwerk Eschweiler of Eschweiler-Ratinger Maschinenbau AG.

During this time Eschweiler Bergwerks-Verein introduced some pioneering new technical innovations to its plant, in particular where the generation of energy was concerned. For example, a firing system involving travelling grates with an under-grate blast was developed for the power stations at Eschweiler Bergwerks-Verein. As the coal dust of the lean coal could then not be burnt easily due to the low content of volatile substances, this resulted in the construction of the first coal dust firing system with large combustion chambers at the Gouley pit in 1920.

The worldwide economic crisis occurring at the end of the 1920's also affected the Aachen Mining District with its full force: by the end of 1932 almost 1 million tonnes of glance coal landed on the tip at Eschweiler Bergwerks-Verein. The economic difficulties coincided with a catastrophe of virtually inconceivable proportions: a terrible mine explosion on 21 October 1930 at the mine Anna II in Alsdorf cost the lives of 271 miners while a further 304 were injured, in some cases seriously. This also caused the collapse of the frame at the Eduard pit, destroying some of the surface installations.

Following the rise to power of the National Socialists in 1933 the Aachen glance coal mining industry was obliged to join the Rhenish-Westphalian Coal Syndicate and accept restrictions on output. Eschweiler Bergwerks-Verein was unable to sell its products itself but maintained its right to continue to provide supplies to ARBED. Output thus stagnated until 1937. In this year sinking of shafts started at the pit Emil Mayrisch (near Siersdorf).

With the start of the Second World War production was then brought into line with the requirements of the war. The events occurring during the war resulted in major impairment of production; all pits in the Aachen Mining District had to be closed down in September 1944. The pit Eschweiler-Reserve became submerged and had to be shut down with the Nothberg coking plant. This was the end of glance coal mining in the Inde Mulde after over a century of operation.

After the end of the Second World War production was initially very slow to pick up again. The pits Laurweg, Gouley, Anna, Adolf and Maria had suffered rather serious damage and in some cases could only be put back into service in 1947; the sinking of the two shafts at Emil Mayrisch also resumed in the same year. As the stocks of coal become exhausted at Grube Laurweg, work started on the amalgamated mine Gouley-Laurweg in 1950, with the coal being hauled at Grube Gouley; the reinforced concrete winding tower which can still be seen there today was built in 1958. The two pits Anna I and Anna II in Alsdorf were also combined to form an amalgamated mine after 1952. A new winding tower was erected over the Franzschacht, and restructuring of the mine for an output of 8,000 tonnes per day was completed in 1956. However the development below ground was hindered by a fire which occurred at the pit on 8 August 1954. The power station and the coking plant Anna also underwent scheduled expansion: in 1958 the latter was equipped with over batteries with a total of 301 coking ovens for a coking coal level of 6,000 tonnes per day. Grube Adolf, which was used to produce fat coal, was already able to achieve its pre-war capacity of 2,800 tonnes/day by 1951 while Grube Emil Mayrisch resumed production on 15 April 1952. In November 1958 a daily output level of 3,000 tonnes was achieved; the pit coal first had to undergo processing at Grube Anna II until a new processing station was commissioned at Emil Mayrisch in 1958. For the Aachen Mining District this fulfilled a major prerequisite for the medium-term survival of mining.

In 1957 Eschweiler Bergwerks-Verein turned its attention towards the Ruhr and acquired the majority shareholding in Bergbau-AG Lothringen with the pits Lothringen (in Bochum), Graf Schwerin (in Castrop-Rauxel) and Herbede (in Witten-Herbede). Aachen mining was completed by the purchase of the mining company Gewerkschaft Carl-Alexander from the Röchling family in 1965.

In the following years the crises in the German glance coal mining industry became increasingly noticeable by the Aachen Mining District and Eschweiler Bergwerks-Verein. Grube Maria, which produced forge coal, was closed down in 1962 and the anthracite mine Gouley-Laurweg in 1969. The restriction on the production of forge coal resulted in the merger of the pits Anna and Adolf in 1972 to form an amalgamated mine with a simultaneous reduction in output. This meant that in 1972 the Aachen Mining District only still operated the mines Emil Mayrisch (with an output of 6,000 tonnes/day), Anna/Adolf (with an output of 8,000 tonnes/day) and Carl-Alexander (with an output of 4,000 tonnes/day), the coking plant Anna (with a coke production of 5,800 tonnes/day), the briquetting plant Laurweg (with an output of appr. 600 tonnes/day) and the power stations in Siersdorf and Alsdorf. In 1970 Eschweiler Bergwerks-Verein attained the highest production level in its history at 8.6 million tonnes of glance coal; with a staff of 23,800 the company was the region's largest employer.

The subsequent history of glance coal mining at Eschweiler Bergwerks-Verein is characterised by a steady decline. In 1972 production was shut down at Grube Adolf while it was decided to close Grube Carl-Alexander in 1975. 1978 saw the start of a restructuring programme with the aim of amalgamating the pits Anna and Emil Mayrisch; the underground connection between the two mines was created in 1983 and extraction via Grube Anna had ceased by the end of the year. In 1987 the bodies responsible for glance coal mining in the Federal Republic of Germany resolved to close down the mining operations of Eschweiler Bergwerks-Verein by 1992. The power station Anna was shut down in 1987, the coking plant Anna on 30 September 1992 and the pit Emil Mayrisch on 18 December 1992. This was the end of over 200 years of mining by Eschweiler Bergwerks-Verein in the Aachen Mining District. In 1987 Eschweiler Bergwerks-Verein founded the company "Beteiligungsgesellschaft Aachener Region mbH" with the aim of preserving existing jobs and creating new opportunities; the miners employed at Emil Mayrisch mainly found re-employment with the mines operated by Ruhrkohle AG and the strip mines of Rheinbraun AG.

The Aachen glance coal mining sector did not solely consist of pits operated by Eschweiler Bergwerks-Verein. Grube Sophia-Jacoba is located right in the north of the district. The sinking of shafts started in 1910, with Friedrich and Eduard Honigmann making successful use of the sinking process which had become known under their name. Extraction started in 1911.

After the death of Eduard Honigmann (1915) his heirs sold the pit to the Dutch company "Maatschappij tot Ontginning van Steenkolen-velden (NEMOS), which then founded the mining company Sophia Jacoba. In 1973 the company was sold to ROBECO ("Rotterdamsch Beleggingsconsortium NV"); today Ruhrkohle AG and Eschweiler Bergwerks-Verein AG are the shareholders of Sophia Jacoba GmbH. On 27 March 1997 production ceased at the last pit in the Aachen Mining District.

The anthracite mine, which sells most of its production as domestic coal, has a total of eight shafts. It produces around 1.5 million tonnes of glance coal per year; almost 3,700 miners are employed at this modern pit. Since 1971 pit 6 has been in possession of one of the world's most powerful hoisting engines. In 1983 a unique coal washing station based on a circular design was taken into operation. The winding towers of the central shaft in Ratheim makes an unforgettable impression due to their architectural beauty.

In 1911 capital from Lorraine was used to found the mining company Carolus Magnus in Übach. After a rather difficult start the mine was producing over 1 million tonnes by 1938. In the Second World War the pit's coking plant was more or less destroyed. After the end of the war the mine was taken over by Compagnie Minière de Rhénanie, Paris: at 755,000 tonnes in 1952 the mine achieved its highest production level since 1945 but it was the first mine to close in the Aachen Mining District in 1962.

Industrial Monuments

Major monuments of early glance coal mining in the district are the pump house at the Grube Eschweiler, which in 1794 was the first pit in the region to use a steam engine, and the shaft building (Malakow tower) of Grube Atsch in Stolberg, which was built in 1845/1846.

In particular the surface installations of Sophia Jacoba in Hückelhoven still testify to the strong tradition of mining in the Aachen Mining District which has lasted until the present day. The two winding towers of the central shaft 4 / 6 built in Ratheim between 1957 to 1964 can be seen from far and wide with their light-coloured cladding. They were designed by Fritz Schupp "with the greatest clarity and transparency" as the then Mine Director Helmut Kranefuss put it, and are considered as a highlight in the work of the industrial architect. They set an unmistakable accent in the landscape. The glance coal processing station built in 1983 undoubtedly ranks as one of the most striking installations of its kind in Germany mining - but its future is uncertain. Of the surface installations built in brickwork at shaft 3 in Hückelhoven special attention must be given to the generously dimensioned administrative building built around 1920 and 1936/1937 and the hoist frame installed in 1929/1934. The mine in Hückelhoven is of major significance in terms of urban planning; the previous importance of mining for the economy of the region is also borne out by the colony oriented towards the administrative building dating from the founding period of the mine. The fate of the hauling plants is extremely uncertain following closure.

Of all the large-scale mines in the Aachen Mining District none has been completely preserved. The mine Emil Mayrisch in Aldenhoven, which was started in 1938 but did not enter into service until after the Second World War in 1952, was designed by the Dortmund architect Willi Görgen. As regards the hauling plant, a winding tower was installed above shaft 2 in 1955/1956 while a hoist frame built in 1923 from Eschweiler was used for shaft 1 and a steam hoisting engine dating from 1918. After closure the hauling plant was dismantled at shaft 1 while the other surface installations have been incorporated in the operations of a waste recycling system.

Of the Aldorfer Zeche built in 1850 and the coking plant Anna, which was for a long time the most productive mine in the Aachen Mining District, only a small number of buildings and technical installations have escaped demolition. Special attention should be given to the hoist frame at shaft 1 built in 1914/1923 which acts as a symbol for the town of Alsdorf. The mining museum which is currently being set up at the site of Grube Anna in Alsdorf has taken on the task of documenting this sector of industry.

Certain importance can also be given to the existing surface installations of the pits Langenberg and Voccart in Herzogenrath and Gouley in Würseln and also parts of these installations at Carolus Magnus in Übach-Palenberg.

Most Important Pits in the Aachen Mining District according to: Salber (1987), p. 109

Pit	Start of Production	End of Production
Adolf	1913	1972
Anna	1854	1983
Ath	before 1667	1879
Atsch	15th/16th century	1870
Birkengang	16th century.	1883
Carl-Alexander	1921	1975
Carl Friedrich	1909	1927
Carolus Magnus	1919	1962
Emil Mayrisch	1952	1992
Eschweiler Reserve	1880	1944
Furth	16th century.	1884
Gemeinschaft	16th century/1906 (production not started)	
Gouley	before 1599	1969
Hankepank	16. Jh.	1864
Kämpchen	before 1580	1914
Königsgrube	?	1904
Langenberg	before 1573	1913
Laurweg	16th century..	1955
Maria	1848	1962
Nordstern	1876	1927
Sichelscheid	16th century..	1859
Sophia-Jacoba	1914	
Spidell	16th century.	1905
Alte Teut	1685	um 1800
Neue Teut	1863	1904
Voccart	1777	1912
Zentrum	14th century..	1891

The number of monuments is falling steadily. The tips can still be seen from far and wide and are probably the most striking monuments to mining in the landscape of the Aachen Mining District. It should not be forgotten that academic training for the mining sector is still offered by the Rhenish-Westphalian Technical University in Aachen.

We can now conclude that the Aachen/Erkelenz Mining District does not contain any mine which can compare with the pit Zollverein 12 in Essen; the pit Sophia-Jacoba 4 / 6 in Ratheim, which is possibly worth consideration, pursues with its two winding towers a different stylistic direction and is also unable to measure up with the mine in the Ruhr in terms of dimensions.

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2.6.1.1.3 Saar Mining District

With around 10% of the reserves and an approx. 16% share in the output of German glance coal (7.37 million tonnes in 1997) the Saar is the second largest mining district in the Federal Republic of Germany.

The productive deposit of the Saar/Lorraine hard coal field extends from the French Boulay in the west over the border to Germany the boundary of Rhineland-Palatinate in the east of the Saarland. The southern limit of the deposit approximately follows the line Saarbrücken - St. Ingbert - Bexbach. To the north the deposit is bounded by the financially viable depth limit of around 1500 m given the dipping of the strata or the Primsmulde in the vicinity of the mine Ensdorf. As in the Ruhr, glance coal mining started in the south of the district, where the coal crops out, and migrated northwards towards deeper layers of coal.

The coal found in the Saar Mining District is highly to moderately volatile with sulphur content between 1% and 1.5%. It is good-quality boiler coal which is also used as coking coal.

Development of Hard Coal Mining in Saar Mining District
The history of the Saarland has been shaped by coal and steel. For almost 250 years, in particular in the last hundred years, hard coal, this region's most important mineral resource, has had a major influence on the history of the Saarland. It was only the rich deposits of coal which resulted in the formation of a separate administrative unit for the industrial region around Saarbrücken. And lastly in the federal state of the Saarland which has no natural geographical boundaries and has only managed to acquire an identity through its industrial development and above all its mining industry.

The historical development of the Saarland is closely linked to the development of mining. The position of the Saarland on the border is the second most influential factor for its history. The changing German/French history of the last two centuries has also had a major impact on the development of mining in the Saarland. After the end of both world wars the Saar Mining District was a key issue in the disputes between the two nations. Twice during this century the Saarland was compelled to develop independently of Germany, due to its very resources, with its mines being put in French ownership or administration. All in all, the mines in the Saarland have changed their owners no less than 10 times since the founding of state mining almost 250 years ago: a burden which no other industrial district had to cope with. Steady development, which mining needs more than other industries, was hindered by the political events of the last hundred years. Its progression towards becoming a productive centre of mining was also made more difficult by the repeated changes in currency, separation from established economic areas and many restructuring programmes.

The first record of glance coal mining in the Saarland dates back to 1429: it was decided by the jurors of Neumünster (Ottweiler) at that time that the glance coal worked in the district was owned by the Count of Saarbrücken and could not be mined without his permission. The peasants digging for coal at the outcrop of the seams thus required authorisation from their ruler and were obliged to pay a charge, the so-called "Grubengült", which generally corresponded to an eighth of the coal worked. The coal from these peasants' workings was mainly used for lime burning and fertilising the fields. The replacement of wood as a domestic fuel by glance coal only took place gradually.

If the coal mined was initially just used by the peasants for their own needs, a proper trade in coal also started to develop step by step. Forges were the first purchasers of coal, followed by iron smelting factories and glassworks. The coal from the Saarland gradually acquired importance outside its own boundaries: it was transported over lengthy distances using horse-drawn wagons, shipped on cargo boats to already reach Trier and Koblenz downstream on the Saar and Moselle. The loading station on the Saar at Saarbrücken first mentioned in 1608 testifies to this lively trade in coal (the so-called Kohlrech).

If little attention had been paid until then to operation of the mines by the rulers, the Counts of Saarbrücken and the Lords of Leyen and Kerpen apart from collection of the fee, the increasing demand and rising sales awoke the interest of the princes. Fürst Wilhelm-Heinrich von Nassau-Saarbrücken was the first to recognise the economic value of glance coal for his state budget. With the "seizure" of the coal mines and the payment of compensation to the previous owners the nationalisation of mining in the principality of Nassau-Saarbrücken started on 15 January 1751. On 27 November 1754 the Prince of Saarbrücken completed the process of nationalisation with the ordinance governing the "reservation" of the glance coal fields and mines. This was the start of concentrated, systematic and economic mining of coal in the Saarland. From the middle of the 18th century the regulated extraction of coal gradually superseded the previous illicit digging for coal, resulting in the formation of a separate branch of industry. Annual production increased fivefold to 19,000 tonnes of coal in just ten years, between 1758 and 1768. In 1790 270 miners were employed at the state mines and produced 50,000 tonnes of glance coal per year. However, the revenue from coal mining remained small and did not bring about the hoped-for improvement in the state budget of the principality.

The French Revolution of 1789 was not without its consequences for the region on the Saar and its mining industry: The principality of Saarbrücken was occupied by French troops in 1793. Fürst Ludwig fled and the French Republic assumed control over the Saar region and its coal mines. France leased all mines in the Saarland to Compagnie Equer for a period of 10 years, from 1797 to 1807. After expiry of the leasing period, which had not gone satisfactorily for the French state, it put the mines back under French administration in 1808. It was Napoleon himself who gave the order to draw up a map as a record of the mines and coal pits. Two engineers from the Geislautern Mining College, which had been founded in 1807, Beaunier and Calmelet, prepared this "Coal Atlas of the Saarland", the first record of the deposits of coal in the Saar.

By 1813 the number of miners had already risen to 693, resulting in an annual production of 83,000 tonnes of glance coal. It was under French administration that the first miners' association (Knappenverein) was founded. In a contract all miners of the former principality of Nassau-Saarbrücken pledged mutual support and formed a special fund (the "Knappschaftskasse") to assist members in need.

For the region around Saarbrücken the collapse of the Napoleonic Empire and with it the return of the left bank of the Rhine to Germany resulted in the imposition of Prussian sovereignty and administration - and for mining in the Saarland it spelt new ownership and the start of a new era. For over a century, from 1815 to 1919, the Prussian state took over the ownership and management of the mines in the Saar, with only a small part of the Saar district containing the St. Ingbert and Bexbach pits being given to the kingdom of Bavaria.

Glance coal became the driving force behind the swift industrialisation in the 19th century; the growing demand for energy was constantly conquering new markets for coal. After the first railway line was opened in the Saar Mining District with the inauguration of the Bavarian Ludwigsbahn from Ludwigshafen to Bexbach in 1850, this was quickly followed by other railway links (e.g. from Saarbrücken to Trier in 1859 and from Neunkirchen to Bingerbrück in 1860. The railways resulted in a major improvement in the transportation of coal from the Saar, and the "railway pits" Heinitz, Reden, Altenwald and Von der Heydt grew up along the railway lines, followed by Dechen, Friedrichsthal, Itzenplitz, Sulzbach and Ziehwald.

At the same time technical inventions and improvements designed to provide the constant increase in capacity required were also being carried out. Important milestones of such technical progress were the first underground mining shaft to use hoisting engines for hauling in Schwalbach at the pit Kronprinz Wilhelm in 1826, track hauling underground and in 1844 the introduction to the Saarland of the Davy safety lamp, which replaced the hazardous open pit lighting system previously in use underground. To ensure the supply of coke to the iron and steel industry which was also experiencing strong growth the fat coal mines of Camphausen (1871), Brefeld (1872) and Maybach (1873) were opened, with large coking plants being set up in Dudweiler, Altenwald and Heinitz at the same time.

If annual output reached 83,000 tonnes in 1813, it had already risen to 600,000 tonnes in 1850. In 1900 the Saar Mining District recorded an annual output of 9.3 million tonnes of glance coal, and this was followed by 13.2 million tonnes in 1913. The manpower employed in the mines of the Saarland grew at an equivalent pace: from 700 (1813) to 4,600 (1850), 41,800 (1900) and 56,600 (1913). Towards the end of the Prussian administration which had lasted over 100years the Saar Mining District numbered 166 mines including 66 main shafts. 24 coal washing stations were in operation, supplying coking plants and three pit power stations in Heinitz, Weiher and Luisenthal. At the end of the First World War the value of the business was put at 340 million gold marks.

After the end of the First World War France laid claim to the pits of the Saarland as reparations for the coal mines in the north of France destroyed during the war. According to article 45 to 50 of the Treaty of Versailles Germany was obliged to cede ownership of the mines in the Saarland with sole mining rights to France. In January 1920 the Saarland's pits were transferred to the French mine administration "Mines Domaniales Françaises de la Sarre".

The new French mine administration tried to increase the production levels which had fallen during the war by introducing technical innovation such as pitching hammers and cutting machines so that output of coal already reached the 1913 level (around 13 million tonnes) in 1924. However, the worldwide economic crisis occurring at the end of the 1920's again resulted in a fall in production to 10.5 million tonnes in 1932. At the same time a total of nine pits (of 29 mines in 1920) had to be closed down in 1931 and 1932. In 1934, the last year of French administration, 11.3 million tonnes of coal was worked by 45,000 miners. The administration of the "Mines Domaniales" then ended one year later in 1935.

When the Saarland administered by the League of Nations was reintegrated into the German Reich, the Saarland's mines also reverted to German ownership. As France had been granted the ownership and sole mining rights to the coal in the Treaty of Versailles in 1920, the German Reich had to pay 900 million Franks or 150 million gold marks to acquire the ownership to the Saarland's mines once Germany and France had previously agreed the transfer of title to the mines of the Saarland in the treaties of Rome and Naples (1934 and 1935).

The Saarland's mines were incorporated in a new joint stock company, "Saargruben-AG", with all shares being held by the German Reich. The company was recorded in the Commercial Register on 1 January 1937. The new German administration continued with the operational amalgamations started by the French, introduced a large number of technical innovations and in particular improved the safety of the mines. However, this upward trend ended just a few years later with the outbreak of the Second World War. Although coal production reached another peak of 16 million tonnes in 1943, numerous mines had been destroyed by the end of the war; output fell to 3.5 million tonnes of coal in 1945 and manpower had fallen to 34,000 miners by the end of 1945.

The Saarland was occupied by American troops in March 1945. The mines, which had suffered extensive damage in some cases, thus came under American control in the form of the "Saar Mining Mission". When the American troops arrived, 5,500 miners were employed in underground mining, with a daily output of only 1,310 tonnes. On 10 July 1945 supervision of the mines was transferred to the French "Mission Française des Mines de la Sarre"; on the same date the French military government took over administration of the Saarland.

During the first two years after the war the only possibility was to try and deal with the worst damage from the war using the limited technical and financial resources available to so gradually take on miners again and increase production levels.

As France wanted to bind the Saar Mining District more closely to itself than the other parts of its occupation zones for economic reasons, the French government was working towards economic and monetary union between the Saar and France. When the Saarland constitution came into force in December 1947, this effected its economic incorporation in France and its separation from Germany. The French administration of the Saarland's mines was also reorganised under the framework of the economic incorporation in France. The "Régie des Mines de la Sarre" was founded on the basis of the law governing the introduction of the Franc in the Saarland on 15 November 1947. The new administration was provided with all (movable and immovable) assets of Saargruben-AG which was currently undergoing liquidation. As early as1948, the first year of the new administration, 84% of the pre-war capacity was achieved with a manpower level of 62,000 miners.

The responsibility for the mining of coal in the Saar was confirmed in the Saarland Mine Convention of March 1950. Another convention, the "Saar Mine Agreement" concluded between France and the Saarland dated 20 May 1953, paid tribute to the wish repeatedly expressed by the government of the Saarland to have greater involvement than before in the administration of the mines in the Saarland. The Saar Mine Agreement was accordingly taken as the basis for the founding of the company "Saarbergwerke" on 1 January 1954, with the management being supervised by a twenty-strong "Saar Mine Council" consisting of an equal number of representatives.

However, in the Saarland resistance to the policy of economic integration was growing. On 23 October 1955 67.7% of the Saarland's inhabitants voted against the Saar Statute of October 1954. One year later, on 27 October 1956, this resulted in the Luxembourg "Agreement between the Federal Republic of Germany and the French Republic to Settle the Question of the Saarland". This agreement put a final end to the disputes about the coal in the Saarland lasting hundreds of years between the two countries in a manner satisfactory to both parties: in addition to agreements about the working of coalfields in the Warndt area and the future organisation of coal sales, the contract also contained the principles for reorganisation of glance coal mining in the Saarland. Article 85 required the Federal Republic of Germany to appoint a new legal entity for the Saarbergwerke within a certain period; at the same time the Saarland was entitled to acquire a holding in the new company by taking over shares representing 26% of the nominal capital. After the founders' meeting on 30 September 1957, the new nationally and regionally owned company of "Saarbergwerke AG" was entered in the Commercial Register in Saarbrücken on 1 October 1957. 74% of the nominal capital was allocated to the Federal Republic and 26% to the Saarland.

In 1958, just one year after the founding of Saarbergwerke AG, there was a rapid deterioration of the market position of German glance coal. Cheap mineral oil was forcing its way onto the market, and the price of imported coal had also become much cheaper due to the slump in sea freight. Idle shifts thus also had to be introduced in the Saarland mines, the first on 14 July 1958.

A reduction in outputs became unavoidable; in 1959 the pit St. Barbara in Bexbach, which had been newly founded under the aegis of the French, was the first to be shut down. As the coal stockpiles in the Saarland had reached the 2 million tonne mark in 1960, further plants had to be closed down in the following years: St. Ingbert (1959), Heinitz (1962), Victoria (1963), Kohlwald (1966), König and Jägersfreude (1968). This was the only way to reduce the output of 16.2 million tonnes (1960) to 10.6 million tonnes (1970). In the same period the total manpower levels fell from 52,964 to 26,883. In these 10 years the underground output of 2,013 kg per man and shift (kg/MS) rose to 3,632 kg/MS. A new mine was also built during this time: the Warndt mine which started production in 1963, providing up to the present day valuable coking coal for the steel industry in the Saarland; in addition the coking and power sectors underwent continuous expansion. 1959 saw the commissioning of the Fürstenhausen coking plant, with the capacity of this plant being doubled in 1966. In the power sector the addition of Barbara (+ 150 mW), Weiher (+ 300 mW) and Fenne (+ 150 mW) resulted in an increase of electric power from 1.7 billion kWh (1957) to 4.1 billion kWh (1970); new business fields were also built up as well.

The 1970's were characterised by further rationalisation and downsizing, but also by an increase in the output per shift. Participations were consolidated and brought into line with market developments.

Due to the oil crises of 1973 and 1979 the German glance coal mining industry was urged by the national energy policy to restore production levels and thus contribute to ensuring the supplies of German energy. Saarbergwerke was in a position to swiftly boost production to over 11 million tonnes (1982), while at the same time taking on new staff, a political requirement. In 1982 the total manpower once again stood at around 26,000. The company had also undertaken to offer work to over 1,000 trainees each year.

Further expansion of the coking and power station capacity also occurred during this period: Weiher III in 1976, the model power station Völklingen in 1982, and in 1983 the power station Bexbach with partners from south Germany. In 1984 the first coke was produced at the central coking plant Dillingen after a two-year building period.

However, in the middle of the 1980's a number of unforeseen developments put an end to the brief renaissance of German glance coal: the slump in the price of crude oil, the stagnation of primary energy consumption, the continuous fall in the dollar exchange rate and a steady decline in the sales of coal to the steel industry cast a doubt over many of the newly introduced measures. Recent years have been characterised by increased adaptation in the Saarland's mining industry: the participation of Saarbergwerke AG was scaled down to a company focusing on energy and environmental technology. Output fell to around 9 million tonnes (1992) while at the same time the number of staff was reduced to approx. 18,000.

The results of the first round of coal negotiations with representatives of the federal government, the coal-producing states of North Rhine-Westphalia and the Saarland, the trade unions and mining companies in 1989 hardly lasted two years. In a second round of coal negotiations in 1991 the participants agreed to a further reduction in coal output. Increased rationalisation and cost cuts were to be achieved by means of "optimisation models" of the individual mining districts. For the Saarland's mining industry this meant the closure of two mining centres (the Reden and Luisenthal pits) but also the creation of two amalgamated mines in the west (Warndt/Luisenthal) and the east (Göttelborn/Reden). Together with the Ensdorf mine these three locations were meant to result in an annual output of around 8.2 million tonnes of glance coal and permanent employment for 15,000 people combined with a much lower level of costs.

Given the trust placed in continuation of the agreement of 1991 a total of DM 570 million was invested in the realisation of the so-called Three-Location Concept in the Saarland. The optimisation of mining in the Saarland was completed with the merger of the pits Göttelborn and Reden to form the amalgamated mine Ost in November 1995. But just one year before, new changes adversely affecting the mining industry started to emerge in the context of the discussions about the subsequent financing for the "Century Agreement", which provided financing of German glance coal mining through the "Coal Pfennig" paid by the power consumers. The financing of the glance coal subsidies via the "Coal Pfennig" which was no longer judicially upheld by the Federal Constitution Court was superseded by the provisions of the Energy Article Act. The guaranteed quota was replaced by a fixed finance ceiling which was so designed to result in a further 1 million tonne cut in production for Saarbergwerke: the reduction in output could still be divided up between the three mines Ensdorf, Warndt/Luisenthal and Göttelborn/Reden in 1996, thus initially upholding the Three-Location Concept.

The political debate about coal subsidies continued and ended - after lengthy and sometimes heated disputes - with the Coal Compromise of 13 March 1997. To date this compromise represents the most painful intervention in German glance coal mining: by the year 2005 six or seven of the in all 17 mines still in operation must be closed down; by that date over half of the jobs in mining will have disappeared and production reduced from 50 million tonnes to 30 million.

For mining in the Saarland this decision spelt the end of the recently concluded optimisation model of the Three-Location Concept as one Saarland mine had to close by the end of the year 2000. The decision as to which mine would cease production was taken under consideration of economic factors and fell on the amalgamated mine Ost which had only been merged at the end of 1995. On 25 November 1997 the supervisory board of Saarbergwerke AG consented to the cessation of coal production at the amalgamated mine Göttelborn/Reden by the end of the year 2000.

A further condition for conclusion of the Coal Compromise in March 1997 was the founding of a new company Deutsche Steinkohle AG on 1 October 1998. This company unites all German glance coal operations under the aegis of RAG AG (Ruhrkohle). This involves the mines and coking plants of Ruhrkohle AG and those of Saarbergwerke AG. Preussag Anthrazit GmbH, which operates a glance coal mine in Ibbenbüren (North Rhine-Westphalia), joined the new company in January 1999.

Industrial Monuments of Saar Mining District

The glance coal mining district of the Saar contains numerous industrial monuments documenting the history of glance coal mining. In particular it includes individual monuments such as the well-known mining directorate built in Saarbrücken between 1877 and 1880 which is still the administrative headquarters of active mining in the Saarland, or Germany's first reinforced concrete winding tower built at the Camphausen mine in Fischbach in 1910/1911. In addition it also offers documentation involving gallery installations with high aesthetic appeal seldom found elsewhere, starting in the first half of the 19th century and ending in the second half of the 20th.

The Saar Mining District is also in possession of many interesting hoist frames and winding towers whose number is however constantly declining as more and more mines close down. The last fine example of a modern hoist frame is to be found over the central shaft of the Göttelborn mine, which is due to be closed down in the year 2000.

Complexes of monuments at the Saarland's mines will be considered below for the purpose of comparison with the surface installation of shaft 12 at Zeche Zollverein. The two pits Itzenplitz and Maybach are among the oldest pit complexes which have been preserved, at least in large areas.

Grube Maybach at Friedrichstal was built in 1873 and named after the Prussian minister Maybach. The mine developed at a fast pace and was soon one of the most important mines in the Saar Mining District. Production ceased in 1981.

Of its original surface installations the three hoisting engine houses of the shafts Albert (1882), Marie (1889) and Frieda (1902) can still be seen. They have a uniform design and, with the administrative building and the monument to the 98 miners who died in an explosion in 1930, form an impressive complex of buildings. The hoisting engine at the shaft Albert dating from around 1900 has also survived. This complex, which has unfortunately lost all three hoist frames, is completed by the existence of an sizeable colony for office and mine workers which was built between 1893 and 1912. The different designs used for the houses reflect the social hierarchy prevailing within the workforce at the time. The café, school, church and a dormitory round off today's finest example of a closed living and working community in the Saarland's mining industry. This makes the loss of the last hoist frame not long ago even more incomprehensible.

The oldest parts of the complex of **Grube Itzenplitz** at Heligenwald dates back to the late 1880's: the hoist frame at shaft 3 (1886), which is considered to be the oldest preserved frame in the Saar Mining District, and the loading installations, which still document the plant scheme used for this pit. The hoisting engine house and the switching station (around 1900) also form part of this complex as well as the more recent installations at shaft 2 and the pump house built around 1900 in Weiher / Itzenplitz and the impressive colony with its prayerhouse. Regrettably the complex is not in a good state of repair.

The surface installations of **Grube Velsen** at Ludweiler/Warndt are some of the most authentic examples of mining installations of the time before and during the First World War. Grube Velsen was built in 1889 and named after the future Chief Mining Officer Gustav von Velsen. The buildings which can still be seen today were built between 1908 and 1917. In 1965 the pit lost its independence: it was attached to the Warndt mine as a secondary pit and closed down as an extraction location. Special attention should be given to the pit house, the two hoist frames and hoisting engine houses with their functioning steam engines. The complex also includes the colony consisting of 160 houses for either one or two families in the district of Velsen. This settlement which dates from Prussian management and since 1920 that of the Mines Dominiales is not only the largest but also the best preserved colony from the period of French administration.

In Ensdorf the complex at the Duhamel shaft at **Grube Ensdorf** has been preserved. Important stages in the development of the Ensdorf pit was the sinking of the first underground mining shaft in the 19th century (1826) and the completion of the gallery Ensdorfer Stollen started in 1833, a hauling gallery 2350 m in length which was used for hauling the pit coal to the Saar and the loading station based there and whose portal architecture dating from 1842 has been preserved. Further shafts were sunk between 1861 and 1913, the last being the Saar shaft which was renamed the Duhamel shaft by the French mine administration from 1920 to 1935. This was a tribute to the services of Duhamel to the Mining Atlas drawn up in cooperation with the engineers Beaunier and Calmelet from 1807 to 1810 which, at Napoleon's behest, was to document the position of the pits and seams in the Saar Mining District on its 66 pages of maps.

In 1925 the Duhamel pit became a separate mine. In 1957 the Duhamel and Griesborn mines were amalgamated to form the Ensdorf mine. Large parts of the surface installations to be seen today were built in 1917 and 1918. The architectural quality and stylistic unity of the installations featuring Romanesque forms based on historicism - consisting of the hoist frame installed in 1917 with the two machine houses and compressor station - is striking; the relevance of the installations documenting mining in the Saarland around 1920 is further reinforced by the surviving machinery: two of the original steam-driven hoisting engines made by the Zweibrücken machine factory Dingler in 1918 and 1938 have survived and are still in service. The complex is rounded off by the pit house built under French administration in 1924; the main facade has survived in its original state. All other surface installations - the coe, administration and coal processing station - are more recent. The waste tip, which can be seen from far and wide, marks the location of the Duhamel shaft. Today the Ensdorf mine is the most productive and cost-effective German mine in operation: in 1977 the pit was Europe's first deep mine to achieve an underground output of 12.3 tonnes per man/shift. Another magnificent achievement of engineering was the driving of the gallery Barbarastollen, a hauling gallery with a length of 3500 m which overcomes a height difference of 657 m: it was put into operation in 1978.

Another Saarland mine of interest is the **Bergwerk Reden** which is now closed down and was named after the Prussian minister Graf von Reden (1752 - 1815). The first underground shaft was sunk in the middle of the 19th century, and another four were added by 1914. After the reintegration of the Saarland in the German Reich (1935) the mine was developed into a large-scale installation. After the Second World War between 1958 and 1965 twelve pits and hauling locations were merged to create the mine which mainly produced bright-burning and fat coal.

The extensive surface installations with their hoist frames, machine houses, ventilating and processing equipment spread out before the enormous waste tip which is visible from miles around. Special attention should be given to the coe and pit house built in 1935/1936 which is characterised by its alternation in colour between red and brown bricks on the external facade and, in many elements of style, is reminiscent of the surface installations of Zeche Zollverein. The portal at the west wing of the building is striking due to its monumental design: it is subdivided by pillars, the door lintel is decorated by a key-pattern frieze. To perfect the clarity of its facade a larger-than-life bronze sculpture of the mining officer Fritz Koelle is positioned in front of the entrance. Where the machinery is concerned, the pit's three steam engines dating from 1938, 1939 and 1941 would be of interest. The two monuments to the mine accidents in 1864 and 1907, the office workers' housing and the inspection building round off the complex whose completeness is under threat since closure of the mine.

However, all complexes of monuments considered above cannot measure up with the quality of Zeche Zollverein in Essen. The examples in the Saarland not only fall short regarding the dimensions of the installation, the architectural quality including the uniformity of design as well as its economic significance: all complexes are small-scale pits compared with pit Zollverein 12 and, apart from the Reden mine, feature architecture based on historicism and not new functionalism; it is therefore difficult to compare them with each other. In addition, their state of repair is not generally good and the future is uncertain in the case of the Reden mine.

One more Saarland mine must be meanwhile taken into consideration: the **Bergwerk Warndt**. On 14 March 1958 subgrading started on a site 32 hectares in size to the north of Karlsbrunn near the French/Lorraine border; shaft sinking commenced on 20 May 1958 using the freezing method. When planning the surface installations the objective was to take a large number of principles and special factors into consideration. One requirement was the creation of a well-organised and self-contained installation. Special attention was to be given to the functional arrangement of the buildings, i.e. short distances and a practical concentration of linked and related operational areas. The idea was also to provide for the possibility of extension at a later stage by giving consideration to future operational and technical developments while the architectural design was to be aesthetic yet extremely functional.

On 20 July 1960 work started on the erection of the approx. 70 m high winding tower which consisted of seven floors and was built of prefabricated shell elements made of exposed concrete. It accommodated two four-cable machines as hoisting engines each with a capacity of 2970 kW. These two machines were the largest and most powerful systems of their type to be found in the Saarland glance coal mining sector at the time of installation.

The surface installations, which were all built as steel framework structures with clinker brick facing were oriented towards the position of the main shaft, the approach road and the mine station. The outdoor switchgear was installed to the left of the road; to the right there was the gatehouse with kitchenette, telephone switchboard and offices.

If we follow the path of the miner on arrival, we will next arrive at the wash coe with facilities for 3888 miners. We then use a two-storey connecting passage to arrive at the pit house with the works offices, lamp coe and the mine surveying office. Next we have the magazine 100 m in length and the workshop building. The processing station was designed for a throughput of around 600 tonnes/h.

Apart from the north shaft of the Ensdorf mine, the Warndt mine is the only pit in the Saar Mining District to have been built after the Second World War. Its surface installations reveal an intention to open up the deposit in Warndt and to secure the energy supply in the Saarland in particular on a long-term basis. This intention found its expression in the uniform design of the surface installations: today we cannot find among the mines still in operation in the Saarland any other complex of a similar uniform design with a generously dimensioned architecture consisting of large cubic structures. This mine complex is the most important and most valuable monument of the 1960's in the mining industry of the Saarland. In addition to this more regional relevance the pit also ranks on a national scale as one of the few complete new mines in the Federal Republic of Germany; in this regard the surface installations are an important monument documenting economic, technical and social development in mining but, given the era and its integration in the environment of the Warndt forest region, cannot compare with the "Zollverein" monument.

We should also consider a number of remarkably large and mostly completely preserved **residential settlements**. The "Prussian settlements" of the mines Heinitz at Neunkirchen, Camphausen at Fischbach, Von der Heydt at Saarbrücken and Göttelborn at Göttelborn were built in the last quarter of the 19th century and were extended at the start of the First World War; the Madenfelderhof colony at Schiffweiler is a characteristic example of the housing policy of the Mines Dominiales Françaises (around 1920).

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2.6.1.1.4 Saxon Lugau/Oelsnitz Mining District

If we consider the quantities of coal produced by the German glance coal mining districts, little importance can be given to the three Saxon districts of Freital near Dresden, Lugau/Oelsnitz and Zwickau in the east of Germany accounting for an average of around 2.5% of the German output of glance coal until 1945. However, during the 127 years of mining activity (1844 - 1971) they did produce a total of 142 million tonnes of glance coal. Their percentage share of workable glance coal stocks from the limnic deposits of glance coal is much smaller. As the stocks of glance coal from these deposits were of major importance for the economy of Saxony and some relicts of the mining activities ceased in the 1970's still exist, the Lugau/Oelsnitz glance coal mining district approx. 30 km^2 in size with its deposits of glance coal at Lugau, Niederwürschnitz, Neuwürschnitz, Oelsnitz, Hohndorf and Gersdorf must be taken into consideration.

Development of Glance Coal Mining in Lugau/Oelsnitz Mining District
The first Carbonic glance coal to be found in the Lugau/Oelsnitz Mining District was discovered in 1831 in what is today the district of Neu-Oelsnitz during the construction of a drainage trench. The attempts to sink prospecting shafts were initially unsuccessful.

In 1843 Karl Gottlob Wolf founded a "Small Company of Equal Parts" with 26 participants: the precursor to the joint stock company Oelsnitzer Steinkohlenbauverein. The attempt to sink the first shaft in 1843 did not succeed. In 1844 the second shaft, the so-called Wolfschächtel, produced the first coal from this district at a deepness of 10 m. Encouraged by this success other entrepreneurs tried their luck in the neighbourhood of Wolf. Most of the many shafts jammed together in Neu-Oelsnitz and Niederwürschnitz were abandoned by the mine owners and coal miners in 1845 and 1846 through lack of money.

The landowners resisted all efforts towards amalgamation; success only came to the businesses which took advantage of technical progress by using suitable means and were able to overcome the difficulties using steam power. Following the introduction of steam power in other branches of industry the demand for glance coal started to increase; the workings moved from the edge of the basin northwards further into the basin of the Erzgebirge (Ore Mountains) where the seams were thicker - but also covered by increasingly thick cap rock.

Wolf's first deliveries of coal were destined for Stollberg and later in large quantities for the machine factory Richard Hartmann at Chemnitz. This was the basis for the formation of larger mining operations. The funds necessary to develop productive pits were provided through consolidation between landowners, manufacturers and merchants.

The decisive step towards underground mining was taken in 1855 with the founding of the companies Zwickau-Lugauer Steinkohlenbauverein and in 1856 the Steinkohlenbauverein Gottes Segen and the Oelsnitzer Bergbaugesellschaft. These companies sank the shafts "Neue Fundgrube" and "Gottes-Segen-Schacht" in Lugau and the "Hedwig-Schacht" in Oelsnitz to depths of 600 m.

The favourable prospects were the signal for the sinking of further shafts and the establishment of new companies. One significant step for the mining companies was the construction of the railway line from Niederwürschnitz to Wüstenbrand which was taken into operation in 1858 and linked the Lugau-Oelsnitz Mining District to Chemnitz at an early stage. A second important line, the Bahnlinie Stollberg serving St. Egidien via Oelsnitz, was opened in 1878.

From the three companies mentioned above and others the companies Gottes Segen and Deutschland developed in time into the two largest mining companies in the Lugau-Oelsnitz Mining District.

As regards the history of **Gewerkschaft Gottes Segen**, the parent plant was founded under the name of "Steinkohlenbauverein Gottes Segen" in Lugau on 12 June 1856. The development of the mining field approx. 87 hectares in size located to the southwest of Lugau started with the sinking of the Gottes-Segen shaft. A steam-driven water drainage system was also set up next to a steam hoisting engine. Just a few years later a total deepness of 374.5 m was reached. Difficulties with ventilation, which were not solved by an underground connection to the adjacent Carl-Schacht in 1864, prompted the company to sink the Glückauf shaft in 1866, 14 m from the Gottes-Segen shaft. The final deepness of 412 m was reached in 1897. To improve the selling products the first coal processing plant was already set up in 1866. The absence of English coal from the German market gave the company a tremendous boost at the start of the 1870's. An important step was the extension of the mining field by the purchase of the 190-hectare concession of the Fürstlich-Schönburgische Steinkohlenwerk with the two shafts "Kaiserin Augusta" and "Gottes-Hilfe" as well as the Rittergutsfeld approx. 167 hectares in size at Oelsnitz. In particular the Kaiserin Augusta shaft sunk between 1869 and 1874 was very favourably positioned for mining of the rich deposits of coal. The Gottes-Hilfe shaft opened up a series of rich seams down to a depth of 550 m. The company flourished until the First World War but a lack of manpower during the war and the economic difficulties of the post-war period prompted the shareholders to sell the company to the state of Saxony in 1920. It had already taken over the Lugauer Steinkohlenbauverein at Lugau, the company Kaisergrube at Gersdorf and Steinkohlen AG Vereinigtfeld at Hohndorf and then amalgamated the four companies to form the new "Gottes Segen" company. In organisational terms the company Gottes Segen consisted of four divisions: the Lugau division with the Gottes-Segen shaft, the Glückauf shaft, the Vertrauen shaft and the Hoffnungs-Schacht, the Oelsnitz division with the Kaiserin Augusta and Gottes-Hilfe shafts, the Kaisersgrube division with the Kaisersgrube shafts I and II and the Concordia shafts I and II and the Vereinigtfeld division with the Vereinigtfeld shafts I to III. To improve the ventilation of the underworkings of the Oelsnitz division the Heinrich shaft was used as a ventilation shaft 1.5 km southwest of the Kaiserin Augusta shaft between 1924 and 1926.

However, the merger did not bring about an improvement in profitability - on the contrary, cost increases, the departure of manpower, declining currency values and competition with other coal mines put the company in a critical position and compelled further amalgamations. In 1925 the hauling plants at the Gottes-Segen and the Glückauf shaft ceased operation. The stocks of coal were allocated to the adjacent Vertrauen shaft and the Lugau and Kaisersgrube divisions were merged. The surface installations of the Vertrauen shaft were closed down after it had been connected to the coal washing station of the Kaisersgrube via a cableway. At Vereinigtfeld in Hohndorf the hauling plants of shafts II and III were shut down and the entire production routed through shaft I. As the economic situation become more critical, the two Concordia shafts ceased operation in 1928, the Hoffnungs-Schacht in 1929 and the two Kaisergrube shafts in 1930. In 1931 production also ceased at Vereinigtfeld shaft II. The remaining output was taken above ground via the most productive shaft in the district, the Kaiserin Augusta shaft modernised at the beginning of the 1920's where the largest and best-quality deposits of coal were mined. Of the13 main shafts in operation after the founding the company "Gottes Segen" in 1920 only three main shafts were left over, i.e. Kaiserin Augusta shaft, Gottes-Hilfe shaft and the Vertrauen shaft, in addition to two ventilation shafts (Gottes-Segen shaft and the Heinrich shaft).

The scaling-down of the business resulted in an improvement in the utilisation of the remaining installations and a reduction in the producing costs. This meant that funds were available for the creation of a new gangway floor and further extension of the Kaiserin Augusta shaft. The installation of a second hauling plant allowed the two other remaining main shafts to be closed down. The coal processing and power station also underwent modernisation. Following introduction of the above measures the annual output of approx. 1 million tonnes, which before the First World War was produced using 16 shafts and six processing stations, was extracted solely via the Kaiserin Augusta shaft from January 1938, also undergoing processing there.

The Kaiserin Augusta shaft was the main hauling pit of the company "Gottes Segen"; it produced a total of 60 million tonnes of coal between 1874 and 1971. The usable annual output for individual years was as follows:

1923	900,000 t
1928	850,000 t
1933	800,000 t
1938	1150,000 t
1941	1050,000 t
1952	1010,000 t

For the Kaiserin Augusta shaft this meant in specific terms that following the installation of the small hauling plant in 1935, 5,400 cars left the shaft in 14 hours (3,600: large installation, 1,800: small installation). The manpower level stood at 3,500 people at this time.

The history of the company "**Gewerkschaft Deutschland**" started in 1871 with the constitution of the company "Aktiengesellschaft Steinkohlenbauverein Deutschland". This company with a mining field of 112 hectares formed the parent plant of the subsequent company "Deutschland". Between 1871 and 1874 the Deutschland shaft I was sunk to a deepness of 699 m, and shaft II to a deepness of 751 m between 1872 and 1879. Unusual difficulties including pit fires, strong rock pressure and the occurrence of firedamp forced the company to undertake financial restructuring. The last hope was to convert the joint stock company into a Gewerkschaft mining company with the result that the new company Gewerkschaft Deutschland was formed in 1889.

A new coal washing station and a new power station were completed in 1896. This power station represented the largest electric installation in the whole of the German glance coal mining industry at that time.

In 1906 it was decided to merge the glance coal mine "Vereinsglück" in Oelsnitz with Gewerkschaft "Deutschland". Further glance coal mining rights were acquired at the same time so that Gewerkschaft Deutschland became the leader among the mines in the Lugau/Oelsnitz Mining District.

The First World War put an end to the steady upward growth in the years which followed, and 1918 finished with a loss due to the downturn in business. The acquisition of the majority of shares by the City of Leipzig in 1919 heralded a new trend. In 1920 saw the transfer of the Oelnitzer Bergbaugesellschaft with the Hedwig shaft and the Friedens-Schacht as well as Steinkohlenbauverein Hohndorf with the Helene and Ida shaft to Gewerkschaft Deutschland. The oldest glance coal mine in Oelsnitz, Oelsnitzer Bergbaugesellschaft, had thus ceased to exist.

To maintain the business in a more or less profitable manner the attempt was made to build up the division "Deutschland" as the main works and headquarters of all four divisions for the entire production, processing and shipment and the joint supply of power, something which was never completely successful due to the shortage of space. The Deutschland shaft II was extended to 840 m and a new winding tower built 50 m higher. Following the driving of a connecting cross cut in 1932 hauling at the "Vereinsglück" division was transferred to the Deutschland shafts. With the introduction of all these measures the Hedwig shaft, Ida shaft and the Friedens-Schacht and the two Vereinsglück shafts were only used for the supply of materials, man-riding and ventilation while the Helene shaft was closed down and filled.

The Second World War also left its mark on the two glance coal mining operations. The war and the deterioration of the coal seams at "Deutschland" resulted in a dramatic fall in production and a virtual complete standstill in operations between 13 April to 8 May 1945. After the collapse the two works took up operations again on 9 May 1945. On 1 January 1946 the two operations were merged with the remaining works of the Saxon glance coal mining industry in Zwickau and Freital to form "Sächsische Steinkohlenwerke GmbH, Landeseigenes Unternehmen".

Expropriation was carried out in 1946: the companies "Gottes Segen" and "Deutschland" were converted to the legally and economically independent nationalised companies VEB Steinkohlenwerk "Karl Liebknecht" and VEB Steinkohlenwerk "Deutschland".

Kaiserin-Augusta-Schacht	in	Karl-Liebknecht-Schacht
Gottes-Hilf-Schacht	in	Friedrich-Engels-Schacht
Vereinigtfeld-Schacht	in	Rudolf-Breitscheid-Schacht
Heinrich-Schacht	in	Hermann-Bläsche-Schacht
Vereinsglück-Schacht	in	Albert-Funk-Schacht
Hedwig-Schacht	in	Albert-Jacob-Schacht I
Friedens-Schacht	in	Albert-Jacob-Schacht II
Ida-Schacht	in	Rosa-Luxemburg-Schacht

Despite serious difficulties the district's output at the Karl-Liebknecht shaft was increased from year to year and with an annual output of over 1.2 million tonnes in 1950 attained the level before the Second World War. The Karl-Liebknecht shaft thus accounted for 43% of the entire output of all glance coal mines in the state of Saxony. Despite the introduction of modern mining machines production could not be increased any further as the geological conditions did not permit economic operation of this machinery. To mine other parts of the deposit the Neuwetterschaft was sunk as a ventilation shaft with a deepness of 240 m 200 m to the west of the Karl-Liebknecht shaft between 1952 and 1954. In this context Adolf Hennecke's legendary activist shift remains unforgettable.

In 1960 economic considerations led to the merger of the two glance coal mines into VEB Steinkohlenwerk Oelsnitz with the divisions "Karl Liebknecht" and "Deutschland" and connected below ground in 1961. In 1960 the mine still had three main shafts and nine material, man-riding and ventilation shafts. All drifts encompassed 130 km of open underworkings while the total manpower was approx. 10,000 miners at that time.

However, the surface installations of Deutschland had meanwhile become worn out; in particular the processing station could only be kept in operation with extensive repairs and operated at a loss. The stocks of coal at the Karl-Liebknecht shaft were limited to tectonically highly stressed residual areas containing large amounts of waste at the basset of the deposit while Deutschland's stocks were located in the pit pillars of the Deutschland and Albert-Funk shafts. Following extensive work it was possible in 1965/1966 to route the production of the "Deutschland" division via the Karl-Liebknecht shaft. This allowed the processing station of the "Deutschland" works to be closed down and demolished.

Following the decision taken by the former GDR's council of ministers in December 1967 regarding the scheduled gradual phasing-out of glance coal production at the Oelsnitz mine the last mine car left the shaft on 31 March 1971. This was the end of a mining industry which had lasted 127 years, and had produced 142 million tonnes of coal between 1844 and 1971.

The shaft cylinder of the Karl-Liebknecht shaft (formerly the Kaiserin-Augusta shaft) was filled in 1975. In 1976 work started on conversion of the Karl-Liebknecht shaft into a museum, which was opened on 4 July 1986 as the GDR's central glance coal mining museum and one of Germany's largest museums of mining.

Industrial Monuments

The Lugau/Oelsnitz Mining District still contains numerous mainly individual monuments, e.g. the buildings of the mines Gottes Segen and the Einigkeitsschacht, which are typical of pits dating from the first decades of mining on an industrial scale. Massive shaft houses with gable roofs, the roof of the Einigkeitsschacht in the style of a tower and once with a ridge turret, are reminiscent of the shaft houses of the ore mines in the Erzgebirge in terms of industrial architecture. Next to the shaft houses there are the hoisting engine houses, which have always been equipped with steam engines in the glance coal mining sector. The Einigkeitsschacht in Lugau still has its heavy square chimney against while the once lower-level machine house was raised as early as the 19th century. Workers' colonies can also be seen, having undergone extensive renovation in some cases after the fall of the Berlin. Tips and glory-holes are a further reminder of the history of mining in this landscape of monuments.

The industrial monument of the **Karl-Liebknecht shaft** at Oelsnitz, which has been converted into a museum, is the most important outstanding document of local glance coal mining. The shaft, which used to be called the Kaiserin-Augusta shaft and was first sunk in 1869 to reach a final deepness of 588 m, was initially equipped with a steam hoisting engine and the standard ironwork hoist frame. The winding tower, which is approx. 50 m high and can still be seen today, was installed over the shaft after the First World War in 1923. With its red clinker and light-green surrounds the winding tower is today the emblem of the former mining district, a landmark that can be seen from far and wide. The tower was equipped with a powerful electric hoisting engine, with the electrical system being supplied by Siemens-Schuckert-Werke and the mechanics by the Zwickauer Maschinenfabrik. The Oelsnitz district was in possession of a number of such tower hauling plants but the hauling plant installed over the Karl-Liebknecht shaft was the most remarkable in technical terms; it consisted of an engine with an approx. diameter of 4 m using 600 V DC which had a rating of over 1000 kW and drove a Koepe sheave 6 m diameter. In another building next to the machine house there is the associated Ward-Leonard converter system which generated the DC supply for the electric tower hoisting engine with varying voltages depending on the required hauling speed.

An efficient coal processing system was installed in 1925/1926, followed by the bunker system for railway loading in 1929, and a technical jewel - a second hoisting engine installed in 1933 next to the shaft house in a separate building: a steam hoisting engine from the

Gutehoffnungshütte Oberhausen-Sterkrade with a rating of 1800 hp. It too has survived and can be started up using an electric motor. This machinery made the Kaiserin-Augusta shaft one of Germany's most modern and productive glance coal mines of this time.

In the former gang bathhouse of the pit a highly authentic reproduction 400 m in length has been set up with original machinery showing the situation underground. Here the visitor can comprehend to a certain degree under what conditions Adolf Hennecke ran his historic shift on 13 October 1948.

However, our previous conclusion also applies to the pit of the Karl-Liebknecht shaft: it basically cannot compare with the landscape of monuments of the Zollverein mine. The two pits date back to the 1920's and are also set in a landscape complex full of monuments to the history of mining comprehensively documented by a instructional mining trail but the Oelsnitz mine lacks the dimensions and the formal scope of the monument in Essen and the creative force of the two architects. However, unconditional significance on a national scale must be attributed to the shaft at Oelsnitz: this mining complex is the best and, due to its comprehensibility, most impressive monument of glance coal mining in east Germany.

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2.6.1.1.5 Glance Coal Mining Monuments in Germany

If we review the monuments still existing at the German glance coal mining installations which are active or have already been closed down, the exceptional status of Zeche Zollverein will become clear. There are undoubtedly telling monuments to be found in all German glance coal mining districts - individual monuments such as gallery mouths, mine buildings, hoist frames and winding towers as well as area monuments and complex such as tip landscapes, pits and colonies - but we look in vain for a pit which can measure up with Zollverein. There is nothing to compare either in terms of its dimensions, state of repair, representative architecture and the unity of its appearance or the expressiveness of its environment. Only the pit Zollern 2 / 4 in Dortmund-Bövinghausen as an older example and the Warndt mine built in the Saarland after the end of the Second World War correspond to Essen's example of uniformity of design without however being able to match up as regards quality. All other monuments of glance coal mining cannot compare with Zeche Zollverein as individual monuments.

If we include mines from ore and salt mining, we have to consider a number of other mines: the mining installations of the Rammelsberg ore mine in Goslar, the iron ore mine Dr. Geier in Waldalgesheim, the potassium salt mine in Bleicherode and the magnificent salt works of Bad Reichenhall, Bad Rappenau and Bad Dürrheim are characterised by high-quality generously dimensioned architectural monuments with great aesthetic appeal and expressive content.

The **mining installations of Rammelsberg** in Goslar already form part of the world cultural inheritance by virtue of their importance as monuments. They were designed by Schupp and Kremmer, the architects of Zeche Zollverein as a complex staggered on a slope in the framework of an extensive new building programme 1936 ff. The Rammelsberg is rightly considered in terms of quality as the world's best and most telling example of a metal ore mine which has also worked one of the world's most famous deposits for over a thousand years. Most of the machinery has survived at the mine: the underground installations are partly accessible and can be visited by tourists. The surface installations feature forms of high architectural quality which blend in with the landscape and demonstrate among other things the picture of a processing plant built on a slope which is rare today. At the present time the Rammelsberg is being developed into one of Germany's leading mining museums and demonstration mines for visitors.

The **iron ore mine Dr. Geier** at Bingen on the Rhine was built during and after the First World War and supplied the German blast furnaces with manganese ore and dolomite into the 1960's. This mine was created by the Darmstadt architects Georg Markwort and Eugen Seiber using a generously dimensioned uniform design and dominates the landscape of Hunsrück. The surface installations arranged around a central "cour d'honneur" and the associated colony including the fall-in areas at the foot of the mine document the working and social conditions prevailing at this mine, which is extremely large by the standards of ore mining. The monument however has lost machinery and is thus lacking its full expressive character. Nevertheless we must consider the Dr. Geier mine as an outstanding monument documenting the history of German (and also Central European) iron ore mining.

The **potassium salt mine** in **Bleicherode** in the south of the Harz is not so much a monumental structure as a complex of carefully planned pits devoted to the principles of "picturesque urban design"; this mine with major significance for international potassium mining was built between 1899 and 1903 with an architecturally unified complex of surface installations featuring forms based on historicism. It is dominated by an administrative building fortified by a (water) tower; as its major industrial monuments we still have steam hoisting engines dating from 1909 and 1935 in both machine houses, including a rare example of a triple machine.

The **salt works of Bad Reichenhall** built between 1849 and 1851 were designed according to high standards in terms of architecture and machinery and feature a "palatial" exterior. Inside the central works building two large cast-iron pump systems driven by water wheels are still in operation today, transporting the salt water from the accessible underground level to the salt works. However, the salt works designed according to the principles of historicism and the **salt works** of **Bad Dürrheim** (1822 - 1827) and **Bad Rappenau** (1823 ff) with their generous dimensions and axially symmetrical design can only compare with mine installations in the Ruhr to a very limited extent: beside the chronological difference in origin they also lack the expressive force and dynamism of Zeche Zollverein, its aesthetic architecture and also the dimensions of the complex and its environment, not to mention the basic differences in the working of completely different deposits with diametrically opposed conditions which result in their operational/functional characteristics. This assessment ultimately also applies to the comparison between the Ruhr mine with the Rammelsberg mine, the Dr. Geier mine and the potassium salt mine in Bleicherode: the consequence is that Zeche Zollverein must be considered and evaluated as undoubtedly the best example of a large-scale mine in Germany, and not just for glance coal mining in the late 1920's.

To a certain extent, that is, in terms of its architecture, stylistic forms and the axial orientation in the urban context, a comparison can at best be made between the Essen mine and the **German Mining Museum** in Bochum built in 1937 ff. and may well be included in our considerations, with its hoist frame built in 1944 and relocated to Bochum from the former Germania mine in 1973. However, the difference in functions and the "subsequent" composition" as a museum forbids a further comparison between the two installations in the Ruhr: a comparison can only be made in terms of stylistic architectural design. This also applies to the reference to the coe and pit house of the Saarland mine Grube Reden at Neunkirchen built in 1935/1936 with its miners' monument of Fritz Koelle.

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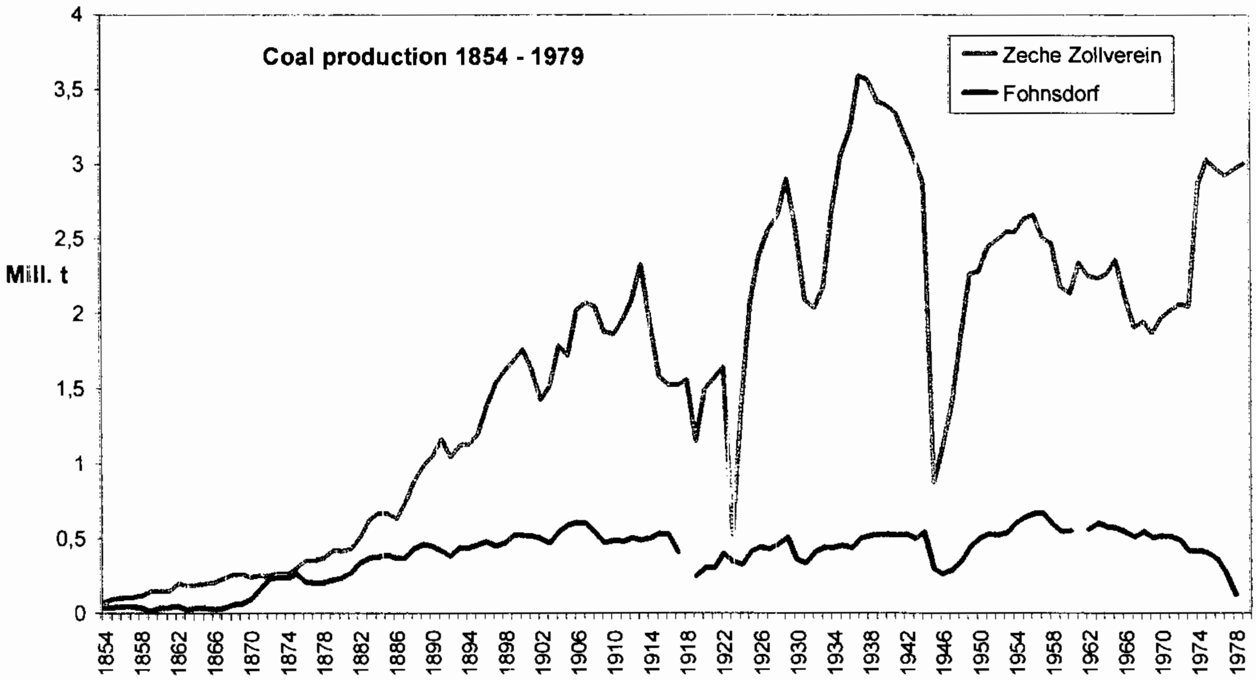
2.6.1.2 Austria

Fohnsdorf was built on Austria's most important glance coal deposit. The blind coal cropping out there was found in a single basin-shaped faulted seam. The seam was max. 8 m deep, was 2.5 to 3 m thick in the Wodzicki shaft and tapered to 0.5 m - 1.3 m at Stillweg. The glance coal deposit was worked down to a deepness of around 750 m.

Development of Glance Coal Mining at Fohnsdorf

The glance coal deposit of Fohnsdorf was discovered in 1670 and was originally worked at the outcrop of the seam by Johann Adolf Fürst Schwarzenberg using open cut mining. In general terms however mining did not become important until the 1840's through the usage of the pit coal in the local iron and puddle works. Between 1840 and 1869 mining remained under state ownership; during this time there was a changeover from gallery mining to deep mining and production was carried out using the three pits Josefi, Lorenzoni (1857/1858) and Antoni (1870). At the neighbouring Stillweg Henckel von Donnersmarck used the Eduard gallery for extraction and Karl Mayr the Karl-Schacht. Output rose from 1066 tonnes (1842) to 263,467 tonnes (1875), with the highest rates of growth occurring in the decade 1850 - 1860 and from 1867 to 1875 under the Steirische Eisenindustrie-Gesellschaft.



A new era for glance coal mining at Fohnsdorf was ushered in 1881 with the founding of the Österreichisch-Alpinen Montangesellschaft, which purchased the Fohnsdorf mine in the very same year. In 1882 and 1884 the company already started sinking two shafts, which went into production in 1890 and were named after the first director-general Karl August von Frey ("Karl-August-Schacht") and the first president Ludwig Graf Wodzicki ("Wodzicki-Schacht"). In the pre-war period the maximum output occurred in 1906 at 606,000 tonnes; in 1916 a staple pit was sunk at a deepness of 743 m. Sinking of the shafts was followed by the initial major development of the "Wodzicki-Schacht" in the 1920's: the old hoist frame dating from 1887 had to be raised, a new steam hoisting engine was purchased from the Friedrich-Wilhelms-Hütte in Mülheim an der Ruhr in 1923 and installed in 1925. Compressed air was now used underground; in 1936/1937 there was a changeover to longwall caving. In the following years Fohnsdorf become Austria's most important coal mine: in 1929 it accounted for around a quarter of Styrian production at 506,300 tonnes of coal, i.e. just under half of the coal produced by the Alpine group.

1946 saw the nationalisation of Austrian coal mining: a step which provided the foundation for the economic reconstruction of Austria in the 1950's. In 1957 the mining industry reached its highest ever output of 671,600 tonnes. Further investment had been carried out by 1962. By 1959 an angled main shaft had been created, a washing station built and modernisation of the compressed air station carried out. However, the international coal crisis in conjunction and the increased demand for natural gas and mineral oil put an end to the boom in coal mining. After there had already been a call for closure of the pit in 1962, the Graz-Köflacher Eisenbahn- und Bergbau-Gesellschaft (GKB) as the subsidiary of Alpine shut down the mine in 1978in the context of the general crisis in the mining sector. In 1980 the main components of the "Wodzicki-Schacht" were categorised as a protected historical monument and turned into a museum, which was opened in 1983.

Industrial Monuments

Of the surface installations only the hoist frame and the machine house with the steam hoisting engine survived after closure of the mine house; all other mine buildings were demolished. At 47 m the hoist frame is very tall and still includes the components dating from 1884 to 1887, i.e. from the time the mine was founded. The surviving surface installations form a historical complex which characterises Austrian glance coal mining. In fact there is no other glance coal mine of a similar quality in Austria. However in comparison with Zeche Zollverein the mine can almost be described as a "small-scale installation: the production quantities only represent around one third of the output of Essen's large mine. We are thus unable to compare Fohnsdorf and Zollverein.

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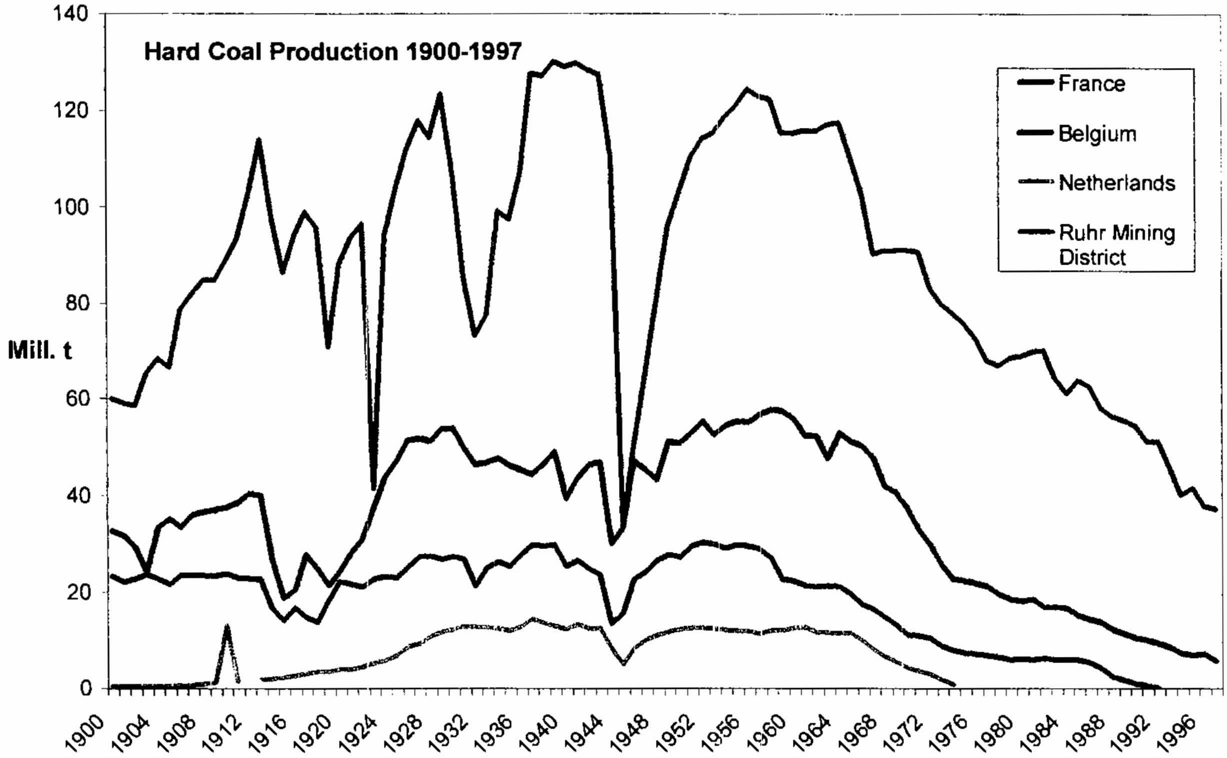
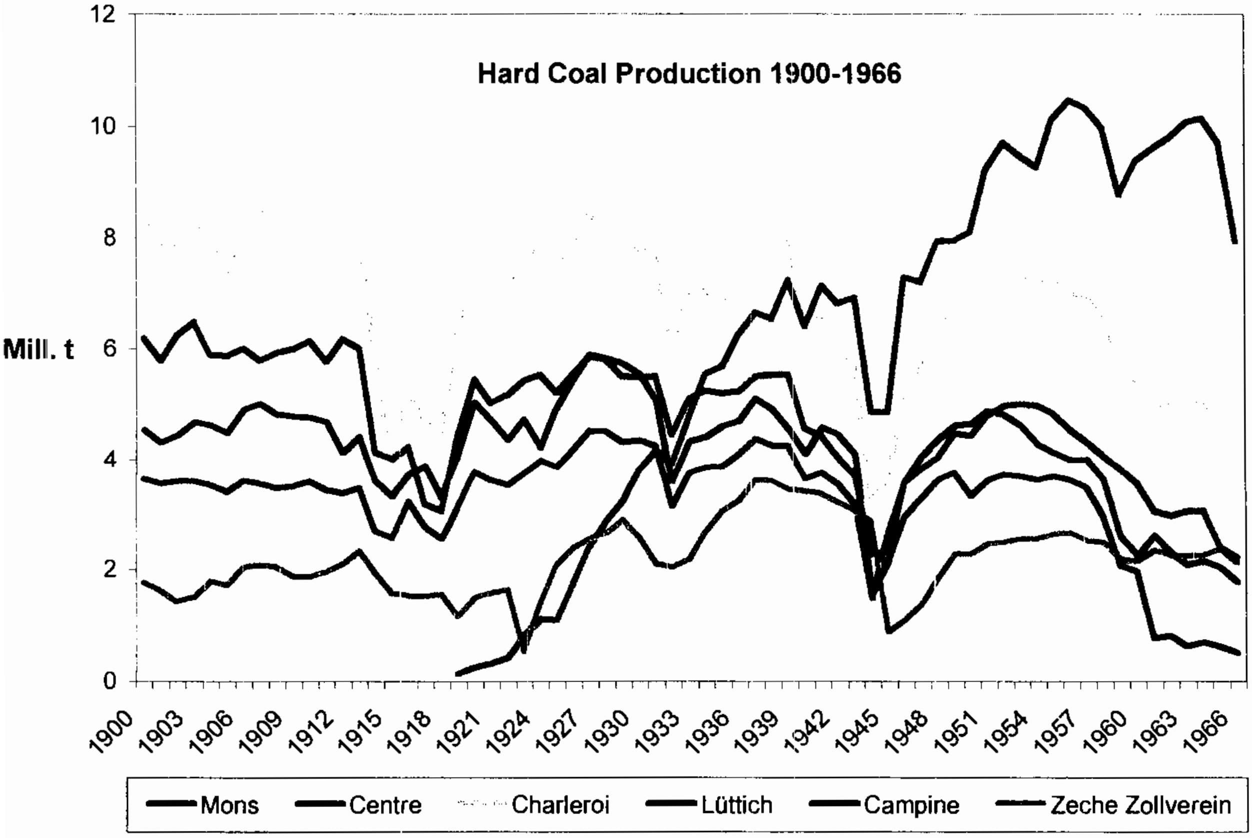
2.6.1.3 Belgium

In Belgium, the deposits of hard coal from the upper carbon are divided between a southern belt, extending from the French field North - Pas de Calais to the Hainaut basin and Liège, and a northern belt in the Campine and North Limburg. The northern belt continues after Dutch Limburg and runs into the southern belt in the Aachen-Erkelenz field. The northern basin is separated from the southern one by the Brabant Massif where there is no upper carbon. The southern part of the Belgian hard coal mining region is located in the geological structural unit of the Namur depression and is integrated into the Mons basin (the so-called Borinage), Centre, Charleroi and Basse Sambre (Namur) and Liège. The former three are also referred to together as the Hainaut basin. In the Campine, the coal seams run flat in a northerly direction and are buried several hundred metres below the imposing mountainous surface. In the south, the coal seams are close to the surface in places and are more dislocated. Due to the different formation of the deposits in the south and north, hard coal mining developed in different ways in the two regions.





2.6.1.3.1 The Borinage field at Mons

The Borinage comprises the coal areas between Mons and the French border; this field does not include the locations to the north of la Haine (Hautrage, Terte, Villerot, Pommeroeul, Bernissart, Nimy and Ghlin), nor those to the south of Mons (Clipy and Asquillies); the field covers an area approximately 20 km in length and 15 km in width.

Geological characteristics

The Borinage is situated in the alluvial plain of Haine; the hard coal deposits worth extracting are in the south at a maximum of 150 m below the surface, but which can be buried 200 m to 300 m down in the central part and in the north. Extraction began at places where the hard coal lay on the surface (e.g. at Flénu, Quaregnon, Wasmes and Pâturages). Bituminous coal (with 15% to 30% volatile components) and - preferably - Flénu, an easily inflammable coal, was mined there and used for domestic heating, for puddling, baking tiles and fayances, for smelting glass and to produce gas for lighting.

The structure of the coal deposits is characterised by a series of partial deposits which in places are overlaid.

The deposits of the actual Borinage (the so-called Massif du Borinage), where the most productive mining takes place, have a total of 89 coal seams within a total depth of 1900m, those of L'Assise du Flénu 59 seams with a total depth of 34m. The Massif de Grisoeuil, which is partially covered by the Massif du Borinage and separated from this by the so-called Borinage gap, forms the extraction area for the pits at L'Agrappe and l'Escouffiaux: There are around ten seams of bituminous coal there (with approx. 20% volatile components), divided over a depth of 200 m; these deposits are heavily disturbed, in addition the seams of the Massif de Grisoeuil were among those with the greatest concentrations of pit gas in Belgium. Fire-damp explosions were a constant hazard when mining these seams, causing the deaths of 112 and 132 miners at the La Cour de l'Agrappe mine in Frameries in 1875 and 1879, a total of 73 deaths at Fief de Lambrechies in Pâturages on 15th and 17th May 1934, and 36 deaths at Grand Trait in la Bouverie on 1 October 1936.

Lying directly on the coal-bearing limestone and bordered by the step of Namur, the Comble Nord deposit is located above the Placard gap. The "Charbonnages de Bernissart" company began investigating this sub-field in 1839, but it was only in the late 1860s that shafts were first sunk into the productive carbon. The shafts of "Charbonnages du Nord des Rieu-du-Coeur" were sunk from 1870 to 1873; those of "Charbonnages du Nord du Flénu" in Ghlin from 1873 to 1887. "Société des Charbonnages des Produits du Flénu" mines at a depth of 1,150 m from its St. Henriette pit; the mine was abandoned in 1910 as a result of too unhealthy working conditions caused by the unbearably high temperatures of up to 50°C and considerable pockets of pit gas. Intensive mining in Comble Nord took place in the 20th Century by "Charbonnages du Hainaut", "Charbonnages d'Hennies-Pommeroeul" and "Charbonnages du Nord des Rieu-du-Coeur". "Société des Charbonnages du Rieu-du-Coeur" faced the same problem in 1946: The temperatures in the gallery at 1,350 m ranged between 45°C and 50°C.

The development of hard coal mining in the Borinage

The first mention of coal mining in Hainaut dates back to 1229; a few years later on 6th June 1248, the cathedral city of Mons, the Mayor of Quaregnon and a handful of noblemen concluded a contract regulating coal mining in their area of jurisdiction. Coal pits already existed in Gilly and Charleroi by 1262. Up to the end of the Ancien Régime, the Borinage had numerous small and micro mining operations leased out by the local gentry and abbeys. These also determined the method of extraction and the tolls to be paid.

Although mining represented a lucrative source of income, it was first exploited systematically, intensively and in organised fashion from 1750 onwards. In 1691 there were 120 shafts in the Borinage and almost as many waged workers (as miners), in 1750 45 mining companies extracted coal from 83 shafts. Several reports from 1730 mention the need to remove water by steam engine instead of animal power, but the first fired machine of type Newcomen was only deployed in 1740 in L'Auvergies in Pâturages. This was followed by Le Bois de Bossu (1745/1746), by Le Buisson in Hornu (1747) and by Crachet (1750). The first Watt steam engine was used in 1785 at the "Charbonnage des Produits" to remove water.

The end of the Ancien Régime brought about a re-organisation and re-structuring of mining: From that time production increased, large numbers of miners arrived from elsewhere and worked alongside the local population. From 1830 the population of the Borinage developed parallel to the increase in the number of mining workers. It stabilised, however, in 1866 because of the lack of further-processing industries.

At the start of the 19th Century, the majority of shares in the most productive pits (e.g. Crachet, Cache Après and Ostennes, Produits, Agrappe and Escouffiaux) belonged to French merchants and coal dealers. Following the military conflicts and the economic crises of 1815 and 1830/1832, the first mining companies with capital muscle appeared and consolidated the smaller mining operations. They improved the infrastructure and provided adequate transport facilities; this is how "S. A. des Charbonnages de Belle-Vue, Basieux, Dour and Thulin", for example, came to be formed on 17th May 1843. In contrast, unprofitable pits, such as the "Charbonnage des Andrieux" were closed down (1843).

In this period of the second quarter of the 19th Century, new companies mainly formed in coal fields where the coal was easy to extract, the deposits known and the infrastructure already sufficiently developed; in Le Flénu ("S. A. des Charbonnages du Levant du Flénu", "S. A. des Charbonnages du Couchant du Flénu", "S. A. des Charbonnages des Produits du Flénu" and "S. A. des Charbonnages du Haut Flénu"), in Wasmes ("S. A. des Charbonnages d'Hornu et Wasmes") and in the west of the coalfield near the French border ("S. A. des Charbonnages de Belle-Vue, Baisieux, Dour and Thulin"). Nevertheless, a few notable companies remained independent and in French hands, such as "Sociétés du Grand Hornu, de Belle et Bonne, du Rieu-du-Couer".

The Borinage reached its economic peak between 1860 and 1870 on the back of plant mechanisation and modernisation of the plant undertaken at that time. The Charleroi field, which expanded as a large coke consumer thanks to the development of iron-processing industries, drew level with the Borinage in 1860: These two coalfields produced 30% of Belgian hard coal between them. The Borinage reached its peak of production in 1873 and kept to this high level until 1913 - despite the fall of exports to France. The extraction monopoly for Flénu coal, much sought after by industry, was given to the Mons coalfield at the end of World War I. The Héribus location of "Société Anonyme des Charbonnages du Levant du Flénu", the last large-scale investment of "Société Générale" started production in 1918.

The mining companies which were established later in the north of the Borinage on account of the improved shaft sinking process were either independent (such as "S. A. des Charbonnages d'Hensies-Pommeroeul") or dependent on the "Banque de Bruxelles - Brufina" (such as "S. A. des Charbonnages d'Hainaut").

However, with the discovery of the coal deposits in the Campine at the beginning of the 20th Century, the Mons mines lost their monopoly on fat coal and Flénu coal production, whilst the coalfields of Charleroi, Namur and Liége continued to extract mainly semi-fat and thin coal. Thus the pits in the Mons basin were abandoned because of the investments required in the old and low-profit plants.

The subsequent period saw a time of crises and re-structuring. The concentration of production, on account of the disastrous financial situation in the 1930s, led to a first wave of pit closures in 1932. The mines of Wallonia ran up huge operating losses between 1930 and 1934 (more than 800 million Francs), in 1937 the coal extracted from the newly-opened Campine pit already accounted for a quarter of Wallonian production. The competition with the other coalfields intensified dramatically with increasing mechanisation of extraction, something which rarely succeeded in the Borinage.

After World War II, the Borinage pits initially went through a hard time - despite the general economic upturn. Production dropped on the one hand due to the lack of workers. For this reason the Belgian pits recruited 50,000 Italians to work in the mines in 1946, followed by a further 23,000 East European refugees in 1947. On the other hand the required material was scarce, such as support frames, pit wood etc. In addition, mining in the Mons coalfield depended almost exclusively on holding companies, such as "Société Générale", which preferred to invest in the metal and oil industries rather than modernise the mines. At the same time they were reluctant to see coal prices increased because they required cheap coal for their steel works and power plants.

The coal and steel union and the Schuman plan of 1951 hit the Belgian mines hard, particularly in the Borinage, but they were not able to bring their production costs into line with the other European producers. The reasons for this were the smaller thickness of the seams and the reduced mechanisation options due to the irregular, often staggered deposits as well as the high quantities of pit gas and poor temperature and weather conditions.

In 1954, at the request of the Belgian government, a commission of the coal and steel union reported on the short-term and long-term profitability of the pits in the Borinage. This anticipated tolerable results for "Société des Charbonnages du Levant et des Produits du Flénu and "Société des Charbonnages Unis de l'Ouest de Mons et des Charbonnages du Hainaut", while predicting unacceptable deficits for "Charbonnages Belges de la S.A. Cockerill".

The investments required by the coal and steel union and the National Council of Mining Companies tore huge holes in the budgets of a number of mining companies still producing coal at the end of the 1950s. Although modernised, many companies were forced to close down production when the subsidies ended. This happened in July 1960 at the Crachet location of "S. A. Cockerill", a part of "Charbonnages Belges", and at the pits in Hornu and Wasmes, despite these being completely modernised in the ten years following World War II. In fact excavation in these mines was handicapped: The average daily production of 415 t was hardly a third of that at the mines of "S. A. des Charbonnages du Hainaut" at 1,040 t daily.

The drop in coal consumption led to the formation of huge stockpiles in 1958. The coal and steel union formed in 1951 presented a rescue plan for Belgium. The aim was to reduce production by 9.5 million t within five years. As Belgian production in 1957 still amounted to 18.6 million t, this plan entailed the closure of almost half of all production locations. In response, a 14-day strike broke out at the pit in Crachet-Picquery on 13th February 1959, and which then spread to the Centre, Charleroi and Liége coalfields.

By 1960 there were only two companies left: "S. A. des Charbonnages d'Hensies-Pommeroeul" (based in Sartis) and "S. A. des Charbonnages du Borinage", the latter being the result of a fusion between the mining companies of Charbonnages du Levant et des Produits du Flénu, de l'Ouest de Mons, du Rieu-du-Coeur, de la Boule, du Hainaut and Cockerill, a part of Charbonnages Belges, and of Hornu et Wasmes (with the locations still in production Héribus and No. 3-3 to Tertre).

All operations ceased at Héribus in February 1968. Tertre, as the youngest site in the coalfield and only put into operation in 1937, closed in 1971 despite complete modernisation of the pit operations and conveying equipment. The Sartis location of "S. A. des Charbonnages d'Hensies-Pommeroeul" which had been operated since 1912 became the last pit to be closed down on 31 March 1976. This closed the final chapter on coal mining in the Borinage.

Technical monuments

The most significant technical monument in the coalfield is the huge, complete plant of Le Grand Hornu /see Chapter 3.1.2.6) of "Société Civile des Usines et mines de Houille du Grand-Hornu", whose shafts 12 and 7 closed down in 1951 and 1953 respectively. The Crachet-Picquery pit in Frameries, closed in 1960, is the second most important monument of a large-scale mine in the region and has - as a special feature - retained its shafthead winding gear.

As a stand-alone monument worthy of attention, the Malako tower of Charbonnage de Belle-Vue above shaft 6 has survived in Dour. Erected at the start of the 19th Century and closed in 1880, the only walled shaft tower in the coalfield served around 1910 as a hotel and today as a student building. The re-inforced concrete shafthead frame over the Puits Sauwartan (or Brand Bouillon du Bois de Saint-Ghislan) likewise still stands in Dour and which produced until 1938. The re-inforced concrete winding tower in Hyon-Ciply near Mons documents the last era of hard coal mining in the coalfield.

A few of the sharp conical slag heaps that once characterised the view of the Borinage still exist. The best example is the L'Héribus mine tip near Cuesmes/Mons which was bought up by Mons Council in 1983 and turned into a park. The locality of Flénu lies between its four slag heaps, in addition the slag heaps at shafts 9 and 12 of Le Grand Hornu should also be mentioned.

Characteristic miners' communities have been retained in Hensies-Sartis as the garden town Louis Lambert, in Le Grand Hornu and in Bernissart as terraced houses.

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2.6.1.3.2 The coalfield of "Bassin du Centre"

The so-called Centre mining region lies between Mons and Charleroi. Its hard coal deposits of 20 to 25 seams with a thickness of 15 m to 20 m were mined at Casteau, Thieusies, Ville-sur-Haine, Houdeng and Morlanwelz until the last pit closed on 29th June 1973.

The development of hard coal mining in the Bassin du Centre

The first documented evidence of hard coal mining dates back to 1299, as Gilles Rigaut, Master of Roeulx, granted the monks of Bonne-Espérance cloister the right to prospect for coal on their holdings in Houdeng and Goegnies. The Benedictine monks of Saint-Denis en Broqueroie also prospected successfully for hard coal in 1372. Further pits appeared on the land of La Louvière cloister at the end of the 14th Century, in 1378 the water was able to be drained from parts of deep-lying deposits in a mine belonging to l'Olive nuns' cloister in Morlanwetz.

The hard coal deposits began to be mined industrially in the early 18th Century: the success of the Société du Grand Conduit de Houdeng led to the founding of Charbonnages de Barcquegnies in 1715. Twenty years later, the Seigneurie de l'Aulne granted the Thiriar family in La Louvière an indefinite concession to extract hard coal. Further mines were sunk in Houssu, Sars-Longchamp and Thieu, amongst other places. The Emperor's decree of 1810 names over 15 concessions (Bois-du-Luc, Mariemont, La Louvière, Bascoup, l'Olive, La Barette, Houssu, Strépy-Bracquegnies, Sars-Longchamps, La Hestre, Trivières, Thieu, Carnières, Saint-Denis et Obourg, Havré et Chaud-Buisson), together employing a total of around 2,500 miners and staff. The first steam machines for draining water appeared in 1766. The first steam-powered conveying machine in Centre was deployed in 1807 at the Bois-du-Luc mine, seven further pits followed (Saint-Eloi in Carnières, Houssu, l'Olive, Bascoup, La Hestre, Mariemont and Bracquegnies).

The mines in Centre employed around 20,000 workers in 1900. Despite World War I, Centre enjoyed its greatest economic boom in the years between 1900 and 1930. By 1921 the workforce had swollen to around 28,000, including numerous Flemish migrants. Advanced technology, the great skills of the engineers, foremen and technicians, the proximity of abundant further-processing works and an outstanding network of roads, railways and canals led to this successful development of the coalfield, the production of which was sold mainly through Brussels and Antwerp. However, the extraction activities starting around 1930 in the Campine hard coalfield caused several hundred engineers and technicians to migrate from Centre to this new, highly-promising region.

This development led to a concentration of mining operations in Centre. Thus 1930 saw several fusions: The mines of Ressaix, Leval, Péronnes and Sainte-Aldegonde including Haine-Saint-Pierre and La Hestre with 8,000 workers merged, as did the pits of Mariemont, l'Olive, Chaud-Buisson and Carnières with Bascoup affiliated in 1913 with 6,200 workers, likewise the mines of Bois-du-Lac with La Barette, Trivières, Saint-Denis, Obourg and Havré with 3,120 employees. There were other mines in Strépy-Barquegnies with 2,650 miners, in Maurage with a workforce of 2,200, La Louvière and Sars-Longchamps merged in 1897 with 2,020 workers and in Bray with 1,500 workers.

Mining in Centre began to decline after 1930: Economic crises, World War II, the removal of timbers at the face, long strikes, international competition and the exhaustion of the partial deposits worth extracting led to pit closures in Centre. In the last year of the war (1945) and thereafter, thousands of German prisoners of war were deployed in the 19 active mining locations to increase production, these followed by immigrants from all over Europe. By 1948 the number of miners had risen to 24,055 (of which 11,276 foreigners, the majority of these Italians).

The first coal crisis began in the 1950s: The Bray pit was closed in 1949, Barquegnies kept going until 1958. One year later (1959) the mining companies of the pits Ressaix, La Louvière and Mariemont merged to become "Charbonnages du Centre", at the same time the Saint-Emmanueo pit in Bois-du-Lac closed after 124 years of operation, the Maurage pit closed all works in 1961: That left just 6,202 miners in Centre, of which 2,655 Italians.

Two mining companies kept production going for a few more years: In 1969 Ressaix closed its last shaft (Saint-Albert), even after the overground facilities had been extensively modernised in 1954/55. The last tons of coal in Centre were mined on 15th June 1973 at the Quesnoy site in Bois-du-Lac, barely a year after the first oil crisis.

Technical monuments

Significant monuments are to be found above all in Houdeng-Aimeries at the Emmanuel pit in Bois-du-Lac and in Chapelle-lez-Herlaimont at the Charbonnages de Bascoup Sainte-Cathérine site, which is dominated by slag heap 7 visible from far around. The collection at Bois-du-Lac is among the most vivid monuments to Belgian mining (see Chapter 3.1.2.6). The re-inforced concrete winding tower at Charbonnages du Centre's Ressaix mine must be mentioned. Also worthy of note are the re-inforced concrete structure of the wash room in Péronnes-les-Binche built in 1954 and the well-preserved miners community in Villers-Saint-Ghislain.

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2.6.1.3.3. The Charleroi and Basse-Sambre coalfield

The most important coalfield economically in Belgium was Charleroi: It extended from Anderlues in the west to Farciennes in the east and, together with the Basse-Sambre, formed an extension of a wide-area coal deposit reaching beyond Namur. The various mining companies in this coalfield had already joined together to protect their mutual interests as the "Association Charbonnière des Bassins de Charleroi et de la Basse-Sambre" based in Charleroi.

The deposits of Charleroi - Basse Sambre are around 45 km long and some 10 km wide; they make up a central link in the coal belt that runs from the German border following the courses of the Sambre and the Maas, extending continuously to the English Channel, thereby taking in

Centre, the Borinage and the French Departements Nord and Pas de Calais. In the north the seams emerge at the surface, whilst in the south the same seams meet a dislocation in the coal-bearing limestone; the overall deposit rises to the east, then to disappear completely due to erosion in the synclinal of Namur. In contrast, there are no geological barriers to the west, but rather a continuous transition into the Bassin du Centre.

This deposit is characterised by a complex of heavily dislocated and folded seams of small thickness (0.5 m to 1.2 m), lying close to each other and containing little pit gas in the east and north but much more in the west and south. It is made up of the most varied sorts of coal with anthracite in the east and top-quality coking coal in the west.

The mines extracted at different depths because of the way the seams fall towards both the south and the west. Their depth varies from 150 m in Centre de Jumet to 1450 m at shaft no. 19 at Monceau-Fontaine, a record at that time in Belgium, and perhaps also in Europe. Opposed to this, the Gosselies pit was extracting coal in overground operations at the end of the 1970s.

The contribution made by the different mining companies to the coalfield's total output varied greatly: Whilst Noël Sart Culpart in Gilly only produced 200,000 t per annum, Monceau-Fontaine turned out 2 million t of coal at its peak (admittedly from 12 shafts). The locations were seldom concentrated, at no time were economically significant production units formed. The structure and the variety of the deposits, the fragmentation of concessions, the financial policy of the owners and the sluggishness of the authorities meant the majority of the companies were happy to preserve the status quo, something which eventually accelerated the decline of mining.

Mechanisation of extraction came very late, and then only to a very limited extent, because only small companies with limited financial means operated in the west of the coalfield whilst those companies with a greater financial capacity had only minor output pits. Nevertheless, it should be said that the majority of the seams leant themselves poorly to modern extraction equipment due to their lack of depth and heavy folding. Thus the first coal planes were only deployed in the 1960s at the best faces of the mines at Roton, Aiseau-Presles, Mambourg and Monceau-Fontaine, but they could not prevent the decline in the majority of pits. Powered walking supports were only used twice in the coalfield, once at Monceau-Fontaine accompanied by a circular cutter which was not a success, and a second time in Roton where use of a plane worked somewhat better.

Development of hard coal mining in the Charleroi and Basse-Sambre coalfield

Even though Liège and Charleroi have argued since time immemorial over which one was the first to mine coal, there is no dispute that Charleroi produced the last wagon of Wallonian coal on 29th September 1984; the commemorative plate laid in the courtyard of the former Ste.-Catherine mine of Charbonnages du Roton bears witness to this.

A seven hundred year history spans these two events. Documents from the 13th Century mention mining in Gilly and in Charnoy (Charleroi). In Basse-Sambre a decree granted a certain Gérars le Charbonnier permission to set up a coal mine in a wood near Velaine-sur-Sambre. These early mining operations originated where the seams came to the surface, something which led to a fragmentation of the concessions characteristic of all Wallonian coalfields. If a 1770 report is to be believed, 32 pits of some size existed at that time in the region which later became known as the Black Country. Added to this were countless "cayats" (micro-pits) with shafts from 10 m to 12 m deep with diameters of between 1.5 m and 2.5 m. These pits were operated by self-employed miners.

After 1810 the concessions were granted on the basis of the law signed by Napoleon in Antwerp on 21st April of the same year: This mining act gave the state all rights below the surface and the sole right to grant extraction. Thus in the subsequent year the majority of mining companies were founded who were responsible for production in the coalfield up to 1984. In 1950 there were still 18 companies with 54 mining operations and an annual production of some 7.5 million t.

The history of hard coal mining in the Charleroi - Basse Sambre coalfield is a long sequence of prosperous periods, occasional economic crises and bitter, sometimes violent, social strife.

The creation of the coal and steel union in 1951, which put Belgian coal in direct competition with the other member countries, spelt the end for the unprofitable, technically outdated Wallonian hard coal mining industry. This decline was accelerated by increased competition from other fuels, such as oil, gas and nuclear power. In order to cushion the social effects of the economic catastrophe, the Belgian government set up a system of subsidies which enabled unavoidable closures to be spread over a longer period of time. After a number of revolts, such as the large-scale strikes in the 1960s, the miners resigned themselves to their fate and accepted the inevitable. Coal had lost its shine, officialdom lost interest, the criticism of "wasting money" on an industry which was a throwback to the last Century grew louder. Thus at the end of 1980 only the Ste.-Catherine site of Charbonnages du Roton was left, its closure planned for 30th September 1981 before being granted a final stay of execution until 30th September 1984.

The Le Roton pit, as the last mine in Wallonia and formerly the largest producer of anthracite in Belgium, continues to operate its coal washing facilities and briquette works with imported coal. The "Houillères d'Anderlues" coking plant is nowadays called "Cokeries d'Anderlues"; since coal production stopped in 1969 the coke furnaces have been run on coal imported from the USA. The pit gas emerging from the mine facilities is suctioned off and sent to power stations or fed into the natural gas network by Houillères d'Anderlues; with exploitation becoming smaller, thoughts turn to converting the pit to a natural gas storage facility.

Three companies stand out in the history of hard coal mining in the Charleroi region in different ways: Monceau-Fontaine, Bois du Cazier and Roton-Farciennes.

The **Monceau-Fontaine** mining company was the most important in the coalfield by far: Its history consists of a long series of mergers and take-overs. The initial company was founded in 1807 and comprised a certain number of cayats, although it took another 29 years before one comes across the company under its later name. "Société de Monceau-Fontaine", which belonged to Société Générale de Belgique, was founded on 9th June 1836 and disposed over an astonishingly large mining field of over 1,700 ha. From this time there were no less than ten expansions and annexations, allowing the company to control concessions of over 7,260 ha by 1948 and making it the largest hard coal producer in Belgium. The company went under the name of "Société Anonyme des Charbonnages de Monceau-Fontaine et du Martinet" in the period from 7th February 1852 after taking over "Société des Charbonnages du Martinet" which had gone bankrupt in 1850 and was bought in a public sale by a certain Ferdinand Spitaels, before finally being passed on to Monceau-Fontaine on 7th February 1852. Prompted by the take-over of "S. A. du Charbonnage de Marchienne", the company assumed its final name of "S. A. des Charbonnages de Monceau-Fontaine" again on 17th January 1908. After "Charbonnages du Nord de Charleroi" had also been taken over in 1948, the concessions included 25 localities: The distance between the two furthest removed shafts, no. 17 in Piéton and no. 25 in Couillet, was around 16 km.

Although the company's policy was directed at increasing its concessions, the structure of a collection of numerous locations with low production capacities of only 500 t to 1,000 t per day, sometimes from a single face, meant that output remained extremely low. The nature of the concessions, their development stretching back more than one hundred years, the structure of the deposits and the variety of coal extracted generally justified this method of mining management. In 1953 the company employed some 10,000 people and produced 1.75 million t of hard coal.

A turning point in the history of this company came in 1966. Several sites, no. 24 in Couillet, no. 3 in Courcelles and no. 8 in Forchies, were closed in the 1950s, the remaining deposits were extracted via other shafts. The Government called an end to the financial support for the loss-making locations 10 and 25 in 1966, leading to their closure, sites no. 6 and no. 4 followed in 1967. Now began a long, slow death which ended on 31st March 1980 with the closure of shaft no. 17 in Piéton. Between this was Belgium's last mining disaster at no. 25 in Couillet in 1972: A sudden rush of pit gas killed six miners.

The second significant mine was that of **Bois du Cazier** near Marcinelle. The worst mining disaster ever suffered in Belgium happened on 8th August 1956, killing 262 miners; at the same time this marked the end of an era. After the "coal battle" which helped the country back to its feet faster than many others after the war, oil began to present increasing competition to hard coal. Was it really necessary to keep a coal industry going under difficult and dangerous extraction conditions and handicapped by extra expenses just to retain control of fuel sources?

The disaster at Bois du Cazier acted as a trigger and as the start of the inevitable decline of hard coal mining in Belgium, human emotion flowed into ecological drama and in the tragic de-industrialisation of a whole region. And that just at a time when Bois du Cazier, as a small pit, was undergoing modernisation. As with the majority of pits in the basin, the daily production stagnated below 1,000 t, a new shaft had just been sunk capped by a winding tower which pointed the way to a forward-looking solution. The mine continued producing for a number of years after the disaster and was finally shut down on 15th January 1961.

In contrast to "Société de Charbonnages des Monceau-Fontaine", which was held by "Société Générale de Belgique", the **Roton** mine had always been a family-run concern. Count Philippe de Néverlée, who had previously been granted the concessions for Baulet and Oignies-Aiseau, was given all rights to the concession of Roton Ste.-Catherine.

The mining operations of the Roton-Farciennes extended to the border of the basin of Charleroi and Basse-Sambre in that part of the deposits consisting of high-quality anthracite. These were the same rights owned until 1950 by the Société Anonyme des Charbonnages de Roton-Farciennes et Oignies-Aiseau, and on which the three mines of Falisolle, Oignies-Aiseau and Roton-Farciennes were erected. As the deposits became worked out, the Falisolle mine closed in 1950 and the shaft facilities of Oignies-Aiseau closed in 1954 and 1960. In the meantime, the company had started a wide-ranging development programme at the Sainte-Catherine site of the Roton-Farciennes field, enabling the personnel affected by the closure of

Oignies-Aiseau to be transferred. The main thrusts of this programme, limited to the Sainte-Catherine mine, were the sinking of a new extraction shaft using the most up-to-date equipment, the construction of a new face at a depth of 718 m and a complete revamp of the overground facilities. The new mine started production in 1960. However, the investment hardly paid off: Roton was subsidised from 1964 onwards. Its modern equipment, considerable reserves of hard coal and an output capacity of 3,000 t per day made Roton the last Wallonian mine in 1975 and the first Belgian anthracite producer with an annual output of 700,000 t. Together with the two extraction sites Ste.-Catherine and Aulniats, this output was retained up to 1969. After completion of a concentration programme, the same output was reached at the Ste.-Catherine location. Ste. Catherine was closed on 24th September 1984.

The hard coal mines in the east of the coal field (Basse-Sambre) were generally fairly short-lived, although they only disposed over the lower reaches of the deposits whose thickness seldom exceeded 0.5 m.

The Velaine mine was shut down in 1912. Flawine, with its gallery working, was only operated intermittently and never exceeded 100 t per day. In the final analysis, the history of mining in this region consisted of a string of failures. Thus the Le Bois Planty mine in Floriffoux, whose concrete winding tower still stands, hardly ever worked.

The last open pit in Basse-Sambre was situated on the edge of the parishes of Jemeppe and Velaine-sur-Sambre. The seams could be reached by means of an inclined shaft and were mined by "Société Elisabeth" from its "Ste.-Barbe" site in Wanfercée. The mine workings were closed on 18th March 1961.

The situation in the west was completely different, where the pits Petit-Try, Tamines or Bonne Espérance-Lambusart supplied the country very effectively over a long period.

Technical monuments

The outstanding and most significant technical monument in this coalfield is the collection at Charleroi-Marcinelle with the Bois-du-Cazier shaft facilities: This mine with its two shafthead frames, the re-inforced concrete winding tower, the community and the cemetery document the hardship of the miners employed in Belgian mines particularly well (see Chapter 3.1.2.6).

Shaft 6 of "Houillères d'Anderlues" in Anderlues has retained the shafthead frame erected in 1952; methane gas is suctioned off from the shaft. The re-inforced concrete shafthead frame of the Ste. Barbe du Bois Planté of Charbonnages de Floreffe-Soye has been preserved in Floriffoux, although in poor condition.

The shafthead frame made from re-inforced concrete has survived with the rope wheels in Monceau-sur-Sambre and which belonged to site no. 14 named Fosse du Bois or Petit Martinet and was closed on 15th July, the conveying machine has been lost. Likewise in Monceau-sur-Sambre, a metal shafthead frame still stands beside the Charleroi-Brussels railway line though in bad condition. The conveying machine house has been cannibalised, the collection belongs to site no. 4 of Martinet which was closed on 15th July 1967. Two imposing, stand-alone metal shafthead frames of site no. 25 (also called Péchon) dominate the landscape in Couillet; the mine was shut down on 31st March 1975. A miners community rounds off the monument collection. The remains of an otherwise technically successful concentration is the winding tower of Charbonnages du Roton in Farciennes. This stands above the last shaft sunk in the basin since 1960 and which conveyed the coal from both Sainte-Catherine and the Aulniats site until 1984.

The miners community built between 1845 and 1850 in Marchienne-au-Point ("Grand Coron"), which is laid out in the shape of a horseshoe, is among the most notable examples of an early miners community - despite its poor condition.

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2.6.1.3.4. The Liége coalfield

The Liége basin is the most easterly section of the Haine-Sambre-Meuse coal deposits. Its large sweep extends some 30 km in length from Engis in the south-west to the Herve hills in the north-east and has a maximum width of 13 km between Herstal and Beyne. It is at its deepest in Westfal at 1,250 m, the 250 m of Namur only has low-quality coals. For this reason the Liége mining companies extracted nearer the surface than in the Borinage, and only three locations reached depths of 1,100 m. The total number of seams in Liége Westfal is only around 50 and their average thickness of less than 70 cm makes them the smallest in Belgium. The lowest seam thickness worth extracting was 40 cm.

Almost all types of coal were mined in the Liége basin. When mining operations started, more fat coal and semi-fat coal was mined than thin coal, as the depths increased then more thin coal (70%) and semi-fat coal, types of coal which extended the life of the mining industry because they were mainly used for domestic heating.

The Liége hard coal deposits were among the hardest to extract from a technical point of view. Their heavily folded "distorted" state, caused by pressure and shifting, over-layering and dislocation, pushed up extraction costs considerably. The exclusive deep mine workings were confronted with great water containment difficulties due to the cleavages in the deposits; in contrast, there was a lower volume of pit gas than in Hainaut.

The geographic spread of the Liége basin gradually increased as mining progressed and sales markets expanded. It was initially limited to the western flanks of the Maas valley and the hills of Herve. Mining activities shifted at the beginning of the 19th Century to centre around Seraing due to the improved water containment equipment and under pressure from a modern iron and steel industry. A short time later the railways also allowed hard coal to be mined from the Hesbaye plateau, whilst the mines on the lower Maas (Basse-Meuse) experienced a clear increase in output in the 20th Century.

The development of hard coal mining in the Liége coalfield

The Liége coalfield reached its highest output in 1913 with 6 million t and in 1953 at the time of the "coal battle" with 5 million t: At that time this represented a quarter of Belgian production and a half per cent of world output. For a long time the Liége coalfield was able to retain second place out of all Belgian coalfields behind Charleroi as regards output and the number of employees, although it was overtaken by the Campine coalfield in 1934.

The Liége basin was generally regarded as the hard coal region "par excellence" in continental Europe until well into the 18th Century, as the one where "the fire was hotter than fire". The experience gained there and the specialist literature this produced had influence throughout Europe, the "industrial revolution" has one of its roots in the Liége hard coal mines.

Already used by the Gauls and Romans, the "terra nigra carbonum" is first mentioned in 1195; the writer describes "black earth, very similar to charcoal, which is most useful to the blacksmiths for forging metals and to the needy for heating". From the beginning of the 13th Century there are numerous passages describing an almost regular extraction of the outcropping seams as normal practice. Shafts at Ans near Liége had reached a depth of 100 m by 1360, up to the beginning of the 16th Century the maximum achieved was 175 m.

The antiquity of hard coal mining in Liége was due to legislation governing ownership of mines. In the former principality, the owner of the land also owned the underground resources. This principle stimulated individual entrepreneurial qualities and had turned the region around Liége into a kind of "molehill landscape" since the Ancien Régime. Mining laws, reckoned to be among the oldest in Europe, developed at a very early stage.

In addition, the need to contain the water in the "deeper" pits on the slopes of the Maas led to the construction of a notable network of drainage channels (so-called Areines): They led from the bottom of the shaft to the deepest points in the valleys from where the water was diverted to the rivers. These channels were maintained and monitored with care and provided the briquette factories in Liége in the 18th and early 19th Century with utility water. The first "fire machine" according to the Newcomen system on the continent was installed in the Liége coalfield in 1720.

The church, as the largest landowner, was the first to mine coal, initially it extracted the coal itself, later it issues concessions to third parties. the "classic" form of coal mining in Liége was handed down from the 14th Century and lasted until the beginning of the 19th Century: The company of "comparchonniers" differed greatly from a modern company, not possessing any company capital. The owner of the pit, who joined the company, sold their financial strength according to a number of shares (so-called parchons) to the pit. The company used this to finance the necessary work and paid the profits out in proportion to the inward investments made by the individual shareholders. The shareholders were namely obliged to the debtors, the most important enclosure work was their duty in turn. At the start the "comparchonniers" included simple miners, alongside merchants and noblemen. This method of mine operation and the rights of landowners to the deposits pushed the development of mining in Liége forwards until the end of the Ancien Regime: Limited financial means, too small companies, timber removal, legal disputes among competing mining companies and the lack of professional training of many entrepreneurs led to the decline of mining.

Before the French regency from 1794 to 1814, the public authorities in Liége only seldom had to check the administration of mines. This was done by a group of experts nominated by lay assessors, known under the name of "Cour et Justice des Voirs (vrais) Jurée du Charbonnage", and comprised of experienced mine workers (maîtres houilleurs). Under the French regime the state was given the monopoly on granting mines (law of 21st April 1810), coal mining was placed on a new basis causing a long-term industrial upturn and securing its long-term future.

The opportunity was taken to re-organise the Corps des Mines was given a new role as a mining regulation body. The renowned Ecole de Mines de Liége, which was started in the time of Dutch and Belgian government, turned out the best-training mining managers and enjoyed a high reputation.

The number of mining locations multiplied until the middle of the 19th Century to around 100, the once numerous although unprofitable small extraction sites closed down or were mothballed. The concentration of companies also began in the Liége coalfield from 1850, which then owned improved technical equipment and extended concessions. The number of locations and mining companies began to shrink once more, and this trend continued until mining ended, beginning in the 1920s with the closure of the least profitable units.

The biggest mines in Liége produced barely 20,000 t in the 18th Century, by 1812 this had already risen to around 50,000 t. Cockerill produced some 100,000 t in 1849, Marihaye reached almost 460,000 t in 1898. The driving force behind these increases was the iron and steel industry, the large Liége mines generally produced more than 400,000 t per annum during the 20th Century. The highest annual output was reached in the 1950s immediately preceding the great coal crisis, the mines Bonne-Espérance, Batterie, Bonne-Fin, Violette and in Gosson-Kessales producing more than 800,000 t. This output was nevertheless always well below that of the pits in the Campine coalfield or that of Hainaut. In contrast, the quality of the coal mined in Liége often beat its Belgian competitors.

The legal structure of the mining companies first began to slowly change in the late 19th Century. The Liége coalfield remained under the control of family-run companies through the centuries, public limited companies only took over after 1870. In contrast to the other Belgian coalfields, the influence of the banks remained low. These conditions lent the Liége basin a particularistic, patriarchal spirit which initially prevented mergers and was averse to state control and influence - except in times of urgent crisis.

This could not prevent concentrations of several companies in the long run. The largest pit fields finally belonged to "S. A. des Charbonnages de Wérister": Stemming from a modest 17th Century pit located around Herve, it ended up with rights divided between two fields amounting to 4,897 ha, the largest concession en bloc was that of "Charbonnages du Hasard" with an area of 3,609 ha.

The Liége pits were always among the largest employers in the region. Despite a great number of small and micro companies, some employing as few as five or six miners, a few large companies with workforces of some hundred miners already existed in the 16th Century. According to a census in 1812, the pits had workforces of between five and 730 workers. The 1,000 person hurdle was exceeded in the middle of the 19th Century, at the end of the century it was 2,500, between the two World Wars 3,000 and during the "coal battle" in the 1950s 5,000. At the same time the Limburg-Maas and Monceau-Fontaine mines had workforces of 7,600 and more than 9,000 employees respectively.

Technical monuments

The most important monuments of the Liége hard coal mining industry are the hard coal mine of **Blegny-Trembleur**, closed in 1980, with its Marie shaft sunk in 1816 as the oldest extraction shaft still preserved in Belgium and the modern re-inforced concrete winding tower, also the former pit Hasard-Cheratte not far removed for here, which started operations in 1907 (see Chapter 3.1.2.6). The first-mentioned pit is nowadays a renowned mining museum with access allowed, the latter is inaccessible. The "Garden Town" ("Cité-jardin de Cheratte") built in 1925 is just as notable as the management building of "Charbonnages de Bonne-Espérance, Batterie, Bonne-Fin et Violette" in Liége (251, rue Vivegnies) built in 1897. A final mention should be given to the shafthead frame of the Bas-Bois mine near Soumagne, which is to become part of the planned Musée de la Vie Populaire.

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2.6.1.3.5 The Campine coalfield

In contrast to the other coal basins, the Campine was discovered very late on in 1901. Coal extraction began in 1917 at a time when most of the other Wallonian basins had already reached the peak of their production. Nevertheless, the quality of the coal mined - above all the fat coals much in demand at that time - justified the interest of investors not only Belgium, but also in Luxembourg and France. The exceedingly high costs of sinking shafts using the freezing method limited the size of the concessions to between 30 km² to 50 km² and restricted the coalfield's infrastructure to seven large locations, which were built without exception between 1907 and 1939.

The seams discovered in the Campine ran under the largest, practically uninhabited, heath in Flanders which had no infrastructure worthy of mention. The workforce was not available locally, obliging the companies to undertake large-scale campaigns to recruit workers whilst they were sinking the shafts. Communities were built which drew thousands of workers from other regions, seven garden towns were created alongside the mine workings in what at that time was a "modern" form of urban planning. They were placed in the middle of a largely agrarian landscape which had been inhabited until then by a small, strict Catholic population.

The development of hard coal mining in the Campine coalfield

The discovery and late exploitation of the Campine coal basins was due more to economic, political and technical reasons than to the lack of geological knowledge. The existence of hard coal deposits in the Campine region had been already suspected between 1870 and 1880. At that time Belgians such as the professors Guillaume Lambert and André Dumont, Louis Jourdain and Evence Coppée carried successful test drillings in Dutch Limburg and in the Aachen basin which pointed to a continuation of the deposits in the west.

The reasons for the delayed confirmation of the existence of the deposits by drilling, the first of which was performed in 1898, were of an economic nature. From 1850 onwards the coal industry in Belgium, as in several other European countries, experienced spectacular growth. This expansion lasted until 1874, after which coal prices collapsed, reaching their nadir in 1896. These twenty years of crises caused output to stagnate, although were able to be maintained at the same level of around 30% of total production. Thus opening new mines did not make sense.

The situation changed from 1890 due to a dramatic development of the iron and steel industry. Belgian production of cast iron doubled between 1891 and 1903, and then again between 1903 and 1913: National steel production increased six-fold between 1900 and 1928. The steel works required great quantities of hard coal, the Belgian coal industry could not satisfy demand for fat coals as coking coal; as a result production of coke sank.

The coalfields of Charleroi, Namur and Liége reached peak production before World War I. The same happened in the Borinage and in Centre in the 1920s. Belgium had to import 13.% of its coal requirement in 1900 to satisfy domestic demand and tens years later a third of the coke required. It was therefore no coincidence that people began to take an interest in the Campine deposits at the turn of the century.

The first drillings of Urban and Putsage in Lanaken in the north of the Liége basin and those of "S. A. de Recherche et d'Exploitation" of professor André Dumont in Elen in 1897 and 1898 were unsuccessful. The Campine deposits were finally discovered in August 1901 in As. Three years previously Louis Jourdain had already proposed this spot as a promising site. However, as he did not have a majority shareholding in "S. A. de Recherche et d'Exploitation", he was not able to authorise test drilling there. This discovery of fat coal triggered a real "run on coal". Around sixty deep drillholes were sunk in less than two years and no less than 42 concessions had been applied for by 1905. Apart from having to select from the wide range of possible concession holders, two factors then caused the exploitation of the deposits to be delayed.

In the Belgian parliament the socialist opposed the privatisation of ground resources and demanded that coal be nationalised - a practice pursued continuously up to that time, one based on Napoleon's mining law of 1810 and which was supposed to promote coal extraction. At the same time they demanded better working conditions for the miners and a miners' statute.

A similar nationalisation programme had partly been implemented in Holland in 1901 to prevent German capital taking over the concessions. It was feared there that German owners might delay production for reasons of financial competition. The Belgian socialists thus drew on what they regarded as the Dutch example, but at the same time made reference to the nationalised Prussian mining industry. They further hoped that state control of mining in the "new" Campine coalfield could head off uncontrolled action by anarchistic trade unions common in the coalfields of Wallonia. At this time the Flemish movement stood steadfastly behind nationalisation process, as the Flemish capitalist were actually not in a position to stump up the means needed to get production going. Some circles were already dreaming of a federal Belgium with the "Ruhr" replicated in Limburg.

Minister Francotte issued the first concessions to the private sector in 1906 in the middle of the parliamentary recess, the new mining law was passed in 1911. Due to the anticipated difficulties and costs of sinking shafts, the concessions given were 16 times larger than comparable fields in the Wallonian coalfields. 500 m of sandy soil holding water had first to be penetrated to get at the deposits, the only process applicable for this was the expensive freezing method. In Zolder it took 23 years before the first coal was produced. Added to this was the delay caused by World War I. These delays and the costs run up meant that the production of Campine coal fell almost exclusively into the hands of large financial groups.

The development of the seven largest mining complexes in the Campine coalfield
Once the concessions had been granted and the seven companies had been constituted, new drilling started in the Campine heathland. It was now a case of situating the shafts and the extraction locations in the best possible places. Moreover, areas were earmarked for the future slag heaps and for building large garden towns to house 20,000 miners families over the next ten to fifteen years.

Thus the Zolder mine, which began producing in 1930, already had plans for a town in 1913 which envisaged residences for 1,022 workers, 50 staff and supervisors, four engineers, a church, a function hall, a gym, a square with kiosks, schools, swimming pool, hotels and playgrounds. Building had started before World War I.

The mine at Eisden even featured more than 2,000 living units. In Genk district, in which three mines were located, population density rose from 29 to more than 700 inhabitants per m^2 within 80 years. The companies' houses could only be rented - purchase was not permitted - by active miners. This was intended to put a stop to persistent absenteeism and frequent changing to competitor mines.

World War I and inflation put the brake on sinking work in most mines in the Campine. With the exception of Winterslag (1917), every mine began production long after the war: Beringen (1922), Eisden (1923), Waterschei (1924), Zwartberg (1925), Zolder (1930) and lastly Houthalen (1938/1939). Nevertheless, output reached 139,930 t in 1919; this rose in 1924 to 1 million t and amounted to 3.2 million t in 1929. This meant that the newly exploited Kempen basin accounted for almost 12% of the total Belgian production of around 27 million t. The mines first turned in a profit in 1933, subsequently sales became difficult causing unemployment among miners, after the devaluation of 1935 the international economy improved, production was maintained during the German occupation.

Mechanisation of the mines began after World War II ended, however it was only at the end of the 1950s that pre-levels were attained once more as regards output per man and shift. After World War II coal production in the Campine played gave an important boost to Belgium's economic development, although the surplus of cheap oil brought about the first coal crisis as early as 1957. Output could not be developed further, state assistance for private concession holders was postponed. in addition Belgium had difficulties integrating into the newly-founded coal and steel union. The consequence was the gradual closure of all pits, initially in the south of Belgium (Wallonia).

After a short revival of production due to the hard winter of 1962/63, the time of re-structuring had come: Houthalen merged with Zolder in 1964, Zwartberg was closed in 1966 in spite of dogged resistance by its miners. The five remaining companies merged in 1967 and formed N. V. Kempense Steenkolenmijnen, which continued production with state aid. However, the economic and financial state of the new company did not basically improve: A new re-structuring programme was launched in 1987, bringing with it the closure of mines in the east, i.e. Winterslag, Eisden and Waterschei. The plan soon led to the final closure of the Campine mining industry, which was played out on 29th September 1992 as the last site was closed in Zolder. Mining in Limburg thereafter belonged to the past.

A total of 441 million t of coal was mined from the Campine coalfield, which represented approx. 30% of overall Belgian production in the period from 1917 to 1992, as Wallonia produced 950 million t in the same period. The highest number of miners was 44,060 in 1948.

The highest output was achieved in 1956 with 10,468 million t, making up 35.5% of Belgian output at that time.

Despite the pains of the region of Flanders, neither coal-based chemicals nor other coal-consuming industries moved to Limburg during the whole period of excavation. The reasons for this were the cheap rates of transport and because these industries had already developed in other areas due to the efforts of the main shareholders of the mining companies.

Technical monuments

Earnest initiatives are underway in Beringen to convert part of the overground facilities - among them the shafthead frames, the conveying machines, the wash room and the architecturally notable power centre - into a mining museum. The central area of Eisden mine (near Maasmechelen) with the production equipment at shaft 2 has been under protection since 1993. Also protected are parts of the mine facilities of Waterschei (near Genk) at shaft 2, of Winterslag (near Genk; main building, wash room, power centre) and of Zolder (shaft 2, main building, electricity centre). It should be said that all the mine facilities in the Campine have not been able to retain their former uniform appearance.

All seven mines had built their own independent living quarters for the members of their workforce. These "greenfield site" communities possessed their own social, religious, cultural and leisure facilities: Nurseries, schools, home economics schools, vocational schools for miners, hospitals, cinemas and casinos, theatre, music school, sport centre. It is still possible to recognise these company towns today from their doubled isolation, firstly with regard to the owners of the mines who organised them, and secondly with regard to the villagers to whom the miners always stood slightly apart. Good examples are the Beverlo community of the Beringen mine built in 1908, the garden towns of Eisden, Houthalen ("Meulenberg"), Winterslag, Zolder ("Berkenbos", Tuinwijk Koolmijnlaan-Naaldert" and "De Lindeman") and Zwartberg ("Noordertuinwijk" and "Zuiderwijk") built from 1920 onwards.

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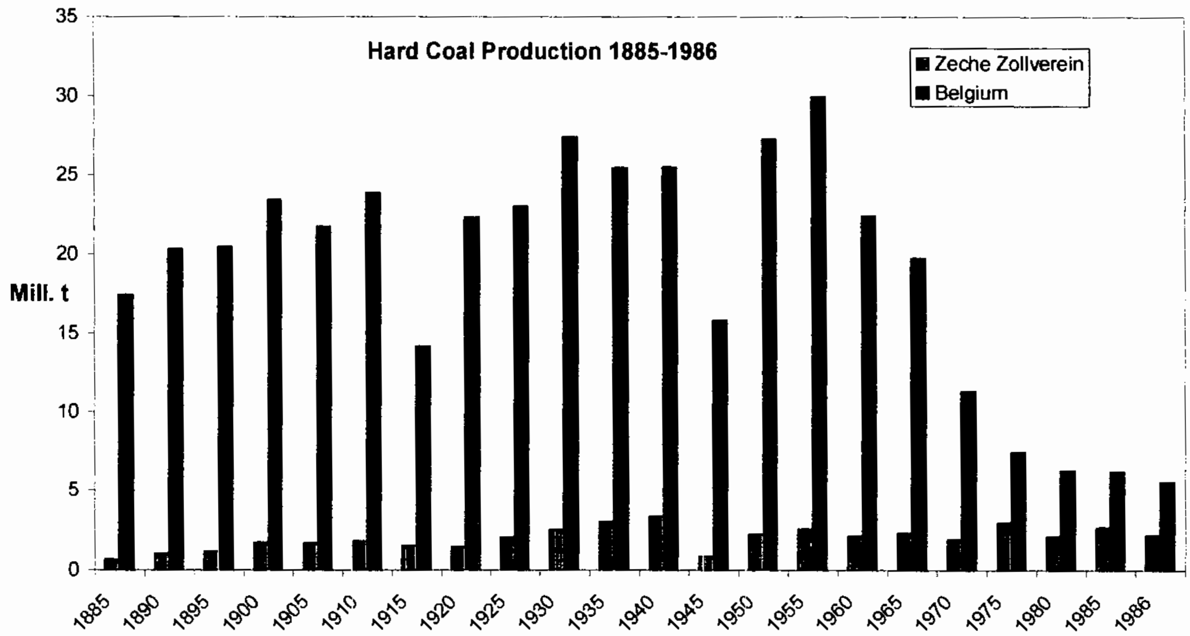
2.6.1.3.6 Monuments of hard coal mining in Belgium

Amongst the monuments of Belgium hard coal mining worth mentioning must be the two large monument landscapes of Le Grand-Hornu and Bois-du-Lac, although these originate from the first half of the 19th Century and thus are much older than the monument landscape of the Zollverein mine.

The now world-famous hard coal pit **Le Grand-Hornu** in Boussu (Prov. Hainaut) was built between 1810 and 1832 by the businessman Henri de Gorge (1774 to 1832). With its lay-out oriented to ideal town planning, it reflects the will of its founder to link the production site of a mine with a residential community and social provisions. The architect of these pit facilities with their monumental style of building was Bruno Renard (1781 to 1861), whose draft plans were definitely influenced by the example of the Royal Saltern of Arc-et-Senans by Nicolas Ledoux and the principle of revolutionary architecture.



Henri de Gorge was a progressive spirit who was open to all technical innovations of his time, such as the use of fire machines or horse-drawn railways in mines. For this reason the secondary facilities of Grand-Hornu were built in the immediate vicinity of the hard coal mines: Renard grouped the buildings around a central, wide, elliptical open space with a statue of the founder placed in the middle (before 1855). The workshops and administrative rooms of the plant are erected in "large" form and favour arched doors, columns and building blocks clearly borrowed from the Renaissance. The actual production complex is surrounded by an expansive workers' community which is well worth seeing (so-called Cité du Grand-Hornu) which contains, among other things, the director's residence of Henri de Gorge and social institutions such as schools, ballroom, hospital and public baths.

Le Grand-Hornu stopped excavation and production in 1954 due to the directives of the European Community for Coal and Steel. The subsequent years so a slow decay set in until 1969, when a royal directive order it to be demolished. Some of the former operating buildings were razed. However, the remaining areas were renovated in 1971 and subsequent years under the management of the architect Henri Guchez and designed as offices and workshop for an architect's practice. These renovation, which caused considerable controversy at the time, must nevertheless be regarded as a milestone and the beginning of the slow process of preserving the industrial heritage.

The operating buildings of Le Grand-Hornu were bought by the province of Hainaut on 21st June 1989 and opened as a museum in December 1990. The complex also play host to an exhibition centre ("Ateliers du Grand-Hornu") which was set up by the "Association Grand-Hornu Images".

The Le Grand-Hornu plant is without doubt a monument of European significance and one of the major monuments of heavy industry. Nevertheless, it cannot be compared with the monument landscape of the Zollverein mine, neither in economic importance within Belgian hard coal mining nor from the period of time or its state of upkeep. It would certainly not be false to place Grand-Hornu, together with the Saltern of Arc-et-Senans, as prime examples of large-scale production plants oriented to ideal towns - a comparison which is not in keeping with the "Zollverein" monument, despite its large dimensions.

The hard coal mine of **Bois-du-Lac** in Houdeng-Aimeries (La Louvière), founded between 1838 and 1853 and expanded and modernised several times over the course of the years, today's houses the "Ecomusée Regional du Centre" which is now in the process of being established. This mine, run by "Société du Grand Conduit et du Charbonnage de Houdeng", became one of the most important pits in Wallonia during the 19th Century. The St. Emmanuel shaft, sunk in 1846 and closed in 1959, the last shaft "Le Quesnoy in Trivières" was shut down in 1973. The "Carrés du Bois-du-Lac" was built in axial alignment next to the "Cité de Bosquetville" mine between 1838 and 1874. The residential community, consisting of several irregular squares and including social facilities such as schools and a theatre, was constructed as a magnificent ensemble according to uniform architectural principles, although also being aesthetically effective. The residential community was fully renovated in the meantime. The mine buildings, including the shafthead frame above the St.-Emmanuel shaft (today belonging to the Belgian state) have been restored step-by-step since 1981. A small but instructive museum has been set up in the wages hall ("Salle de Paie") on the history of mining. The entrance gate to the mine is worthy of note, its portcullis door between two round towers was known to the miners as "La Guillotine".

Although the monument collection of the Bois-du-Lac mine certainly has national significance, it also cannot be compared to the Zollverein mine and its monument landscape: As with the large-scale plant of Grand-Hornu, the architecture of the Bois-du-Lac mine belongs to a different era to that of the Zollverein facilities, whilst the great economic importance of the pit in a national, Belgian framework bears little resemblance to the example in West Phalia.

A completely different monument "quality" is found at the monument of the **Bois-du-Cazier** pit in Charleroi. Although the outward appearance of the double shaft facilities create a certain "effect" on visitors due to the symmetry of the two shafthead frames, the significance of the monument lies not in the architecture, but in the symbolism: It was here on 8th August 1956 that 262 miners died in a terrible mining catastrophe, the workers originating from all over Europe (136 Italians, 95 Belgians, 8 Poles, 6 French, 6 Greeks, 5 Germans, 2 Hungarians and one from Britain, Holland, Russia and the Ukraine respectively). The hard coal pit was shut down in 1967 and placed under protection in 1990 as a monument to the solidarity of miners and to all "unknown miners" lost to accidents. In the meantime, Charleroi council has designated the mine as the headquarters of the "Musée de l'Industrie de Charleroi".

In the Liège area, the two pits **Blégny-Trembleur** in Argenteau and **La Cheratte** in Visé should be drawn on for comparison. Shortly after the closure of the Blégny-Trembleur pit on 31st March 1980 as the last working mine in the Liège basin, the operating buildings were opened to the public as a mining museum with access to the pit. However, the mine facilities do not present a uniform face from an architectural point of view, covering operating plant from the period around 1840 (e.g. the Puit Sainte-Marie) to its closure (among other things a tall, upright winding tower made of re-inforced concrete): As far as considerations of uniform appearance are concerned, it is just as little to be compared to the Zollverein mine as the La Cheratte pit workings. Although La Cheratte - situated on the bank of the Maas - possesses a remarkable number of individual monuments of significance within the mine collection, it does not give the impression of a grand design. The operating buildings of the former Société Anonyme Charbonnage du Hasard, which stopped work in 1977, certainly belong to the most noteworthy witnesses of historic industrial architecture in Belgium: Not dissimilar to a fortress from the middle-ages, the shaft building, constructed in 1907 and converted in 1954, rises above shaft 1, accompanied by the compressor house. The nearby shaft 2, erected in 1922 in steel trestle design with brick filling, was razed in the 1980s. In contrast, shaft 3, erected in 1946 in re-inforced concrete, has been retained, likewise the Puit Hognée on the slope of the Maas which represents a very early example of a shafthead frame in re-inforced concrete.

The administrative buildings (so-called Phalanstère) are located in the surroundings and, on the other side of the road from Liège to Visé/Wezet, the garden town dating from 1925 with 254 residences and the recuperation house (so-called Maison du Curé) built in 1928.

Apart from these, Belgium - and particularly the Wallonian coalfield - has hardly retained any significant technical monuments in the form of complete mine facilities: The Crachet-Piquery hard coal mine in Frameries (Prov. Hainaut), established in 1782, had to be closed 1960 in spite of an extensive modernisation programme between 1943 and 1957. The overground facilities erected at that time, including the almost 1,600 m long overground route and the strut frame headgear which has been retained, keep the memory of a working pit alive in the same way as the two shafthead frames of the Le Pêchon mine shafts in Couillet, standing alone in the "green field", although neither plant can be compared to the Zollverein mine - if only for their state of preservation. The same applies to the shafts of the Houthalen-Helcheren mine or the pit facilities of the Kempense Steenkolenmijnen of Zolder, Waterschei, Winterslag, Beeringen and Eisden, large parts of which were razed after the closures. Although it is still possible to gain an idea of the scale, the dimensions and also the economic might of these mines from the expansive communities, impressive because of the uniform planning, and from a few operating buildings designed with extraordinary architectural extravagance (including a few shafthead frames), an undisturbed, overall impression can no longer be derived.

The landscape in many places is still impressive, however, dominated as it is by (peaked) slag heaps of the closed hard coal mines and the residential communities.

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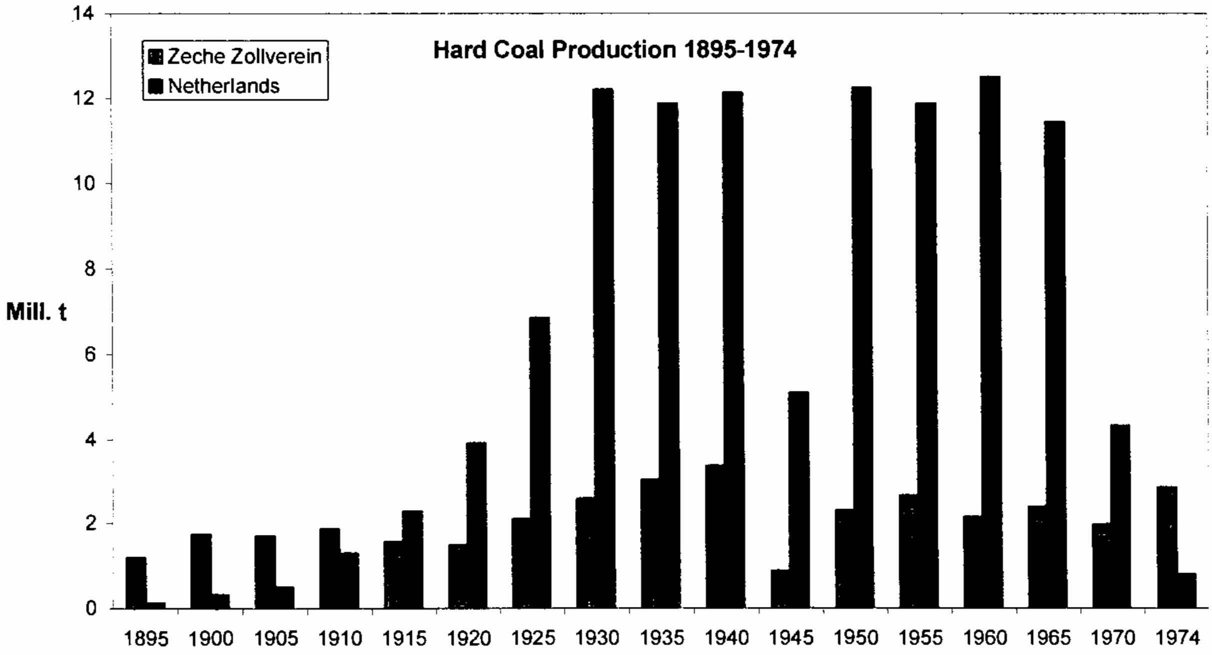
2.6.1.4 The Netherlands

The development of hard coal mining in Dutch Limburg

The extraction of hard coal in Limburg had already started modestly in the 11th Century. The first galleries began to be driven in the 14th Century, wood pumps were used to contain water around 1600: The miners, whose job it was to keep the mine dry, were called "Pompeurs" (pumpers).



The abbey of Rolduc near Kerkrade played a decisive role in the early days of hard coal mining in Limburg. This abbey was already engaged in mining around 1600: The abbot, Léonard Dammerscheidt had secured the mining rights for his monastery in 1573 by purchasing land, in 1616 the abbot Balduin Horpusch installed a water containment system in which all pumps were driven by a water wheel. This installation allowed the number of pump boys to be reduced. The growing population, the industrial development of the breweries and foundries as large-scale consumers of power, allied to the scarcity of wood, caused interest in coal to heighten in the 18th Century. In 1742 the abbot took charge of the mine management himself. Abbot Heijendah, as representative of the abbey, thereby entered into negotiations with the imperial government in Brussels concerning mining rights, the concession granted by the empress Maria-Theresia in January 1733 enabled activities to be scaled up. However, in 1750 it was established that: "The whole region has been hollowed out by 600 years of mining exploitation and filled with water". The two mines "Jagdveld" and "Heggen" were flooded in 1772, prompting the abbey to commission Akense Honin, a machine engineer from Aachen, to design a new machine powered by wind or water to drain the pits. A steam-driven machine was also considered, but as the fat coal needed to operate this would have had to have been bought in from rival companies in Eschweiler or Liège, this idea was put to one side.

Nevertheless, the thin coal mined by the pits in Kerkrade was best suited for domestic heating purposes. Thus sales in Winter were good whilst demand stagnated in Summer, leaving the coal lying around and causing storage problems. In addition, it was difficult to transport the production during the short Winter days on poor roads. Thus the first intermediate storage depot for fuel was set up in Aachen in 1779. The abbey's coal extraction reached its peak at the end of the 18th Century under the management of abbot Chaineux.

As the French troops advanced, the French state took control of the Church's property in 1794 ("Mines Dominiales"), the two concessions "Neuprick" and "Bleyerheide" were issued under French law to private persons in 1808. The "Mines Dominiales" were transferred to the Dutch state under the Agreement of Vienna (1816), the course of the Worm determined the border between Prussia and Holland. The districts of Herzo, Genrath and part of Kerkrade on the right-hand side of the road to Aachen, Geilenkirchen and the villages of Maubach, Strasz, Kohlberg and Pesch went to Prussia.

Employment and production declined during the French occupation. in 1816 the coal and iron industries of Hainaut, Liège and Dutch Limburg made a joint plea to the Government to try to improve the situation. However, despite the best efforts of King Willem I to support Dutch industry, the situation did not improve between 1815 and 1830. When the Kingdom of Belgium was established in 1830, Dutch Limburg and the state mines initially came under Belgian jurisdiction. In 1839, in contrast, Dutch Limburg was once again joined against its will to the northern Netherlands and the mines were taken back by the Dutch state.

After 1839 the technically outdated steam-driven machines were replaced on the orders of the Aachen-Maastricht railway company, as the new owner of the mines, and new shafts were sunk which allowed access to deposits up to 330 m underground. A rail link built in 1871 to the Aachen-Maastricht line, which had been running since 1856, opened new perspectives for increased output.

The mines "Willem-Sophia", "Oranje-Nassau" and Laura en Vereeniging"

Following successful test drillings, the mining company received a first concession on 28th January 1860 ("Willem") and a second on 8th February 1861 ("Sophia"). However, the sinking of the shafts proved to be so difficult and expensive that it drove the company into bankruptcy. The Société Anonyme des Charbonnages Willem-Sophia" (Willem-Sophia Mining Ltd) based in Brussels solved the problem of sinking the shafts and the first coal was mined in 1902 in Speckolzesheide; the company operated at a profit from 1904.

Trial drillings between 1872 and 1878 between Kerkrade and Sittard had also come across coal deposits worthy of exploitation. The Maastricht businessman H.L.C.H. Sarolea who had built railways in Java and Sumatra and run mines settled in Heerlen in 1885. He bought the Heerlen field on 2nd May 1893 and called it "Oranje-Nassau". To this end Sarolea founded the SA Société d'Exploitation des Charbonnages limbourgois" together with the brothers Honigmann in 1893 and thereby the Oranje-Nassau mine. The first shaft sunk according to the so-called Honigmann method reached a depth of 97 m in 1897, the first coal was extracted in 1899. In 1889 Sarolea was granted the concession to built a rail line from Herzograth via Heerlen to Sittard. Thus in 1896 a link was created to the Dutch network. "Oranje-Nassau" was purchased in 1908 by Carolus Magnus, a steel magnate and operator of the Aachen mine "de Wendel".

André Dumont, a Belgian, had already caused a furore in 1877 with a publication on Dutch mines. In this he denounced the lack of Dutch interest in mine operation, expressed his fear of

German influence and predicted Belgian investments in Dutch Limburg. It was "Société Générale de Belgique" which took up this call to arms and bought the concession "Laura" from German owners in 1899, the first coal was produced in 1907.

Spurred on by the success of "Oranje-Nassau", one concession after another was applied for and new mines quickly sprung up in the region between Heerlen and Sittard. The Dutch government recognised the need to ensure its own sources of power, and 1901 a law was passed stating that concessions not yet granted would remain the possession of the state. This led to the establishment of several state-owned mines from 1902: "Wilhelmine" in Terwinselen first started production in 1906, followed by "Emma" in Hoensbroek in 1911, "Hendrik" in Brunssum in 1916, lastly joined by "Maurits" in Geleen near the Belgian border and Charbonnage Campinois d'Eisden, which commenced production in 1923. The company decided to expand its coal activities in 1916, which was initially hindered by World War I. However, the state-owned mines established a carbo-chemical concern in 1928, the "Dutch State Mines", which produced 14,321 million t of nitrogen in 1937; between 1950 and 1965 production lay at around 12 million t.

The Dutch Limburg coalfield reached its peak in 1957: 31,505 miners were employed underground, of which two thirds, i.e. 19,878, in the state-owned mines. Added to this were 24,410 overground employees, of which a large number were employed at the coking plants "Emma" and "Maurits" belonging to the nationalised company "Cokeovens". The first coal crisis brought an end to mining in Limburg: From 1956 studies were made into alternative forms of energy to supply the Netherlands, such as nuclear power, gas and oil. The state-owned mine "Beatrix" then under construction was never put into operation. Minister Den Uyl announced the closure of hard coal mining in the Netherlands on 14th December 1965: Coal extraction finished in the region with the shut down of "Oranje-Nassau I" and "Julia".

Technical monuments

The overground facilities of the Limburg mines were quickly dismantled. Only a few technical monuments remain as documentation of mining activity: Among these are Nulland pit in Kerkrade, a singular re-inforced concrete shafthead frame erected in 1907, shaft 2 of the pit "Oranje-Nassau" in Heerlen, a shaft building with shafthead frame constructed between 1896 and 1898, and a few workers communities in Heerlen and Kerkrade. The museum of Kerkrade keeps the memory of hard coal mining in Limburg alive. It must likewise be said of the Dutch Limburg coalfield that no monuments exist which come anywhere near the rank of the Zollverein mine.

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2.6.1.5 France

Although France is a country with a rich tradition in hard coal mining, today the winnable and viable coal stock at its disposal amounts to only 98.6 m tons SKE. The amount of hard coal which is still extracted in France nowadays is at an equally low level (approx. 5.8 m tons in 1997). Of all the coalfields in France, the Nord / Pas-de-Calais coalfield, the foremost mining area in earlier times, has gained particularly in importance. Other coalfields such as the Loire, the Cévennen, the Auvergne, Blanzy, the Aquitaine and the Dauphiné play rather a subordinate role in French coal mining. Only the Lorraine coalfield has been able to substantially raise its extraction rate since the 1940s, and, with the cutback in mining in the Nord / Pas-de-Calais coalfield in the 1960s and 1970s, it rose to become the most productive French coalfield. However, Lorraine has not come anywhere near achieving the Nord / Pas-de-Calais maximum yearly extraction in the 1920s and 1930s of up to 35 m tons.

2.6.1.5.1 The Nord / Pas-de-Calais coalfield

The hard coal deposit in northern France, near Valenciennes, is the continuation of the wide-ranging deposit which stretches from the Ruhr through the coalfields of Aachen, Rolduc, Liège, Namur, Charleroi and Mons into northern France to Condé, Anzin,Denain, Roeulx and to Hardinghen, and finally on to England. There were about five hundred years between the beginning of mining in the Liège region and the discovery of coal in 1720 in Fresnes in the Departement Nord, and only in 1841 was development of the Pas-de-Calais deposit embarked on, with the sinking of a shaft in Oignies on an estate owned by Madame de Clercq.

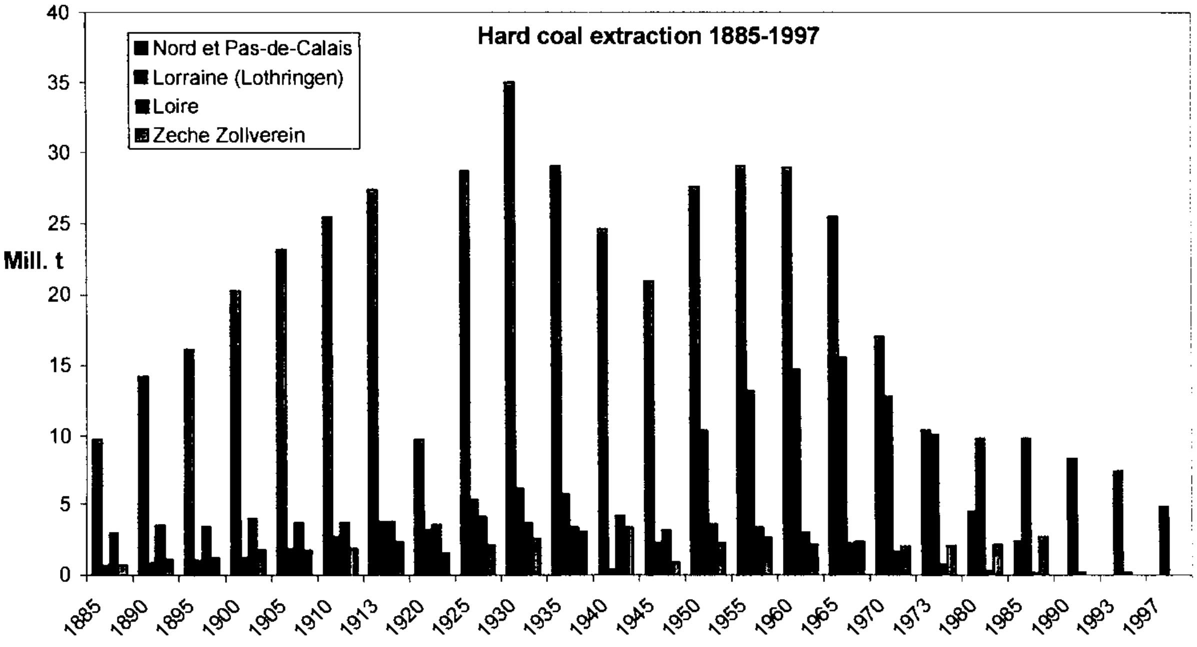
As a 120 km long and four to twelve km wide band, the deposit in northern France stretches first of all from the north east to the south west, then it makes a curve and runs from the south east to the north west. The deposit is not very compact, in a 100 m hard coal formation, there is no more than 4 m to 5 m of coal in the middle, the seams are often not very rich and are irregular in thickness. This has caused severe problems for mining. Stratification also varies greatly. In Pas-de-Calais it is mainly horizontal and in the north it is sharply inclined, resulting in greatly varying mining methods.

At the end of the carboniferous period, the deposit folded upwards which led to the creation of large faults (Faille du Midi, Failles Pruvost, Barrois, Chalard). The large number of secondary faults, of varying importance, meant that very often operating sites enjoyed only a short life span, or that equipping them required high expenditure. There were large and frequent outbreaks of pit gas. In addition, the deposits become slowly deeper from east to west, and with increasing depth the soil pressure and the temperature rose, requiring adequate ventilation facilities. An advantage lay in the large amount of coal types available for varying applications. Not only lean, quarter-fat, half-fat and caking coal, but also flame carbon could be extracted, so that the requirements of the varying consumers and industries (chemical, coking, briquetting, heating and power plant) as well as households could be met.

The development of coal mining in the Nord and Pas-de-Calais coalfields

The history of the coal basin in Nord / Pas-de-Calais begins in the Valenciennes area at the beginning of the 18th century. At this time, Jacques Desandrouins, together with his partners, Pierre Desandrouins-Desnoelle, Pierre Taffin, Jacques Richard and Nicolas Deshaubois founded their first mining company, whose management was entrusted to the engineer Jacques

Mathieu. After several unsuccessful attempts, coal was discovered in February 1720 in the Jeanne Colard mine in Fresnes-sur-Escaut. Success, however, was only for a short duration as water inflows, alongside many other problems, made it impossible to continue with extraction at this mine. They continued, however, with their endeavours and on 24th June 1734 in Anzin in the Pavé mine they discovered hard coal of a much higher quality. This coal discovery initiated the founding of the "Compagnie des Mines d'Anzin" in 1757, after which the neighbouring companies of Aniche, Douchy and Vicoigne followed.



Coal mining in Pas-de-Calais, however, began only in 1841 with the discovery of the deposit in Oignies. From now on, this coalfield experienced a huge boom with the establishment of mining companies in Béthune (1851), in Lens, Bruay, Marles and Courrières (1852), in Noeux (1853) in Dourges (1855), in Ostricourt (1860) and elsewhere. In 1913 two thirds of the French coal production was mined in Pas-de-Calais at 27.4 m tons. This high level of coal mining did not keep pace, to some extent, with the required security measures in the mines, as is confirmed by the terrible mining disaster at Courrières in 1906, in which 1099 miners loss their lives and also by the strikes in 1884, 1902 and 1906.

World War I, with its almost total destruction of the mines, brought mining to a standstill. At the end of the war, redevelopment was achieved by employing a large number of foreign workers. In 1930 a record extraction of 23.5 m tons was achieved purely by the Pas-de-Calais mines, which accounted for 66% of French production. Before World War II, 108 pits, belonging to 18 very different companies were mining the Pas-de-Calais deposit. During these between-war years the industries dependant on coal were also developing: in 1938, 19 power plants, 15 coking plants and 13 briquetting factories were established in this coalfield, not forgetting the important coal chemistry of Mazingarbe. In 1913, 129,890 people worked above and below ground, by 1938 there were 146,280 workers.

World War II and the occupation of the northern French coalfield caused the next break, and afterwards restructuring began through nationalisation of the mines. Under the decree of 13th

December 1944 the "Houillères Nationales du Nord et du Pas-de-Calais" was formed, which, through legislation of 17th May 1946, was restructured as "Houillères du Bassin du Nord et du Pas-de-Calais" (HBNPC). From now on, the coalfield was divided into nine groups (Valenciennes, Douai, Oignies, Hénin-Liétard, Lens, Liévin, Béthune, Bruay and Auchel). Each group was supposed to increase extraction to help reconstruct the French economy. This resulted in the well-known "coal battle" (Bataille du Charbon")which Maurice Thorez started in Waziers. The goal was a daily extraction of 1000,000 tons.

Post-war modernisation is characterised by increasing mechanisation. To the extent that mining conditions allowed, there was gradually progress from the coal pick to the plough and cutting roller and from wooden to metal props for shaft support and, finally, to self-advancing support. The number of sites declined from 109 in 1947 to 64 in 1960, with a simultaneous increase in extraction per man and shift.

Since 1960 the recession has accelerated, embedded in a succession of Government plans for the gradual closing down of coal mining. The Jeanneney Plan (1960) was followed by the Bettencourt Plan (1968). In 1963 this culminated in a strike lasting for over a month. During these last days of Houillères du Bassin du Nord et du Pas-de-Calais, the Liévin mining catastrophe on 27th December 1974 occurred, in which 42 miners were killed.

Coinciding with cutbacks in mining, restructuring and rescue companies were founded, such as "Service d'Acceuil des Implantations Industriels" (1966), "SOFIREM Société Financière pour favoriser l'Industrialisation des Régions Minières" (1967), "Fonds d'Industrialisation du Bassin Minier" and "FINORPA Financière du Nord / Pas-de-Calais" which took over SOFIREM in 1984. Nevertheless, founding these companies could only alleviate but not eliminate the social hardship resulting from the closing down of mines.

On 21st December 1990 the 9-9bis pit in Oignies, representing the last site, closed down. This brought the period of coal mining in the Nord / Pas-de-Calais coalfield to a close. Two years later "Houillères du Bassin du Nord et du Pas-de-Calais" was wound up and replaced by "Charbonnages de France – Bassin Nord / Pas-de-Calais". Above-ground activities were retained e.g. coking plants and coal chemistry by "Cokes de Drocourt", briquetting by "Agglonord", pit heap treatment by "Terchanord", waste-slate processing by "Briqueterie d'Hulluch" and "Surschiste", treatment and utilisation of pit gas by "Méthamine" and maintenance and installation of technical equipment by "GMT Générale de Maintenance et Technologie". These companies have combined to form the "Société Filianord".

A total of 2 bn tons of surface coal has been extracted in this mining area, whereby the highpoint of mining was between the 1930s and 1960s. During this period, an average of 200,000 people were employed to mine about 30 m tons per year.

Technical monuments

Individual mines could be preserved as ensembles, such as the Arenberg colliery in Wallers der Mines d'Anzin with shafts 1 (1936), 2 (1920) and 3 (1961), the Oignies der Mines de Dourges colliery with shafts 9 (1941) and 9bis (1832) and the Loos-en-Gohelle der Mines de Lens pit with its pithead gear over shafts 11 ("Pierre Destombes", 1923) and 19 (1960).

Further visible traces of mining include, in particular, the preserved pithead gears over the Dutemple shaft in Valenciennes (Mines d'Anzin, 1921), over shaft 9 of "Compagnie de l'Escarpelle" in Roost-Warendin (1955), over shaft 2 of the Sabatier (Mines d'Anzin) colliery in Raismes and shaft No. 3 of "Mines de Liévin" in Liévin (1923). Other headgears can be found at Bénifontaine over shaft Félix Bollaert 13bis (about 1920), at Condé-sur-Escaut over shaft 2 of the Ledoux pit (1951), at Evin-Malmaison at shaft 8 (including the winding engine), at Fresnes-sur-Escaut over shaft Sarteau Nord (a rare example of the Malakoff tower in northern France, from 1853), at Haisnes-les-la-Bassée at shaft 6 ("Alfred Descampes", about 1920) and at Marles-les-Mines at shaft 2 ("Saint-Emile", 1906).

The monument ensemble that best keeps alive the development of northern French mining in the Departements Nord and Pas-de-Calais, is the internationally significant **Centre Historique Minier** in Lewarde, which is located at the **Delloye Mine**.

This pit once formed part of the former Aniche mining company. At the turn of the century, coal from the deposit was still being excavated above the Vuillemin mine at the surface. In 1911 the first drilling for shaft 1 was begun, up to a depth of 270 m, but was interrupted by World War I. In 1926 the sinking of shaft 2 began and reached a depth of 379 m. Between 1928 and 1930, the company erected the surface installations, together with the headgears, and established the necessary railway connection. In 1931 the new pit could begin mining. 18,634 tons were extracted in the first year.

Originally the workforce at the Delloy mine consisted of miners from the Vuillemin mine, and in 1933 300 men (274 of whom worked underground) joined them from the Sessevalle mine. Between 1936 and 1937 miners from the Azincourt, Barrois, Bonnel and Saint René mines were transferred to Delloye. After the war a large number of foreign workers and German prisoners of war, and also Italians, Poles and North Africans were employed. The underground workforce, however, increasingly consisted of Frenchmen. In 1963 the Delloye mine reached the highest ever open-pit extraction of 1,218 tons, in 1971 the pit had to be closed down because the deposit had been totally exhausted.

The Centre Historique Minier was founded in 1982 at the instigation of the Houillères du Bassin du Nord et du Pas-de-Calais, the local authorities and the Ministère de la Culture. Today it is the most significant mining museum in France. The surface installations – i.e. the two headgears with their winding engines, the pithead buildings, the changing room with the lamp house, the office buildings, the treatment plant, the ventilating equipment and the stable – were partially renovated and partially put into new (mostly museum) usage after closure. Of particular interest is an "exhibition mine" which, although erected above ground, shows the underground working and mining conditions very clearly. The Centre Historique Minier, with its collections and exhibitions, also houses an archive of the former mining companies and makes considerable contribution to the memory of northern French mining in this coalfield.

In the end, however, as also applies to the northern French coalfield, despite the great achievement of converting the Fosse Delloye into the Centre Historique Minier and the preservation of several important material witnesses to coal mining, no monument can approach the quality and standing of the Zollverein mine in the midst of a cultural landscape so industrial in character. This applies also if you simply take size into consideration. Compared to the surface installations of shaft 12 of the Zollverein colliery, Fosse Delloye is a relatively "small" mine.

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2.6.1.5.2 The Lorraine coalfield

The development of coal mining in the Lorraine coalfield

The Lorraine coal deposits, known since the 15th century, lie in the Saar-Moselle basin, which nowadays, after a turbulent history, is shared by the German-French border.

Right up to the 18th century virtually only batches near the surface were mined, but from about 1780 the de Wendel family started the first trial drillings. Through the Paris Agreement of 1815, the whole of the then mining area went to the Prussians, who continued with the trial drillings and who granted the first concession in Schoeneck (Departement Moselle) in 1820. During the following decades, further concessions were granted to several mining companies. The de Wendel family erected several blast furnaces in Stieringen (today Stiring-Wendel), near the coal mines. In 1870 the Departement Mosselle was annexed by the German Third Reich and the coalfield divided into the three regions of Petite-Rosselle, Carling and L'Hôpital. At that time, a total of around 230,000 tons of coal was mined each year in these three regions.

Up to this point in time, the applicable French mining legislation had prohibited the amalgamation of several concessions. German law, in contrast, allowed a rapid amalgamation of mining companies. In 1873 the Saar-Mosel mining company was founded with Belgian capital, which, among others, took over the mines at Carling and L'Hôpital, whereas, for their part, the de Wendel family became the owners of the coal mines of Petite-Rosselle with the Forbach and Stiring concessions. During this time, further trial drillings showed the presence of coal at Folschviller, Faulquemont, Boulay and elsewhere, however, no substantial industrialist with sufficient capital could be found to build a new mine. In 1910 the German company which operated the Le Houve mine built the first thermal power plant in the Lorraine coalfield and supplied the whole Departement with the energy generated there. In 1913 extraction, which had increased steadily, reached almost 4 m tons, which, however, was still a long way from the 114 m tons mined in the Ruhr at that stage.

After the Versaille Agreement and the return of Alsace and Lorraine to France, the French Government redistributed the concessions, with the de Wendel company being an exception. Other steel companies received concessions to the north west of the coalfield, as well as in Faulquemont, however, it wasn't until 1930 that the first shaft was sunk. Mining also began in Folschviller at this time.

As a result of heavy mechanisation, mining increased substantially between the two wars and workforce requirements increased proportionally, which were met by foreign workers – mostly from Poland, but also from Italy, Czechoslovakia and Austria. In 1926 foreign workers accounted for about 60% of the total workforce, between 1913 and 1938 the total number of mining employees rose from 13,500 to almost 25,000. The Lorraine companies, which had formed themselves into a sales organisation, sold coal and coke throughout France and, up till the outbreak of World War II, also exported to Germany.

The coalfield, which between 1939 and 1945 was mined relatively little, suffered serious damage. Flooded mines, destroyed plants and estates required large investments for reconstruction. Thus, in 1946 French coal mining was nationalised, central management coming under the newly-founded Charbonnages de France. In addition, miners were granted special status, which allowed them housing rights, paid holidays and very favourable social services. These measures were supposed to attract new workers and to retain existing ones.

The management company for the Lorraine coal mines, the Houillères du Bassin de Lorraine (H.B.L.), whose subordinate units "Sarre-et-Moselle", "Petite Rosselle" and "Faulquemont-Folschviller" retained the mining boundaries of the former mining companies, sunk several new shafts, modernised the machinery and equipment in order to increase mining output and continued to attract foreign workers. By the end of 1949 the number of employees reached almost 43,000 and mining output amounted to almost 10 m tons a year.

At the same time, the H.B.L. began to intensify the refinement of rough coal and built the thermal power plant and chemical complex at Carling. In 1948 the production of metallurgical coke was begun, up till then a problematic undertaking, as the Lorraine coal could not previously be processed into blast-furnace coal. Only with the mixing of various types of coal, sophisticated granulation and the use of compressing operations could coke be produced efficiently.

Since 1952 H.B.L. was able to continuously increase mining output. At the end of the 1950s new shafts were sunk and 40 km of new tunnels were ploughed, despite the competitive pressure from Saarland which forced the H.B.L. to stockpile increasingly more coal. Ancillary operations were also extended. The thermal power plants at Carling and Grosbliederstroff on the Saar were put into operation in 1952 and 1954 respectively. They replaced the smaller power plants which earlier supplied each individual mine or operating unit and they also sold a large part of the electricity generated to the EDF, the French public electricity company. The coking plant at Carling provided a sufficient quantity of metallurgical coke, while the coking test plant at Marienau carried out intensive research on coking processes. Coal chemistry produced not only tar and benzol, but also raw materials for the manufacture of synthetic products such as artificial fertiliser, textiles, acids, explosives and artificial aromas.

In the 1960s, however, the trend which had become evident in the previous decade was confirmed. Oil became increasingly important and competition from foreign coal made itself very apparent. Taking the first steps in a rationalisation process, the H.B.L. set up its central administration in Freyming-Merlebach in 1964, and mechanisation was intensified which put the H.M.L. ahead of all the European coal mining companies when it came to mining output. Between 1958 and 1967 the number of employees fell from 46,000 to 34,000 as a result of severe job cutbacks, whereas production reached its peak at 15.6 m tons in 1964. Even at that stage, however, H.B.L. began founding substitute industries producing tyres, furniture and boilers. In 1968, the downswing intensified on all sides and production sank lower each year to reach a low point in 1974 at 9 m tons of coal.

Thus coal mining entered an intense phase of necessary restructuring. In order to accelerate job cutbacks, the H.B.L. resorted to early retirement measures, whereby the workforce could be reduced to 23,000 by 1973. After the large building projects of the 1960s, when about a dozen new estates were built on the outskirts of the industrial and mining zones, the H.B.L. gradually shifted its responsibilities for infrastructure (roads, water supply) on to the local authorities. In 1970, all the chemical operations under Charbonnages de France were combined under the name CdF Chimie, in order to centralise investment. Following general industrial development, the coal chemical plants gradually reoriented themselves towards petrochemicals. In 1972 and 1974 the Sainte-Fontaine and Faulquemont mines were the first to close down.

The decade between 1974 and 1983 marked a revival in coal, thanks to the oil crisis. Although the Sainte-Fontaine mine was reopened, the Folschviller mine and those mines lying to the south had to be closed down. After several years of restructuring, however, this 180 degree turnaround was a difficult undertaking, and the steel crisis also did not help to greatly extend the sale of coke. Restructuring continued with the renovation of dilapidated estates, support of home ownership and the continuation of plans to transfer responsibilities to local bodies.

Since 1984 oil prices have once more dropped, and coal, which has to be mined from ever deeper pits (nowadays up to 1,200 m), has increasingly suffered under competition from cheaper foreign coal. Added to this, the EDF, up till then a major consumer of coal for its thermal power plants, began to orientate its energy policy increasingly towards nuclear energy. From now on, the French Government subsidised the resumption of industrial diversification in the Lorraine mining and steel coalfield, which entered 1986 and 1987 with the closing down of the Sainte-Fontaine mine, the Marienau coking plant and the power plant at Grosbliederstroff.

Modernising the installations allowed the remaining mines to distinctly increase output. Fully mechanised extraction at the La Houve mine made this pit one of the most efficient in Europe; thanks to innovations, the Carling coking plant is now able to produce coke "á la carte"; at the Emile Huchet power plant in Carling in 1990, a new type of boiler with circulating fluidised heating was put into operation, which can be fed with all types of coal and coal residues and can recycle its own soot. Nevertheless, there are plans to close down the last H.B.L. mine in 2005.

In 1997 coal mines in Lorraine extracted about 4.763 m tons of coal, while employing about 9,500 people.

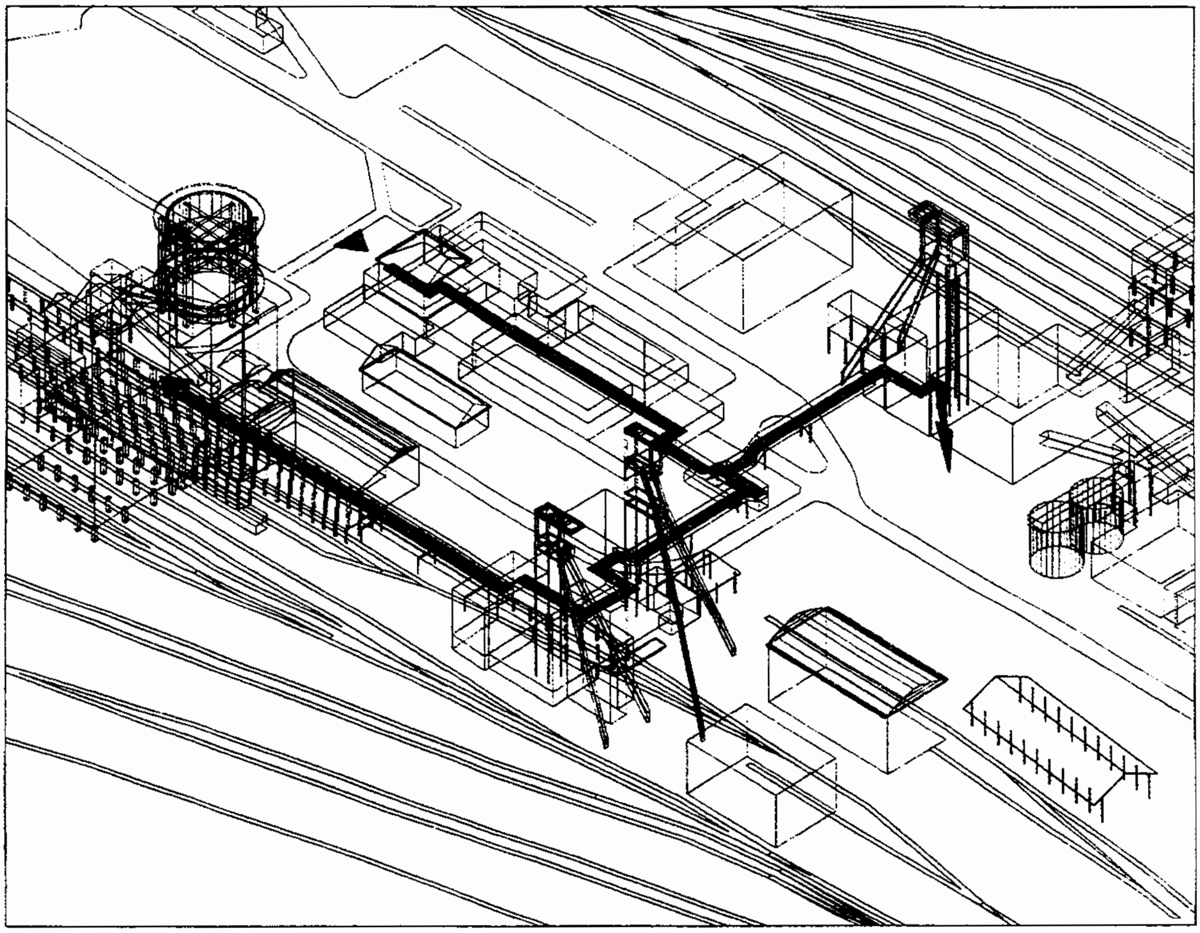
Technical Monuments

The outstanding technical monuments of coal mining in Lorraine are, on the one hand, the Wendel-Vuillemin mine in Petite-Rosselle (Carreau Wendel-Vuillemin) and, on the other, the shaft tower at Sainte-Marthe in Stiring-Wendel.

The Wendel-Vuillemin pit is an industrial museum nowadays and it is very characteristic of heavy industry in the 19th and 20th centuries. At first glance you may only notice a relatively modern industrial complex from the 1950s, however, between the beginning of mining in 1866 and the closing down of the mine in 1986, one hundred and twenty years of coal mining have left numerous traces of the various industrial activities.

In 1856 Charles de Wendel began the first trial drillings, based on recommendations from Emile Vuillemin, in order to extend company mining fields which were limited in the north by the German-French border (Saint-Charles mine). This was the beginning of coal mining in the Petite-Rosselle area which lasted for more than a century. The mine was named after its two pioneers in 1865.

Up till 1945 the history of the mine was governed by the development of private mining companies, subsidiaries of railway and iron concerns which were dependent on a sharply competitive European market. The mine, owned by the limited partnership "Les Petits-fils de Francois de Wendel", based in Hayange, after the de Wendel company had gradually gained control of the "Compagnie des Mines de Stiring", experienced numerous changes, although only concerning short-term operations. After 1920 very little extensive investment was made; the mine was the main supplier of boiler coal.



The Wendel-Vuillemin / Carreau Wendel pit: Museum complex (from Carreau Wendel, A la découverte d'un site industriel, 1995)

From 1945 to 1960, after nationalisation, the Wendel mine became one of the largest complexes under the Monnet Plan, and its comprehensive modernisation enabled mining to increase three fold within less than ten years. The mine was now greatly extended: the sinking of the Wendel III shaft (1952), the modernisation of the existing Wendel I and II, as well as Vuillemin I, and the building of Wäsche III (1958). These extensions were carried out within a new framework: mining operations were integrated within national planning and were laid out on a long-term basis. At the same time, comprehensive modernisation of the mining installations was planned, but the first recession in 1949 and 1950 meant that plans to build a new office building had to be given up. It was decided to extend the old building once more, which meant that the mine has retained traces of each development phase. Furthermore, the loss of the concessions in Warndt (1956) interrupted modernisation of the Vuillemin mine. The excavation shafts I and II were converted into man-riding and material shafts respectively.

From 1960 onwards, the recession was long lasting and large-scale new building complexes could no longer be considered. They thus had to come to terms with the existing ones by modernising the installations. Wäsche I/II (1929) bear witness to the changes in mining projection, inasmuch as their installations were fully modified and a new building was more or less placed on top of the old one.

Even though only the foundation remains of the former Wendel I shaft, you can still recognise the mine's subsequent development phases by the unusual assortment of building styles. The Vuillemin II shaft, the machine hall in Wäsche III, the architectural collage of Wäsche I/II, which were greatly extended between 1891 and 1970, - each of these constructions are reminders, in its own individual way, of the important development periods in coal mining in the course of industrialisation in Lorraine.

Alongside its historic importance, the mining installations are of considerable (museum) educational importance. 5,000 tons of coal were mined each day at the Wendel I/II shaft, 5,000 miners (in the 1960s as many as 5,900) found jobs here. These figures are extremely important in understanding the magnitude of the Lorraine mining industry. The mine also lies in a totally altered "artificial" landscape. The mining face of the sandstone quarry which forms the northern extremity of the coal mining terrain, testifies to the considerable quantities of sand which were blown into the underground mine cavities as packing. Similarly, the pit heap, visible from afar, symbolically indicates the extent of coal mining. The enormous dimensions of the surface installations and the colliery railway network provide a strong impression of the extent of "heavy industry".

In 1988 the H.B.L handed over the Wendel mine to the C.C.S.T.I. du Bassin Houiller Lorrain (the cultural centre for science, technology and industry in the Lorraine coalfield). The goal of this body is to up-grade the industrial heritage of the coalfield, develop its scientific and technical culture and encourage discovery tourism in the transformed region. The Wendel-Vuillemin mine, which forms the heart of this cultural programme, is to be modified and built up as an industrial museum and as a centre of social and industrial history in the Saar-Lor-Lux area.

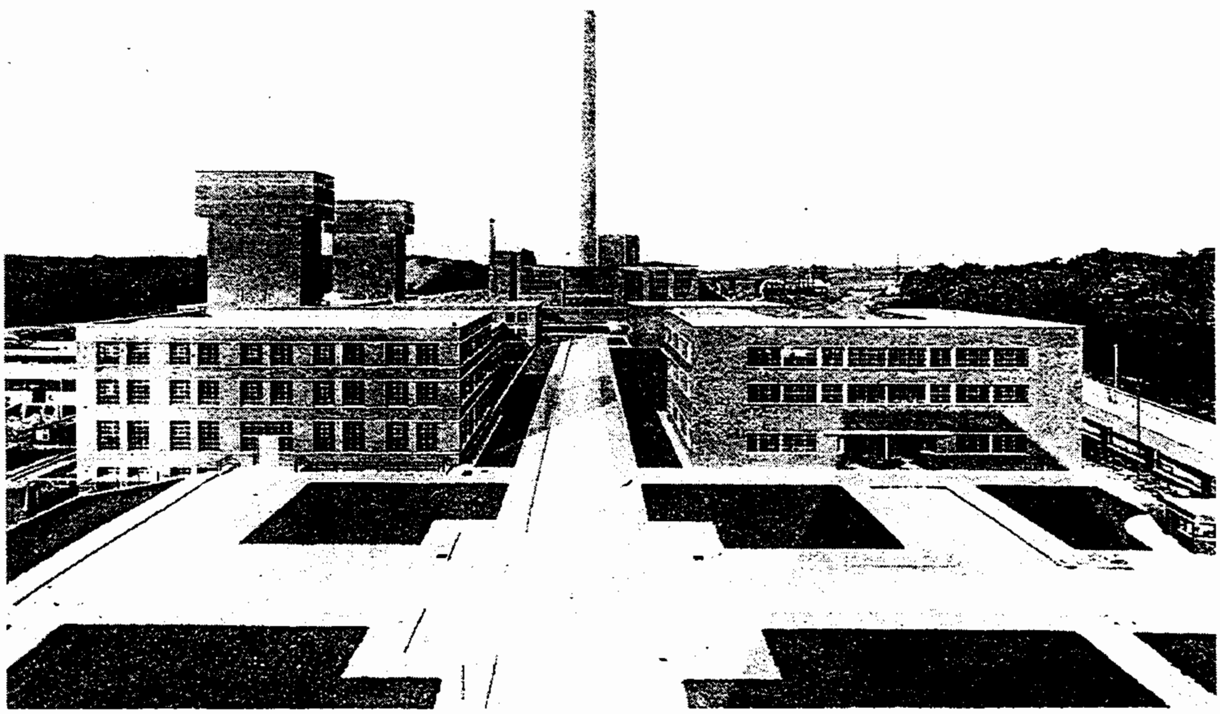
Compared to the surface installations at the Zollverein mine, however, it must be remembered that the Wendel-Vuillemin mining complex does not equal the monumental landscape of the Ruhr, either in its size or the artistic quality of the individual constructions. And although the Lorraine monument is significant in illustrating developments in the eastern French history of coal mining, with all its socio-economic manifestations, and also in connection with the residential and housing estate monuments, it cannot justify the claim of being part of the world cultural heritage. This assessment also remains valid if you add the other coal mining monuments in Lorraine to supplement the importance of the Wendel-Vuillemin complex. Should they manage, however, when coal mining in Lorraine has run out, to found a museum with cross-border importance which includes monuments to heavy industry in Saarland within its scope, then a museum of European significance would be created.

The independent community of Stiring-Wendel was formed in 1857 by uniting the village of Verrerie-Sophie, the hamlet of Vieux Stiring and the estate of Stiring-Nouveau. These share the uniqueness – other than the fact that they are the oldest remaining **workers' estates** in the Lorraine coalfield – of being built originally for foundry workers and not miners.

Since 1846 the Stiring-Wendel area has been explored for coal. In 1852 the engineer Karl Kind directed the sinking of the **Sainte-Marthe shaft** in Stiring, after three very promising trial drillings. It is the only shaft remaining from the coalfield's inaugural period, however, it was never used for extracting coal, as in 1854 it was flooded. After that it was used as a water reservoir for the foundry up to its closure, and later for the community right up to the 1960s.

Alongside Carreau Wendel in Petite Roselle, the surface installations at the **Fürst in Folschwiller mine** (1931 to 1979) can lay claim to some interest with a monument ensemble from the 1940s, including a pithead gear and the 1950s garden-city estate of **Cité Huchet** in Saint-Avold. However, neither these monuments and estates on closed-down mining sites, nor the currently operating pits (e.g. in Forbach with Siège Simon) can rival the monument ensemble of the Zollverein colliery as part of the world cultural heritage.

The mining complex of **Faulquemont** (near St. Avold) – constructed between 1933 and 1935 by Joseph Madeline – could, in certain aspects, be regarded as a "counterpart" to shaft 12 of the Zollverein colliery, as the surface installations laid out on both sides of a central "Zechenstraße" and the axial alignment to the power plant smokestack can be seen as a near copy of the Essen colliery. After closure of the colliery, however, the surface installations were to a large extent demolished.



The Faulquemont mine, 1935 (from L'usine et la ville. 150 ans d'urbanisme 1836–1986, special edition Culture Technique. Exhibition catalogue of the Institut Francais d'Architecture, Paris 1986, p.49

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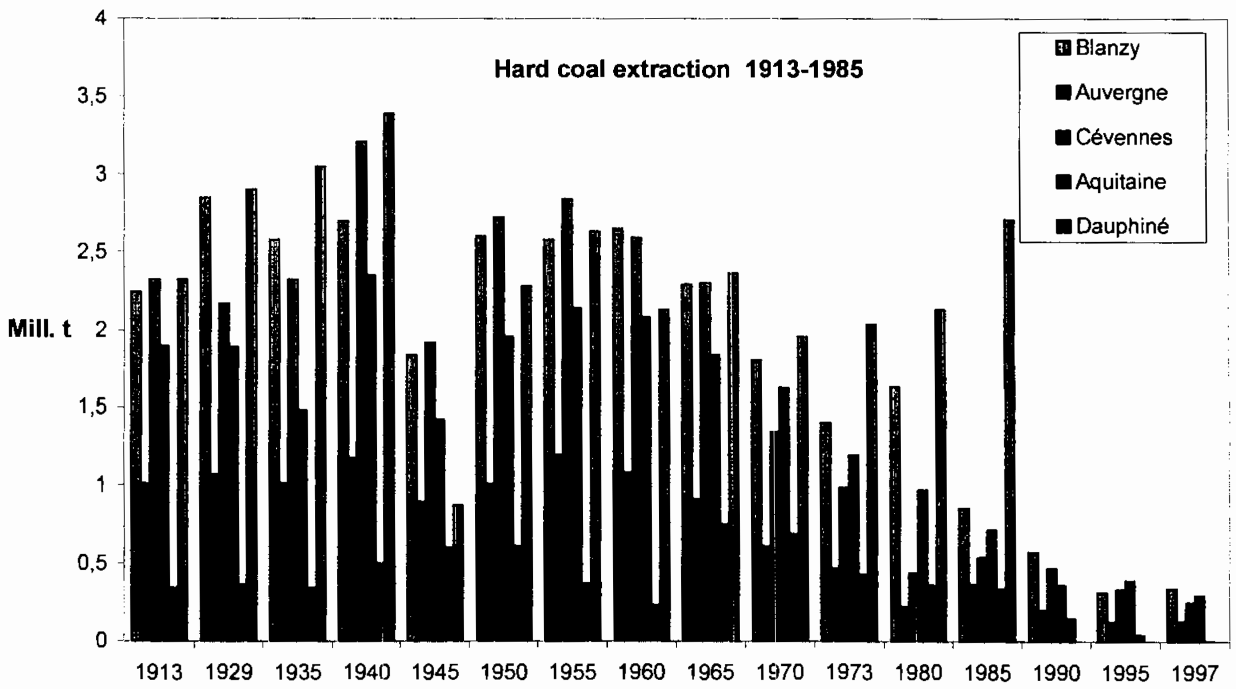
2.6.1.5.3 The central and southern French coalfields

In the centre and to the south of its national territory, France has several smaller, economically not insignificant coalfields (Bassin du Centre-Midi). These include, in particular, the Loire basin coalfields (near St. Etienne), the Blanzy and Le Creusot basin and the basins of Autun and Epinac, Aubin and Decazeville, Carmaux and Albi and of Alès and Ronchamp.

The development of coal mining in central and southern France

Coal mining in central and southern France can look back on a long life. Coal mining in the Lyon area was mentioned as far back as 1321 and 1540, and at the beginning of the 19th century more than half the coal consumed in France came from coalfields in the central and southern French Departements of Loire, Gard, Aveyron, Allier, Hérault, Tarn, Isère and Quercy. St. Etienne played a decisive role as a mining town at this stage; the railway lines between St. Etienne and Andrézieux/Loire and later on to Lyon were the first in France. St. Etienne was chosen to be the centre of one of the most important French mining schools, and nowadays holds the head office of Houillères de Bassin du Centre et du Midi, a subsidiary of Charbonnages de France. In 1997 central and southern French coal mining, with about 2,400 employees, extracted about 2.04 m tons of coal (of which 1.03 m tons was from underground mines and 1.01 m tons from surface mines).



Technical monuments

The most important technical monuments to coal mining in the Centre coalfield are located in Le Creusot/Montceau-les-Mines, St. Etienne/Couriot and in La Machine.

The most representative example of a colliery in the Cevennen coalfield, which has been converted into a technical monument in the form of a coal mining museum, is located at **Saint-Etienne**. The **Couriot pit** has its beginnings in 1850; the Chatelus 1 shaft was sunk in 1850 and has a strange, pagoda-like headgear which was reinforced with concrete in World War I under the advice of Eugène Freyssinet. It was the first headgear in the Loire region to be made of metal and remained standing up to 1966. The Chatelus 2 shaft was equipped with a wooden headgear (1867) which only survived for a short period. The Société Anonyme des Mines de la Loire, the most important mining company on the Loire with 17 operating collieries, sunk a new shaft ("Couriot") of 727 m in 1913.

Up to 1973 Puit Couriot extracted, with a maximum of 1,500 miners, 3,000 tons of coal a day. An efficient coking plant was attached, with 42 coke ovens as well as an ammoniac and benzol factory. The gas produced was piped to the St. Etienne gas company and the Roche-la-Molière chemical company

The surface installations were converted into a museum after the coal mine was closed down; an exhibition mine maintains the memory of the mining and extraction methods used in Loire coal mines. The surface installations consist of the steel headgear, the shaft hall and the winding engine house as well as the neighbouring office and factory buildings. In the middle of the Centre historique minier there is a monument in honour of the miners who were killed during the war or in carrying out their jobs. It was created in 1920 by Paul Graf.

Le Creusot and **Montceau-les-Mines** are cities created from coal mining and the iron industry. From the 18th century, an important industrial area emerged between the Saône and the Loire, which is inseparably linked to the Schneider and Chagot family names. From 1860,in Montceau-les-Mines a new city developed along the Canal du Centre, built for transport, and opposite the administrative building. In Le Creusot the old city, built at the beginning of the 19th century, was very quickly displaced by the rapidly growing industrial complex. Even today the centre of Le Creusot is the reserve of the factory premises. Important monuments of this development are the "Cité de la Combe des Mineurs" estate established in Le Creusot in 1826, but above all, the "Château de la Verrerie" glassworks built in 1787, which meanwhile has been converted into an Ecomusée. In the Montceau-les-Mines coalfield particular attention should be drawn to the **Blanzy** mine. The need to mine coking coal in order to supply foundries with the required fuel, led to the establishment of an important coal industry. In 1868 the Saint-Claude shaft was sunk, which at a depth of 500 m was not only the deepest shaft in the coalfield, but also, in 1881, the first to be equipped with an electric winding engine. In 1973, after the mine closed down, the idea of building a mining museum was broached, in 1974 it was decided to convert the former Saint-Claude pit and in 1981 the museum was opened. The museum has a steam-driven winding plant, a lamp house and an exhibition tunnel, which was cleared and rebuilt between 1975 and 1995, and now offers an underground trip.

To the west of Le Creusot and Blanzy lies the **La Machine** coal mining area, which has been mined since the 18th century. Under the direction of the Duc de Montausier, Daniel Michel, an engineer from Liège, erected a horse-driven capstan over one of the numerous shafts, from which it can be assumed that mining started at an early date. The worker's estate, still in existence today, and which was declared a parish in 1785 and an independent community in 1793, has mining and this "engine" to thank for its origins.

The La Machine mine fell into the hands of the Schneider company in the 19th century. In 1836 Schneider became a shareholder of Compagnie Gargand, which, in turn, sprang from

Compagnie des Houillères de Decize. From 1865 up to the nationalisation of coal mines in 1946, the mine supplied the factories in Le Creusot. Finally, up to the closure of the mines in 1974, one of the head offices of Houillères du Bassin Blanzy was located there.

This spacious city, erected during the 19th century, demonstrates even today the close link between city, coal mine and company. The estate buildings are a true "museum of varying housing models" and house, for Nivernais standards, a unique population from all over the world. The Musée de la Mine, set up in the former company head office, provides a good impression of the cultural variety, while the Les Glénons pit in La Machine preserves the memory of coal mining.

A smaller coalfield in the south Vogesen was located near **Ronchamp** (Franch-Comté). Mining began there in the middle of the 18th century with farmers working in the mine as an additional income. In 1875 the colliery employed 1,500 miners and mined about 200,000 tons per year. Around 1900 the Arthur de Buyer shaft at 1,008 m was the deepest shaft in France. After 1945 the mine was transferred to Charbonnages de France, which closed it down in 1958. Of the surface installations, the remains of the shaft mentioned previously and the headgear over the Sainte-Marie shaft have survived. With its wonderful collection of tools, lamps and articles the museum is a reminder of daily life at the coal mine. In the direct vicinity of the colliery, lies the pilgrimage church built by Le Corbusier.

Aside from the complexes already mentioned, **coal mining museums** are also found at Alès, Cagnac and Firminy (with exhibition mines or technical monuments) as well as in Aubin, Decazeville and Villars.

When comparing the French coal mining complexes with the Zollverein colliery in Essen, the differences become immediately apparent. The French coal mining complexes, in comparison to the one in Essen, – and in particular the surface installations – are insignificant in size, date from a different period and were built according to different architectural criteria. However, the estates connected to the French mines are more extensive and larger in size and have, to some extent, ground plans which point to planned development. Just these differences in quality, presented here only in outline, show distinctly that the central French monument ensembles cannot be compared to those in the Ruhr area.

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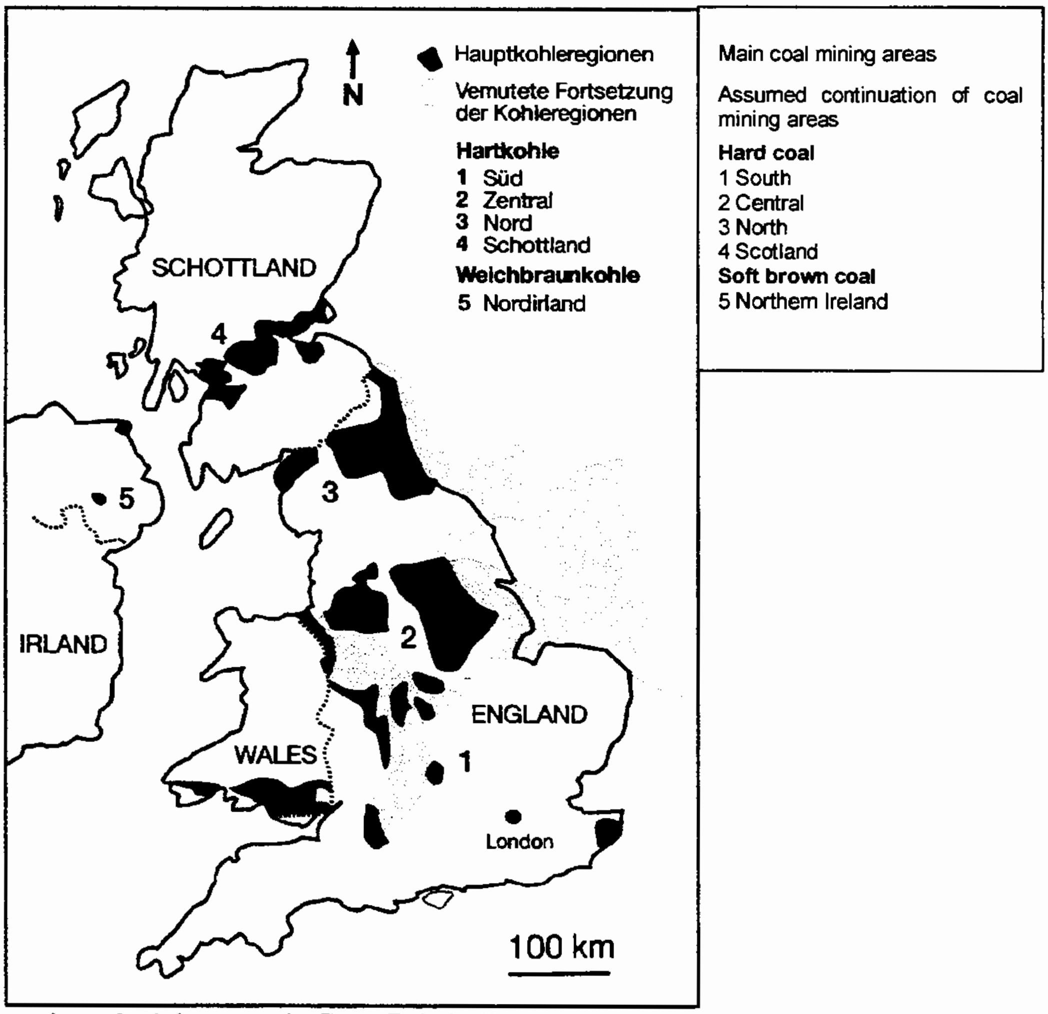
2.6.1.6 Great Britain

The viable and exploitable coal deposits in Great Britain amounting to 2 bn tons (0.8 bn tons SKE) are distributed across the entire country, from Scotland in the north to South Wales in the south and west, and over to Kent in the south east. Today the following mining regions and coalfields are distinguished:

1. Scotland (Fife, Lothian, Clackmannan, Central, North Ayrshire, Central Ayrshire, Douglas and Sanquhar coalfields)
2. North East (Scremerston, Northumberland, Durham and Midgeholme coalfields)
3. North West (Cumberland coalfield)
4. East Pennine
5. Lancashire, North Wales and the West Midlands (Burnley, South Lancashire, Goyt, North Staffordshire, Cheadle, Leicestershire and South Derbyshire, Warwickshire, South Staffordshire, Clee Hills, Coalbrookdale, Shrewsbury coalfields)
6. South Wales, Forest of Dean and Bristol (South Wales, Forest of Dean and Bristol and Somerset coalfields)

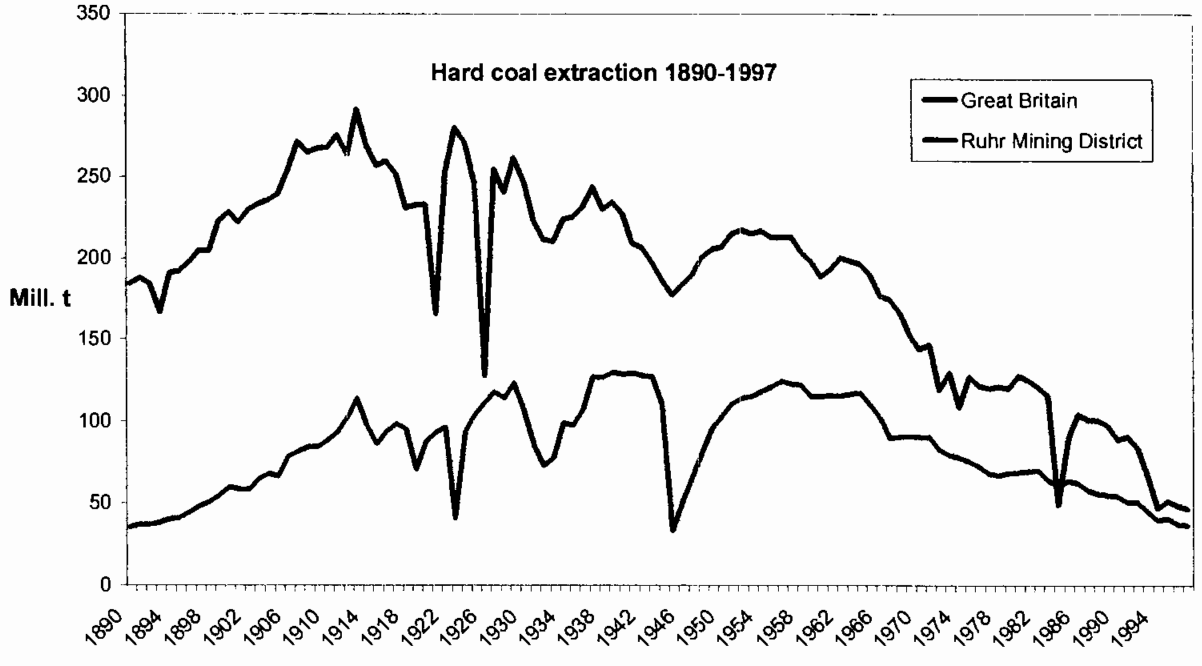


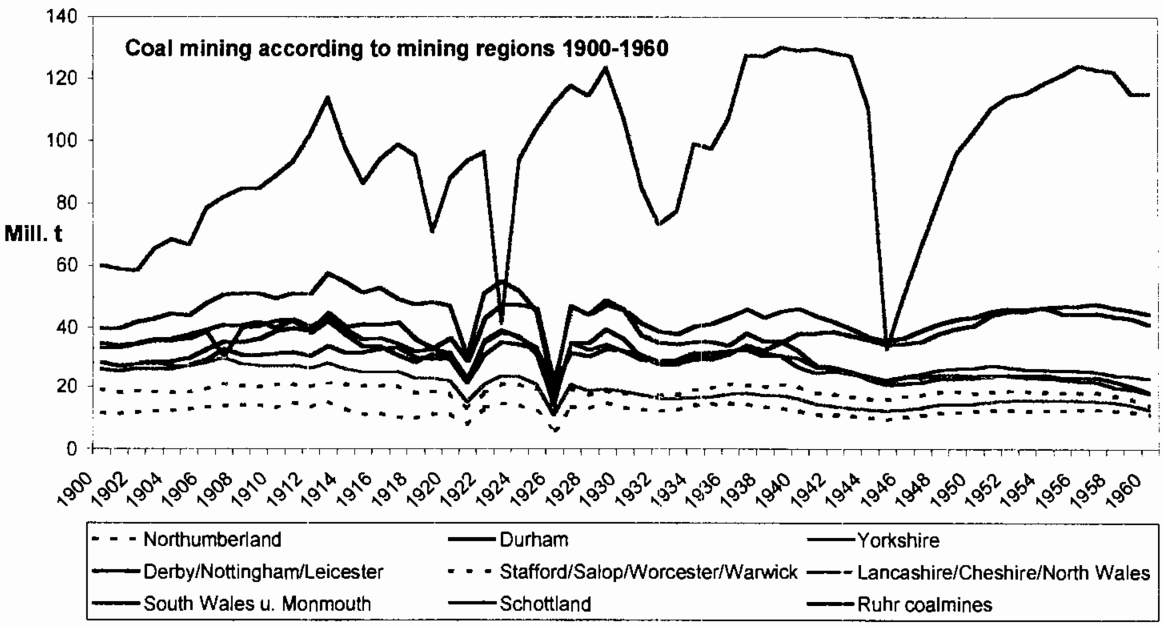
The main coal mining areas in Great Britain (from Kelter et al. 1999)

The development of coal mining in Great Britain

The development of British coal mining in virtually all areas reaches as far back as Roman times. It is generally assumed that even then coal was mined south of Hadrian's Wall on the Tyne to the east and at Solway Firth to the west, where the seams mostly rise to the surface.

Tradition has it that in the 12th century in **Scotland** the monks of Newbattle in Carriden on the Forth mined coal at the seam extremity in order to heat their churches. The right to do so was granted to them by the Earl of Winston in 1202, and this is the first historic record of British coal mining.





Mining companies managed to secure a limited market for coal during the 13th century, at least in the 13th and 14th centuries it seems as though coal was mined at several sites in Fifeshire, in the Lothians and in Linlithgow. This was mostly used for forging, cooking and heating purposes. In 1428 David Wemyss began to mine coal on his estate grounds in East and West Wemyss, directly on the coast, and to use the coal for evaporating seawater in order to produce salt. The large, modern mines of the Wemyss Coal Co. later developed from these beginnings.

From 1408, Count Orkney allowed coal to be mined near Dysart at the seam arising at the seacoast. Mining must have been quite simple: coal was extracted at the end of the seam from the seacoast or from riverbanks and the in-flowing water was redirected through channels or bailed out by hand. When the mines became too deep, they were abandoned. Sometimes several dams were also built of clay and set at short intervals, and the in-flowing water was lifted with buckets from one dam to the next.

In the 15th century, the revival of coal mining led to coal trade with the Netherlands, inasmuch as Dutch ships, bringing goods to Scotland, would return with coal as ballast. However, in the 15th century mining suffered severe setbacks. On both sides of the Forth flooding caused serious damage, leading Mary, Queen of Scots to prohibit the export of Scottish coal. A turning point followed in 1575, when the Culross mines were leased to Sir George Bruce who was the first to sink a shaft to the base of the seam and kept the mines dry by lifting out the water with a paternoster lift. In 1575, Bruce also sank a shaft from an artificial island in the Forth and linked it horizontally to the mainland shafts. This mine was regarded as "the miracle of Scotland" for a very long time. In the 17th century, several mines were extracting coal from over 2.5 km below sea level. The coal was mostly used in salt works, in 1630 in the Culross region this was about 45,000 tons of coal a year. In 1725 the first steam engine was used in Scottish mining for pumping water, at the Edmonstone mine in Midlothian and in 1841 the first horse-driven capstan was used. Up to this point in time, women and children were enlisted to mine the coal. They carried the pit coal in baskets and sacks by ladder to the surface. By the middle of the 18th century large quantities of Scottish coal were being shipped to London. Between 1745 and 1765, between 3,000 and 6,000 tons of coal arrived in the Capital.

Coal mining in **Lanarkshire** only developed in the 18th century, but then grew very quickly with the awakening of the industrial area on the Clyde as a result of the growing trade with the American colonies.

Tradition has it that on the **North East** coast the earliest mining took place near Newcastle-on-Tyne. The monks of Tynemouth were the first to dig for coal in northern England, although the monks of Newminster had previously acquired the right to gather the coal which had drifted ashore, so-called sea coal, near Blyth. The first recorded North-East coal to be shipped was in 1269, and in the 14th century monasteries bought mined coal. In 1325 a ship sailing from France loaded with grain was the first to return with coal as ballast. In the 15th century demand for coal as a household fuel increased, which further boosted coal mining. Trade with France grew and coal mining became more important when The Grand Lease, a mining area which was originally owned by the Counts of Leicester or, respectively, Queen Elizabeth, passed to merchants from Newcastle. At the beginning of the 17th century there were already 28 coal trading companies and 85 coal ships in Newcastle.

The history of government involvement in the British coal mining industry also begins in the early 14th century. In 1306 Parliament successfully requested Edward I to ban coal burning in London. The reason for this complaint would be called environmental pollution nowadays. The Government, however, soon found out that it could not stop this practice and so it imposed a tax on coal imports (1379). In the 1420s Henry V introduced further duties. The King received 2 pence on each caldron of coal (53 hundredweight) shipped out of Newcastle and around 1600 the taxes on Newcastle coal sent abroad were raised from 2 pence to 5 shillings, and to 1 shilling for coal being transported to British harbours. The latter went towards the support of the Duke of Richmond, Charles II's illegitimate son.

Around 1600 the largest proportion of Newcastle coal was sent up the Thames to London. As well as being taxed when it left Newcastle, from 1670, the coal was once again taxed when it landed in London, to help rebuild St. Paul's Cathedral and other churches destroyed in the Great Fire four years previously.

The duties imposed by the Crown on North East mining up to 1850, did not, however, prevent it from flourishing; but serious problems did occur with drainage and the frequent occurrence of firedamp. Nevertheless, in 1800 1.25 m tons of coal was shipped from the Tyne, and from the North East coast as a whole, 2.5 m tons, with an extra 10,000 tons of coke.

In **South Wales** coal mining began at the latest at the end of the Middle Ages or in the early Modern Era, but this coalfield has only become well-known for its coal export since the 1840s. During the 17th century, mining took place either on the surface or not far underground, and from 1611 to 1677 a series of mining rights are documented. Only towards the end of the 18th century was coal mining systematically introduced. The reason behind this was that coal began to be used for the first time for smelting iron ore. The establishment of numerous iron works followed and at the beginning of the 19th century coal was mined, in particular, in the regions of Merthyr and Dowlais. As very soon more coal was mined than the iron industry could use, the excess was shipped from Cardiff. To effect this, the Glamorgan Canal from Cardiff to Merthyr was built in 1798, which was later extended to Alberdare and in 1841 replaced by the Taff valley railway. The railway linked the Rhondda, Aberdare and Merthyr valleys directly with the coast. In the first year coal sales were about 40,000 tons, in 1842 almost double and in 1863 they reached almost 3 m tons of coal.

The first large-scale coal mining began in the county of North Glamorgan in the Merthyr and Aberdare valleys, and was followed by mining in North Monmouthshire. Here coal was also predominantly used to supply iron works. The four valleys of Rhymney, Sirhowy, Ebbwy and Blaina, in which mining flourished, are narrow and cut for several miles into the mountain range, coal and iron seams lay beside each other. Thus numerous iron and coal works developed and soon each valley contained the works of a single company which operated and owned the mines and foundries in mixed production. Cheaper iron imports, particularly from America, led, however, to the iron works being transferred to the coast and the works in the valley came to a standstill. The companies became purely mining companies.

Between 1835 and 1840, the value of Welsh coal as a smokeless boiler coal was recognised. When sailing ships were replaced by steamships, Welsh coal grew in importance. The superiority of the so-called Admiralty's Coal was recognised throughout the world by the 1870s at the latest. Not only was the British war fleet supplied almost exclusively with Welsh coal, but all the high-speed steamships made their record runs, before World War I, using smokeless Welsh coal, and it became possible to refuel in all overseas harbours with this sought-after quality coal.

In the **East Midlands**, particularly in Yorkshire, the Romans are supposed to have mined coal, and in 1306 coal digging was regulated by law. Active mining took place in the 16th century in the area of Leeds, Halifax and Sheffield, in the 17th century the danger of firedamp was noticed and in 1788 in the mine shafts belonging to the Counts of Norfolk wooden guide rails were used for the first time. In 1790 metal rails were used underground and in 1842 Benjamin Biran was granted a patent for the first ventilator and anemometer.

From the middle of the 18th century coal mining became larger scale when the wool and cotton industries experienced greater demand for coal in the aftermath of the invention of the steam engine, and the transformation from water to steam power and from manual to machine work was underway. In the 2nd half of the 19th century, mining was fostered by the iron and steel industries and mechanical engineering, while small industries consumed coke produced from the Silkstone seam.

In **Staffordshire** mining reaches back to the 17th century. It was mentioned in 1665 in connection with the ironstone industry and the iron works near Birmingham. But, as in Scotland and **Lancashire**, mining only pushed down to deeper depths in the middle of the 19th century. Lancashire was exporting cannel coal at an early stage to Ireland, and in the 18th century in Shropshire, railway tracks were already in use on a large scale both above and below ground.

Kent is the newest of all British coalfields. The discovery of coal in this area goes back to trial drillings which were undertaken in 1890 near Dover, in connection with the planned Channel tunnel. The assumption by geologists that the northern French coal deposits stretched into South East England were thus confirmed.

In 1850, in the context of free trade, coal taxes were lifted. Around this time an important phase began of government participation in the British mining industry. Attempts to improve mine safety and to provide a healthier work environment were embarked on, and an ever growing interest in improving pit safety had its beginnings, which was partly based on the need of the mining industry to deal with the demands of the industrial revolution. Additionally, it was recognised that a series of essential developments could not be realised until a series of technical problems, connected with safety measures, could be solved. A growing social consciousness was also created as a reaction to the pressures of the industrial revolution. In particular, Lord Ashley, the later Earl of Shaftesbury, was a supporter of better working conditions, especially for women and children.

In 1840 a Royal Commission was called into being, which reported two years later on child labour in mines. The report contained a remarkable number of interviews with women and children who worked an average of 12 to 14 hours a day, mostly pulling wagon-loads of mined coal with the help of belts or chains. Children at the age of five or six, or even younger, went underground. These attempts to improve the inhuman working conditions culminated in the Mines Act of 1842, which denoted the first government inroads into the affairs of the British mining industry. It prohibited women and children and boys under the age of ten being employed underground, and introduced the principle of inspections by the Ministry of the Interior. This created the first public officials concerned with British mining, and the Mines Department remained a part of the Ministry of the Interior up to World War I.

Since then the British Parliament has been continuously concerned with coal mining and particularly with issues of safety and working conditions. From 1850 to the ratification of the Mines Act of 1911, the number of inspectors increased steadily from 4 (1850) to 83 (1911). Mine safety improved considerably as a result of the inspection policy. Between 1851 and 1855, the average rate for fatal accidents in the mines was 4.30 per 1000 persons, between 1873 and 1882, this figure was almost halved to 2.24. 30 years later (1911/1912) this figure could be further reduced to 1.17.

After its fastest expansion phase in the late 19th century, when it dominated the world market, British coal began to lose important market shares as other producers appeared on the market. The main competitors at this time were the United States, Germany and the Russian Empire.

Between the late 1880s and 1913, Great Britain's share of world coal mining fell from 41% to 25%.

World War I brought a change of emphasis in government involvement in the mining industry. Interest in safety remained, and does so today, but since 1914 the Government became more and more involved with the economic future of the industry. This is why responsibility was transferred in 1917 from the Ministry of the Interior, first to the Trade Ministry with its own Secretary for Mines and, finally, in 1942 to its own department, the Ministry of Fuel and Power, the precursor to the later Department of Energy.

Overall extraction in 1913 was 287.4 tons per man and year compared to 99.6 in 1987/1988. From the 1913 extraction, more than a third, at 98.3 tons per man and year, was exported, compared to 2.2 tons per man and year in 1987/1988. At that time coal only accounted for about 10% of overall British exports. Collieries numbered almost 3000 (1913), compared to 94 (1987/1988), the number of employees was 1.1 m, compared to 104,000. Extraction per man and shift was about 1 ton compared to 3.62 tons in 1987/1988.

Here we have a picture of an industry which was very labour intensive, had low productivity and consisted of numerous small and very small collieries. But still mining was more than 2½ times as high as in 1987/1988, and it was possible to sell more than a third on the world market. Great Britain is the only large coal producer world wide whose extraction rate steadily declined between the 1870s and World War I.

As conditions for miners worsened, wide-spread strikes occurred in 1893, 1898 and 1912. In 1912 more than 1 m miners refused to work for more than a month, resulting in the Minimum Wage Act of 1912, in which the principle of a minimum wage was introduced.

In World War I, large numbers of employees were enlisted for military service. Mining per shift sank from 21.5 hundredweight (1913) to 17.23 hundredweight (1918) and 14.36 hundredweight (1920). At this time of labour shortage and falling productivity, there was an increased demand for coal. The Government had to resort to limiting the price of coal, thus controlling company profits, and at the same time pressure from miners for crucial wage increases grew. In 1915 this led to a miners' strike at coal mines in South Wales, and in March 1917, the then Army Minister, Lloyd George, intervened with the Government taking over the control of extraction and distribution at British coal mines under the so-called Coal Controller. Coal prices were regulated and mine profits frozen at the level pertaining in the three years before the war.

The Government continued to exercise its influence over mining even at the end of World War I, in the form of joint control with the companies. A Royal Commission under Sir John Sankey, comprising of six members from the Miners' Federation and six members from mine owners and industry representatives was founded. Nationalisation of the mines, which many had hoped would improve conditions, could not, however, be achieved. The mining problems thus remained unsolved.

As coal began to lose its dominance, with the rise of oil and changes in world markets, mine operators attempted once more to reduce wages. This led to the long, severe strike of 1926. Another Royal Commission under Sir Herbert Samuel attempted in the same year to close down uneconomic yields in the British mining industry. The Government under Baldwin supported this effort with its Mining Industry Act (1926), which sought to concentrate mining in efficient shafts through company mergers.

These efforts met with some success. At the end of 1929 there were merger plans which affected 233 pits employing 219,760 people, however, the plans only affected a very small part of the mining industry. In the following year there were still 931,000 employees in mining and 2091 (!) operating mines. Despite all the efforts of the Mining Reorganisation Commission, introduced in 1938 by the Coal Mines Act, only limited progress was achieved. In 1938 there were still 1860 mines with 791,000 miners and in 1939 extraction per man and shift at 1.14 tons was hardly higher than at the beginning of World War I.

In 1938 a further attempt was made through the Coal Law, which foresaw the lifting of coal licences by a Government Coal Commission, in order to push through mergers. World War II brought the Government once again in direct contact with the mining industry. Renewed nationalisation of the mines resulted.

At the end of World War II, in January 1947, the Government took over British mining. Mining was restructured and in 1985 the National Coal Board was founded. Up to 1994 mining remained in the hands of the Government, and through the Coal Industry Act of 1944 the Coal Authority was founded, which, since 1 January 1995 has been carrying out privatisation of British mining. Today a total of 19 underground mines and 32 surface mines are operating. They are combined in four large companies (Mining (Scotland) Ltd., Celtic Energy Ltd., RJB Mining and Coal Investments PLC), at the same time, four mines exist as individual companies (Betws Anthracite Ltd., Goitre Tower Anthracite Ltd., Monktonhall Mineworkers Ltd., and Hatfield Coal Co.).

Technical Monuments

The search for high quality, outstanding and significant monuments to coal mining, which, at the same time, are well preserved in their entirety, leads to disappointment in Great Britain. Although numerous individual monuments do exist, there are no colliery ensembles, so that we can state from the start that a monument and landscape ensemble comparable to that of Zollverein colliery does not exist in the United Kingdom. However, we should mention the impressive, large-scale miners' estates (e.g. the garden city at the Oakdale Colliery in South Wales) and also the mining landscapes, however, as mentioned above, their culmination in large, aesthetic collieries is missing.

As for the pits in **South Wales**, the inventory of the Royal Commission on the Ancient and Historical Monuments of Wales lists an imposing number of monuments and documents from the history of coal mining. The mines built on the Welsh deposits were, however, either small so-called drift mines, on which hardly any larger surface installations of architectural value existed, or so-called deep-shaft pits, which, on closure, lost about 90% of their significant features, such as pithead gears – mostly smaller iron constructions such as Tomson chocks etc. Most of the collieries did not have – as far as changing rooms, washing plants etc. are concerned – nationally important buildings, but rather used very simple constructions. One colliery which had a large engine house serving its two shafts, was the Penallta mine near Hengoed, closed down in 1992. This engine house ranks among the oldest preserved examples of its type in Great Britain, while the changing room, built in 1938, is counted among the outstanding achievements of the Miners' Welfare Committee.

Crumlin Navigation Colliery near Crumlin, built between 1907 and 1911 and closed down in 1967, numbers among the sites preserved almost in their entirety. The site consists of two winding machine houses, a pump house, various functional buildings arranged on two levels and a large smokestack, but it has lost its pithead gear and thus its "visible symbol".

The Six Bells colliery (near Abertillery) was also imposing by Welsh standards, but was totally razed after closure, as was Merthyr Vale (near Gelligaer). As most of the Welsh collieries lay in small, narrow valleys, larger pits could not usually be built. A particular exception was the Cynheidre colliery which possessed a remarkable hammer-head pithead frame. No Welsh colliery, however, could remotely rival the Zollverein colliery in Essen for the size, scale and architectural quality of its surface installations and also for the quantities mined.

Concerning quantities mined, there are large differences between the Welsh collieries and the Zollverein colliery. In the early 1930s, for instance, the Panallta colliery, built between 1906 and 1909, mined 860,000 tons of coal with over 3000 employees, and in 1979 only 222,000 tons with 690 employees. Merthyr Vale was sunk between 1869 and 1873 and in 1979, worked 240,000 tons of coal per year with 621 employees, while the Six Bells Colliery, operating since 1890, only 111,000 tons of coking coal per year with 638 miners.

Likewise, the **Shropshire** coalfield has never produced a colliery with either real economic significance for mining nor one with notable surface installations. Only the Granville Mine could be compared, with some justification, to the Zollverein colliery. After the nationalisation of coal mining and as part of the modernisation programme carried out from 1949/1950 onwards, the surface installations of the colliery, which had evolved over time, were replaced. With its uniform axially-symmetric architectural plans, it resembles, to some extent, the colliery in Essen, however, the size is not there, nor is the range of monuments.

The surface installations in the North East coastal region offer little worth mentioning. The changing room buildings at the Elemore Colliery at Hetton should be mentioned which were built in the wonderful 1930s brickwork architecture, under the British Miners' Welfare Fund, and which, thanks to the quality of their masonry, can certainly compete with the Essen colliery. But, just as at the Easington Coal Company site in Easington Colliery, built by F.G. Frizell in 1935, the majority of the colliery ensemble was razed, so that the architectural remains can only present a very imperfect picture of how this representative colliery looked.

If you want to properly judge the appearance of English mines around 1935, then you should fall back on the 1936 inspection report of the chief mining officer, Erich Winnacker, who summarised the surface installations of mines in the British isles as follows. "The surface installations of British coal mines are exceedingly simple and mostly in a condition which would amaze Germans. Only what is absolutely necessary is built, and that as cheaply as possible. This is most likely due to the fact that the usual life span for British pits is assessed at only 50 years. The surface installations are therefore only sufficiently maintained to last this period. Because of this fundamental refusal to spend money on anything not absolutely necessary, everything above ground which is not income earning is avoided. The surface installations thus have a considerable age and resemble pictures from old mining records.

The pits originally consisted only of the shaft shell, the winding engine building with winding engine, and the accompanying steam boilers. As mechanisation increased, power houses were built to produce compressed air or generate electricity, and as the demand for the quality of the various types of coal increased, processing plants were built as well. The latter became increasingly the rule in British coal mining and provided a reason for new construction. But often, as applies here as well, building was limited to a larger roundabout and a new processing plant at surface installations which looked totally antiquated, particularly to foreigners. The coal dust furnaces found on some sites are, however, up-to-date.

Recently, welfare funds have built bath houses, canteens etc. beyond the actual operating plant.

Because shafts were sunk successively one after the other, all signs of planning are missing in the surface installations; the sites were developed to suit each case separately. Where there was a sloping site, or one on a main road in the narrow mountain valleys in South Wales, the layout of shaft and loading area was inherent.

Winding engines and power plants often have separate boiler houses.

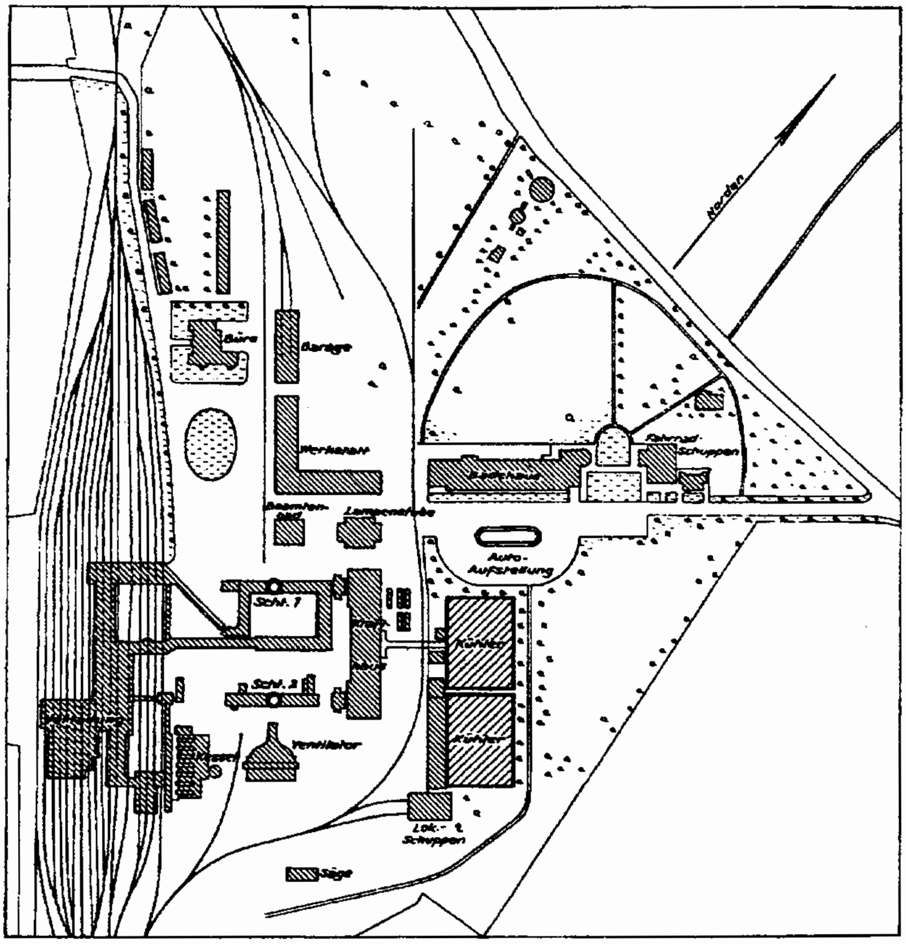
The recent double shaft pits with deep shafts were, of course, given a different layout. First of all, because they had a longer expected life span thanks to larger coalfields, and then because they have to manage greater yields, mostly mechanically." Winnacker pointed to surface operations in the East Midlands and in Warwickshire as being successful, up-to-date surface installations, whereby he particularly points out that "the new surface installations were built extremely spaciously and with gardens according to the Westphalian model." such as the surface installations at Houghton main mine, the Yorkshire main mine and the Coventry mine. Continuing his description of the surface installations, Winnacker says, "The processing plants are built as near the pithead as possible where there is place. Often, however, separating plant and washing plant are directly above the mine railway station, hundreds of yards away from the shaft and from the sorting belts, in order to avoid unnecessary abrasion during loading. The raw coal is then either brought by railway wagons, in trolleys, on chain conveyors or on conveyor belts to the processing plants and the processed goods are loaded directly into main railway wagons. The distance between shaft and processing often acts as a buffer during breakdowns.

The workshops are mostly exceedingly small, despite the degree of mechanisation, as repair and maintenance of the machines is left up to their suppliers. Only a few companies, with mines lying almost next to each other, have created central workshops, such as the Fife Coal Co., Ashington, Hartly Main and Powell Duffryn coal companies, and Staveley mine.

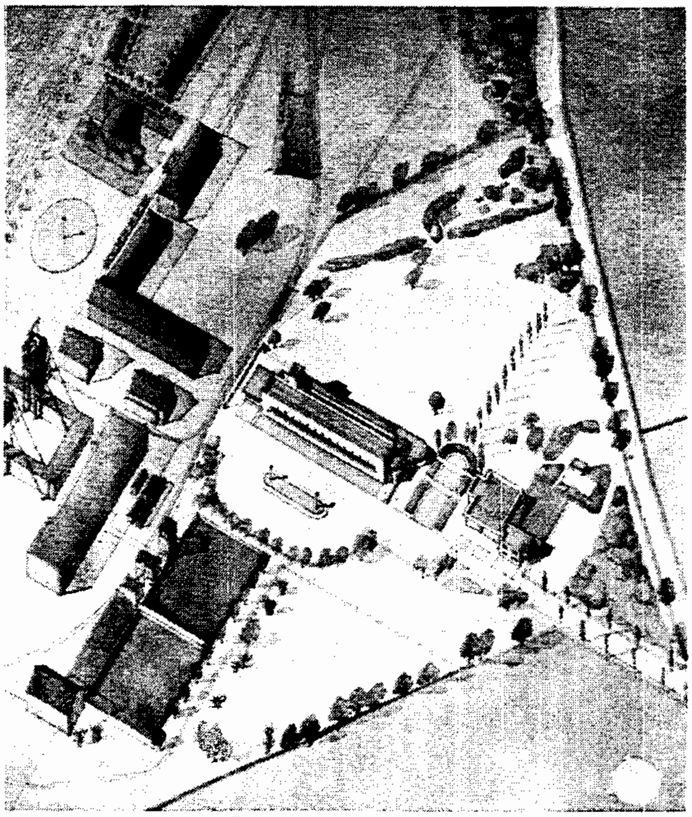
The loading stations and the mine railway stations are large in comparison to the other surface installations. The number of tracks used when loading is often large, because very often different types of coal are being loaded. Usually the railway stations are used for stockpiling coal types which are not selling well at the time. You see hundreds of yards of tracks with loaded railway wagons waiting to be dispatched.

The coking plants are always separate from the mine surface installations and are often equipped with their own coal processing. If the coking plants supply furnaces, then they are located at the furnace works...

The operating plants are generally not fenced off from their surroundings, gatekeepers and entry control badges are not used. The latter are used only for underground workers near the shaft. Only at the Fife Coal Co. pits was the situation different, where the mines were fenced off and entrances began to be guarded after a visit to the German coal mining regions, even though there was no particular requirement. It is very usual to enter the railway complexes and surface operations or use them as a through road. Nevertheless theft does not occur."



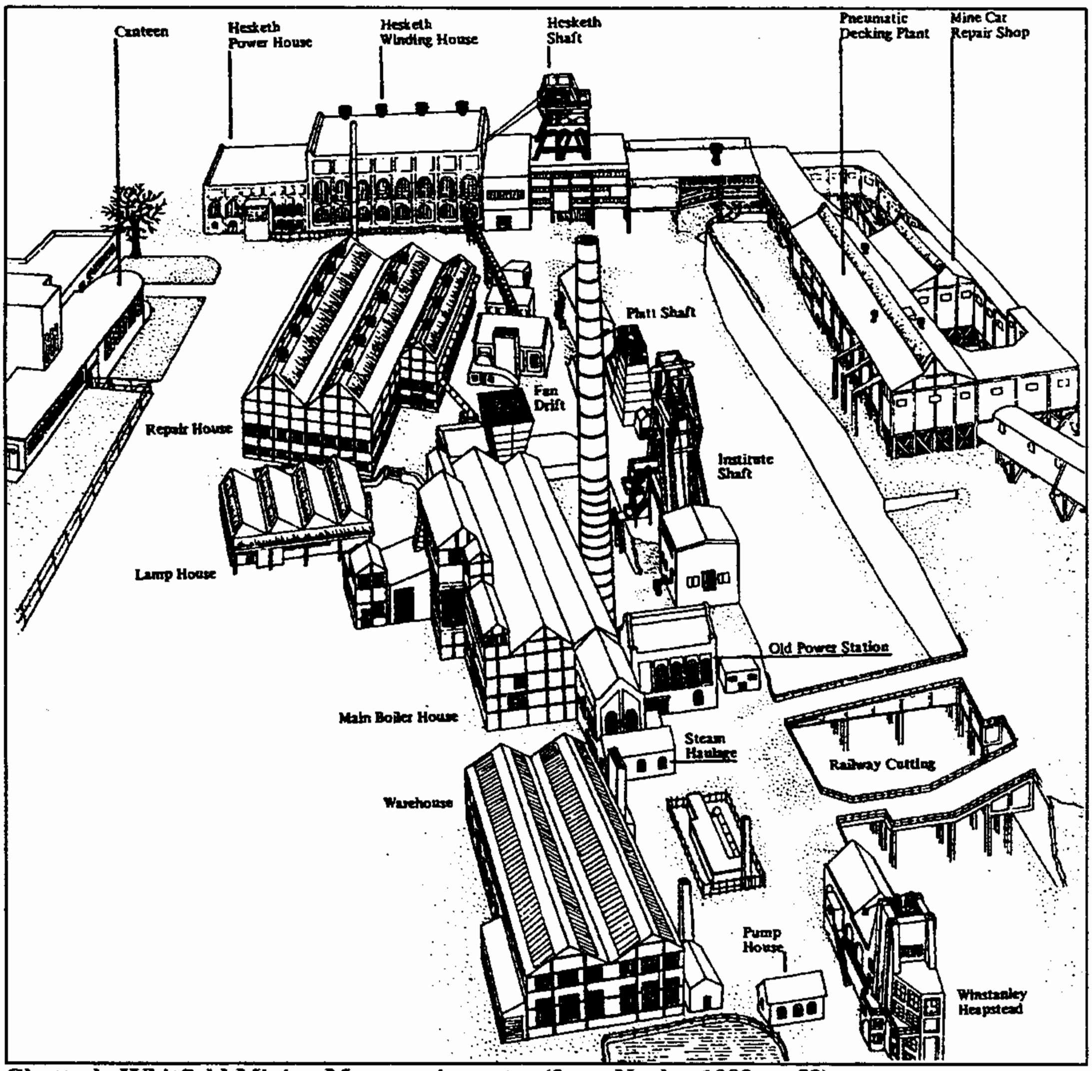
Layout of the surface installations at Coventry mine (from Winnacker 1936, picture 649, p. 753)



View of the surface installations at the Coventry mine (from Winnacker 1936, picture 648, p. 752

On the basis of this authentic, contemporary description of how surface installations at British coal mines looked, the conclusion can be drawn that also on the British Isles no coal mine surface installations can be found to rival the monument ensemble provided by the surface installations in Essen. This impression is shared by all mining experts questioned, who, without exception, characterised British coal mines as being created functionally and without much effort, expense or architectural decoration. This general impression is not contradicted by any of the sites which stand out from this picture, (e.g. the Coventry mine). The latter has its surface installations laid out according to a multi-axial architectural system, which is symmetric in parts. However, an axis on the road leading to the headgear is missing, for instance, as well as the rigorous unification of the surface installations into an ensemble. The English site requires "a lot of place" for its buildings, which "float" unusually freely in the surroundings.

An overview of the British coal mining monuments, should not close without a look at the **mining museums**, of international repute and high standard.



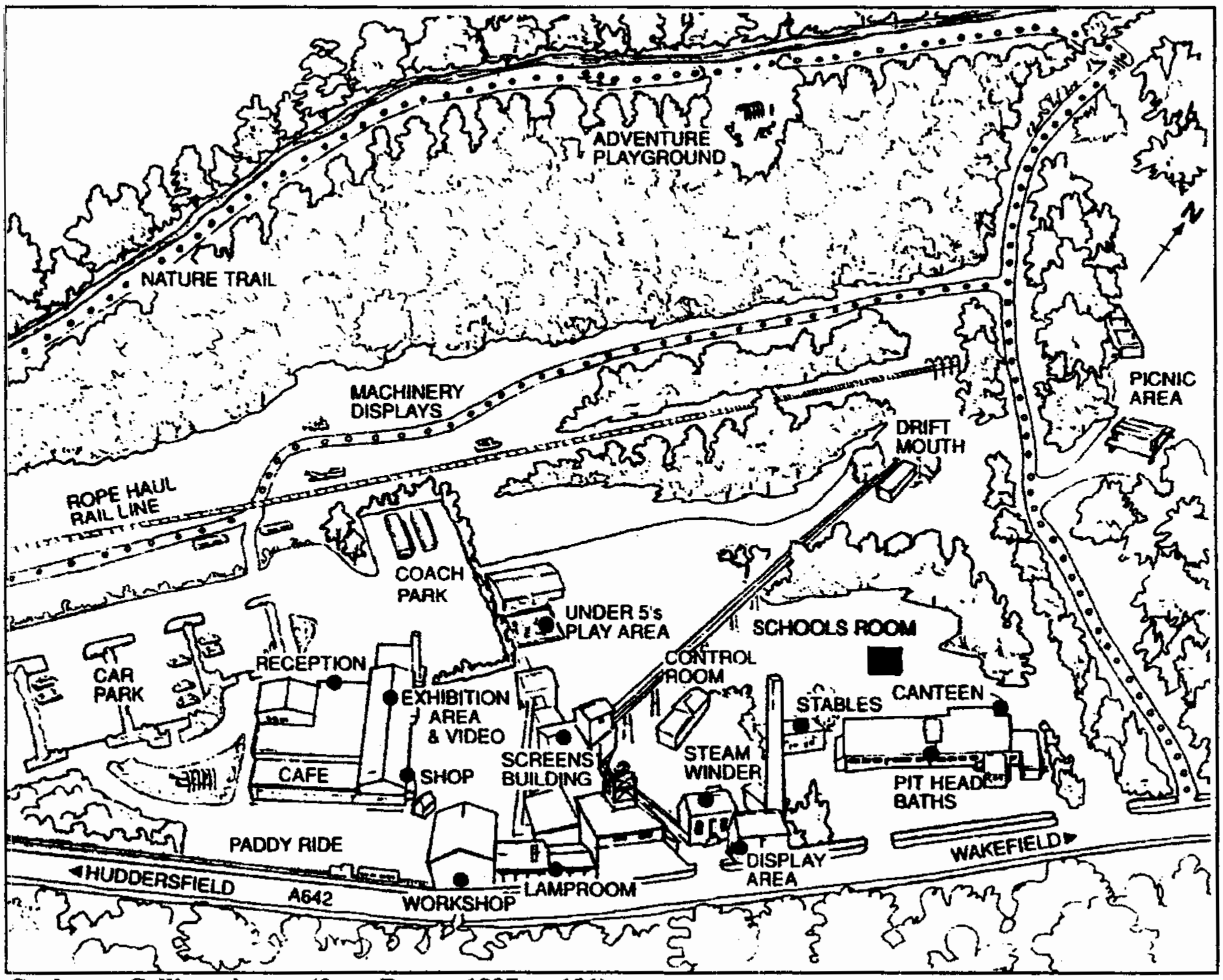
Chatterly Whitfield Mining Museum, isometry (from Naylor 1982, p. 53)

The best and perhaps also the biggest English museum is the **Chatterly Whitfield Mining Museum** at Stoke-on-Trent in Staffordshire, which, in addition to substantial remains of original surface installations, includes five shafts (Winstanley, Platt, Bellringer, Middle and Hesketh shafts), and a remarkable steam engine, built in 1914 (the so-called Hesketh winder complex). The surface installations consist of buildings which were built at different periods, and a "planning hand" is not to be found. To this extent, Chatterly Whitfield cannot rival the mine at Essen and its surroundings.

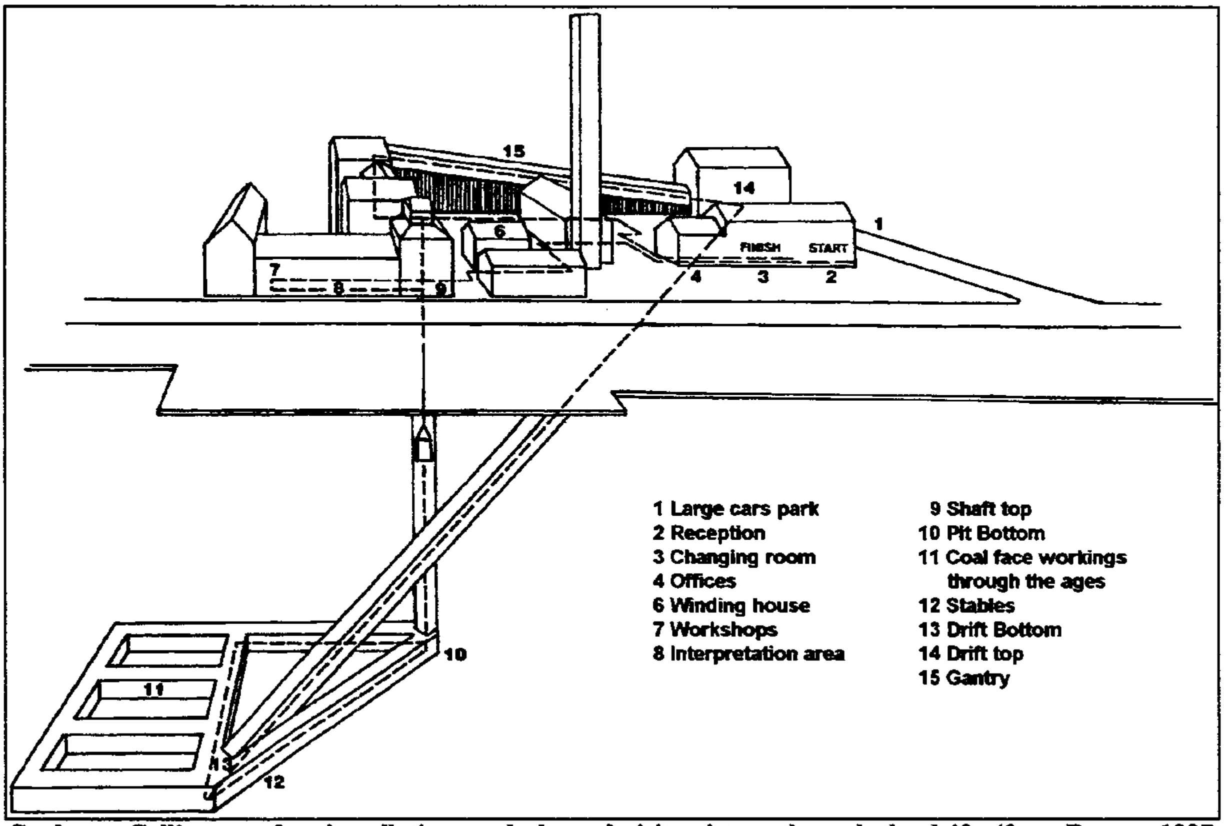
The beginnings of the coal mine reach back to the 18th century and in 1750 monks from the neighbouring Hulton Abbey are supposed to have mined coal. In 1872, Chatterly Coal and Iron Company acquired the mine and gave it its current name. Around 1900, the colliery was one of the most heavily producing mines in England, extracting about 1 m tons per year.

The particularly long underground tunnels are currently not passable, although the descent to 213 m is supposed to be introduced once more. At the moment, the exhibition mine is closed.

The Yorkshire Mining Museum set up in the **Caphouse Colliery** in Wakefield reaches back to at least 1791. The mine was closed down in the early 1880s and, after much conflict and effort, was designated to become an English coal mining museum. The surface installations were integrated into the museum concept as were some of the underground drifts. The former wooden headgear had to be replaced by a steel one of similar construction, however, the winding engine house still houses the original steam engine. The intended descent to a depth of 150 m is not as yet possible.



Caphouse Colliery, layout (from Brown 1997, p. 131)



Caphouse Colliery, surface installations and planned visitors' tour through the drifts (from Brown, 1997, p. 128)

The Caphouse Colliery ensemble cannot rival the Zollverein colliery's monument landscape, when it comes to size and the quality of the architecture.

The **Big Pit Mining Museum** at Blaenavon should be mentioned as the best site in **Wales.** The surface installations were preserved after closure, and converted into a museum and an interpretation centre. Big Pit is a typical example of a deep shaft mine. Descent into the underground drifts is offered by former miners and is a real experience. It has been suggested that Big Pit together with its monument landscape be placed on the world cultural heritage list as a technical monument, however, regarding size and significance of the surface installations, it is clearly of a different quality to the Zollverein colliery.

Other Welsh mining museums include Cefn Coed Musuem at the former Blaenant Colliery in Crynant, the Lewis Merthyr Colliery in Rhondda Heritage Park and Merthyr Tydfil (both in Mid Glamorgan). The latter museum documents extraction and working conditions at a surface coal mine.

In Scotland, the Scottish Mining Museum should be mentioned. The comprehensive surface installations (including the winding engine) at the former Lady Victoria Colliery in Newton Grange / Midlothian have been largely preserved, however, the stringing together and staggering of long one-storey buildings gives the impression of an "inorganically grown" ensemble, from which the headgear peers out. The office in Preston Grange documents original Harvey pumping equipment based on the design of upright "Cornish engines".

To summarise, it should be noted that England, as the "motherland of coal mining", does not possess mining installations which either resemble or are comparable to the monument ensemble in Essen.

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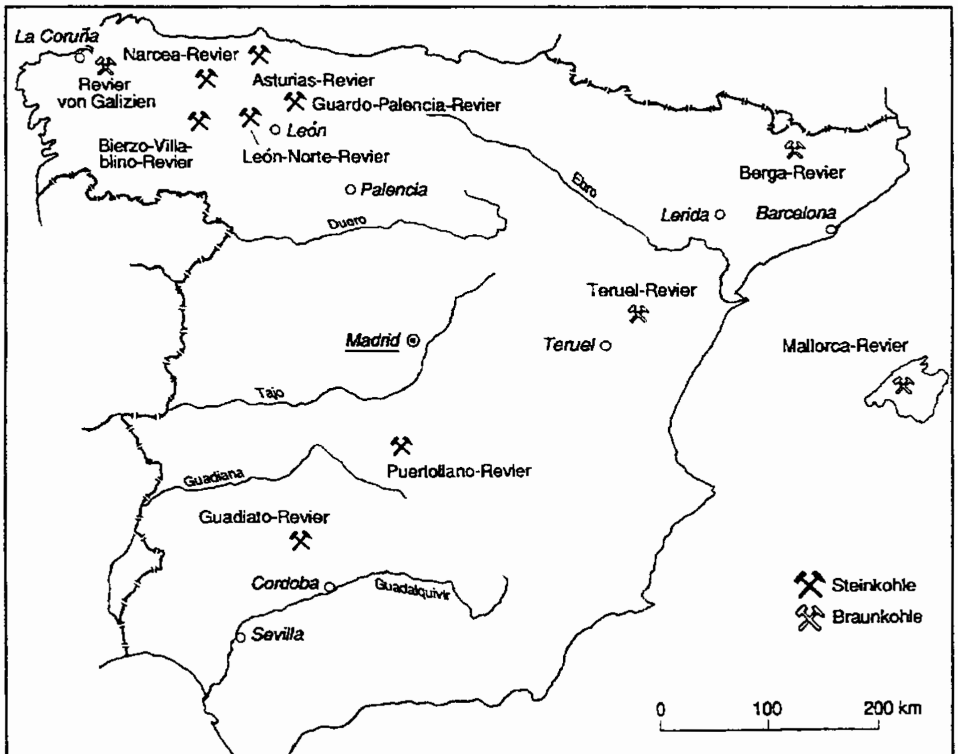
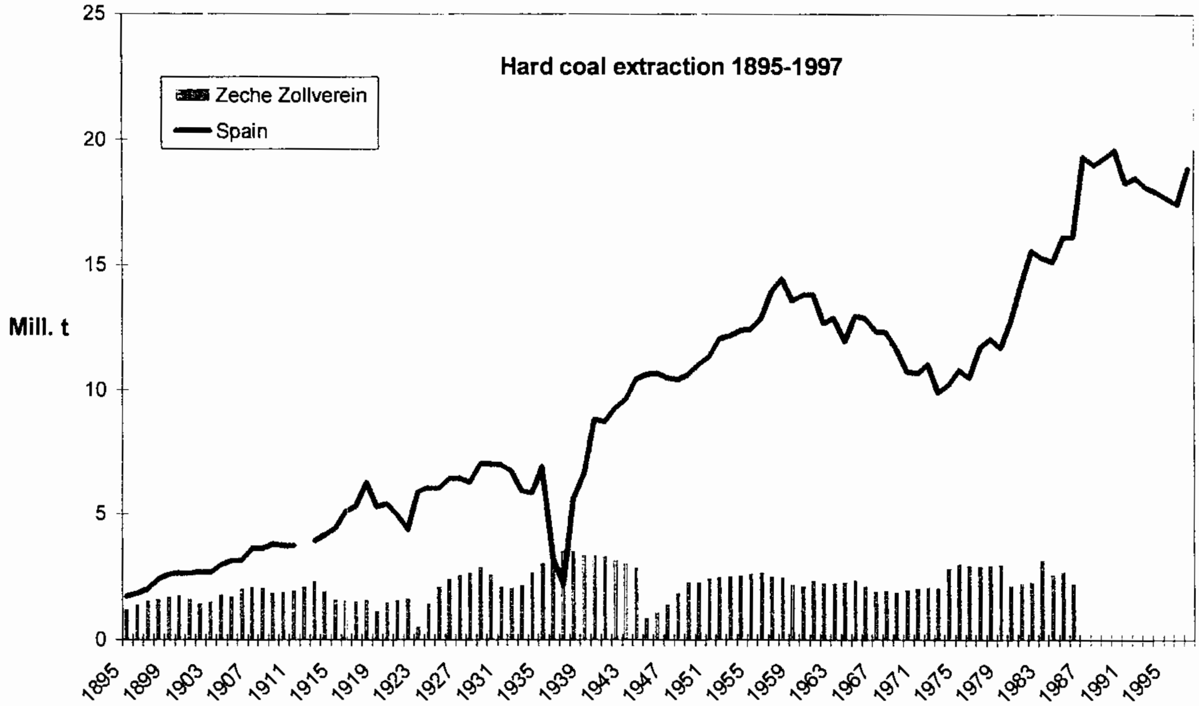
2.6.1.7 Spain

With exploitable coal reserves of 480 million t SKE (1997), which consist mainly of hard coals, Spain has few coal reserves by world standards. However, with an annual production of approx. 19 million t of hard coals (1997), Spain is one of the largest coal producers in the EU.



The Spanish coalfields (from the Jahrbuch Bergbau, Erdöl und Erdgas, Petrochemie, Elektrizität, Umweltschutz 1999, p. 234)

Spain's hard coal production in divided between two areas: the main deposits, which have so far provided the major share of Spanish hard coal production, are found close to the coast in the North in Asturia and in the Cantabrian Mountains in northern Leon (the Narcea, Asturias, Guardo-Palencia, Bierzo-Villablino and Leon-Norte coalfields). The smaller deposits of Peurtollano, together with Córdoba and Belmez (the so-called Gaudiato coalfield) are found in the southern part of the Iberian Peninsula north of Seville, in the eastern part of the Sierra Morena.



At the beginning of the 1880's, Spanish hard coal production reached an annual total of 1 million t, rising by 1897 to over 2 million t (comparison: in 1895, the Coal-mining Customs Union was already producing 1,188 million t of hard coal!). Apart from drastic drops in production in the 1930's, Spanish hard coal production increased more or less steadily to 14.4 million t by 1958. The crises in the development of Spanish hard coal-mining resulted in a decrease in production to around 10 million t annually by 1973. In the 1980's, production exceeded the previous highest level of 1958, and was further increased to over 19 million t by 1990. In the following years, annual production up to 1997 amounted to around 17 – 19 million t, figures which cannot conceal the unprofitability of Spanish hard coal-mining, since the production costs in Spain are on average four times that of the world market price. The Spanish Government and the Unions agreed on a reorganisation of the coal-mining industry. In order to make the inevitable production cuts as socially acceptable as possible, a "Coal Plan" was negotiated for the period 1998 to 2005, which provided for a cutback in production to 13 million t and the shedding of 7,000 jobs out of the total of 25,000.

These developments can be confirmed by the Asturia coalfield – which is representative of all the other Spanish coalfields. The mining here is carried out by the nationalised company Empresa Nacional Hulleras del Norte S.A. (HUNOSA) based in Oviedo, Spain's largest coal producer. Hit by the critical developments in European hard coal-mining, HUNOSA is also currently reducing production, closing down inefficient pits, and thus following a medium-term plan which is designed above all to reduce production costs. In addition, groups of mines are to be formed, which will work on those parts of the deposits which are most easy to mine. These measures will be accompanied by a continued reduction of the work force of around 17,000 employees in 1992 (1992) and a diversification programme.

The development of hard coal-mining in Asturia

The coal-bearing mountains of Asturia cover an area of 520 km^2 extending along the northern slopes of the Cantabrian Mountains, with the northern parts of the deposits being covered by more recent sediments. The first mine to be built in this area, which also extends out beneath the sea, was the La Camocha pit. The arrangement of the deposits is very complicated, no general direction of the seams can be defined, fold features of the hills and numerous tectonic disturbances, mainly many small ones, all present considerable difficulties to mining. The incidence of the seams is usually semi-steep to steep. The productive strata down to a depth of 1,200 m contain over seventy seams with a total thickness of 34 m, while the average thickness of the minable, often heavily folded and disturbed seams themselves is 60 to 70 cm. The largest seams have a thickness of 170 cm, while the lower limit is a thickness of 40 cm.

The main basin is comprised of several partial basins with troughs and saddles; the arrangement of the deposits is complicated. Rarely are undisturbed seams longer than 200 m found, and the possibilities of mechanisation are limited due to the difficult geological conditions. Nevertheless it must be mentioned that it is exactly such difficult deposits which have made HUNOSA a market-leader in the mechanised mining of thin and steep seams: roller-cutting machines, self-stepping hydraulic cutters and full-face cutting machines are all in use, and the know-how available from Asturia is being used in the Donbas basin, amongst other places, where similar deposit arrangements predominate.

Due to the mountainous terrain of the country, mining was first carried out above the valley floor - as in all other European hard coalfields. The "discoverer" of hard coal in Asturia is held to be Carreno Peon, who - according to a report from the year 1787 - first made a closer examination of a seam that had been burning for around 50 years while out hunting. In 1767 it was ordained by the state that the use of the hard coal would be reserved exclusively for the weapons factory of El Ferrol, and not for the farmers, who therefore had already searched out other deposits for their own use.

On the 28th Match 1789, the Asturian Navy Minister Antonio Valdes commissioned one Jovellanos from Gijon with the compilation of a study on the deposits of hard coal: following the completion of this work on 9th April 1789, the Government passed several laws in the years 1789, 1790 and 1792 in which, amongst other things, the state's preserve over hard coal was lifted and the establishment of a school of mining was planned. Lack of demand, difficult business conditions and the fact that the domestic smelting industry continued to stick to its use of charcoal, hindered any increase in the exploitation of the coal both then and during the years of the Napoleonic Wars. By the end of the 18th Century, around 100,000 dz were being mined.

The shortage of domestic reserves of charcoal due to the clearance of existing areas of forest lead in 1838 to the establishment of the Direccion General de Minas, of which Guillermo Schultz was a member as the Inspector of Asturian and Galician Mines. He produced the "Geological and Topographical Atlas of Asturia" and the "Geological Description of the

Province of Oviedo". Incipient liberalism and the wars of King Carlos, which brought with them the consistent use of hard coal by the Navy, also benefited the mining industry, among other things: in 1833 the "Real Compania Asturiana de Minas" was founded with the capital of Belgian businessmen and Spanish emigrants, and began to mine the deposits in the area of Aviles (near Arnaao). From 1840, mining underwent a boom: new companies such as the "Asturiana Mining Co.", the "Hulleras de Sta.-Ana", the "Sociedad Anglo Asturiana", the "Compania Asturiana de Carbones y Hierros" and the "Compagnie miniere des Asturies" were founded with Belgian, English and French capital, and the involvement of foreign countries in the Asturian coal industry is amply demonstrated by the names of well-known personalities such as Eduardo Stopford, Guillermo Partington, Juan Langford, Eugenio Rousseaux, Carlos Green and Carlos Baily. But this upturn proved to be very short-lived: the poor transport connections - especially from Sama to Gijon - and the ineffective expansion of the harbour at Gijon prevented any long-term progressive development in mining. The urgently needed coal route was completed in 1842, at the same time as the railway line from Nalon to Gijon, which thus rendered it almost superfluous, while the coalfield at Caudal was not connected to a harbour, despite all the efforts of the Asturia Mining Co. to transport its coal production to the coast by means of a rail line. Only the iron-smelting industry, which fired up its first blast furnace in 1848, could have provided the mines with a market for increased coal production, but unfavourable business conditions also hindered this opportunity, since Andalucian iron still dominated the market in Spain, and Asturian iron could not establish itself on the burgeoning European market against English and Belgian products. The Asturia Mining Co. therefore had to shut down their blast furnaces in 1849, while the Compania Lenense Asturiana continued in production only under severe financial difficulties.

Business conditions did not improve until the second half of the century. Since 1856 a road had been planned, which was completed in the 1880's, and connected the mountains and the plateau to the coast. The railway line at Langreo was completed in 1854, and the line from Oviedo to Gijon in the year 1872. The harbour at Gijon continued to be extended at various stages, although the construction of the seaport at El Musel was not begun until the end of the 19th Century. With these improvements in the infrastructure, the demand for the products of the iron and steel industry started to climb: the "Sociedad Duro & Co." was founded in 1859, and the "Fabrica de Mieres" (from the liquidated "Sociedad Hullera y Metallurgica de Asturias") and the "Sociedad Minas y Fabricas de Moreda y Gijon" in 1879. A network of protectionist measures such as tax concessions, bonuses, high customs duties and subsidies safeguarded the Asturian products, above all against English imports. While the Asturian mines and pits had produced 252,000 t in the year 1861, production rose to almost 470,000 t in 1886.

Heavy protection of the coal industry by the state also continued in the last quarter of the 19th Century. The mines at Aller started up production from 1883, and in 1894 the railway line Ciano - Sta. Ana - Soto del Rey to the main Leon-Gijon line was brought into operation, although it was the devaluation of the Peseta from 1896 onwards which above all provided a strong bulwark against the import of foreign products. By these means, a production figure of around 1 million t of hard coal was achieved in 1895. After the "Sociedad Metalurgica Duro-Felguera", founded in 1900, and the "Sociedad General Espanola de Carbones", founded in 1902, took up production in the Sta. Ana and Quiros coalfields respectively, overall production reached 1.5 million t of hard coal in 1904, and 2 million t in 1907. This increase in production had been significantly influenced by taxation and political measures: besides the already-mentioned economic protection by the state, the losses of Cuba and the Philippines meant that Spanish shipping companies became interested in coal which was not competitive on the

international market. In 1909 the Liga Maritima introduced a special rate for the transport of coal: when the seaports of El Musel, San Juan de Nieva and San Esteban de Pravia were all completed at about the same time, the consumption of domestic coal in Spain began to rise immediately.
The second half of the 19th Century was also the great era of consolidation and the foundation of the large mining companies. Between 1863 and 1888/1889, the most important company in the coal industry was the "Union Hullera y Metalurgica", which traded under the name of the "Fabrica de Mieres" from 1879. The Count of Comillas founded the "Hullera Espanola" in the Aller coalfield in the year 1892; in 1883, under the principal influence of the engineer Luis Adaro, the consolidation of several pits, mines and smelting works was carried out to form the "Union Hullera y Metalurgica de Asturias". In 1906, this company merged with the "Sociedad Metalurgica Duro-Felguera", for a long time the main producer of Asturian hard coal. Capital from Bilbao was used to found the "Compania de Carbones Asturianos" and the "Sociedad Hullera de Turon", which in its turn founded the "Sociedad General de Ferrocariles Vasco-Asturanall", which built a narrow-gauge railway line between the coalfields of Turon, Aller and Caudal and the harbour of San Esteban de Pravia. In 1919, a large part of the shares in the "Sociedad Hullera de Turon" were acquired by the "Altos Hornos de Vizcaya".

The First World War brought a brief boom to Asturia coal-mining: since imports of coal were discontinued, domestic production increased significantly, many small pits were expanded and new mines were brought into operation. The number of pits rose from 129 before the outbreak of the war to 314 at the end of 1918. When English coal came back onto the Spanish market after the end of the First World War, many companies collapsed, especially those which were weak in capital. On the 21st February 1921, the representative of all the Spanish coalfields submitted a petition to the Government asking for subsidies, bonuses, special tariffs, import duties and a drop in wages for the work force: in the following period, wages were first cut, and under the dictatorship of Primo de Riviera the bonus system was lifted and the Navy allowed to meet its demand for coal from free stocks.

Under the impetus of efforts to become independent of coal imports from abroad by increasing domestic production, the 1920's saw numerous acts of legislation by the state to support and revitalise the Spanish coal industry. The "Consejo Nacional del Combustible" (National Fuel Commission) was founded as the combined organ of the representatives of the state, the coal and fuel producers and the main consumer industries. This body was intended to co-ordinate Spanish policy in the area of coal and other fuels; one measure was the implementation of the "Estatuto Hullero" (The Coal Bill) for the direct and indirect support of coal companies, amongst other means by increasing work shifts from 7 to 8 hours.

Nevertheless the level f success was not great, for in the 1930's too, around 1 million t still had to be imported annually. In the Autumn of 1934, the difficult situation in the industry, the economy and the accompanying unsatisfactory social conditions lead to a miner's strike of unheard-of proportions. In order to reduce the stocks at the pit-head – at the Asturian mines alone these amounted to over 360,000 t at the end of 1935, rising to 440,000 t by the end of May 1936 – a sales syndicate with monopoly rights was created: these laws however had no time to have any effect on the situation, since the Civil War had broken out in the meantime, which attracted a great deal of sympathy in Asturia: the pits and mines of Asturia were taken over by the workers and placed under the control of the "Consejo Tecnico Obrero Administrativo de Minas Reunidas" (Worker's Technical Administrative Council of the United Mines).

By the end of the Civil War in 1939, Spain's economic foundations had been destroyed: 1,2 million people had lost their lives, industry together with the mines had suffered severe damage and a great part of the work force had been lost. The Spanish Government therefore decided, as part of rigidly enforced efforts at self-sufficiency, to stimulate the production of goods with state funds, and in 1941 founded the "Instituto Nacional de Industria" (INI) together with a string of subsidiary companies, among them the "Empresa Nacional Calvo Sotelo dc Combustibles Liquidos y Lubricantes", and for other branches of the mining industry the research company "Empresa Nacional Adaro de Investigaciones Mineras". The increase in production from the mines which now began to set in was achieved by means of special inducements for miners (including bonuses for beating production targets, exemption from military service and construction of housing, although this was accompanied by a certain militarisation of the work force) and by heavy subsidisation of the companies themselves. These reconstruction and expansion plans of the Government for the coal industry were either impeded or completely destroyed by the Second World War. While other, neutral countries enjoyed an economic upturn due to increased exports, Spanish industry was able to draw no benefit from the political situation. The credit required for reconstruction was not forthcoming, and the economic situation deteriorated even further in 1946 when aid under the Marshall Plan was withdrawn and the UNO refused to provide any form of financial support because of the internal political situation in Spain. The Spanish state continued to try to support the mining industry by means of heavy intervention. This lead to an amendment in the legislation governing the industry. In order to mine minerals of great economic importance, e.g. coal, iron, metal ores and salts, it had always been necessary to obtain a state concession, although no confirmation of the existence of deposits or their viability had been required up to 1944 for the granting of the concession, which naturally offered adequate opportunities for speculation. The field had to have a minimum area of four sections of 10,000 m^2, and would also be taxed on the basis of each t of gross production.

Previously it had been the practice that the owner of the field would not himself start a mining company, but would lease the field to tenants. The tenant in turn then often sub-let his holding to several to several sub-tenants, thereby achieving a high return: in some cases even individual seams and strata were sub-let! This situation, in conjunction with the high taxes, meant that only the richest deposits could be worked, and thus lead to over-exploitation. While working at the upper levels entailed relatively low costs, and could therefore be successfully worked by small companies, deeper pits could only be viable if larger production volumes could be achieved, which in turn necessitated larger coalfields. Due to economic difficulties, many owners of smaller pits could now no longer maintain their ownership, and had to give them up: the financially stronger companies thereupon either bought up the concession or took up a new lease on the vacant fields. This lead to extensive consolidation in the 1940's and 1950's, especially in favour of the larger companies.

The Spanish Government attempted to remedy the above situation by means of the Mining Bill of 19th July 1944, together with the export regulations of 9th August 1946. For minerals such as coal, ores and salts, firm evidence was now required of the existence of the deposits and their economic viability. The minimum size of the field was also set at 1 million m^2 for hard coal, and the compulsion to exploit such a field was introduced. In order to avoid the danger of excessive foreign ownership, concessions were only granted to Spaniards and Spanish companies who had made their base in Spain. The decisive stipulation was that the foreign share in the capital of the company could only amount to a maximum of 25%, with exceptions having to be approved by the Minister for Trade: all the senior employees of the company had to be of Spanish nationality. The supervisory powers over the pits by the mining authorities were strengthened and the compilation of business plans was made a requirement: the state introduced a form of management principle into the mining industry.

In order to ensure a rapid increase in the production of hard coal, the state decided on supportive measures. These consisted of the preferential supply of the required materials, even if they came from abroad, and of the transfer of the necessary labour, to whom it was attempted to offer special incentives to work in the mining industry in the form of special allocations of food and exemption from military service. In fact the Spanish Junta did achieve an increase in production, although in order to cover its requirements for fuel, Spain still had to import around 1 to 2 million t of coal – mainly from England. This amount dropped in 1951 to 580,000 t due to the lack of foreign exchange: the aim was still the complete independence of Spain from hard coal imports. Production was to be increased annually by 350,000 t through mechanisation, by 240,000 t through improvements in productivity, and by a further 1.45 million t by the exploitation of new reserves, i.e. by a total of 2.4 million t per year, in order to be able to cover the increasing domestic demand.

At the beginning of the 1950's Asturia was producing from 6 to 7 million t of hard coal per year: this was about two-thirds of Spain's total requirement for hard coal. The production was shared by 32 companies, amongst which however only three pit systems produced an annual figure of over 300,000 t. The irregular and widely varying storage conditions entailed high wastage through washing and a high proportion of low-value fine coal. The underground productivity level in the year 1950 was a little over 0.6 t per man per shift. Of around 42,000 staff and employees in the Asturian mining industry, just on 30,000 worked below ground, with the remaining 12,000 being surface workers. Silicosis was much feared by the underground workers, and lead to an increase in the proportion of surface workers, while the proportion of "picadores" and "barrenistas" (coalface workers and stone-cutters) in the overall work force decreased. The problem of the next generation of workers was a source of continual concern in Asturia. A travel report from the year 1952 remarks that Asturia could have produced up to 2 million more t of hard coal per year without any significant new equipment – if the specialist work force, machinery, equipment and pit-props had been available in sufficient quantities.

In 1960 the total number of Spanish companies engaged in the mining of hard coal and anthracite still amounted to 387. In the years up to about 1970, the Spanish Government succeeded in increasing production to an annual figure of around 15 million t, although even higher demand was forecast for the coming years, particularly for coking coal. In order to aim for an annual production target of 17 million t, the Government made available credit in the amount of 67.5 million Dollars for the period from 1966 to 1971: this credit covered about 65% of the planned investment in systems and equipment, together with the ongoing development of the whole production process; the remainder was to be financed by foreign credit and the funds of the coal-mining companies. It was hoped that with modern equipment, productivity in the bituminous coal pits could be increased to 1.1 t per man per shift and 1.0 t per man per shift in the anthracite pits.

Spanish coal-mining was forced into retrenchment under the influence of the low-price policy of the oil-producing countries. HUNOSA was founded in July 1967 by a decree of the Spanish Government of 9th March 1967. By means of the merging of several small Asturian mining companies into a single group, a rationalisation effect was to be achieved, such as that aimed for at the time by similar measures in other European countries with a mining industry, e.g. in the Federal Republic of Germany by the foundation in 1968 of the Ruhrkohle AG.

In contrast to the Belgian or German mergers, the Spanish Government decided, in the case of HUNOSA, on a significant level of state ownership in the company. The Spanish state originally held a majority shareholding in this merger company of the northern Spanish coal-mining area of 76.9%, while the remainder of the capital was controlled by eight private companies on the basis of the funds invested.

Production restrictions and the shedding of jobs, also as a result of mechanisation, lead to lengthy strikes, which in the year 1969 alone caused HUNOSA to register a loss of 14.3 million Dollars. In view of these difficulties and the competition with imported coal, many smaller mining companies closed down their pits, or merged them with HUNOSA, which in 1970 accounted for 75% of Asturian production. Up to January 1970, ten more companies merged with HUNOSA: at the same time, and due to the poor economical developments within the mining industry, the state took over all the capital shareholding with the aid of the state industrial holding company INI.

The difficult situation of the mining industry in general, and of the state-owned HUNOSA in particular, had been taken up for many years by parliamentary committees. The Chamber of Deputies (Lower House of Parliament) addressed the problems of HUNOSA in a special resolution by the passing of the Enérgetico Nacional plan for 1983 to 1992: this requires the development of a concerted plan for the revitalisation of the coal-mining region of Asturia. At the same time, and in anticipation of these parliamentary requirements, the management of HUNOSA at the beginning of 1984 submitted a three-year plan for the period 1984 - 1986, which is linked to previous investment plans and restructuring measures: the plan has been agreed and approved by the Government, INI and HUNOSA. The three-year plan was accompanied by an agreement negotiated with the representatives of the work force. This lead to considerable social tensions and a significant drop in production in the year 1984.

This reorganisation concept was based on the following fundamental points:

- The three-year plan should offer the basis for an evaluation of the viability and the safeguarding of the mining industry under HUNOSA up to the year 2000.
- The technical aim in the meantime was to be to increase overall productivity by improvements in shift performance, increased mechanisation and reduction of lost shift work.
- Wage costs within the period of the plan should only increase by 5.5% in relation to the index guidelines for 1983.
- The pensionable age was reduced to 64 years.
- Overall efficiency was to be improved by taking on 2959 new miners during the period of the three-year plan, with the simultaneous reduction of the administrative structure.

In order to ensure that the three-year plan was put into effect, the provision was imposed that the state subsidies would only be paid to HUNOSA provided that the latter achieved at least 98% of the established production targets every year. The administrative authorities had assumed that a sufficient level of production would ensure satisfactory coverage of the costs. The overall production of the company was thus allocated a key role in its further financial development. HUNOSA in fact reached its target in 1984 with a performance of 99.5% for the whole company, but the following two years unfortunately failed to come up to expectations. The HUNOSA annual report for the year 1985 thus states that great efforts were still required for the realisation of previous energy policy aims. Coal production in Asturia at this time amounted to 6.565 million t, of which 3.674 million tons were produced by HUNOSA (3.147 million t underground).

The three-year plan of HUNOSA came to an end in December 1986, without the established productivity and profitability targets having been achieved. As a result, the Spanish Government developed a plan at the beginning of 1987, as part of a two-year interim solution, to shed around 2,000 of the existing 18,700 jobs in the industry. The Government's plan was based on the assumption that real cost-reduction measures could no longer be postponed on the basis of Spain's entry into the EC, and that EC approval would have to be obtained before further subsidies could be granted. The representatives of the employees opposed this decision strenuously. In 1987, HUNOSA recorded its worst result so far, setting its losses over the last five years at around 1.5 billion Dollars. In 1991 the company produced 2.613 million t of hard coal, and the work force comprised about 17,500 employees. The company was divided into six departments within two coalfields (Cuenca del Caudal and Cuenca del Nalón): the Grupo Carrocera (with the Carrio, San Mamés and Entrego pits), the Grupo Modesta (the Soton, Maria Luisa and Samuno pits), the Grupo Candin-Siero (the Candin, Fondon and Pumarabule pits), the Grupo Barredo (the Barredo, Polio and Tres Amigos pits), the Grupo Nicolas (the San Nicolas, Montsacro and Olloniego pits) and the Grupo Aller-Turon (the San Antonio, Santiago/Aller, Santa Barbara, San Jose and Mina San Victor pits). 24 pits, six surface operations and seven processing/washing systems were in use. The productivity of the whole company for 1991 was 791 kg v.F. per man per shift, and that of the individual pits varied between 728 and 1,251 kg v.F. per man per shift. In its structure and output, the shift corresponded to that of the Federal Republic of Germany at the beginning of the 1950's.

Since 1991, HUNOSA has closed further pits, and today (1999) operates the following mines – in two groups – with the following production outputs (1997):

1. Zona del Caudal

Montsacro Mine	(429.308 t (gross), 249.514 t (net), 713 men)
Tres Amigos Mine	(141.652 t (gross), 78.926 t (net), 315 men)
San Nicolas Mine	(388.186 t (gross), 250.218 t (net), 965 men)
Aller Mine	(759.706 t (gross), 569.674 t (net), 1526 men)
San Antonio Mine	(89.964 t (gross), 67.604 t (net), 242 men)

2. Zona de Nalon

Siero Mine	(89.964 t (gross), 67.604 t (net), 242 men)
Pumarabule Mine	(290.700 t (gross), 131.824 t (net), 524 men)
Candin Mine	(413.551 t (gross), 192.616 t (net), 1007 men)
Samuno Mine	(361.442 t (gross), 179.022 t (net), 625 men)
Soton Mine	(402.886 t (gross), 199.410 t (net), 711 men)
Carrio Mine	(301.238 t (gross), 213.546 t (net), 350 men)
Maria Luisa Mine	(482.360 t (gross), 239.306 t (net), 938 men)

The work forces of the pits thus number from 315 to about 1,500 men, and the net annual production in general below 200,000 t per year; in addition, HUNOSA operates three coal washing plants (Batan, Sovilla and Modesta) and a thermal power station (La Pereda).

In 1997 HUNOSA produced from both coalfields, and with a work force of about 8,800 miners, a total of around 4.08 million t of hard coal (gross), or 2.370 million t (net). If one compares the production of the "Zeche Zollverein" with that produced today by HUNOSA, the mines of the Ruhr produced approximately the same volume in the year 1913, for example (2.233 million t), as the whole current output of HUNOSA; the ratio of the work force, at 6,526 to 8,800 in favour of the "Zeche Zollverein", although under very different working conditions and greatly varying levels of mechanisation and rationalisation. The basic problem of Asturian mining lies in the fact that even today, there is no economical process available for the mechanised mining of steeply arranged seams. The procedures currently used require inclined cutting with reverse face advance and highly skilled manual work under unsafe and unhealthy conditions. Without any better solution to the problem of the mechanised mining of steep deposits, the exploitation of the Asturian deposits is economically unfeasible from the present point of view.

Technical monuments

From this contrast and the (production) figures, it becomes clear that mining in Asturia bears no comparison to pits of the status of the Essen "Zeche Zollverein": the Asturian pits – compared for example to the hard coal mines of the Ruhr area – can almost be designated as "small pits". To this must be added the fact that in Asturia, the construction of surface facilities was only possible in river valleys, due to the unfavourable topography, which therefore prevented the construction of any extensive mining facilities. For this reason, Asturian surface facilities have a rather "irregular" and "unplanned" appearance, consisting as they do of buildings of different construction periods. Integral washing facilities are non-existent, and the production of several mines is taken over by centralised processing plants. In this respect too, all Asturian pits differ greatly from the Essen "Großzeche Zollverein"

The Asturian experience can also be applied to the whole of the Spanish mining industry.

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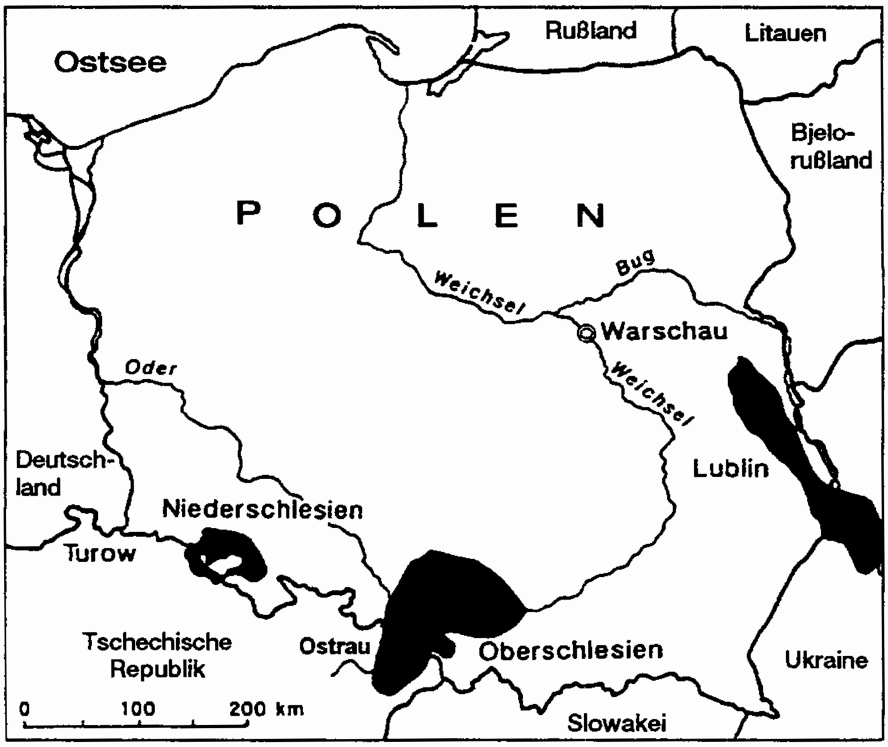
2.6.1.8 Poland

In 1997 Poland had 9.93 billion t SKE (1997) of viable, exploitable reserves of hard coal. With a production of 137 million t, Poland was then – as now – one of the world's major producers of hard coal.



The hard coalfields of Poland (Lower Silesia, Upper Silesia, Lublin) and the Ostrau-Karwiner coalfield in the Czech Republic (from Kelter 1995, Section 5.17, P. 352)

Poland's deposits of hard coal are split up between the Upper Silesian, the Lower Silesian and the Lublin coalfields. 97% of both deposits and production are today concentrated in the Upper Silesian basin, in which 54 production companies operate. With only three companies, the Lower Silesian basin contributes only 0.4% of production, and with the single coal-mine of Bogdanka, the Lublin basin accounts for 2.3% of hard coal production.

The **Upper Silesian hard coal basin** lies between the upper reaches of the Oder and the Weichsel. In the south-west it extends as far as northern Moravia in the Czech Republic as the Ostrava (Ostrau) basin. It covers a total area of 6,400 km^2, of which 5,400 km^2 lies in Polish territory. The coal-bearing strata, with hundreds of coal seams, of which about 100 are exploitable, have been confirmed down to a depth of 2,000 m. According to information from the year 1969, there were at that time 200 which were regarded as exploitable, of which 30 were then being worked. The average thickness of the seams ranges from 1.5 to 2.5 m, although seams with a maximum thickness of around 20 m (!) confirmed. The seams generally lie flat and undisturbed. The types of coal found are coking coals and boiler coals, together with a small proportion of anthracite coals. Due to their size and the thickness of the seams, these reserves make the Upper Silesian hard coalfield into one of the most important hard coal deposits in Europe.

The **Lower Silesian hard coal basin** extends along both sides of Poland's south-west border. The major part of this 500 km^2 coalfield lies in Polish territory, with the smaller, south-western section of the field in the territory of the Czech Republic. Two seam courses with a total thickness of from 10 m to 12 m contain coking coal and anthracite. The deposits have been worked for decades and are now largely exhausted; the difficult geological conditions of the deposits also make exploitation more problematical.

The Lublin hard coal basin in the East has only been partly investigated. Despite the favourable development possibilities forecast at the end of the 1960's, only one mine is in production, mining boiler coals. The exploitation of further deposits is not expected to be feasible due to their great depth and the difficult hydrological conditions.

We shall therefore only look at the Lower and Upper Silesian coalfields, since no mines are to be expected in the "young" Lublin hard coal basin which could be compared with the "Zeche Zollverein".

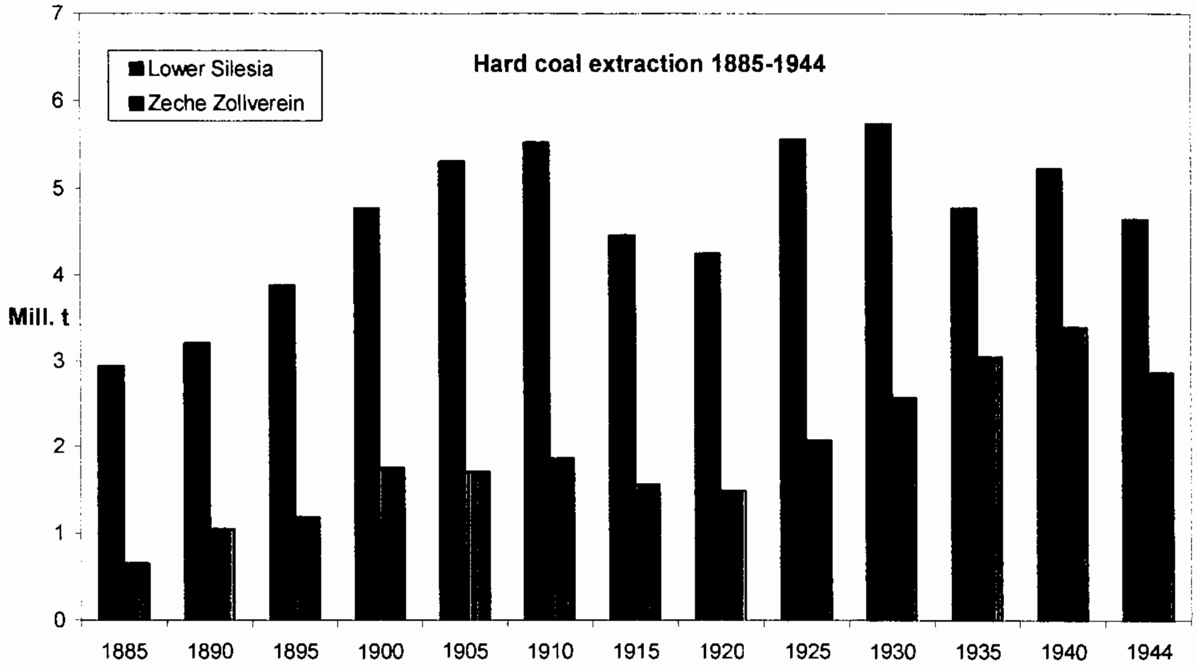
2.6.1.8.1 The Lower Silesian hard coalfield

The development of hard coal-mining in Lower Silesia

The Lower Silesian hard coalfield (also referred to as the Waldenburg-Neuroder field) lies in the south-western part of the Polish region of Wroclaw (Breslau) in the valleys of the Waldenburg and Eulengebirg hills on the border with Bohemia. The field takes in the districts of Walbrzych (Waldenburg) and Nowa Ruda (Neurode) together with some pits also in the district of Kamienna Góra (Landeshut).

The beginnings of hard coal-mining and the use of hard coal in the Neurode area can be traced back to the 15th Century. Sources confirm the existence of mines first in the 15th Century in Zacisce (Buchau, today a suburb of Nowa Ruda). In the 18th Century, following the proclamation of the amended mining ordinances for the Duchy of Silesia and the District of

Glatz, the following pits were officially recognised: 1777 Joseph, 1781 Ruben and Lisette (in Neurode-Buchau), 1768 Wenceslaus, 1785 Florian, 1790 Sophie, 1793 Ferdinand (in Hausdorf), 1779 Valentin, 1793 Rudolph (in Volpersdorf), 1790 Glückauf Carl, 1796 Fortuna (in Ebersdorf), 1798 Segen Gottes (in Schlegel) and 1769 Johann Baptista and 1770 Frischauf between Rothwaltersdorf and Eckersdorf.



The hard coal of Lower Silesia was not under any administrative authority until 1769: the landowners could therefore dispose of the coal as if it were their own property, and the feudal lords controlled the production and the sale of the coals to their subjects. In the 15th and 16th Centuries, farmers were allowed to take part in mining and also start new pits as a special dispensation and for the relevant fee.

In the 1740's, Prussia began to encourage the use of hard coal. Increased use of the hard coal from the Lower Silesian field depended however not only on the consumers, but was determined much more by economic considerations. The extent and the development of mining was thus governed more by the expensive transport from the pits to the consumers, and the associated costs of such transport, so that mining was at first carried out on a small scale only. Until the 17th Century, the coal was mined exclusively on the surface at the protrusion of the seams, while in the transition phase to shaft-mining, the coal was also mined in Duckelbau-Mining. In the Waldenburg area of the field, the deepest level was reached in the year 1801 in the Friedrich Wilhelm pit, and in the Neurode field, the deepest level was in the Alexander pit.

By the end of the 18th Century, mining had developed into the main occupation of the population of the Lower Silesian coalfield area after farming and forestry, textile production and other crafts. In 1800 there were already 50 mines in the Waldenburg part of the field, with a total work force of 1,083 and a total output of 127,000 t, while in the Neuroder field, there were 16 mines being worked, with a work force of 148 miners and an output of 18,000 t.

In contrast to the Upper Silesian coalfield, the Prussian State in Lower Silesia was neither the owner of the field nor the operator of the mining activities. The extent of production was determined primarily by demand, which was in turn regulated by the inadequate transport facilities. The lack of navigable rivers left road transport by wagons as the sole means of distribution, with the result that the main consumption channels of coal from Lower Silesia had to be served by the existing road network: the major part of production was thus used in Lower Silesia itself, with the important centres of consumption being populous towns and cities such as Breslau, Schweidnitz (Swidnica), Hirschberg (Jelenia Góra) and Glatz (Klodzko). No large, coal-using industries however grew up around the pits.

By 1800 only around 150,000 t of coal were being consumed, and it was not until the 1840's that consumption rose to more than double this figure. This increase was brought about primarily by the construction in 1843 of the railway line from Breslau to Freiburg (Wroclaw-Swiebodzice), which was further extended in 1853 as far as Waldenburg. Now, for the first time, the Waldenburg coalfield enjoyed better conditions for the distribution of coal to the centres of consumption lying to the North and West, for Breslau already had rail connections to Berlin, Dresden, Oppeln and Posen. Nevertheless, in the first half of the 19th Century, mining in the Lower Silesian coalfield still remained only the second largest branch of the economy after the textile industry.

Through a concentration of production, the first large mines were created in the first decade of the 19th Century. The intensification of mining brought about by the increased use of coal accelerated the exploitation of the workable seams and the exhaustion of coal reserves in the numerous smaller mining operations. The penetration to lower depths below current mining levels required the use of new technology: the first cable hoist, with a 12" steam-powered reciprocating pump and a performance of 5 hp was installed in 1812 at Altwasser (Stary Zdrój, today a suburb of Waldenburg).

In 1840, the first deep-mining pit in Tannhausen was established in the form of the Sophie pit, which although still using hand-reels for lifting, still produced an annual output of 11,000 t from a depth of 30 m. How technically outdated many pits were is also confirmed by the example of the Frischauf pit in Neurode, in which the seepage water in the pit was still lifted by means of hand-pumps. Without steam-powered water removal equipment, most pits became flooded within a very short time. When new deep-mining pits were brought into operation around 1850, they were therefore equipped immediately with powerful steam-operated machinery. Overall there were 18 such machines in operation at this time. Following the consolidation of the small pits with larger, capital-rich pits such as the Fuchs pit, the Glückhilf pit, the Friedenshoffnung pit and the Segen Gottes pit in the Waldenburg coalfield and the Johann Baptista pit in the Neurode coalfield, it first became possible to create profitable, extensive deep-mining pits.

In the 1850's, the first deep-mining pits with twin shafts were created in the Waldenburg coalfield: they were located close to the railway lines, and water removal and shaft production was carried out with the aid of steam-driven reciprocating pumps and other high-pressure steam-powered machinery. Changes in mining legislation, which related above all to the areas of ownership and administration, went hand in hand with the expansion of the railway system, bringing a new and pronounced economic upturn for the coalfield. The extension of the railway line from Waldenburg-Dittersbach (Podgórze) to Görlitz (Zgorzelec) via Hirschberg enabled the distribution of the coal from the field to the districts of Dittersbach, Hermsdorf and

Gottesberg-Rothenbach, which until that time had had to transport the coal by road to the rail terminal at Waldenburg. Next came the rail connection of the Waldenburg-Görlitz line to the Bohemian rail network (Ruhbank-Liebau branch line 1869) as a result of the Peace of Prague after the war with Austria, which opened the way for the Waldenburg coalfield for transport of coal to the South. The Neurode pits, on the other hand, were not able to transport coal by rail until 1880 and the construction of the mountain railway from Dittersbach to Glatz.

From the 1860's, investment was also devoted to improved processing facilities, such as separation, washing and flotation systems, in order to make it possible to market the lower grades of coal. The first continuous sieving/washing machine in a German hard coal pit was set up by C. Lührig in the Glückhilf pit. The electrification of the pits was instituted in 1890.

The largest pits, both from the point of view of their overall extent and the number of workable seams, were the Glückhilf-Friedenshoffnungs pit in Waldenburg-Hermsdorf and the Fuchs pit in Waldenburg-Weißstein. In 1891, only four of the 17 pits in operation produced 200,000 t, which represented 68% of the total production, while in 1912, five pits were achieving an annual production of over 200,000 t.

Development of the Waldenburg deep-mining pits 1891-1912 (from Piatek 1999)

1891				1912			
Mine	Production million t	Work force	Depth m	Production million t	Work force	Depth m	Field mill. m^2
Glückh.-Frieden.[1]	1.163	6031	271	1.064	5557	409	8.1
Fuchs	0.477	2343	206	0.796	3870	265	7.7
Fürstensteiner[2]	0.413	1826	300	1.198	5611	429	5.4
Carl-Georg-Victor[3]	0.226	1477	221	0.395	2217	255	6.8
Melchior[4]	0.117	416	310	0.388	1774	500	9.5

[1] = consolidated Glückhilf-Friedenshoffnungs pit in Hermsdorf,

[2] = consolidated Fürstensteiner pit in Waldenburg, [3] = Carl-Georg-Victor pit of the Schlesische Kohlen- and Coaks-Werke AG in Gottesberg, [4] = consolidated Melchior pit of the C. Kulmiz G.m.b.H. in Waldenburg-Dittersbach

In the Neurode coalfield, the first deep mining operations began in the year 1847: Here only two pits produced more than 200,000 t of hard coal per year.

Development of the Neurode deep-mining pits 1891-1912 (from Piatek 1999)

1891				1912			
Mine	Production million t	Work force	Depth m	Production million t	Work force	Depth m	Field mill. m^2
Consolidated Ruben pit	0.082	554	207	0.226	1498	279	8.4
Consolidated Wenceslaus pit	0.069	311	150	0.565	2283	357	4.4

In the last years of the 19^{th} Century, the concentration of capital came into effect: In the Waldenburg coalfield in 1891, five hard coal-mines were operated by trade unions, two belonged to the Aktiengesellschaft Schlesische Kohlen- and Coakswerke of Gottesberg, two belonged entirely to the Prince of Pless and two belonged to the firm of C. Kulmiz in Saarau. In the Neurode coalfield, three pits were the sole property of the Count of Magnis, one was operated by a trade union and one belonged to a businessman named Herschel from Zwickau. In order to regulate the distribution and sale of coal, the Niederschlesische Steinkohlensyndikat (Lower Silesian Coal Syndicate) was founded in 1904, to which all the pits belonged, with the sole exception of the Wenceslaus pit.

By 1900, 15 deep-mining pits with a work force of around 20,000 miners were producing over 4 million t of hard coal annually: mining was the most important sector of the economy in Lower Silesia, and also the main source of employment. This mono-structure of the economy continued until the year 1990, when the decision was taken to close down the mines.

Technical monuments

As early as the 1980's, consideration started to be given in the Walbrzych region to the preservation of monuments to the mining industry for posterity. These efforts were initially concentrated on the two shaft mines Gabriel and Irena, which both dated from the end of the 19th Century. The "Ecomuseum" was opened in 1986; it incorporated the surface workings of the Gabriel shaft, the buildings of the training centre, the shaft ventilation system, together with the supply shaft of the Irena pit and the practice shafts.

In 1995, efforts were initiated to establish the planned "Museum of Industry and Technology" in the closed surface facilities of the **Julia** (formerly Thorez) pit. The surface facilities here consist of the two Malakoff towers of the **Julia** (1869) and **Sobótka** (1865) shafts, with their delicate pithead gear, together with an important stock of architectural and machinery features: wash-rooms, pit stations with coal-carts on rails, washing and processing systems all form part of the mining museum which has in the meantime been opened. Amongst the outstanding pieces of machinery items housed by the museum is, for example, the electrical winding machine from the Julia pit (1911). It is planned to increase the museum's attractions by a trip through the mine, and also to include the historic "Fuchs" shaft in the visitor's programme.

In addition, there are further items of pithead gear worthy of mention which characterise the landscape, such as the Malakoff towers of the "Teresa" shafts dating from the year 1864, from whose buildings the pithead winding gear still projects, "Siostrzane" and "Wrangel/Wojciech" from the second half of the 19th Century, the pithead tower "Tytus/David" from the year 1924 and parts of the surface facilities of the "Victoria" mine with its attractive brickwork architecture from the years 1890 to 1914. The time between the two World Wars is documented by the full-wall pithead tower above the "Jan" shaft (1933), and an example of the construction of pithead towers after the Second World War is provided by the lofty towers above the shafts of "Staszic" (1966) and "Piast II" at the Nowa Ruda mine.

With full justification, the surface buildings of the Julia and Sobótka pits must be regarded as the outstanding examples of their type in Lower Silesian mining architecture: they are highly worthy of documentation, and depict by means of their ornate building features and machinery the whole course of the development of mining in Lower Silesia, from the transition to deep mining with the use of Malakoff towers right up to the era of modern coal production in the 1990's. Especially worthy of notice is the fact that the Polish mining authorities and those responsible for national monuments took pains to establish these buildings as national monuments before the closure of the pits, and also to make a good selection of the buildings to be preserved.

If we now make a comparison between the complete workings and the surface facilities of the Lower Silesian hard coal-mines and those of shaft 12 of the Zeche Zollverein, the differences are striking: there the "inhomogeneous", historically-developed buildings of the comprehensive surface facilities during the second half of the 19th Century and up to about 1914, here the uniform pit system "from the same mould" which all grew up within a few years: there the irregular arrangement of the facilities around the pithead, here the planning hand of the architect: there the design of the surface facilities in their historical form, here with the look of the new utilitarianism and functionalism. Both mines possess great qualities with regard to the incorporation of the surface facilities in the mining landscape, with its accompanying settlements, although as monuments they remain very different and varied in their appearance.

2.6.1.8.2 The Upper Silesian hard coalfield

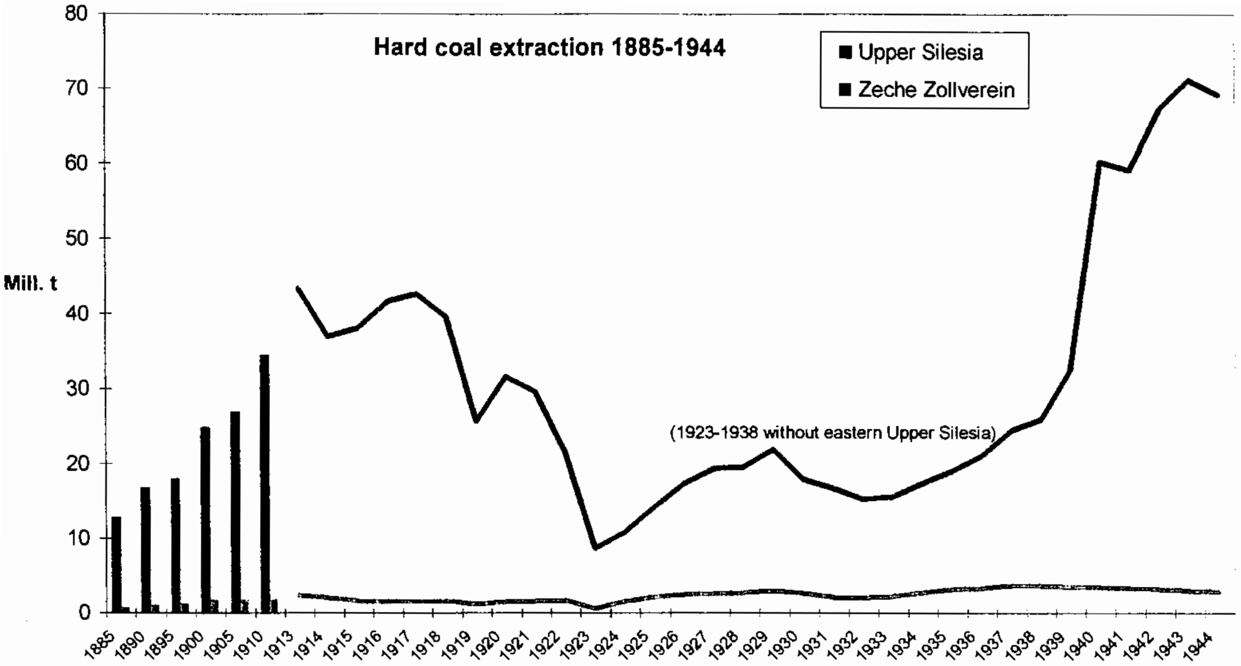
The development of hard coal-mining in Upper Silesia

The beginnings of hard coal-mining in Upper Silesia extend back to the last decades of the 18th Century, and are connected with the development of state coal-mining operations following the end of the Silesian Wars. Mining here can be traced back to the efforts of Frederick the Great, who wanted to support the under-developed Upper Silesia by expanding the domestic mining and smelting industry with the aid of state resources. At the forefront of the developments was the mining of ore, and due to the wealth of forestry in the Upper Silesian region, little attention was initially paid to hard coal as a source of energy: Only small quantities of hard coal were produced by the small open-cast pits at Hultschin and Ruda.

This situation only changed once the value of hard coal for the smelting industry had been recognised: used as a coking coal, hard coal offered considerable benefits for Prussia's mining of iron ore. Thus, on 17th November 1790, the Minister of State von Heinitz issued a decree for the establishment of hard coal-mining operations. This was the beginning of the Upper Silesian hard coal industry. With the Friedrichshütte smelting works in mind, the first mining locations selected were in the area of Heiduk and Chorzow (Königshütte), and for the Gleiwitz smelting works, those in the vicinity of Zabrze (Hindenburg). The first central European blast furnace using coke was fired up at the Gleiwitz smelting works. The eastern workings later developed into the "Königsgrube", while the western workings became the "Königin Luisengrube".

Mines in Upper Silesia (from Szpilewicz 1958)

Period	Number of pits established
1750-1800	13
1801-1900	35
1901-1918	25
1919-1944	3
1945-1955	5
Total	81



The first shaft to be sunk in the eastern part of the field was the Wilhelmschacht (on the site of the later Königshütte station). Further shafts were established around the Wilhelmschacht in the following years in order to supply the newly erected Königshütte smelting works, neighbouring zinc smelting works, tile works and lime burning works. The increasing consumption of hard coal soon demanded the increased mechanisation of the young Upper Silesian coal-mining industry: in 1797 the first steam-engines were installed for water removal and, after the pit was christened the "Königsgrube" in the year 1800, hauling the coal by means of wooden, horse-drawn carts was introduced in 1802 in place of the previous practice of man-handling of sleds. The first steam-powered hoisting machinery followed in 1814 and 1819. Up to 1840, production was concentrated mainly in the western half of the field, but from 1841, the eastern half of the field also began to be worked in the form of the Hedwigsschacht, which was followed in the years 1853 - 1857 by the Erbreichschacht I. At the end of the 1850's, the coalfield experienced a great upturn and the beginning of even greater expansion by means of the first rail connection to the western part of the field, whose new shaft sunk in 1856 – 1857 was for this reason christened the "Bahnschacht". Further shafts followed in the eastern part of the field in the 1860's: in 1864 the Krugschacht I (this shaft reached the first deep-mining level below the main working level; in 1913 the shaft was 168 m deep), in 1869 the Krugschacht II (both in the eastern part of the field) and the Bahnschacht II in the western field, together with the Bismarkschacht I and shortly after the Bismarkschacht II in the southern field, and in 1896 - 1898 the Marienschacht in the western field. The trial shafts sunk in 1898 - 1905 in the northern part of the field created the fourth independently producing shaft system of the Königsgrube.

Developments proceeded in a similar way in the western coalfield at Zabrze. Here too several shaft operations grew up, which were initially of a restricted size. Greater problems were encountered here due the incoming water. Since these difficulties could not be overcome even with the use of a steam-engine taken over in 1795 from the Friedrichsgrube, it was decided to construct a gallery, which would provide a solution to the water problem of all the seams between Zabrze and Ruda; at the same time, the gallery would be used to transport the coking coal produced to the Gleiwitz smelting works. The gallery would therefore have to be connected with the Klodnitz Canal lead from Gleiwitz. The Zabrze lake was selected as the starting point for the gallery, which would run for 7,500 m at a depth of around 60 m.

The work on the gallery was begun in 1800, and by 1811 the work had progressed so far that transport of the coal from the Königin-Luise pit by the Klodnitz Canal to Gleiwitz could begin along the first section of the gallery. In the year 1863 the final breakthrough was made, so that the König pit and the Königin-Luise pit were now connected by means of the now 14 km long gallery.

Because of the unfavourable economic situation and the political conditions, the individual pits now ceased any further development. The production level of 30,000 t per year which had been achieved as early as 1811 now dropped over the years down to 10,000 t, and the work force shrank to only 60 men. It was not until 1857, when the coking coal above the main gallery level ran out, that it was decided to establish deep-mining operations. In 1858 work began on deepening the Dechenschacht, followed in 1850 by the Oeynhausenschacht and in 1852 by the Skalleyschacht. As in the eastern field, the connection to the Upper Silesian rail network had a positive effect on the development of the pits, and a second deep mine system was established: the later Western Field System. In 1854, work began on the sinking of the Krugschacht, the Prinz Schönaichschacht and the von Garnalischacht. In the course of time the older shafts were closed down, and other shafts deepened; the Zaborzeschacht in 1874, the Biskupitzschacht in 1884, the Rudaschacht in 1888 and the Georgschacht in 1890. The construction of the Eastern Field System began in 1869 with the sinking of the Porembaschacht I and II. These were followed in 1875 by shafts III and IV, and at the end of the 1880's by the Paulschacht and the Hermannschacht.

By means of acquisitions and Mutungen, the state mining holdings, which originally consisted only of the hard coal-mines "König" (at Königshütte) and "Königin Luise" (at Zabrze), were extended considerably, and by 1912 also incorporated the hard coal pits at Bielschowitz and Knurow: The Treasury of Mines was thus, next to the Prince of Pleß, who had special regal rights, the largest mine-owner in Upper Silesia. The state mines of Upper Silesia had produced, during the 125 years of their existence up to that time, a total of 182 million t of hard coal, i.e. with a work force of around 22,000 men, the state mines, as the largest single producer of hard coal at the time, was producing almost one fifth of all the hard coal mined in Upper Silesia.

Until 1918, three-fifths of the Upper Silesian coalfield, with the centres of Hindenburg (Zabrze) and Kattowitz, belonged to the German Reich. Following the Geneva Reparations of 20th October 1921, Poland was awarded the coalfields of Dabrowa and Krakau, together

with the major part of the Upper Silesian field, leaving Germany in possession of 14 shaft systems in the western part of Upper Silesia. Poland was given 53 shaft systems in eastern Upper Silesia. After the German Reich and the Soviet Union had occupied Poland in 1939, hard coal production was increased – mainly in the Upper Silesian coalfields – in the interests of the German war economy, from 69.4 million t (1938) to 91.6 million t (1943).

The mines of Upper Silesia fell almost intact into Russian hands in 1945, and remained in Soviet hands until being handed over to Poland at the end of 1946. As a result of the dismantling of the washing and sieving systems and the power stations, and the lack of replacement workers and specialists, a return to proper operating status was impossible. Following the nationalisation of the Polish coal-mining industry at the beginning of 1945, a closed system of organisation had first to be created. With the Soviet example in mind, planning guidelines were issued on the basis of economic plans laid down by the Council of

Ministers, which had been drawn up by a Planning Commission and were also monitored by them. The subordinate directing levels in the area of the mining industry were the Ministry for Mines and Power, the mining associations (mine collectives) and the individual mines themselves.

The mine collectives formed the middle directing level in the administration of the mining industry, and the individual mines were subordinate to them on a regional basis. Hard coal-mining was at this time grouped into seven mine collectives (Jaworzno, Dabrowa, Katowice (Kattowitz), Bytom (Beuthen), Zabrze (Hindenburg), Rybnik, and Walbrzych (Waldenburg, Lower Silesia)). An overall total of 79 mines belonged to these groups, which each comprised between 10 and 16 mines (with the exception of the Lower Silesia group, which included only five mines).

Due to Soviet delivery requirements, production at first began to increase again: from 47 million t in 1946/1948 to 70 million t of hard coal in the year 1949. Due to organisational shortcomings, the rate of increase then started to tail off, and the agreed plan figures could not be achieved. In order to limit the production shortfall, surface mining operations were started at points where the coal lay close to the surface: together with the processing of coal slurry from former flotation pits, around 1.5 million t of hard coal were produced from surface operations in 1955.

Eight deep mines were planned to go into production between 1952 and 1955. In fact, it was actually only five: Ziemowit at Lendzin (1952, started as the Günter pit), Wesola II to the south-west of Myslowitz (1952, started as Fürstengrube II), Kosciusko Nowa at Krenau (1953), Julian at Deutsch-Piekar (1954, started as Radzionkau-Ost) and Wirek Nowy to the west of Bismarckhütte (1954, re-establishment of the former Hugo-Zwang pit). The start of construction of these pits had begun under German direction, while three further pits were subsequently sunk or brought back into production under Polish administration: Halemba to the south of Kattowitz, Mszana south of Rybnik and Porábka south-east of Dabrowa.

The Polish mining industry concentrated during this period predominantly on the Upper Silesian coalfield, and by exploiting its rich reserves, developed in the post-war years into one of the most important branches of the country's economy: As Poland's only significant source of energy, hard coal production underwent a continual increase during the years after the war. The need to increase production arose both from the heavy industrialisation of the country and the associated increased requirement for fuel, and from the need to improve the country's import/export balance of trade. During the 1960's, reconstruction, the modernisation of existing mines and the sinking of new pit systems contributed significantly to this increase. Because coking coal was needed above all for the developing smelting industry, the Rybnik coalfield was the focus of long-term planning from 1957 onwards. In the first half of the 1960's, the pits "1. Mai", "Szcylowice" and "Jastrzebi", each with three to four shafts and depths of between 130 m and 350 m, were extended. In the same period, three more new pits were also taken in hand: "Bornynia". "Moszczenica" and "Staszic", and in 1960, full production was resumed at the pits "Wesola" and "Rokitnica" (formerly Castellengo at Martinau) following severe pit fires.

The highest annual production figures were achieved with 193 million t in the years 1987 and 1988. Like the rest of the European mining industry, Poland's coal industry has today been in a deep crisis for a number of years, which has also lead to a drastic drop in production. In the period 1988 to 1992 alone, annual production sank by over 60 million t to 131 million t, although annual hard coal production was again raised by 1997 up to 137.1 million t.

In view of the high production and transport costs, and also due to the mining conditions and the poor condition of the pits, the Polish coal-mining industry has been forced into negotiations. In 1993 the Polish Government passed the first restructuring programme, and more are to follow. Measures for consolidation and improvements in production efficiency have however already been underway for 10 years. In the period from 1990 to 1997, a series of pits were closed and about 170,000 jobs were lost; from 1991 to 1993 alone, seven pits had to be closed and the work force reduced from 1992 to 1993 by 14% to 353,000. In 1993 there were still 65 mines in production in the Upper Silesian coalfield - by 1997 the figure was down to 54. At the end of 1997, there were still in Poland a total of 58 mining companies. Of the 54 mines in Upper Silesia, 51 are grouped into seven holding companies (Bytomska Sp.W.S.A. in Bytom/Beuthen with nine mines, Rudzka Sp.W.S.A. in Ruda Slaska with six mines, Gliwicka Sp.W.S.A. in Gliwice/Gleiwitz with seven mines, Katowicki H.W.S.A. in Katowice/Kattowitz with ten mines, Nadwislanska Sp.W.S.A. in Tychy with eight mines, Rybnicka Sp.W.S.A. in Rybnik with five mines and Jastrzebska Sp.W.S.A. in Jastrzebie Zdroj with six mines). In addition there are three joint-stock companies (Jan Kanty S.A. in Jaworzno, Porabka-Klimontow S.A. in Sosnowiec and Budrik S.A. in Ornotowice).

In Lower Silesia, production was still being carried out by Nowa Ruda S.A. and Z.G. Julia, together with the Anthrazit Bergbau- und Verarbeitungsgesellschaft in Walbrzych, which started operations in 1992. In Lublin, Bogdanka S.A. in Puchaczow is still in production.

Since the Polish coal-mining industry continues in production at a high loss – the production costs are about 20% above the sales price – a new reform programme for the period 1998 to 2002 envisages further severe measures to preserve the Polish coal-mining industry: privatisation and the closure of unprofitable pits is imminent, more than 20 mines will probably have to be closed down by the year 2002, the annual production capacity is to be reduced by 25 million t from the current 137.1 million t and the work force from the current 244,500 to around 139,000 men. Further mine closures from 2003 onwards are to be financed by a closure fund, to which the mining companies will have to contribute from the year 2000 on. At the same time, support from the state will also be reduced. From 2005, the ongoing process of closures is to be financed entirely from this fund.

Technical monuments

The historically important deep-mining systems in the Upper Silesian coalfield have been so thoroughly changed by the extensive restructuring measures over the course of the post-war years that no complete mine workings from the 1920's or 1930's now exist, although individual monuments have survived which are of a high quality (e.g. the symbolic character of the pithead gear of the Hindenburg pit in Bytom). Even taking into account the significance of the Upper Silesian coal mines for the Polish economy, it must be said that the reconstruction of the older mine systems, many of which dated back to first half of the 20th Century or even the second half of the 19th Century, has replaced these structures with more or less characterless, purely functional buildings. And the pits and mines, still important to the Polish economy, which were created from new, or completed after the Second World War, have no architectural or historical value: this applies for example to the pits Ziemowit, Wesola II, Kosciusko Nowa, Julian, Wirek Nowy, Halemba, Mszana, Porábka, 1. Mai, together with Szcylowice, Jastrzebi. Bornynia, Moszczenica, Stascic, Marcel, Jankowice, Debiensko, Zofiowka and Pniówek.

The centre of the Upper Silesian hard coalfield is **Katowice**; here there are several groups of buildings and individual facilities worthy of mention.

One outstanding feature is the "**Katowice**" pit. Opened in 1823 in Bogucice as the Ferdinand pit, it was joined in the following years by the Benjamin shaft (1834) and the Nottenbohn and the Gruschka shafts (1857 to 1860). In the 1880's, this pit developed into one of the leading hard coalmines in Upper Silesia, and further modernisation measures were carried out before the First World War. In 1936 the pit changed its name to "Katowice", and between 1939 and 1945 it belonged to the "Hermann-Göring works". After the end of the Second World War, the pit was again extended, and in 1996 it was combined with the "Kleofas" pit.

The surface workings of the Katowice pit near to the town-centre to the North of the Allee W. Rozdzienskiego (ul. Kopalniana 6), and consist of 20 buildings designed in the historical architectural forms of the late 19th and early 20th Centuries. The most significant individual monuments of the whole pit are the steam hoists at the Benjamin shaft (today the Bartosz shaft), built in 1892 by the Isselburg smelting works, which remained in operation until 1997, and the smithy, constructed in 1899, which still retains part of its original equipment. Efforts are currently underway to have all these buildings and equipment designated and preserved as a monument.

The beginnings of the **"Katowice-Kleofas"** pit (also in Katowice) reach back to the year 1839. It was constructed on the site of the former "Waterloo" and "Eminenz" pits. In 1953 the pit was renamed the "Gottwald" pit, and in 1974 the "Gottwald" and "Kleofas" mines were combined, and the former pit liquidated.

The majority of the surface facilities, located north of the ul. Chorzowska, were built in a uniform architectural style, and have managed to retain their original exteriors. Of outstanding significance are the wash-rooms originating from the 1920's, the administration building built in 1907 (with a Barbara Triptychon) and the former boiler-house, built between 1905 and 1908, which was converted into a swimming-pool and café in the 1980's. The brick architecture is dominated by the towering pithead gear, and the characteristic mining style of the red-brick buildings has been faithfully preserved by Zygmunt Winnicki, the architect in charge of the restoration. This group of buildings of great architectural significance was the first successful example of the conversion and re-use of former mine buildings for other purposes in Katowice after the Second World War.

The "**Wieczorek**" pit and its Pulaski shaft (ul. Szopienicka 58) feature an attractive strut frame headgear and extensive brick architecture with intricate (mansard) roof designs in the restrained "Jugendstil" style. Founded in 1826 as the "Giesche" pit, the mine was several times merged with other pits during the course of the 19th Century, and in 1899 it was combined with the reserve field and the Carmer shaft, on which the architects E. and G. Zilmann from Berlin-Charlottenburg erected new surface facilities of a uniform style between 1905 and 1907. In 1922 the pit system was renamed in honour of Kazimierz Pulaski, and in the 1960's and 1970's, comprehensive modernisation measures were carried out, which however did not detract from the overall architectural appearance. The mine itself is still in production.

The buildings of the Pulaski shaft must today be regarded as the best example in Katowice and the whole of Upper Silesia of surface workings from the early 20th Century. In addition, both the original electrical hoists from the year 1907 have been preserved, which were built by the

Wilhelmshütte (smelting works) in Mülheim/Ruhr. The pit gallery with its wash-rooms, dominated by a five-storey, octagonal tower, still displays notable elements of the "Jugendstil"; the original St. Barbara altar (including its mosaics) has been transferred to the museum.

Attention should however still be drawn to the surface workings of the **"Alfred"** shaft (pl. Alfreda 1 - 13, al. W. Korfantego 182 - 184), which have now been converted for the purposes of accommodation: built in the 1880's, 1890's and 1920's, they comprise 15 buildings, of which 12 have been designated for preservation as monuments. The surrounding green belt and park areas complete the "charm" of these buildings, which provide one of the oldest testaments to the mining architecture of Upper Silesia. Some of the surface buildings of the "Murcki" pit at the Maria shaft (ul. P. Kolodzieja 2 and ul. T. Boya-Zelenskiego 95) should also be mentioned, especially the pithead gallery built in 1907, which was converted in 1995/1996 by the architect Janina Bolawa into an office building.

Another example worthy of mention is the **"Andaluzja"** pit at Piekary Slaskie, with its three pithead towers arranged all in a line next to each other and its surface buildings of skeletal steel construction. The **"Wieczorek"** pit too, with its shaft "Pulaski" in Kattowitz has a well-designed strut frame headgear and comprehensive reinforced steel architecture.

Many mining settlements have also survived in the Upper Silesian coalfield (in addition to those of the smelting workers), and these still characterise the landscape of the towns and the countryside. An apt example is the "Giszowiec" settlement, with its stark "endless rows" of three-storey brick houses, which testify to their mining origins by the emblem of the crossed hammers.

The early history of mining in Upper Silesia is most impressively documented by the **Königin Luise open-air mining museum ("Skansen")** in Zabrze. It stands on the site of the oldest Upper Silesian hard coal pit, founded in 1791, and contains many monuments. The underground area (ul. Sienkiewicza 43) displays authentic mine sections from the historical Königin Luise pit, together with sections and working chambers from the Zabrze pit from the 1950's: many items of equipment and machinery are on display, e.g. a longwall face disk shearer. This historical pit is associated with the former trial pit **"Guido"**, constructed about 10 years ago and now used as a pit for visitors (Ul. Maja 19), which shows modern mining under realistic conditions as it now takes place at depths of 1000 m and more. This pit displays original working areas at depths of 170 m and 320 m, amongst them the pumping station and the horses' stalls. In the **open-air display**, and in addition to the shaft system itself and the pithead landing, visitors can also see a shaft workshop, an emergency rescue room and a working pit communications system. The 25 m high pithead gear of riveted steel can be used as a viewing platform, and offers a view over the town of Zabrze and neighbouring localities. The switch-room on the pithead landing still contains the electrical equipment dating from the beginning of the 20th Century. The open-air museum also houses a technologically interesting compressor system, an electrical workshop, a machine room and other operating systems dating from the second half of the 19th and the beginning of the 20th Centuries. The most impressive display the museum has to offer is surely a steam-powered hoist built in 1915, which is still in working order, while another machinery exhibit is the shaft winding gear from the now closed "Siemianowice" pit. The museum complex of the former Königin Luise pit is registered in the directory of monuments of the Katowice region.

It must still be said that, both in the case of the Upper Silesian and the Lower Silesian coalfields, neither represents a system of mines on the pattern of the Zeche Zollverein. The best

Polish example of a large, impressive pit system with a surrounding "mining landscape" as documentary evidence of the history of coal-mining is to be found not in Upper Silesia, but in Lower Silesia.

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2.6.1.9 The Czech Republic

2.6.1.9.1 The Ostrau-Karwin hard coalfield

The Upper Silesian hard coal basin extends in the south-west into the Czech Republic as the Ostrau-Karwin hard coalfield: it extends over an area of around 1200 km^2. The coal-bearing strata lie at a depth of up to 1000 m. The central point of this north-Moravian coalfield is the town of Ostrava (Ostrau), which grew up out of the union of Mährisch-Ostrau (Moravská-Ostrava), Schlesisch-Ostrau (Slezská-Ostrava), Witkowitz and Poremba. The development of the town as an industrial centre is closely associated with the discovery of hard coal and the history of coal-mining.

The development of hard coal-mining in the Ostrau-Karwin coalfield

The first mention of coal reserves in the area of Mährisch-Ostrau dates from the year 1753. Four years later, coal was discovered on the land of Count Frantisek Jan Wilczek in Polish Ostrau, which is located in the centre of the later Ostrau-Karwin coalfield, and in 1776 in Karwin, i.e. in the eastern part of the coalfield, on the land of Count Jan Erdmann Florian Larisch. The Count had two small production shafts sunk (Jindrich and Jan), although he closed down the production after only a few months. In the western part of the coalfield, coal was discovered in 1782 in Hultschin/Hlucin on the property of Baron Jan Adam Gutschreiber.

Hlucin belonged at this time to the district of Petrkovice, and thus to Prussian Upper Silesia. Production here was carried on more systematically, since there existed an infrastructural connection with the smelting industry, which was more highly developed, compared to that under the Austrian monarchy. The coal from the Petrkovice region was used both in Upper Silesia and in the border towns of Austria-Silesia (Krnov, Tesin and Opava). At the beginning of the 1820's, about 20 miners worked in these pits (Alte Hluciner, Neue Hluciner, Nanetta, Filip, Klementine, Jan and Reichflöz-Stollen pits), and the value of the production ranged from 3,000 to 4,000 Prussian Talers. By the end of the 1830's, the number of miners doubled, and production rose from 7,100 t (1823) to 23,000 t (1838).

Except for in Hlucin, coal-mining in the Ostrau-Karwin coalfield was discontinued shortly after the discovery of the deposits, or stagnated at a low level, since the demand for coal was low. After prolonged negotiations with the authorities, Wilczek first took up production again in the year 1787, later followed by Larisch in 1794. In 1822 the Freiherr von Mattencloit sank a shaft on the Dobrau/Doubrova estates in Havrina.

Of these three pits run by the nobility, Wilczek's company developed the fastest. In 1802, production reached about 3,000 t, and towards the end of the first decade of the 19th Century, about 7,000 t annually.

The Wilczek coal mines were the most important mines in the Ostrau-Karwin coalfield, and by the beginning of the 1820's in Moravia and Austrian Silesia as well. They were able to maintain this position until the middle of the 19th Century. In the meantime, the production of the Larisch-Mönich pits at the beginning of the 19th Century amounted to an average of 2,000 t, climbing by 1823 to 5,500 t. Count Wilczek was also the first businessman in the coalfield at the beginning of the century who separated the administration of the mines from his other businesses as an independent economic unit.

The numbers of those employed in the mines of the Ostrau-Karwin field are only known for those companies run by the nobility, whereas those for the numerous smaller pits are missing. In 1833 the number of miners employed in the Wilczek pits, the Larisch-Mönich pits and the mines of Hlucin came to a total of about 300, increasing to about 400 in the 1840's.

The relatively favourable geological conditions of the Ostrau-Karwin coalfield permitted mining at a relatively low level of technology, so that mining was generally widely distributed in many small pits. Shaft mining was introduced into the coalfield towards the end of the 18th Century, and until into the 1820's the maximum depths that were worked were 40 m. The decisive factors in the slow development of coal production from the field were the lack of demand and the under-developed infrastructure: there were no commercial operations which could be considered as consumers of coal in large quantities, and the existing iron-smelting works still used charcoal as fuel. In addition, the transport of the coal from the pits to any potential users was very difficult.

Not until the 1840's did the Ostrau-Karwin coalfield start to develop into the most important hard coalfield under the Austrian-Hungarian monarchy. From the end of the 1840's at the latest, a clear upturn in the coal production of the Ostrau-Karwin coalfield becomes apparent: from 1845 to 1849, production increased from 152,000 t to 204,000 t, and in 1914 the output was 9,360,000 t.

The most important factor in the rapid rise in coal production was the iron industry as a consumer of this "new" fuel, following the change-over in 1829 by the Witkowitz Rudolfshütte of the Wilczek mining works from charcoal to hard coal for the smelting of pig-iron. In 1841 the share of coal as a source of fuel was only 11%, but by 1880 this had already risen to 80%.

The second important factor in the expansion of mining was the railways, both as a consumer of coal and as a means of transport of the coal. The completion of the Kaiser-Ferdinand-Nordbahn in the year 1847 was particularly significant, since this connected the coalfield with the industrial centres of Cisleithania and Prussia to the North (and as far as Berlin and the ports of the Baltic Sea). The western part of the coalfield, with Ostrau as the main railway junction of the Kaiser-Ferdinand-Nordbahn, was connected to the eastern part of the coalfield at the beginning of the 1870's by the Kosice-Bohumin rail line, and by the mine railway to Doubrava and Karwin in the year 1869. The importance of the railway for the development of the coalfield can be measured from the growth in production in the eastern part of the coalfield. Further rail lines connected the field to various manufacturing centres to the East and the South. The increasing demand for hard coal was met by the opening up of new pits in the coalfield: between 1852 and 1880 alone, more than 70 new shafts were sunk.

The increase in productivity was also due in large part to the application of modern mining technology, underground production was steadily mechanised, and steam-power was used to an increasing degree, initially only for powering pumping machinery, and then for the first time in 1835 for the sinking of the so-called Altmaschinen-Schacht (the later "Bettina-Eleonoren-Schacht") of the Witkowitz pits in Doubrava. The first steam-powered hoist was installed in 1839 in the "Anselm-Schacht" in Petrkovice, and in 1842 a steam-powered hoisting engine was installed at the Wilczek Theresien-Schurfschacht. From the 1860's, all the large pits made use of steam engines for the transport of coal and the pumping of water, and with the increasing depth of the shafts, steam-driven lifts and cages were introduced, the first in 1872 in the Wilczek pit at Trojice. In the 1860's, the average shaft depth was around 150 m, while Jindrich, the deepest shaft, reached a depth of 209 m. In the 1870's, the average shaft depth had already increased to about 200 m, with the greatest depth being achieved by the 295 m-deep Hermenegilde shaft. In 1895, the average shaft depth had attained 350 m.

The technical progress of the mining in the Ostrau-Karwin coalfield was not due solely to the changed market and demand structure, but also, and to a decisive extent, to the new company and ownership conditions. Although it had been the nobility who had initially been the only businessmen in mining, middle-class businessmen had also been investing to an increasing degree since the end of the 1840's, amongst them the Rothschilds, who in 1848 had taken over the Witkowitz iron works through Salomon M. Rothschild. In the 1850's, their pits were producing almost half the total output of the Ostrau-Karwin coalfield, and by the beginning of the 1880's, their share stood at 53% for coal, and as high as 65% for coke production.

Such family businesses determined the development of mining in the Ostrau-Karwin coalfield until well into the 1870's, but then – with the boom in the coal and iron industry after the turn of the century – the form of the companies began to change: the share of the unions and joint-stock companies in particular in the total production increased sharply, until in 1914 the joint-stock companies were able to increase their production to almost half of the total annual output. From the 1880's until the outbreak of the First World War, the Ostrau-Karwin coalfield was economically the most important coalfield of the Habsburg Monarchy.

The rapid development of the Ostrau-Karwin coalfield suffered a sharp reverse due to the First World War and the resulting political and economic changes, while the pressure from the competition from neighbouring fields was increased. In the 1920's, the following mining companies were operating in the coal industry of the field: the Johann Wilczekschen Kohlen- und Kokswerke in Slezská Ostrava, the Witkowitzer Steinkohlengruben in Mährisch Ostrau, the Larisch-Mönnichsche Kohlen- und Kokswerke in Karvinná, the Steinkohlenbergwerke Orlau-Lazy in Doubrava, the Ostrau-Karwiner Montangesellschaft in Petrvald, the Zwierzinasche Steinkohlen-Gewerkschaft in Slezská Ostrava, the Ferdinands Nordbahn-Gruben in Mährisch Ostrau, the Berg- und Hüttenwerksgesellschaft in Brünn (Mähr. Ostrau) and the Staatliche Bergdirektion (Grube Václav) in Poruba. The development of these companies, their organisation, facilities and technical equipment have been thoroughly described by Voralék (1928) and Capek (1929).

Between the two World Wars, the coal and steel industry developed to a size so far unheard of: investment in mining and smelting continued to grow, while the occupation of the coalfield by Germany lead to a further increase in production from the mines, although at the expense of organisation, equipment and safety. After the end of the Second World War, the coal and steel industry of the Ostrau-Karwin coalfield assumed a special importance in the creation of the new state of Czechoslovakia. After 1948, a totalitarian economic system was created on the Soviet pattern, which was accorded decisive importance by the heavy industry of Ostrau in the implementation of the so-called steel plan. In the years 1964 to 1970, significant restructuring was carried out in the coalfield: 13 pits and three coke plants were modernised, and nine new mines and five processing plants were to be constructed, although this ambitious investment programme was only partially implemented. Nevertheless, due to the priority given to the basic materials industry, the work force of the coal and steel industry grew over the period from 1947 to 1990 from 83,000 to 220,000. In 1945 a technical college for the industry was established at Ostrava.

The political changes of November 1989 lead to a comprehensive restructuring of overall economic life, during the course of which heavy industry has also been privatised. This change, coupled with the separation of Slovakia from the Czech Republic, brought about a dramatic downturn in mining, which continues to the present day.

Technical monuments

The appearance of Ostrava today is still characterised by its history of heavy industry, and evidence of hard coal-mining in particular is present everywhere. A series of mine and pit systems, whose origins sometimes extend well back into the 19^{th} Century, are threatened with the prospect of falling into decay due to the closure of unprofitable operations. Unfortunately, this also affects many valuable, irreplaceable pieces of earlier industrial architecture. As part of a monument preservation programme, some items mining equipment worthy of protection have been inventoried since 1987 and marked for preservation, although such efforts have only been partly successful. The **Anselm Schacht**, which had to be shut down in 1991, was selected as the site for the central mining museum for the Ostrau-Karwin coalfield: the surface facilities have in the meantime been converted for display and exhibition purposes, and underground operations will be displayed in a simulated "Display Mine" above ground. The progression and history of mining in the area is documented by instructional tours around the exhibits. The outstanding monument of the mine and the symbol of the mining history of Ostrau is the steel pithead gear and tower, which was built in 1914/1915, and around which cluster the restrained "Jugendstil" forms and the New Utilitarianism styles of buildings such as the machine room (1914/1915) with its steam-engine, the boiler-house (1908 and 1936) and the administration building (1919). Further parts of the facilities date from the 1920's, although the pithead buildings also include some dating from the 19th Century – such as the old administration building erected in 1897, or the wash-rooms built in 1898.

Another notable monument to mining in Ostrau, besides the Anselm-Schacht facilities, is represented by the equipment and facilities of the **Alexander-Schacht:** its surface facilities with the central "cour d'honneur" reflect particularly the influence of baroque architectural elements in the industrial architecture of the Ostrau-Karwin coalfield in the last quarter of the 19th Century. The pit workings are dominated by the pithead gear of the ventilating shaft with the shaft gallery, the gallery of the air-supply shaft, the compressor house, boiler-house and chimney, together with the lamp-room, wash-room, smithy and the administration building. Amongst the technical equipment which has been preserved is the flame tube boiler made by Breitfeld and Danek (1898/1900) and a turbo-compressor built in 1921 by the firm of Skoda.

Just as noteworthy as a group are the surface workings of the **Michal-Schacht** of the Petr Cingr pit. These mine buildings, designed by the architect František Fiala, form a discrete and complete architectural and technical unit. Due to the unchanged architectural style which has survived to this date, they represent a monument to industrial architecture worthy of preservation, consisting of the pithead gear built in 1913 to 1915, with the pithead buildings and machinery house, the wash-rooms, also built in 1913 to 1915, the administration building, the workshop and the old boiler-house. The original technical equipment includes two hoists (Siemens-Schuckert-Werke, 1912), an electric turbo-compressor made by G.M. Jaeger & Co, Leipzig (1913), two reciprocating compressors (one made by the firm of Skoda from the year 1927) and a flame tube boiler by Breitfeld and Danek (1907). These buildings and equipment are considered as definitely worthy of preservation by the Czech authorities, and due to the extraordinary architectural significance, it is hoped to convert the buildings for cultural and social purposes.

A further notable monument of Ostrau hard coal-mining is the **Jindrich Schacht** of the Oder pit ("Odra"). Following the closure of the mine, the steel pithead gear and the shaft gallery, which are now located in the centre of Ostrava in the immediate vicinity of a large hotel (!), were preserved as monuments, although the grouping looks completely "lost" and out of place in the middle of the completely redesigned coal and steel district.

Other valuable mining monuments take the form generally of smaller groups of buildings with notable pithead-gear towers and (steam) hoists, whose preservation should be encouraged, above all for reasons of town-planning, but whose long-term survival is by no means ensured. Amongst these are the pithead gear and machinery of the Terezie and Michal pit facilities. The **Terezie Grube** (Petr Bezruc-Grube, Ostrau) has two pithead towers set at an angle of 90° to each other, and dating from the years 1901 and 1917, with the associated winding gear and auxiliary equipment from the same period, together with an impressive steel pithead tower, which stands in lively contrast to the older pithead gear and dominates the Trojice valley.

Consideration is being given to converting the tower into a viewing platform or panorama restaurant.

Near to the Ostrava town-centre and in the immediate vicinity of the Vitkovic steelworks stand the surface facilities of the **Hlubina-Grube.** Amongst the most notable features of this pit are the pithead tower, as a dominant landmark of the town, the wash-room, the boiler-house and the compressor building with parts of the original machinery from the 1920's. Consideration is being given to combining the site of the Hlubina-Grube and the Vitkovic steelworks, including the blast furnaces, into an open-air museum.

Also worthy of mention are the surface facilities of the **Vrbice** (Oder-Grube) ventilating shaft next to the railway line from Ostrava to Bohumin: the shaft building with its beautiful brick architecture is one of the best examples of the industrial architecture of the Ostrau-Karwin coalfield, whose quality is acknowledged well beyond the boundaries of the coalfield. It dates, like the pithead gear, from the year 1913, and the associated electric hoist made by AEG Union (1916) is thought to be the only one remaining in the Ostrau-Karwin coalfield which has been fitted with an asynchronous motor. The future of this shaft system is uncertain.

Attention should also be drawn to the other historical buildings and artefacts at ventilating shaft No. 3 of the **Jan Sverma-Grube** (near the main station in Ostrau), with its pithead gear, the shaft gallery, the machine room and the ventilator building, together with the hoist from the years 1898 to 1905, to the **Schacht Louis** (at Vitkovice) and to the **Hermenegild-Schacht** of the Zárubek-Grube in Ostrau with its wash-room (1911 to 1914), its early hoist by Siemens-Schuckert (1912), the reciprocating compressor (Siemens-Schuckert-Werke, 1912) and the electric turbo-compressor (Skoda, 1925).

Less significant (individual) items can be found at the **Oskar-Schacht** (at Lidicim, Petrkovive), the **Maria-, Michalka-** and **Jiri- Schacht** (all in Slezska-Ostrava). A notable feature is also the large number of historical (steam) hoists and compressors in the Ostrau-Karwin coalfield from the early part of the 20th Century: some good examples of these are, amongst others, the machines at the **Ludvik-Schacht** of the Fucik-Grube (1890's) and the **Jakub-Schacht** of the Zárubek-Grube in Ostrava.

In summary, it can be said that the Czech Ostrau-Karwin field offers a great number of very notable monuments, in particular from the early part of the 20th Century. The difficult economic situation of the Czech Republic will not however allow all these monuments to be preserved indefinitely; for this reason, the creation and extension of the mining museum at the Anselm-Schacht are very welcome. A complete mining installation of the size of the Zeche Zollverein has not survived in the Ostrau-Karwin coalfield: the installations at the Alexander-Schacht would perhaps have been most comparable, but in its basic design of a central "cour d'honneur", the "pseudo-baroque" architectural forms and also from the period of its origin, it more closely resembles the pit system of Zollern 2/4 in Dortmund than pit system 12 of the Zeche Zollverein. Unfortunately, the maintenance condition of the Alexander-Schacht leaves much to be desired. Nor do the surface facilities of the Anselm-Schacht bear valid comparison – neither from their general dimensions, nor due to the lack of uniformity of the buildings.

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2.6.1.10 The former USSR

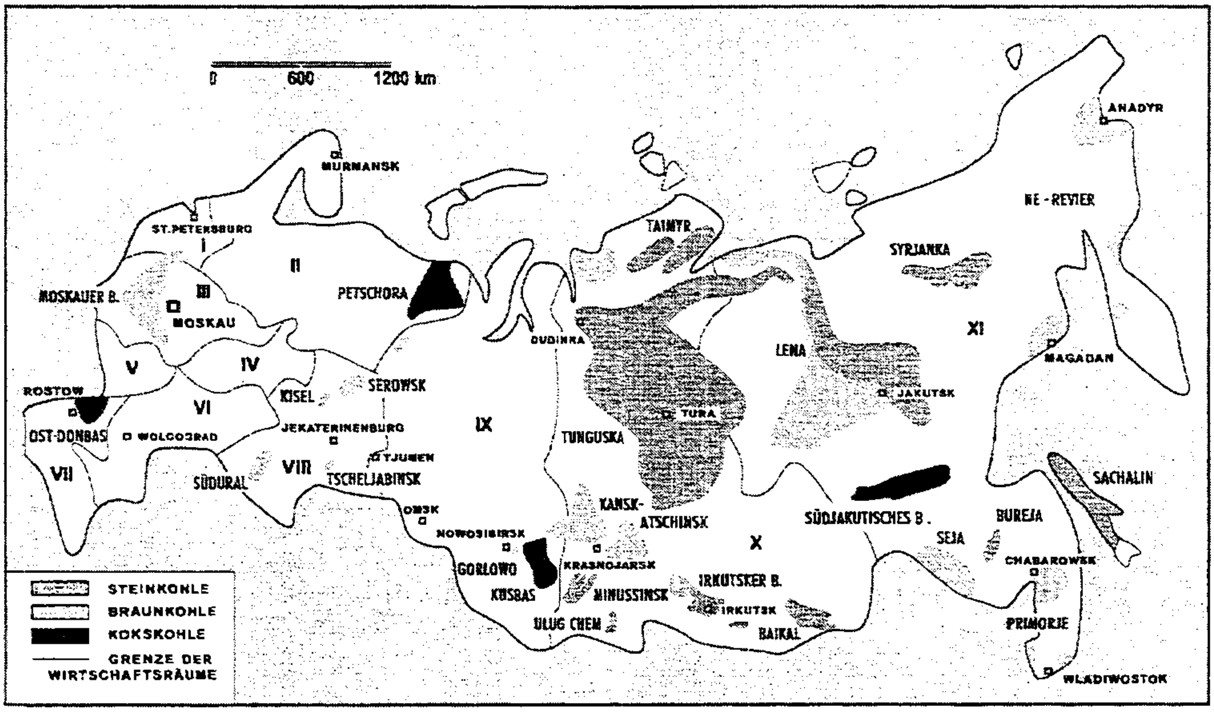
In 1997, the countries of the former USSR together produced over 300 million t of hard coal: in the coalfields of the Russian Federation, 170 million t of hard coal and 70 million t of brown coal were produced, while the Ukraine and Kazachstan produced 74.5 and 70.1 million t respectively. These three countries thus rank among the world's greatest producers of coal.

2.6.1.10.1 Russian Federation

Within its current territory, Russia has coal deposits of more than 2,962 billion t SKE (1997), which represents the largest total volume of hard coal reserves in the world. These are located largely in unexploited parts of the country, many deposits are distributed unevenly and extensively over the country and 80% of the reserves are to be found in eastern and western Siberia; only about 10% of reserves are located in the European part of Russia where the main consumer centres are found. Only a small part of the confirmed reserves considered to be viable and workable, to a level of about 20 billion t of hard coal (= 16 billion t SKE), is in deposits which have already been opened up or are currently being worked.

The development of hard coal-mining in Russia

Hard coal-mining in the Russian Empire has its beginnings in the Tsarist era, although it continued to have little economic significance throughout the 18th and 19th Centuries. To what degree the Tsarist empire was still a "developing country" in the field of hard coal-mining is demonstrated by the attempt in the years 1860 and 1861 to recruit Ruhr miners in order to open up the hard coal deposits of the Donezk coalfield. In 1895, Russia produced only around 9 million t of hard coal, about half of which came from the Donezk area. The production volumes of Russian or former Russian coalfields and regions shown in the table below reflect very clearly the importance of the individual coalfields for the early industrial coal-mining of Russia. Only in the Donezk coalfield were significant volumes of hard coal produced in the early decades of this century, and the production quantities of the Ruhr coalfield, for example, were not achieved at any time.



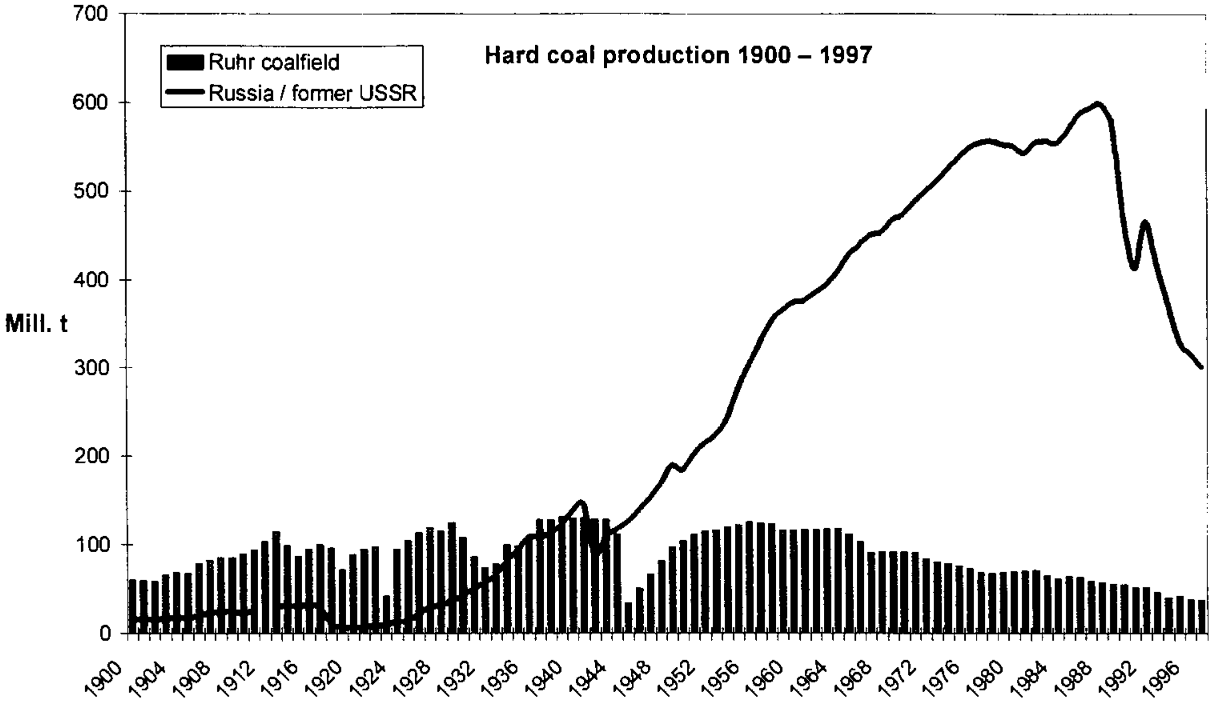
Russia: Regional distribution of the coal basins (from Kelter et al. Figures 3-10, P. 256)

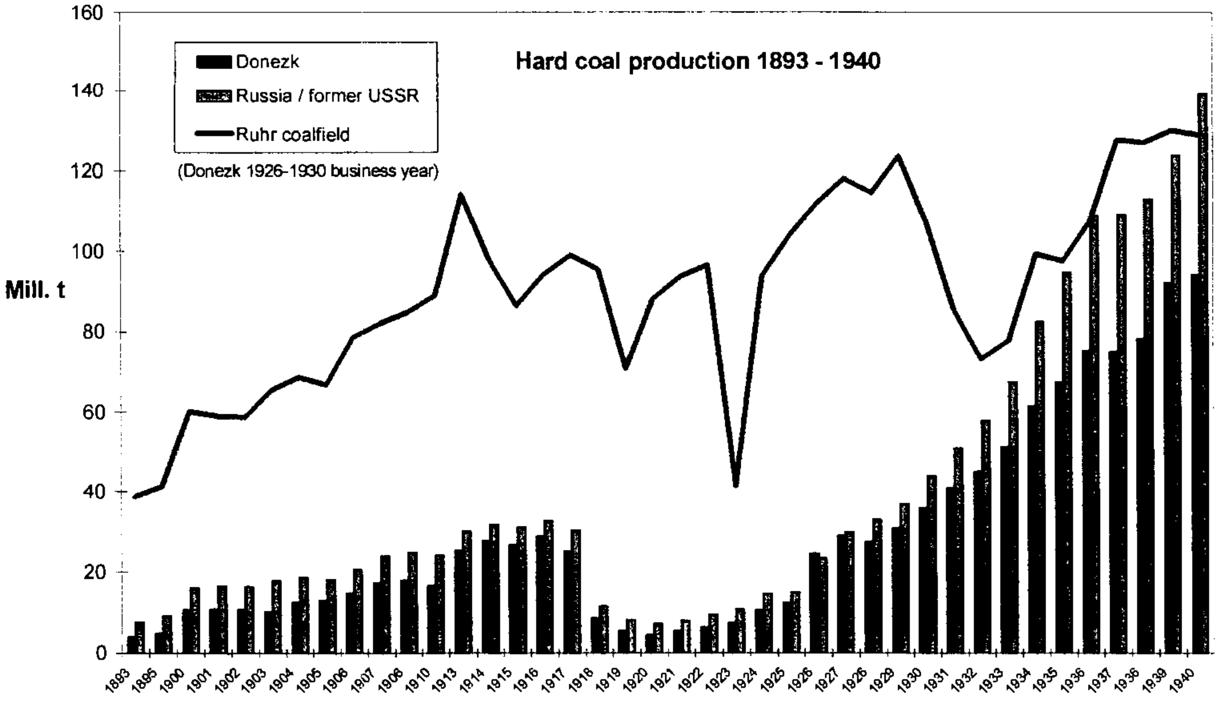
Coal production of Russian coalfields (in 1000 t) from Bubnoff (1923)

	1913	1914	1915	1916	1917	1918	1919	1920	1921
Donezk	25730	27568	26640	28683	25061	8616	5328	4496	5405
Moscow	305	310	461	688	705	399	398	655	697
Caucasus	71	68	75	63	57	N.i.	N.i.	N.i.	N.i.
Urals	1223	1403	1288	1511	1618	606	716	941	1008
Turkestan	140	137	168	201	185	132	180	150	167?
Kirgiz	72?	27	47	75	96	30	40	N.i.	N.i.
Kusnezk	773	857	1133	1184	1255	935	851	896	781
Minusinsk	25	25	33	29	45	18	13	N.i.	N.i.
Ceremchovo	1165	621	682	814?	1146?	802	476	492	474
Trans-Baikal		376	390	543?	573?	N.i.	N.i.	N.i.	N.i.
Amur and coast		438	457	593	540	N.i.	N.i.	N.i.	N.i.
Sakhalin		32?	N.i.	N.i.	N.i.	N.i.	N.i.	N.i.	N.i.

? = figures questionable
N.i. = no information available

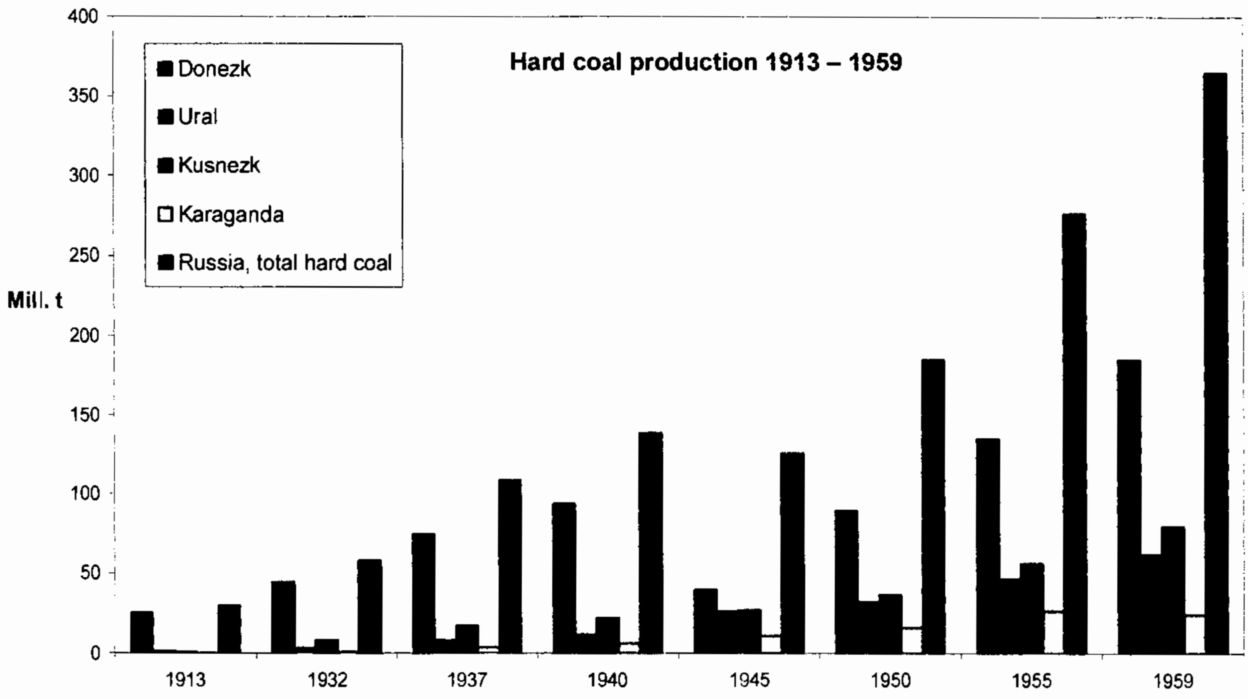
The main cause for the development of the Donezk basin into what was formerly the most important Russian hard coalfield must be regarded as the fact that the main deposits of iron ore in the country were also found in the South, at Krivoy Rog and Kerch. The combination of ore and coal turned the region into the main metal-producing area of Russia, and the part of the country which was most extensively provided with a transport network.





The major part of Russia's supply of hard coal up to the outbreak of the First World War came from the Donezk basin: other hard coalfields provided only low-quality coals and/or their importance for industrial exploitation was still incorrectly evaluated up to the beginning of the 1920's: some examples of this faulty interpretation are above all the deposits of the Moscow basin, the Urals, in Kazachstan (including Karaganda) and the Kuznezk basin, which today is known to contain one of Russia's largest deposits of hard coal. Bubnoff (1923) refers to the significance that should some day be attached to these deposits. Until the more thorough exploitation of the deposits in the second quarter of the 20th Century and later, the hard coal production of this huge country had to play a subordinate role in comparison to that of the

United States of America, England and Germany; to this must be added the fact that for a long time – and despite its low level of industrial development – Russian production did not even meet its own domestic demand: the hard coal deposits of the Urals, the Kusnezk basin and the Karaganda basin did not begin to make a significant contribution to Russian hard coal production until the 1930's.



Because of the unfavourable conditions of the deposits, the low reserves and the low quality of the coal, the Urals, with its important ore deposits, was forced to rely on the import of foreign coal; this lead to the foundation of the Ural-Kusnezk Combine. Its iron-smelting works in Magnitogorsk was to be supplied with coking coal from the 2,400 km-distant Kusnezk basin in Central Siberia, while the coal trains were to transport iron ore to the smelting works of the Kusnezk field as their return cargo. This arrangement was however discontinued after a few years, and Magnitogorsk was connected by a rail line to the coal basin of Karaganda in the Kirgizian steppes of Kazachstan, which was 1,000 km nearer. In addition, hard coal from the Urals was increasingly used, since this could be mixed with the coking coal used in a proportion of up to 30%: this also sparked off increased exploitation and production activity in many smaller southern Ural coal basins around Poltawa, Bredy and Dombarowka.

Since the hard coalfields of Russia, with the exception of the Donezk basin, were only able to achieve real significance for the mining industry at a much later date, this review is restricted to the development of hard coal-mining in the Donezk basin.

Russian coal production in the years following the fall of the Iron Curtain has been irregular. In 1997, the main production came from the coalfields listed in the following table:

In the traditional production regions of Russia, hard coal is mostly obtained by deep-mining, and in the southern Yakutzk basin and increasingly in Kusbass by surface operations and shallow mining down to a depth of 200 m. The average depth of deep-mining operations is 400 m; in the E-Donezk basin, the average depth is 625 m, although working levels of over 1000 m have been reached in five mines. The seams have an average thickness of 2.3 m.

From 1990 to 1996, the hard coal production of the Russian Federation dropped by 90 million t, from 257 million t to 167 million t. The share of coal as a primary source of energy decreased from 30% in the year 1990 to 13% in 1996 due to falling industrial and energy production. The causes for the drop in coal production can be found not only in the industrial stagnation which is occurring, but also in the deterioration in the economic relations of the CIS states with one another and the change-over of consumers to the more economical fuel of natural gas. The Russian hard coal industry is currently in a state of severe crisis.

Coal production in the major coal basins of the Russian Federation 1997 (from Kelter et al. 1999)

Coal basin	**Region / Economic area**	**Largest companies (selection)**	**Production (millions t)**
Kusbass (Kusnezk) (provides 70% of Russian coking coal)	Kemerowo/Western Siberia district	Belowougol Kusbasrasresugol Jushkubasugol Prokopjewskugol Kusnezkugol	93.9
Baikal	Tschita/Eastern Siberia district	Wostsibugol	40.5
Kansk-Atschinsk	Krasnojarsk/ Eastern Siberia district	Krasnojarskugol	35.1
Petschora	Komi/North Republic	Workutaugol Intaugol	21.0
E-Donezk (E-Donbass)	Rostow/North Caucasus district	Rostowugol Gukowugol	14.1
Irkutsk	Irkutsk/ Eastern Siberia district		12.4
Primorje	Primorje/Far East	Primorskugol	11.3
Southern Yakutsk basin	Sacha/Far East Republic	Jakuyugol	10.4

Since 1992, the coal mines which belonged until November 1997 to the state holding company "Rusugol" have been reorganised into joint-stock companies. Rusugol itself has in the meantime been liquidated, and its main responsibilities have been taken over by the Ministry of Fuel and Energy. A programme for the restructuring of the Russian coal industry has been underway since 1993, with considerable support from the World Bank, with the aim of creating competitive, profitable companies and reducing state subsidies.

As part of this programme, the number of coal mines has been reduced over recent years. In 1994, 301 companies were still in operation, which were categorised as follows with regard to their future viability:

Priority companies:	47 deep mines, 19 surface mines
Stable companies:	103 deep mines, 45 surface mines
Unprofitable companies without any prospects:	85 deep mines, 2 surface mines

At the end of 1996, Rusugol still numbered 239 active operations, comprising 176 deep mines and 63 surface mines, and the closure of 86 of the 200 or so coal pits was planned for 1998. At the same time, the privatisation of profitable operations was to be continued, although this caused considerable controversy.

In line with the closure of pits, the work force of the Russian coal industry has been reduced from 908,000 (in mid-1993) to 518,000 (in mid-1997). In the Kusbass coalfield alone, 17 pits have been closed since 1994, making 17,000 miners redundant; 35,000 more people also lost their jobs in the mining supply industry.

To replace the unprofitable mines which have been closed, six new deep mines and nine surface mines are being opened up.

Another major problem of the Russian coal industry is the transport costs. In Russia, coal is usually transported by rail. In 1997, the average distance that coal had to be transported was 1,300 km. Because of the great distances between the production centres and the main points of consumption, together with the drastic increase in rail charges, transport costs have in recent years exceeded the production cost of coal at the pithead. In order to counteract this, the Russian Government in 1998 decreed a 25% reduction in rail charges for various fuels and raw materials, including hard coal.

Export volumes have also dropped sharply in the same way as Russian coal consumption. In 1990, coal exports still totalled 50.3 million t, but by 1997 this figure had dropped to only 21.6 million t. Russia is nevertheless still one of the world's leading exporters of coal. The coal exported is mainly high-quality coal from the Kusbass coalfield, the southern Yakutsk basin, the Petschora and the E-Donezk basins. In 1997, coal exports went mainly to Japan, Turkey, Ukraine and a series of other smaller consumer countries.

Technical monuments

Since most of the "historic" coalfields of the former USSR are now in the Ukraine, hard coal-mining in the Russian Federation has a relatively recent history: it can therefore not be expected to find any mining facilities along the lines of the Zeche Zollverein. Interviews with members of German mining companies who have had the opportunity to see and visit Russian coal mines lead to the unanimous conclusion that although some truly monumental mining facilities have indeed been created (above all in the Stalinist period), none bear comparison to the Zeche Zollverein – e.g. the pit systems of "Okt'jabrskoe" of the "Donezk-ugol" company, the "Komsomolez Donbassa" of "Šachërskantrazit", the "Sudzenskaja" in the donbass coalfield, the "Raspadskaja" and "Kapital'naja" of the "Juzkuzbassugol" company or the "Mezdurecenskij" mine of the "Kemerovougol" company. The majority of Russian surface facilities – in all coalfields – are relatively simple constructions which have been adapted to the harsh climatic conditions. In addition, most are said to be in poor repair. This evaluation is supported, for example, by a review of the literature below on Russian mining architecture.

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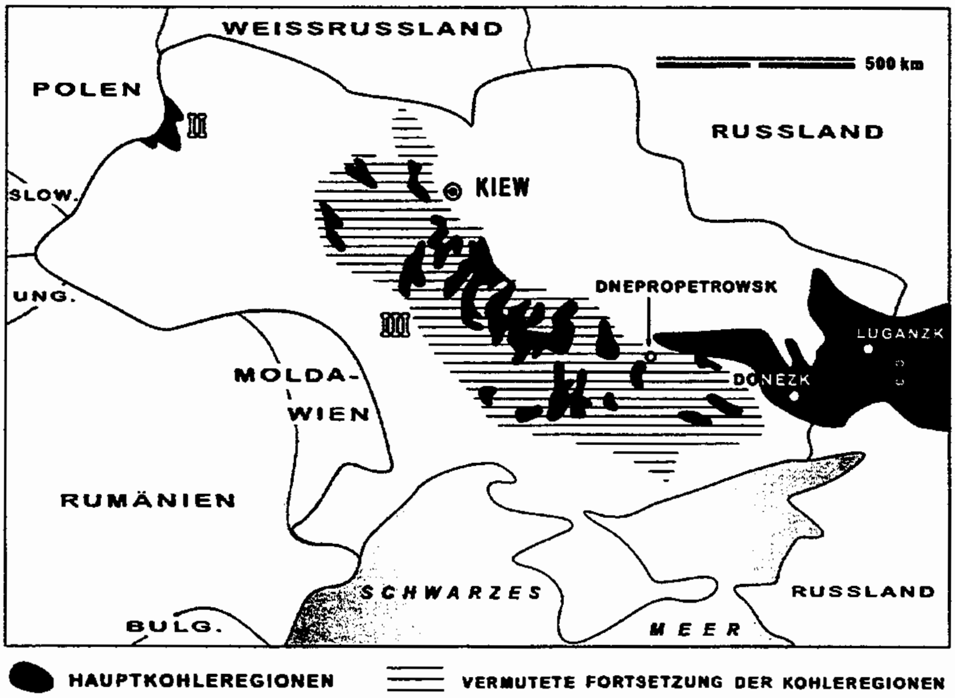
2.6.1.10.2 Ukraine

With over 6.5 billion t SKE (1997) of exploitable, viable reserves of hard coal, a substantial part of the economically minable coal reserves of the former Soviet Union now lie within the territory of the Ukraine.

The main production centre of the country is the Donezk basin (Donbass), which in 1997 produced more than 93% (=70.9 million t) of the total Ukrainian production of 75.9 million t, and which in the Russian period was one of the main production areas for hard coal. The remainder of the hard coal production comes from the Lwow-Wolynsk basin.



The three main coal basins of the Ukraine: I Donezk basin (hard coal), II Lwow-Wolynsk basin (hard coal), III Dnepropetrowsk basin (brown coal), (from Kelter et al. 1999, Figures 3-18, P 274)

The Donezk hard coal basin lies in the (Ukrainian) regions of Dnepropetrowsk, Donezk and Lugansk and in the (Russian) region of Rostov on Don. These deposits cover an area of 60,000 km^2, of which 23,000 km^2 have only thin strata of more recent deposits. The 15 coal-bearing strata of the carboniferous layers contain up to 300 seams, of which 100 have a thickness of from 0.45 to 2.5 m. The industrially exploitable coal-bearing seams of the lower carboniferous layer are distributed throughout the north-west part of the basin, while in other parts of the basin they have practically no economic importance. The coal-bearing strata mainly adjoin the widespread middle carboniferous layer, which contains 20 coal seams with a thickness of over 1 m. The coal-bearing layers and the number of seams decreases from the centre of the field towards the edge and towards the east and North. Down to a depth of 1,500 m, the coal-bearing density averages 2 million t/ km^2. Besides brown coal and anthracite, the Donezk basin contains a wide range of hard coals of widely varying quality.

The development of hard coal-mining in the Ukraine

The discovery of deposits of hard coal in the Donezk region goes back to the time of Peter the Great (around 1722). The deposits of Lisicansk and Gruševka which were being mined at that time also contributed significantly to production later, although they had largely lost their dominant economic position by the first decades of this century. The reason for the interest in this coal at the time lay in its importance as a fuel, since the southern part of Russia was already short of forests at that time. Nevertheless, production remained very restricted during the 18th Century. This was due above all to the inability to organise the proper distribution and use of the coal. A certain increase in production could be noted only at the end of the 18th Century, which was brought about by the founding by Count Potemkin of the Luganski smelting works, which was constructed on the basis of the local availability of both iron ore and coal. The first production figures available also cover the period from 1796 to 1806 (39,613 t).

In the first decades of the 19th Century, the hard coal demand of the Luganski works was the main market for the production from the Donezk basin. In 1806, 73% of the production went to Lugansk, and in 1839, the figure was still 47% (the total production for this year is estimated at 14,346 t). The importance of private consumption and the demand of steam shipping on the Black Sea were however already making themselves felt: when it was discovered, at the beginning of the 1840's, that the anthracite coil from the eastern part of the basin could also be used for firing steam boilers, coal production took a dramatic upturn. Within ten years, the anthracite mines increased their output from 245 t to 19,656 t. This completely transferred the focus of production to the eastern part of the basin, and the western hard coal-producing area was threatened with complete closure, although this danger was averted. In this connection, a great role was played by cheap English coal, which was brought in by English ships as ballast and sold in the Black Sea ports of the Ukraine at "dumping prices". As the mines subsequently increased their production, hard coal prices began to drop at the end of the 1840's; the coal industry recovered only slowly from the economic crisis which now set in.

By the middle of the 1840's, there were 51 pits in operation in the Donezk region, compared to 23 in the year 1823. These mines were mainly small, private operations, and this characteristic of small industry persisted in the coalfield until into the 1860's. Mining and production was carried out by simple manual labour, without any mechanisation, and the situation of the workers was pitiful. Production and quality of the coal was irregular, and hardly suitable for use by large industrial operations, who needed security of supply: the industry was dominated by the speculative tendency of making the largest possible profit with the smallest possible investment.

Until the 1870's, the main consumers of the Donezk coal remained the small consumers and the steam shipping of the Black Sea. Although the first mining company to be founded solely for the supply of Ukrainian steam shipping was established in the 1860's, the fundamental boost for the hard coal-mining industry only came with the railway construction of the period 1868 to 1878. At first this lead to a new "coal fever", with many new companies being founded and as many going bankrupt, but then the industry began to adapt itself to this new outlet. The demands of the railways could not be satisfied by the fluctuating quality and quantity of the production of the small operations, and there thus developed a tendency towards the establishment of larger mining operations and the use of the "modern" technology of the time. While in the 1860's no company had been able to achieve an annual production in excess of 16,000 t, this figure was attained in the 1870's by three mines in the anthracite-mining area and by twelve in the hard coal-mining area. By 1878, total production came to 1,131,366 t, of which 683,390 t was produced by the larger mines. Due to continuing railway construction, which had already made the railways the main consumer of coal, the focus of production now swung back again to the western part of the Donezk basin. A further important role in the positive development of the coal industry was played by the Congresses of the Southern Russian Mining Organisations, which had been held regularly since 1874, and which dealt with transport, labour and customs matters.

In the 1870's and 1880's, a dangerous development occurred for the continued growth of the Donezk coalfield, in the form of increased imports of foreign coal, mainly from Austria and Silesia: in the year 1866, such imports only amounted to 650,000 t, but by 1879 they had risen to 14,752,810 t, and were putting pressure on prices. It was only the discovery of ore in the Krivoy Rog region in the 1870's and the development of the iron industry in the southern Ukraine which created new markets for the Donezk coal, bringing about an enormous increase in production, which persisted until the First World War. The growth of the iron industry went hand in hand with the increase in coke production and the development of various by-products; the first efficient coke furnaces came into operation in 1907, and 659 were already in use by December 1912.

Hard coal regions in the Donezk basin (from Bubnoff (1923()

Region	**Number of pits**	**Coal production 1914 In 1000 t**
Hard coal		
Lisicansk	12	586.40
Marievsk	**26**	**2131.00**
Almasnyi	17	2784.60
Slavjanoserbsk	9	615.90
Central region (inc. Debalzevsk)	20	3451.30
Grišino	7	98.30
Jusovski	9	2475.00
Makejevski	28	4304.66
Belokalitvenski	5	181.80
		16628.96
Anthracite		
Cistjakovski	18	683.00
Bokovo-Chrustalski (inc. Petrvenski)	34	1423.40
Dolzanski (inc. Kartušinski)	8	684.80
Sulinski	17	52.40
Gruševski	30	1239.95
	240	**20712.51**[1]

[1] This listing does not include the mines' own consumption or the production that was turned into coke at the pits, so that total coal production for 1914 would be about 6.4 million t higher, at a total of about 27 million t.

The last two decades of the 19th Century and the years up to 1914 were marked by a steady growth in coal production; the main consumers were the railways and the smelting works. The statistics for the Donezk basin for the year 1913 record a total of 216 mines, of which 116 were producing hard coal and 100 anthracite, and in the years 1913 and 1914, a further 13 hard coal pits and 11 anthracite pits were added with a total of 104 shafts.

In 1912, the existing pits were split up into 36 joint-stock companies and a series of smaller mining operations. Of the joint-stock companies, 25 worked with foreign capital, mainly from France and Belgium, which with 12 million t controlled around 70% of the production. In these years before the outbreak of the First World War, there were already 71 mines with an annual production of over 82,000 t, and in 1914 there were already 1,008 recuperating furnaces in operation in the coke-works.

Work force in the coal-mining industry (in 1000) from Bubnoff (1923) and Huske (1998)

	Donezk coalfield	Ruhr coalfield
1911	132.5	360.9
1912	140.7	374.0
1913	156.6	444.4
1914	192.3	385.7

Over the course of the First World War, the production level in the Donezk coalfield remained about at the level of 1914, despite the increased demand. In 1917 an economic downturn set in, brought about by the revolution and the economic problems of the war, which continued even more severely after the end of the war. Production was hardly enough to cover the sharp increase in demand for domestic coal caused by Russia's isolation from the rest of the world. Northern Russia in particular and St. Petersburg, which had previously been supplied with English coal, was forced to rely completely on hard coal from the Donezk basin, and the railways too required considerably greater supplies of coal. The Civil War completely destroyed the economic importance of what had once been Russia's principle coalfield. The consumption of the pits themselves rose from 8% of their own production (1914) as high as 94% by the second half of the year 1921, so that some pits were consuming almost all their own production themselves.

After the end of the First World War and the October Revolution, the mining industry of the Donezk coalfield found itself in a lamentable condition: in 1920, 723 out of the 1604 shafts were out of operation, of which 256 were flooded and 180 were without a work force. Most of the pits had a depth of up to 100 m, and about a dozen were deeper than 400 m. The surface workings were constructed mainly of wood, only 122 had a steel skeleton framework and 142 were built of stone, large parts of the technical equipment were missing or not in working order, with the result that a further decline in the mining industry could only be averted by concentrating production at the best-equipped and most efficient pits. In the course of the nationalisation of the mining industry which was carried through in the year 1920, only 14 of 61 operations were continued without major restructuring measures, 22 pits had to be renovated at considerable cost, and the remaining 25 were closed down. The other, non-nationalised pits played no further role by the beginning of the 1920's being mainly small, private operations run by farmers.

Nevertheless an increase in production was achieved in 1921 over the previous year, despite the tremendously difficult conditions; the wrecked transportation system however could not handle the onward shipment of production, and most of the coal produced had to be stockpiled.

In the following years, the coal-mining industry of the Donezk coalfield gradually recovered under the state planned economy. In the Second World War, the coalfield was occupied by German troops, and the Russian leadership was forced to attempt to meet its requirements for hard coal from the Kussbass basin and the Urals. These fields had only been in production since the 1930's, and had so far been little used, and great efforts were made to open up more mines. Following the end of the Second World War, extensive restructuring and reorganisation measures were again undertaken, although the poor economic management of the 1980's in the Soviet Union placed the coalfield in severe difficulties. After the separation of the Ukraine from the Russian Federation as a result of the collapse of the Soviet Union, the Donezk coalfield has gained new and decisive significance as the Ukraine's largest mining area in supplying the energy requirements of this young state.

In 1992, the coal from the Donezk coalfield was produced in 22 production units comprising 253 deep-mining pits, while in the Lwow-Wolynsk hard coal basin there was only one production unit with 17 deep-mining operations. More than 40% of the pits had a production capacity of more than 2,000 t/day, and provided 62% of the overall production. Only 8% of total production came from pits with production capacities of over 5,000 t/day.

The average depth of the workings is currently 690 m, and the maximum depth 1,400 m. Many of the pits produce their coal from depths below 1,000 m. The working conditions in the Donezk coalfield are difficult, and are becoming increasingly more complicated: about 100 pits are in danger from pit gas, and in 106 pits, seams are being worked which are at risk from rock burst. The temperature of the surrounding rock at depths below 1,000 m is between 45°C and 50°C. The available mining technology can do little or nothing to compensate for these difficult production conditions. The deterioration of the geological conditions, the drop in performance of more than 12 t of production per man per month in 1997 as against 1989 and the dilapidated condition of the facilities and equipment have caused costs to increase further, to the extent that the production costs in the Ukraine are about double that of the current world market price. The result has been the curtailment of subsidies for the coal-mining industry and the increase of industrial prices.

In 1996, there were 250 pits still in operation in the Ukraine, of which 80% have undergone no significant modernisation for more than 20 years. Only 57 use modern technology in order to achieve profitable production, the majority of the shafts are in need of comprehensive reconstruction, and from a technical and economic point of view, many of the pits should really be shut down. In 1998 alone, 70 uneconomical hard coal pits registered a loss of 136 million US Dollars.

Although 300 million US Dollars was provided by the World Bank at the end of 1996 in order to support reconstruction and closure measures, and the EU has developed an aid programme, only two pits were shut down in 1996, with a few more in 1997. The planned shutdown of production at all 70 loss-making mines was blocked by the objection of the trade unions. At the moment, the closure of 11 pits has been announced. The large state subsidies are going to pay off outstanding debts and invoices.

As a result of the developments described above, annual coal production in the Ukraine has dropped sharply in recent years. While 189 million t were produced in 1985, the figure ten years later (1995) was only 83.8 million t. The production of 79.9 million t in 1997 indicates a certain stabilisation at a low level, although this production volume is not sufficient to meet the Ukraine's own consumption. For this reason, exports in 1997 came to only 2.2 million t, as against imports of 9 million t from the neighbouring countries of Russia and Poland. 60% of the coal is used in the Ukraine for electricity production, and 40% for the production of coke for the metal-working industry.

Technical monuments

Monuments to the hard coal industry are unknown so far in the Ukraine. The production volumes of the Donezk region (1921: 5.4 million t) leave little room to expect that any mining facilities even remotely comparable to the Zeche Zollverein could have existed. This estimate is confirmed by the reports of visitors to the mining installations in the Donezk region.

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2.6.1.10.3 Kazachstan

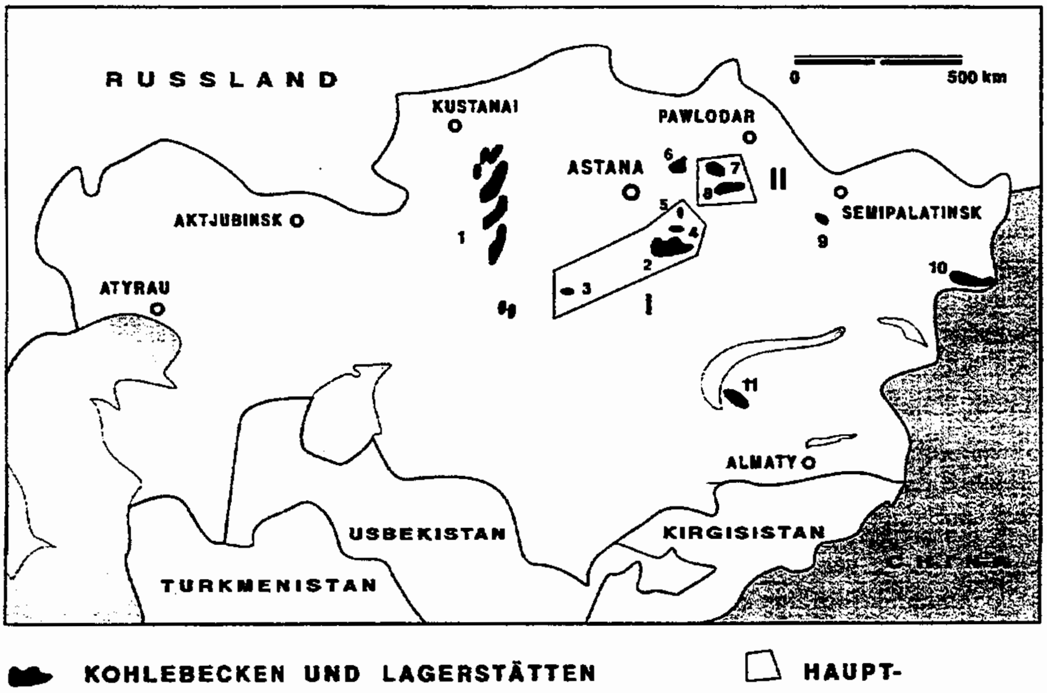
With just over 6.2 billion t SKE (1997) of viable, exploitable hard coal reserves and an annual production of 72.6 million t of hard coal, Kazachstan is one of the three main coal-producing countries of the CIS. As far as is known, Kazachstan has six major coal basins and over 300 individual deposits, of which about 50 are economically important.

The main production regions for hard coal are the areas around the regional capital of Karaganda and Ekibastuz in the Pawlodar region. Both of these coalfields lie in the infrastructurally developed regions of Central and Northern Kazachstan, and together provide 95% of the coal production of this new country.

The Karaganda coalfield is the only one in Kazachstan which produces coking coal: the 24 shafts and three surface mining operations of the coalfields of Kuutscheku, Borly and Schubarkol produce hard coal, of which more than 60% is used, both in the country itself and in Russia, as coking coal and boiler coal. The production depths in this coalfield lie between 400 m and 850 m. The total seam thickness worked amounts to 45 m in the deep mines of the Karaganda basin and from 30 m to 90 m in the surface mining operations.

With an annual production capacity of currently just on 115 million t, the

Ekibastuz/Majkuben coalfield is one of the largest surface mining operations in the world. The three surface mines of the Ekibastuz basin produce hard coal, and the single surface mine of the Majkuben basin (the Schoptykol deposits) produces hard brown coal, which are used as boiler coals in the large power stations of Central and Northern Kazachstan, as well as in the Urals and Western Siberia in Russia. The total seam thickness worked amounts to 150 m to 200 m in the Ekibastuz basin (three seams with a thickness of from 20 m to 108 m) and from 25 m to 100 m in the Majkuben basin.



(COAL BASINS AND DEPOSITS) (MAIN PRODUCTION FIELDS)

Coal deposits and production fields in Kazachstan (from Kelter et al. 1999, figures 3-19, P. 275):
Main production areas: I Karaganda, II Ekibastuz
Coal basins and deposits: 1 Turgaj basin, 2 Karaganda basin, 3 Schubarkol deposits, 4 Kuuscheku deposits, 5 Borly deposits, 6 Teniz-Korshunkol basin, 7 Ekibastuz basin, 8 Majkuben basin, 9 Jubilejnoe deposits, 10 Kendyrlik deposits, 11 Nishneilijsker basin.

Development of the coal production of Kazachstan 1990-1997 in million t (from Kelter et al. 1999)

	1990	1991	1992	1993	1994	1995	1996	1997
Karaganda	48.7	46.9	43.3	37.4	32.1	19.4	17.8	19.7
Ekibastuz	81.9	82.8	82.2	73.1	70.8	62.2	56.4	49.6
Other fields	0.8	0.7	1.9	5.5	1.7	1.7	2.6	3.3
Total production	**131.4**	**130.4**	**126.5**	**111.9**	**104.6**	**83.4**	**76.8**	**72.6**
Of which hard coal	128.0	126.5	122.2	107.2	99.8	79.6	73.2	70.1

The development of hard coal-mining in Kazachstan

In 1988, a total of 143.1 million t of coal were produced in Kazachstan, and since then the production level has been dropping, although the production capacity could allow significantly higher production. For 1995, a production capacity of 165 million t was set, but in 1998 the actual utilisation of this production capacity was only 44%. Among the many problems responsible for this low level of utilisation of the available capacity are distribution problems, payment difficulties on the part of consumers, the curtailment of subsidies, strikes and financing problems in the areas of mine safety, mining technology and modernisation.

The privatisation of the Kazachstan energy industry has today been largely completed. The companies now operating want to supply their smelting works and coal-fired power stations with domestic coal, and also achieve profitable coal exports. In the Karaganda region, coal production has been taken over, amongst others, by the Karaganda Iron and Steelworks/Termitau "Ispatkarmet" (15 deep pits), Samsung Deutschland GmbH (the Kuutscheku and Borly surface operations) and Global Mineral Reserves USA (Schubarkol surface operations). The large surface-mining operations in the Ekibastuz field are run by Access Industry/USA (Bogatyr surface operations), Japan Chrome Corporation (Wostotschny surface operations) and Energougol/Russia (Sewerny surface operations).

Over the last ten years, Kazachstan's domestic consumption amounted to between 60% and 70% of its annual coal production. The high coal consumption of this Asiatic country is due mainly to energy production (76% of the electricity is generated from coal) and the use of coke for the smelting of ore. In 1997, the industrial consumption was around 80%.

The coal exports of 53.6 million t (1990) dropped to 24.9 million t in 1997, but can, if necessary, be increased to 80 million t/year with further rationalisation and modernisation and better utilisation of the available capacity. The main customer for Kazachstan coal exports is Russia, with a share of 98% in the year 1997.

Technical monuments

There is no information on the status or existence of any such monuments, although it cannot be expected to find in Kazachstan any monument comparable to the Zeche Zollverein. The short history of coal-mining and the mentality of the Kazachstan/Russian planners of industrial facilities in building for purely functional purposes and in accordance with available financial resources prevent the assumption that any mining facilities similar to the Essen Zeche can be found in this Asiatic country.

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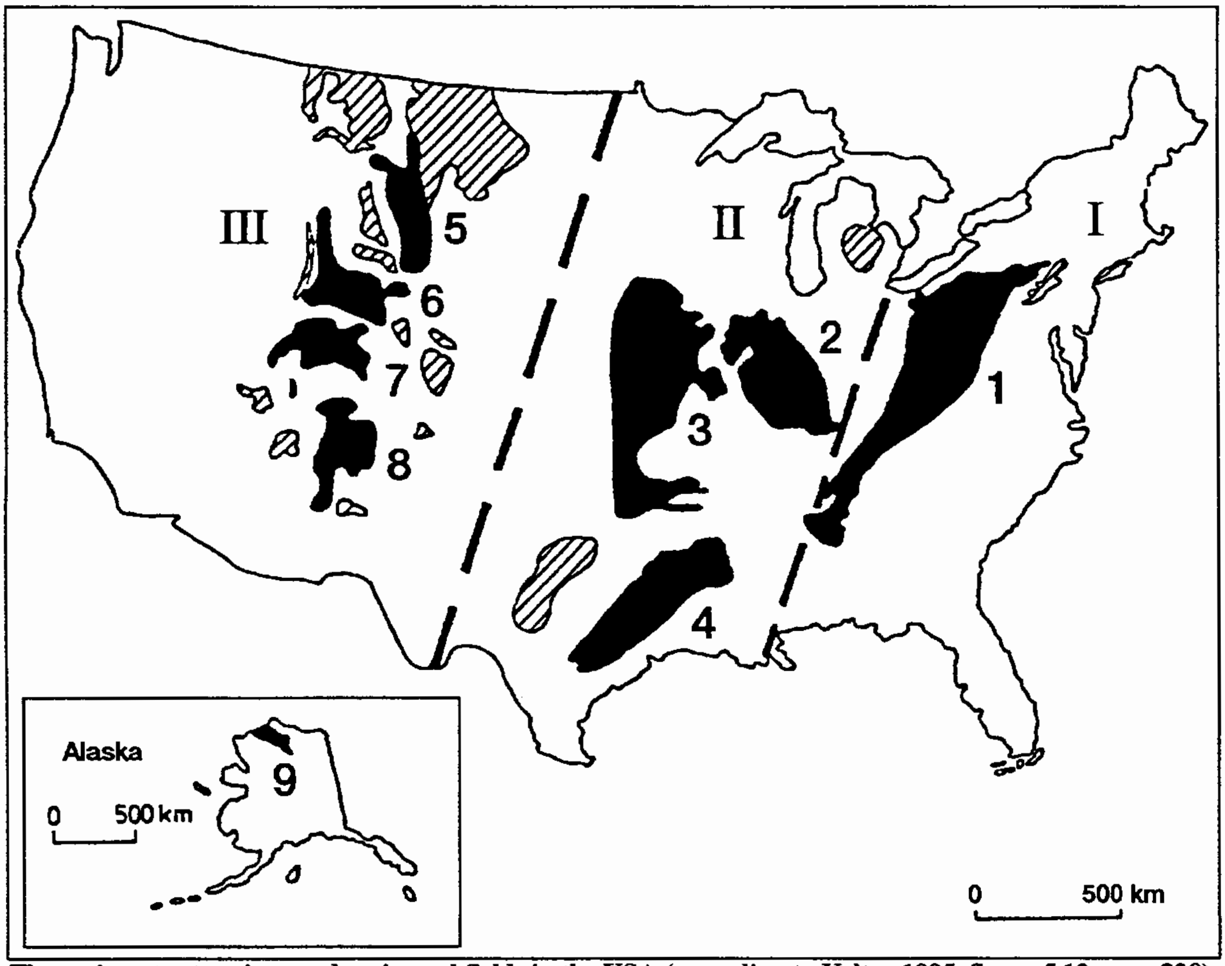
2.6.2 North America

2.6.2.1 USA

The United States of America has the largest amount of workable, extractable hard coal reserves in the world. These reserves are stated to be about 183.5 billion tonnes of SKE, of which about 30% can be extracted cost effectively in open cast mining. With an annual output of 913 million tonnes of hard coal, in 1997 the USA was in second place behind China. The forecasts indicate increasing output.

Special environmental measures have a strong influence on American coal mining. SO_2 output from coal burnt in power stations has been significantly reduced and is to be further reduced in future. For coal mining today this means that more sulphur reduced coal must be produced, that coal must go through extra treatment processes and that flue gas must be de-sulphurised. In view of environmental regulations which are becoming tighter and tighter, combustion and treatment processes will be improved.



The main output regions and main coal fields in the USA (according to Kelter 1995, figure 5.12, page 328)
Main output regions: I Appalachians, II Interior, III West
Main coal fields: 1 Appalachians, 2 Illinois Basin, 3 Western Interior Basin, 4 Texas Louisiana brown coal, 5 Powder River Basin, 6 Green River Basin, 7 Uinta Basin, 8 San Juan Basin, 9 Alaska
Shaded areas = other coal fields and continuation

Coal reserves in the USA are spread right across the country. The main output regions are in the eastern, central and western areas of the country. As well as that there are isolated deposits, often of local importance in nearly every state. Also, coal reserves in Alaska, of which only a small part have been the subject of closer exploration, have been assessed as having great economic significance.

Currently regional changes in output are indicated, i.e. that the output in the west is now exceeding the formerly larger, but in recent years stagnating production of the Appalachians in the east.

Coal production in the USA by regions in million tonnes (from Kelter 1995, Kelter et al. 1999, Mining Engineering Annual Review 1998)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Appalachians	407	421	443	415	415	372	404	395	410	422	418
Interior	175	180	187	177	197	152	163	153	157	156	153
West	279	288	303	311	313	334	370	390	398	410	444

In the **Appalachians** coal mining has been going on for more than 150 years. From Pennsylvania in the NE this seam stretches for more than 1,200 km to Alabama in the SW. The Appalachian basin supplies permo-carbonic hard coal of various coalification grades. In the north the strongly folded eastern region contains high calorie coal. Because of the uniform thickness and the long lateral strength of the seam, this basin is suitable for highly mechanised mining. However, because of the high sulphur content only a small part of the seam is workable and complies with environmental regulations.

The outstanding features of the central area of the Appalachians are a simple geological construction, and the low sulphur content of its safely extractable reserves, most of which can be obtained through open cast mining. In the southern part are seams in the remains of folds the structure of which is awkward because of ground disturbances. The low sulphur open cast mined reserves in the Appalachian region are gaining in importance while the open cast mining of sulphur rich coal is losing ground.

The central part of the USA with the **Illinois Basin, the Western Interior Basin** and the brown coal regions in **Texas** and **Louisiana** are labelled "Interior" in coal statistics.
The Illinois and the Western Interior Basin supply up to 5 m of deep carbonic bituminous coal, which, because of its favourable position enables large mining operations. The Illinois Basin probably contains the largest hard coal reserves in the USA, but, in spite of good transport links, is losing its economic significance because of the high sulphur content of its coal (3% - 7%).

The most significant coal mining areas of the USA are in the west in the Powder River Basin, the Green River Basin, the Uinta Basin and the San Juan River Basin.

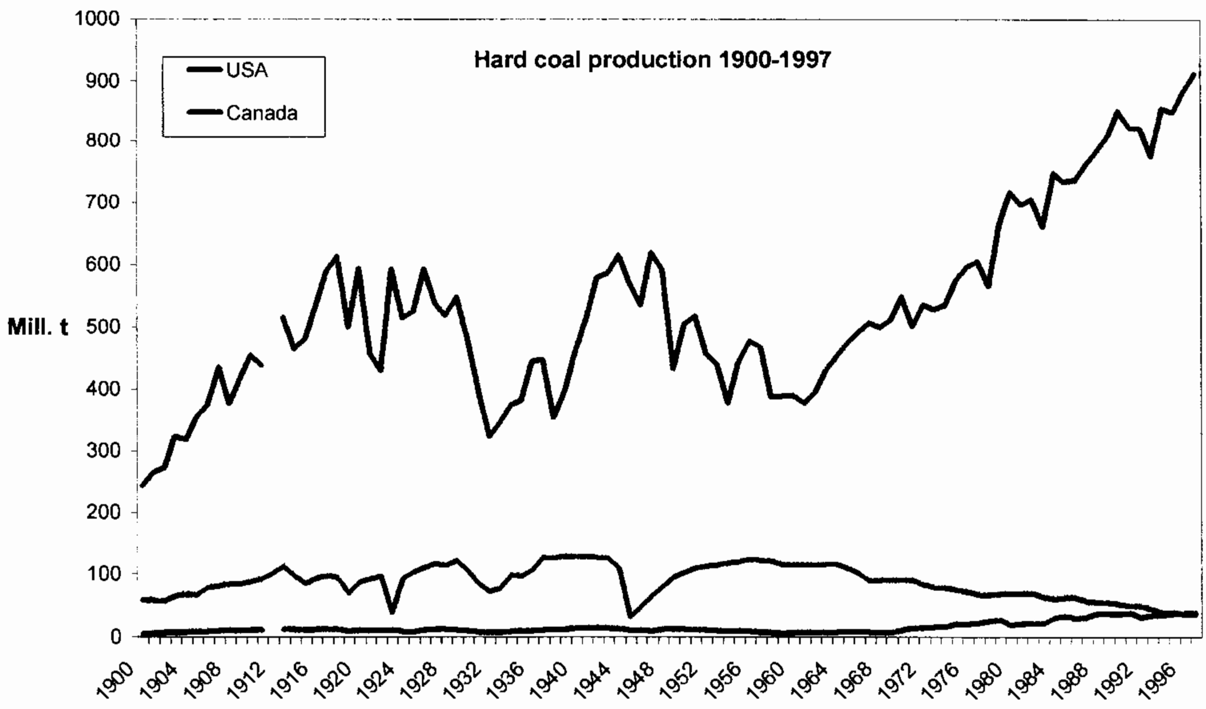
With an area of 50,000 km² the **Powder River Basin** contains the largest continuous reserves in the country in the states of Montana and Wyoming. Tertiary hard brown coal occurs in countless seams which have a depth of up to 30 m. Of especial economic significance is the seam in the middle which is 18 m thick and more than 160 km long. Reserves of about 54 billion tonnes can be extracted by open cast mining up to a depth of 600 m. The Powder River Basin has a significant share of this shift. The coals have a comparatively low heating value but are gaining in importance because of their very low sulphur content (significantly less than 1%).

The **Green River Basin** with an area of 60,000 km² lies predominantly in the state of Wyoming with fingers running out into Colorado. Four of the chalk strata which reach into the tertiary coal bearing formations contain mainly hard brown coals which have been affected by the local magma and have been aged into anthracite. The numerous seams are on average 4 - 6 m thick with a maximum of 13 m. The sulphur content of the coals is always less than 1% and slag content varies between a few per cent up to 20%.

The **Uinta Basin** lies in the states of Utah and Colorado. It comprises an area of about 60,000 km². In the southern part of the basin is hard brown coal, which in the northern part has aged into anthracite because of the influence of the magma. The seam thickness of the individual coal bearing formations varies between 1 metre and 17 m. The sulphur content of the coals at 2% is relatively high. The slag content is between 3% and 10%.

The **San Juan River Basin** has an area of 70,000 km² in the states of New Mexico and Colorado. The seam thickness of the cretaceous coals in various formations is between 3m and 5.5m (locally up to 12m). The sulphur content of the hard brown and the bituminous coal is on average less than 1%, the slag content between 10% and 20%.

Development of bituminous coal mining[1] in the USA
Coal mining in the USA began with the mining of coal in the east, especially Pennsylvania around 1800.



Its rise to its world dominating position in coal output took place in the last two decades of the last century. Even in the 1880s the USA was supplying more than 100 million tonnes a year of bituminous coal, an amount that was not reached in the Ruhr coal field until 1912. But,

[1] The American classification of types of coal differs from that described in chapter 3. Even the terms used in older literature can lead to confusion. According to American classification, anthracite corresponds to anthracite according to DIN. Bituminous coal in the USA, for which the name "soft coal" is also used, corresponds to the bituminous coal types forge coal, rich coal, high volatile coal, open burning coal and partly steam coal. The term "subbituminous coal" means younger bituminous coals (chalk, tertiary) or hard brown coals and steam coals of lower energy content. The Americans call soft brown coals "lignite". Information on coal output amounts for the United States contain not only bituminous coals but also other types of coal.

unlike the output of the United States, this amount could only be increased to a small extent on the Ruhr. At the top of bituminous coal output was, indisputably, Pennsylvania, which was also the leading iron and steel production area of the USA. Pennsylvania alone mined about 80 million tonnes of bituminous coal in 1900.

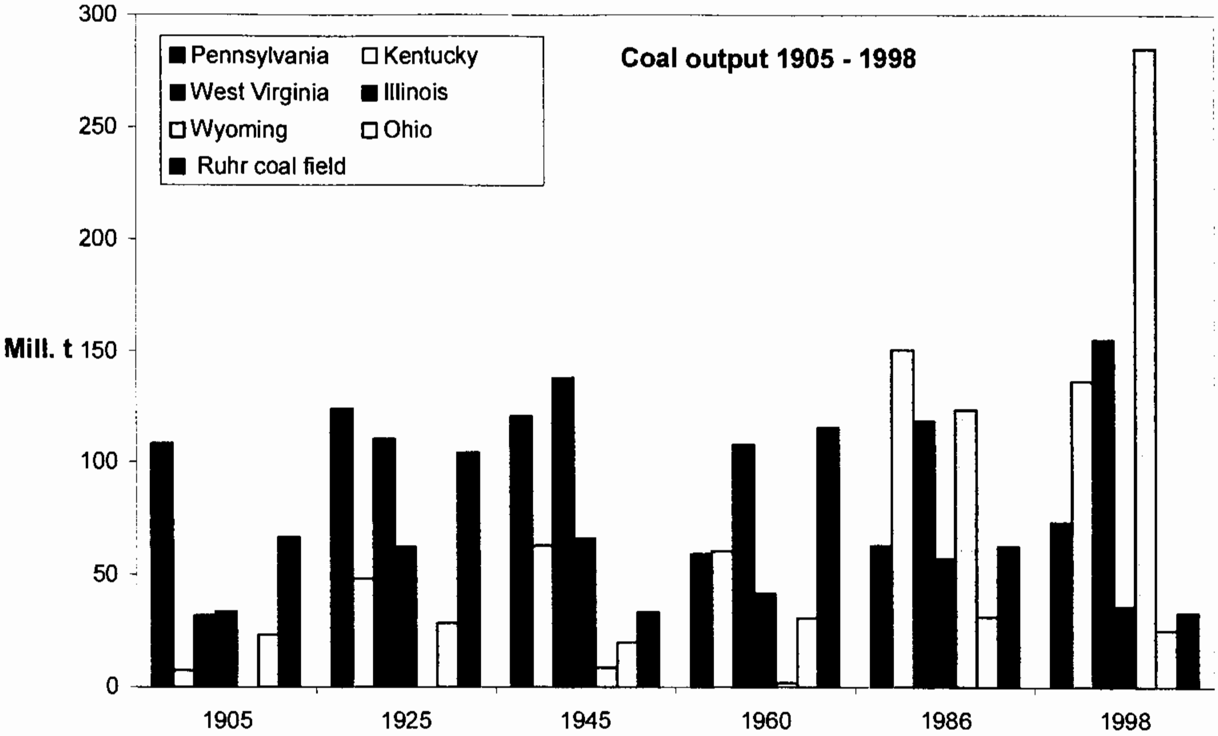
Also of economic significance in Pennsylvania, apart from the bituminous coal reserves were the anthracite reserves. The seams were similar to those in the Ruhr coal field with steep distorted deposits and the USA was producing more than 50 million tonnes of anthracite annually at the turn of the century. Right up until the early 1920s the annual production was more than 90 million tonnes of which the most part was considered domestic fuel and used by the railways.

Competition with more convenient sources of energy such as electricity, gas and oil led to reduced demand. As a result of this production in 1950 was only about 40 million tonnes. Today in Pennsylvania less than 5 million tonnes of anthracite is mined.

For a better estimate of the different dimensions of bituminous coal mining in the USA and the Ruhr coal field the following data should help: Of all the American states, Pennsylvania alone, with an area of 116,000 km² has about a third of the whole German area (356,732.5 km²). On 33% of the Pennsylvania area, i.e. on more than 38,000 km² there are bituminous coal fields and anthracite fields. The state of Wyoming has coal fields on 54% of its extent, with a total area of more than 137,000 km². In comparison with that the mining area of the Ruhr coal field comprises less than 5,300 km². As well as Pennsylvania, at the turn of the century bituminous coal was mined in other states of the USA. Ohio and West Virginia in the Appalachian region were supplying about 20 million tonnes a year at that time. All other coal producing states were way under the above output amounts.

For four decades Pennsylvania and West Virginia were the largest coal producers in the USA. After them came the coal fields in Illinois, Ohio and later even Kentucky (East Kentucky) which supplied a large part of the coal output of the United States. In the 1950s 20 states supplied coal: Pennsylvania, West Virginia, Illinois and Kentucky were producing about three quarters of American coal at that time. It was not until much later, in the middle of the 70s, that the state of Wyoming could increase its coal production significantly and make its way to being the main producing state that it is today.

By the end of the first world war American annual output had increased to 615 million tonnes, by 1938 it had fallen back to 355 million tonnes. Coal was in even stronger competition with crude oil, natural gas and hydroelectric power whose prices, sales and range were now rivalling coal's. The second world war and the initial post war period with its high energy requirements led to increased coal production by 1947 to 621 million tonnes. Then, apart from another increase at the time of the Korean crisis, coal production went down and it was not until another economic boom in 1955 that production went up again. However, the increase in production ended two years later. Annual production went down from 478 million tonnes in 1956 to 100 million tonnes by 1961. After several years of stagnation, bituminous coal output went up constantly and in 1990 reached a record level of just under 854 million tonnes. The total coal output in 1991 was 933.5 million tonnes. Bituminous coal production decreased and in 1993 fell below that of 1988 with some 777 million tonnes. This drastic drop was due to several strikes lasting many months. Especially affected was the Appalachian region with an output drop of 37 million tonnes.



Coal mining in the USA has been undergoing a period of change since then. Structural changes have reduced the number of coal mines and workers. By reducing the number of personnel (1993: 101,300 workers, 1996: 83,500 workers) and transferring production from deep mining to open cast mining, production could be increased from 8,500 tonnes/man year to 11,600 tonnes/man year. In 1991 about 2,400 mines were still in operation, at the end of 1996, only 1,900. 38.5% of total production was in deep mining in 1996 and 61.5% in open cast. By taking these measures and concentrating the coal mining, coal could maintain a market share of more than 50% of electric power generation and bituminous coal production could be increased to more than 900 million tonnes. According to provisional data, 1998 exceeded a production total of more than a billion tonnes.

What was so special about American bituminous coal mining was its high degree of flexibility. Because of natural conditions and other factors, it was and is able to adapt itself to changes in conditions in a way that was unthinkable in Europe. Just converting from deep mining to the cheaper open cast mining - in 1938 only 8.7% of soft coal was extracted by open cast mining, by 1951 it was 23.5% and today more than 60%!- is impressive in view of the size of the American coal mining industry, but it would have been impossible in Germany because of the different types of deposits. The ability to react quickly can be traced back to having capacity which was always high but not fully used. Increasing American coal production by falling back on existing extraction methods would have been almost impossible in the 1950's for example, but the good operating results during the second world war and the post-war years led to extensive investment so that in 1950 half of the output come from mines that were less than seven years old. American coal mining was therefore in a position to give up working old mines that were almost exhausted in spite of the fact that capital costs for new mines were two or three times as high. In 1951 alone 21 deep coal pits and 14 open cast coal pits were brought into operation and 32 lower capacity deep mines and one open cast operation were closed down.

In the United States, because of the wide distribution of coal reserves, there was no question of a main coal mining area - as on the Ruhr. As in so many places in the USA coal was just on the surface or not very deep, the American coal mining industry developed in a completely different way from the way it did in Germany and especially on the Ruhr. A large number of the seams in the east and in the west are very shallow. The number and thickness of the seams are even less than on the Ruhr, but they stretch over great areas and are not very deep so that usually only one seam in the mine has been worked; in the 1950's it was only in the fat coal mines of Alabama and the anthracite mines of North Pennsylvania that several seams were worked at the same time in a mine.

The amount of coal extracted by the operationally simpler and cheaper open cast mining rose in the USA especially during the second world war (see above) and accounted for about a quarter of the output by 1950. Almost half of production at this time came from deep shafts or tunnels with a covering rock thickness of usually not more than 150 m. Exceptions were the mines in Colorado and Utah in the Rocky Mountains region with covering rock thicknesses of up to 1000 m. 20% - 25% of the extraction was done by deep mining with vertical shafts as on the Ruhr The average depth then of American shafts was between 60 - 120 m. A shaft with a depth of 250 m in New Mexico was an exception. In the Ruhr coal field the coal was extracted at this time from an average depth of 756 m.

Furthermore, in the so-called slope mines, coal is extracted from seams which lie underneath the valley floor: the coal is extracted through a sloping inclined shaft. Tunnel mines are called drift mines in the USA. With these the seam extends above the valley floor. Here too there are vertical shafts which, however, are only used for cable transport, ventilation and material transport.

All these mines are distinguished by the common feature that because of reasons of cost only one seam is mined, which is why shaft and open cast mines are always moved to the currently most favourable sites. This also explains why mines on average change their location every 10 - 20 years and why the number of mines in America is large, but their average output is relatively small: in 1948 from 9,000 mines 2,000 open cast mines, only 265 supplied more than 500,000 tonnes per year. On the other hand, 4279 supplied less than 10,000 tonnes a year.

In 1945 there were, according to other information, about 4,000 companies and 6130 mines in soft coal mining. Of these 190 had an output of more than 500,000 tonnes a year. The majority of mines were somewhat smaller: 300 mines supplied between 200,000 and 500,000 tonnes, 290 mines between 100,000 and 200,000 tonnes, 410 between 50,000 and 100,000 tonnes, 1,612 between 10,000 and 50,000 tonnes and 3,328 mines between 1,000 and 10,000 tonnes annually.

By 1955 the number of coal pits had risen to 6,500. Because of advances in underground mechanisation there was now a trend towards larger operational units and larger companies. The largest shaft installation in 1955 with an annual output of 4.46 million tonnes was the Robena mine belonging to the US Steel Corporation and the coal company that had the greatest output, the Pittsburgh Consolidation Coal Company which could point to production of 37 million tonnes in 1956.

From the 1960's to the 1980's the output of North American bituminous coal increased significantly: in 1998 it reached its historical peak with 930 million tonnes. The USA is therefore today the second highest supplier in the world and also has the world's largest reserves of workable and extractable coal. 84% of the output in 1998 was taken by the electricity supply companies in the USA, a little under 8% was exported - a third of that to Europe. 1.3 million tonnes was exported to Germany; the German bituminous coal mining industry has a share in a total of 17 mines in several states in the USA with a total output of 67 million tonnes.

Technical monuments

The fact that mining is spread over such a wide area in the United States has lead to the industry developing differently from the way it has in Germany. In the competition with crude oil and natural gas the mines which are linked in their location with production must be guided above all by their sales area in their other forms. Separating the place where it was extracted from the place where it was processed was a natural consequence. Central preparation units, central large scale coking plants and large scale power stations were set up in places that were favourably situated, on rivers, at railway stations. On various occasions the preparation plant of a mine together with the coking plant was connected to a smelting works. In the United States there were no existing conditions in mining sites for a local linked economy as in European coal fields.

Because of the necessity to change the location of a shaft plant in a very large mining field after a relatively short space of time (see above), open cast mines were set up which were essentially smaller and less costly and therefore could not be compared with European and Ruhr region coal pits. The open cast plants of a typical American mine were described in the 1950's as "really simple" and "small" and consisted mainly of one storey wooden buildings. There would be a small office, sometimes a small pit head baths, a small workshop with storehouse, a lighting room and a filter room with loading. Because of the purity of the seams in 1948 only about 30% of the output was treated by scrubbing, so that scrubbing was only done in larger plants.

The simplicity of open cast mining stems from the fact that for one thing the number of employees in the mines was 10 - 20 times smaller than in Germany and secondly because the life of an American mine, because only one seam was mined, was much shorter so that it was hardly worth having fixed costly mines. As well as that, most mines were opened up with tunnels or inclined shafts so that head frames and mining towers were not necessary and as a consequence did not even exist. Shaft extraction as it stood had only a small depth to overcome so that light, often wooden head frames and, unlike on the Ruhr, low-powered, small conveying equipment was sufficient. With the subsequent use of electricity, units for producing compressed air were superfluous. The favourable flat deposits close to the surface required only minor development and therefore no necessity to set up material transport for the developments. The treatment plants were often not at the mouth of the tunnel or next to the shaft but at a place that had good communications and they often processed the output of several mines.

According to previous research and the current state of knowledge, American mining operations can therefore not usually be compared with European coal mines and especially those in the Ruhr area because the American open cast mines are very often only set up for "short-term" use and have therefore been operated with only little architectural expense. This applies especially to the historic bituminous coal mines in North America which have been mainly set up as open cast mining units with only very few open pit plants or, in the case of deep mining, usually only provided with simple (wooden) buildings. Even the conveying equipment is often made out of wood. This applies to the coal mines in Pennsylvania for example (Joliett Mine at Pottsville or Sweetwater Mine at Valley View) but even the mines that are set up for extracting coal from great depths and for a long time such as the Friedensville mine in Center Valley, the Nemacolin mine at Pittsburgh or the Blacksville no.

1 mine in West Virginia with its steel conveying equipment have "irregular" open pit plants that lack an "organising hand". The American mining companies and owners have therefore allotted their mining plants a rather subordinate role, a pretentious imposing form would be considered unnecessary. Expediency, multi-functional and profitability are the main themes. Investment goes on machines and aggregate stocks rather than the plants.

Therefore it is also not to be expected that there are or ever have been a mining facilities like those of the German Zollverein mines or even coming close to them on the North American continent. Hitherto however no mining facility of comparable quality has been known. This also applies for mining facilities for metal and iron ore.

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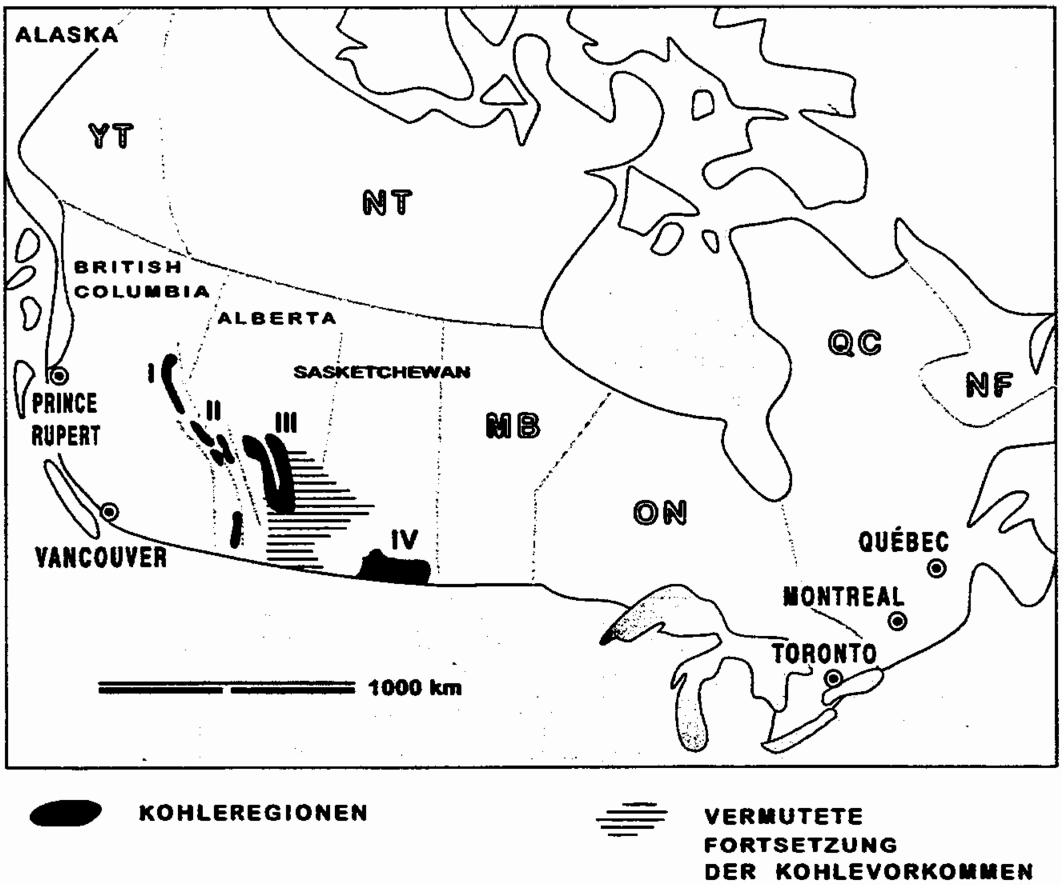
2.6.2.2 Canada

Although larger in area, Canada, as a direct neighbour of the USA has little more than 5.5 billion tonnes SKE of workable, extractable hard coal reserves, 90% of which can be extracted by open cast mining.

The largest part of Canadian coal reserves lies in the western provinces of British Columbia, Alberta and Saskatchewan. The carbonization level of the coal from the jurassic-cretaceous-tertiary age ranges from soft brown coal to anthracite. Carbon coals on the east coast in Nova Scotia and New Brunswick are of only local importance. The coal reserves north of the 60^{th} parallel have not been exploited to a great degree because there is little use for it.



Coal regions

Probable continuation of coal reserves

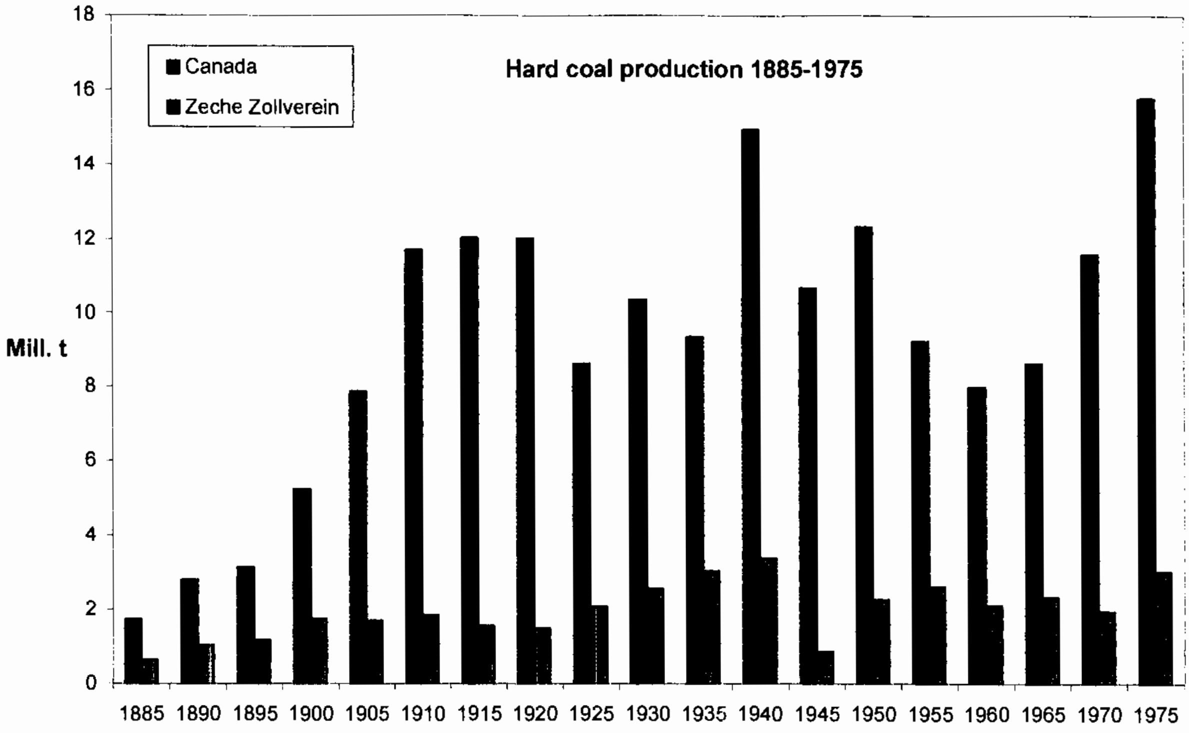
The main supply regions of Canada:
I Mountains, II Foothills, III Plains, IV Sasketchewan (from Kelter et al. 1999, figures 3 - 20, page 280.)

Developing bituminous coal mining in Canada

Before 1990 the whole of Canadian coal production was less than 5 million tonnes a year. Even in the 1950s they were only just beginning to open up Canada's rich coal reserves because the distances to the main areas of use were too great. At that time most of the deep mining operations were in Nova Scotia and Alberta. About 30% of production came from open cast operations. By the end of the 1960s Canada's annual output of bituminous coal was often less than 10 million tonnes. It was only in the 1940's that peak amounts of up to 16 million tonnes of bituminous coal annually were reached.

It was not until the 1970s that an increase in Canada's coal production was seen. In 1976 a hitherto record output of about 25 million tonnes in total was reached, which increased to more than 20 million tonnes a year in 1977 and to 78.7 million tonnes by 1997. Of this 67 million tonnes was hard coal[2], of which 64.4 million tonnes (96%) had been extracted from 18 open cast mines. The export orientated western provinces of British Columbia and Alberta together supplied about 64 million tonnes in 1997. After the closure of a large number of pits deep mining currently takes place in only one pit in Alberta and two in Nova Scotia. Altogether in 1997 9,000 people were employed in coal mining.

[2] The information on Canadian coal production sometimes varies widely. For example in Kelter et al. 1999 and in the year book of crude oil and natural gas, petrochemicals, electricity, environmental protection 1999, hard coal production of 67 million tonnes or 41.26 million tonnes (provisional) was given for 1997 based on differing sources.



Because of its unfavourable communications position Canada has developed a brisk import-export market. The Atlantic provinces import boiler coal, the province of Ontario coking coal for the steel industry. On the other hand the provinces of Alberta and British Columbia are export orientated. It is mainly coking coal that is exported with the main customers being Japan, South Korea, the European Union and Brazil. In 1997 imports from the USA amounted to 13.5 million tonnes, but exports were 36.5 million tonnes with Canada as one of the main exporting countries for coal.

Technical monuments

Because the development of the Canadian bituminous coal mining industry is still in its infancy and the extraction of bituminous coal is done mainly by open cast mining, it is assumed that Canada too has no mine facilities or if they exist their surface facilities are in no way up to the quality of the Zollverein coal pits.

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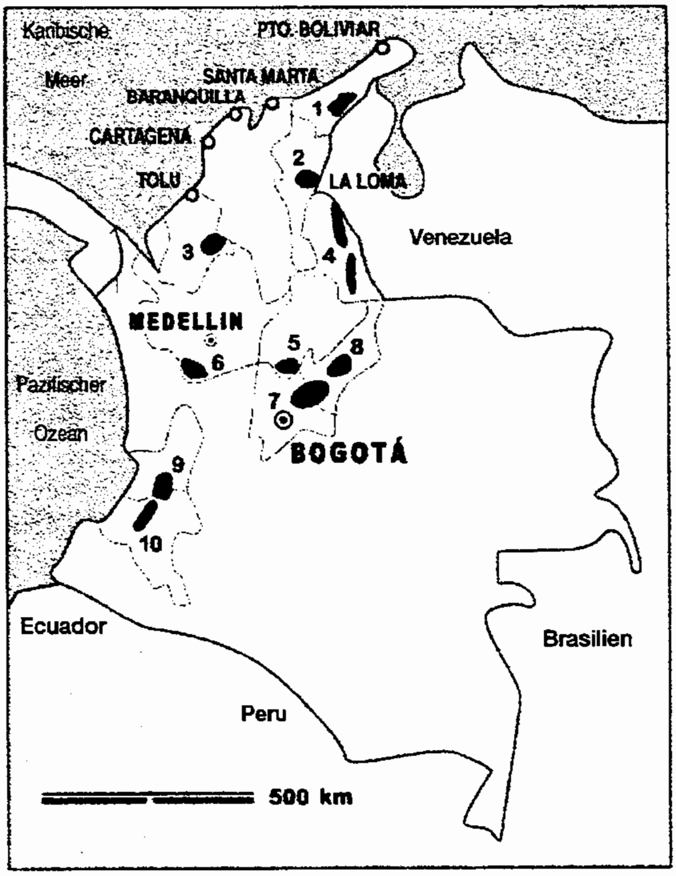
2.6.3 Central and South America

In comparison with other parts of the world Central and South America have very little in the way of coal reserves, a little less than 4% of the workable, extractable hard coal reserves of the world. The reserves are concentrated mainly in Columbia, Mexico, Brazil, Venezuela and Chile with small amounts in Argentina and Peru. Bituminous coal extraction in these countries amounted to less than 3 million tonnes a year by the end of the 1960s but usually it was a lot less than that. It has been Mexico and Brazil, but mainly Columbia that have been able to develop their bituminous coal production since than. While Mexico's annual output is usually way under 10 million tonnes and Brazil's even lower, Columbia has developed into one of the main producers of the world.

2.6.3.1 Columbia

With 6.7 billion tonnes (= 6.3 billion tonnes SKE) of workable, extractable hard coal reserves, Columbia is the coal richest country in Latin America. About 90% of the reserves can be extracted by open cast mining.

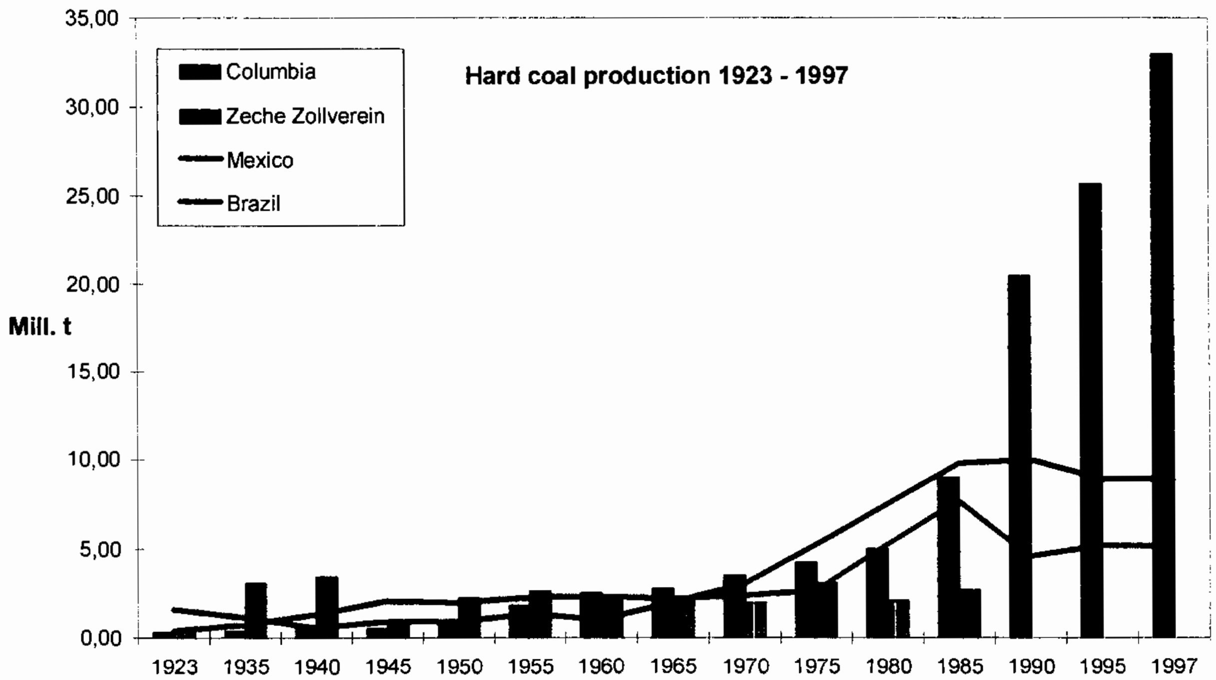


The main production areas in Columbia: 1 Guajira (Cerrejon), 2 Cesar, 3 Cordoba, 4 Norte de Santander, 5 Santander, 6 Antioquia, 7 Cundinamarca, 8 Boyaca, 9 Valle, 10 Cauca (from Kelter et al. 1999, figures 3 -22, page 284).

The deposits which are in chalk and tertiary are mainly in the eastern Cordilleras, the Cauca Valley and the western Cordilleras. The coal is either high quality boiler coal with low sulphur and ash content or coking coal. Often the reserves are small. The most important coal reserves lie in the regions of Guajira, Cordoba, Cundinamarca, Cesar, Antioquia, Valle del Cauca, Norte de Santander and Santander. In the Guajira region in the north east is the Cerrejon deposit with 3.7 billion tonnes of workable, extractable coal reserves.

Developing the bituminous coal mining industry in Columbia

In the general bituminous coal output statistics Columbia is a late arrival. For 1928 an undifferentiated coal output of 298,000 tonnes was given. For the following year until 1949, only that part of the output that was transported by train was given. Because of the complicated geological structure, the small size of the reserves opened up and the low standard of infrastructure development in the country, coal extraction and transport often only took place in very simply worked minor operations without a great deal of technical equipment. The amount of coal extracted was probably not very accurately recorded and was hardly sufficient for the needs of the country.



For 1923, coal output in the Cauca Valley was estimated at 30,000 tonnes. The main production of bituminous coal in the Cundinamarca department in 1944 took place in the fields of Suesca-Sequilé (75,000 tonnes), Chocontá Santa Rosita (50,000 tonnes), Tequendama (50,000 tonnes) and Zipaquira (45,000 tonnes). In 1952 the annual output of coal already amounted to 1,150,000 tonnes of coal,most of which came from few departments and in these from few mines:

Cundinamarca and Boyaca	600,000 tonnes
Valle and Cauca	250,000 tonnes
Antioquia	195,000 tonnes

At the end of the 1980s there was an enormous, very rapid increase in bituminous coal production in order to be able to export domestic coal. Since then Columbia has been the largest coal producer in Latin America. By 1989 Columbian bituminous coal production was already 18,902,000 tonnes (with a total Latin American output of some 40 million tonnes) and in 1997 was significantly above 30 million tonnes (with a total Latin American output of some 53.78 million tonnes). In 1997 Columbia exported almost 26 million tonnes of bituminous coal (mainly boiler coal) and was therefore in 8th position of coal exporting countries.

The small bituminous coal reserves of Columbia are mined even today by a large number of mines. There are 1915 mines in total of which 1880 are traditional deep mines and only 35 open cast. The greatest amounts of bituminous coal are however today produced in North Columbia in the states of Guajira and Cesar near the coast and only in a few mines.

Columbia is building up its position as a significant coal producer and exporter with the participation of foreign partners. In 1922 in the Central Cerrejon coal field bituminous coal production began as an open cast operation with an output of 0.8 million tonnes. By 1997 already 3.5 million tonnes of coal was being extracted by open cast mining and 500,000 tonnes in the Oreganal mine. The largest mining project in Columbia (and in Latin America), and the main exporter is currently the El Cerrejon Norte company in the Cerrejon coal field. With 14.5 million tonnes per year El Cerrejon Norte operates one of the four largest open cast mines in the world. They are aiming at an increase in capacity to 21 million tonnes by 2002.

In the Cesar department a large number of other open cast mines are producing. In 1997 the La Jagua mine exported 4 million tonnes, the La Loma mine, which only started production in 1995 was already exporting 5 million tonnes by 1997.

Technical monuments
The type of development of bituminous coal mines in Columbia excludes the possibility of a comparison with Zollverein coal pit facilities.

2.6.3.2 Mexico

With 928 million tonnes SKE of workable, extractable hard coal reserves, Mexico is in second place of bituminous coal producing lands in Central and South America.

Mexico's coal reserves are distributed amongst various regions in the country but are mainly concentrated in the north in the province of Coahuila. There there are the coal fields of Eagle Pass, Sabinas, Barroteran and Piedras Negras. In the north west is the Yaqui field. In the southern central area, handy for the capital Mexico City, are the Mictepec and Tezoatlan reserves.

Development of bituminous coal mining in Mexico
In the coal fields of Sabinas and Barroteran mines were operated by several American companies in the first half of this century. There were also a large number of coking plants but the amount produced was somewhat "insignificant". Today Mexico produces most of its output in the Piedras Negras coal field. In 1996 two open cast mines and one deep mine produced almost 60% of Mexico's annual output, just under 8% of the annual output was extracted by local producers in the same coal field. In 1996 about a third of the country's

output was produced by four deep mine pits near the town of Muzquiz. Most of the annual production is for domestic use e.g. for producing coke for the steel industry.

Technical monuments

The type of development of bituminous coal mines in Mexico excludes the possibility of a comparison with Zollverein coal pit facilities.

2.6.3.3 Brazil

Brazil has 9.56 billion tonnes SKE of workable, extractable hard coal reserves. The Brazilian bituminous coal pits are in the south of the country in the states of Santa-Catarina, Rio Grande do Sul, Paraná and São Paulo. The seams often occur in small closed basins.

Development of bituminous coal mining in Brazil

Unlike the other southern states, Santa Catarina has its most important coke and coal seams in a wide basin of 130 km long and 20 - 35 km wide. In the middle of the 1950s the 1.50 - 2.45 m thick seam Barro Branco supplied 90% of the Catarina output. In Sideropolis intensive open cast mining took place. 24 companies mined bituminous coal there in about 90 mines, mainly in tunnel pits, the shafts were only 25 - 40m deep. Seven companies have mechanised extraction and transport facilities.

The most important centres for the extraction of cokable coal are at Lauro Müller, Trevisio, Siderópolis, Urussanga and Criciuma. Output there rose from 2.2 million tonnes raw coal (1955) to 7.2 million tonnes (1978). The coal was transported by train to the Capivari central washing facility at Tubarão; the treated coke went to the coking plants and the slack to the large Capivari power station to produce energy. In the 1970s after the Brazilian government tripled coal production with massive investment, run-of-the-mine coal was processed directly in newly equipped fully mechanised pits.

In Rio Grande do Sul there are altogether eight smaller coal basins (Gravataí, Charqueadas, Ratos, Leão-Butiá, Iruí, São Sepé, Hulha Negra and Candiota). The seams there reach an extractable thickness of up to 1.7m, in the southern coal field (Candiota) up to 4m. In the middle of the 1950s the total output from the Rio Grande coal field was 1 million tonnes which was used exclusively in the state of Rio dol Sul. Extraction was done by deep mining and is partially mechanised. Lower quality coal was mined by open cast mining in Candiota.

The Paraná coal field - with its centre in Cambui- consists of several very small basins with tectonically distorted seams. Very simple mining in Paraná was done in the 1950s with tunnels and only one deep mine shaft that was 127m deep. The reserves and the output of 130,000 tonnes - 160,000 tonnes per year of low quality raw coal was only of little importance in comparison with the first two coal fields. In 1976 raw coal production amounted to 295,000 tonnes.

By the middle of the 1970s Brazil was producing annually less than 2.5 million tonnes of bituminous coal, but some ten years later after constant production increases, about 7.7 million tonnes of bituminous coal was being produced.

Figures for the output of the Brazilian bituminous coal fields (tonnes) (from the Department of Land Research (1957))

	1940	1945	1950	1954	1976
Santa Catarina	265,500	815,700	1,095,200	996,000	7,200,000
Rio Grande do Sul	1,065,500	1,139,800	854,700	999,200	1,000,000
Paraná*	2,800	98,300	98,700	60,300	182,190

* = treated coal

Technical monuments

Nothing is known about the technical monuments of Brazilian bituminous coal mining therefore this excludes a comparison of the development of mining facilities in the bituminous coal mines with those of the Zollverein pits: in 1934 the Zollverein pits alone produced as much as all the Brazilian bituminous coal mines put together.

2.6.3.4 Venezuela

Venezuela, with about 383,2 million tonnes SKE only has about 0.1% of the world reserves of workable and extractable hard coal.

Venezuela's coal reserves are distributed all over the country. The most important coal field in the 1950s was San Christobal in the west in the state of Tachira with its mines de Lobatera, La Maporita, Ombrizal Villapol, Miraflores and Las Juarez from which came 97% of the country's output. About 2% of the country's output was mined in the state of Guarico in northern Venezuela from the deposits at Sabana Grande and Morro de Maciro and the remaining production of about 300 tonnes came from the state of Zulia in the north west with its deposits at Rio Cachiri and Rio Guasare.

Development of bituminous coal mining in Venezuela

Venezuela's coal production increased from 6.000 tonnes (1938) to more than 25,000 (1950) to 32,000 tonnes (1954).

Just as in Columbia, bituminous coal mining has only started developing larger capacity for export within the last ten years. The most important coal field today is in the Guasare Basin in the north west; extraction is done mainly by open cast mining at Paso Diablo and from the new open cast mine at Socuy to the south of Paso Diablo. Just like Columbia, in the long term Venezuela will become one of the lowest price suppliers on the world market. However, in order to step onto the world market or to be able to establish themselves further, both lands will have to extend their infrastructure considerably.

Technical monuments

Nothing is known about the technical monuments of Venezuelan bituminous coal mining therefore this excludes a comparison of the development of mining facilities in the bituminous coal mines with those of the Zollverein pits.

2.6.3.5 Chile

With 826.7 million tonnes SKE (hard coal) Chile has 0.2% of the world reserves of workable, extractable coal.

Development of bituminous coal mining in Chile
The most important bituminous coal deposits are in the provinces of Concepci□n and Arauco near the coast and they occur under the Pacific Ocean. The coal does not have good coking characteristics. Important deposits are:

- the coal field of Lirque, north of Concepción; in 1943 it supplied 111,000 tonnes.
- the Lota mine and Schwager mine coal fields at Coronel in the province of Concepción. In 1943 output was 1 million tonnes and 629,000 tonnes respectively. Since 1955 new treatment plants have been set up to increase output.
- the Curanilahue coal field south west of Coronel in the province of Concepción, that started up in 1940; in 1943 production was 50,000 tonnes.
- the Pupunahue mine coal field at Mulpun with an output of 23,000 tonnes (1943).
- the deposits on Chiloé and in the Aysén province had hardly been exploited by the end of the 1950s.

Chile's coal output has hardly changed this century, in any case no significant increase in production has been noticed as a result of mechanisation and rationalisation. The annual output of about a maximum of 2 million tonnes was produced by small and very small mines. In Chile today there are still two or three elderly mines which are probably family concerns (oral information from Andreas Brabeck Dipl. Ing).

Technical monuments
Nothing is known about the technical monuments of Chilean bituminous coal mining therefore this excludes a comparison of the development of mining facilities in the bituminous coal mines with those of the Zollverein pits. In the last few years we have found out that they are trying to set up a mining museum in Lota.

2.6.3.6 Argentina and Peru

Argentina and Peru only have small bituminous coal reserves, so therefore no significant coal mining industry has developed. This is clear from the output which has hardly risen from the first decades of this century until today. The comparison is made all the more difficult because with statistics at the beginning of the century brown and bituminous coal were not separated.

Development of bituminous coal mining in Argentina and Peru
Argentina's annual production from 1951-1954 came almost entirely from the Rio Turbio Basin (Santa Cruz Province) in Patagonia and amounted to 37,000 tonnes, 109,000 tonnes, 82, 800 tonnes or 120,000 tonnes, which was extracted both by deep and open cast mining.

The Goyllarizquisga mine was the most important bituminous coal mine in Peru in the 1950s. It lies 4000m up in the Pasco administrative area. In 1952 140,000 tonnes of bituminous coal were mined there, in 1953 122,500 tonnes were sent to the local smelting plants and ore mines. In other areas of Peru it was not until now that the coal mines began to supply local copper operations for example. Several significant deposits were to a large extent not used at this time. Usually mining failed because of transport difficulties in almost impassable territory.

Technical monuments

So far we do not know of any technical monuments in the Argentinian and Peruvian bituminous coal mining industry and so the late date of origin and the economical development of the bituminous coal mining industry mean that there can be no comparison with the Zollverein coal pits.

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2.6.4 Asia

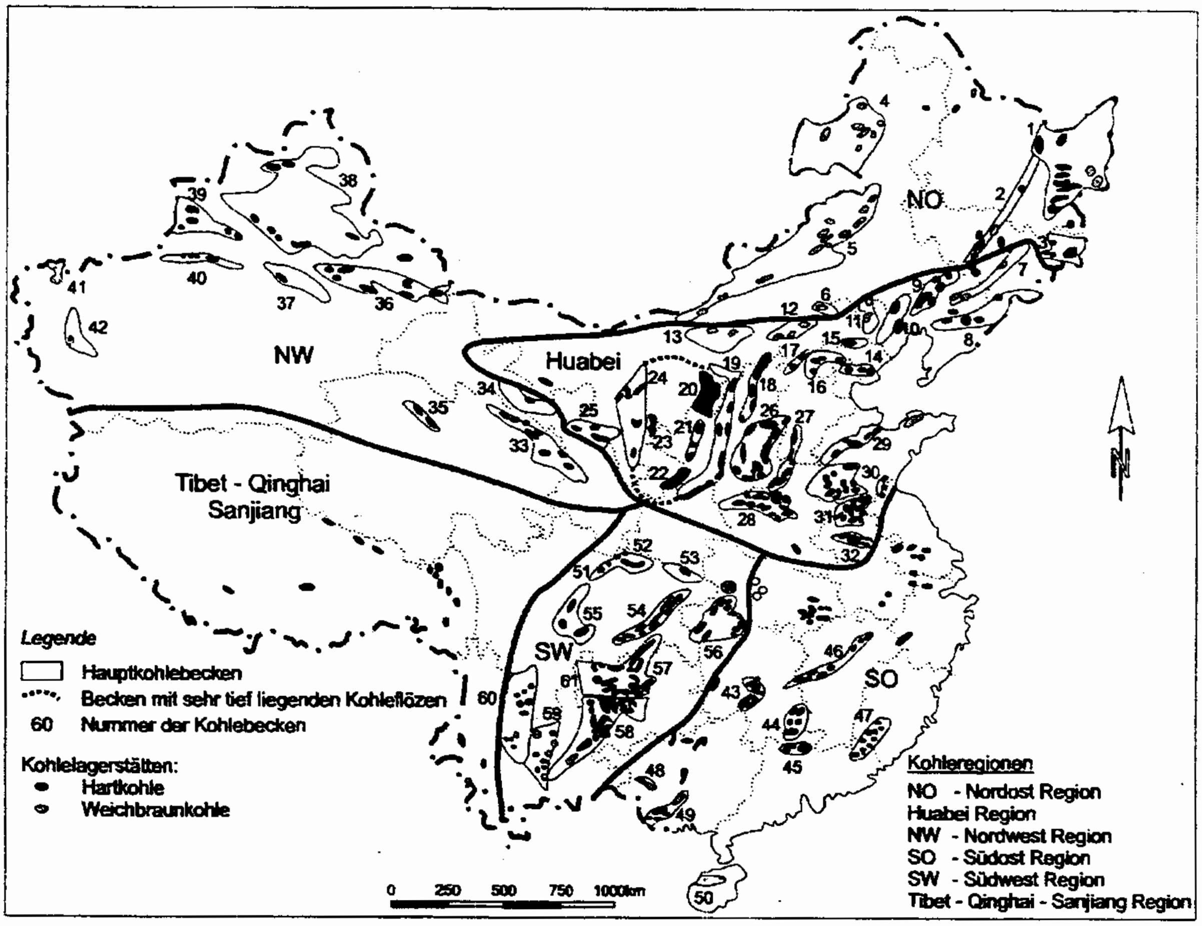
2.6.4.1 China

The workable, extractable coal reserves in China are estimated to be about 114.5 billion tonnes (76.5 billion SKE), of which about 69 billion tonnes is SKE hard coal. 75% of the workable, extractable reserves is bituminous coal, 15% anthracite and 10% soft brown coal. As the largest coal producer China produced about 1.3 billion tonnes of bituminous coal in 1997 alone.

The coal reserves are distributed throughout the country and occur in various amounts in all regions. 80% of the Chinese coal reserves are in the not very well developed areas in the north and north west of the country. Here even the quality of the coal in the northern coal fields is generally better than in the south. On the other hand the industrial areas with their high energy requirements are situated in the coastal regions in south and south east China.

China is divided into six coal provinces of which the Huabei region (northern China) with 47% and the north west region with 38% of Chinese coal resources are the main areas.

In the future, as well as the Datong coal field the Shenmu (Shenfu-Dongshen), Huangling and Antaibao/Pingshu coal fields will be of greatest significance for Chinese coal mining with the most modern and most effective mining methods like long straining work.



Key
Main coal basins
Basins with very deep coal seams
Number of coal basins

Coal deposits
Hard coal
Soft brown coal

Coal regions
NE North east region
Huabei region
NW North west region
SE South east region
SW South west region
Tibet - Qinghai -Sanjiang region.

The main coal basins and provinces of China (from: Kelter et al. 1999, figures 3-8, page 251):
NE North east region: 1 Sanjang-Muling, 2 Yilan-Yitong, 3 Yanbian, 4 Hailar, 5 Bayanhuxu -Eren, 6 Baidacang.
Huabei region (North China): 7 Dunhua-Fushun, 8 Tonghua, 9 Tiefa-Fuxin, 10 Beipiao, 11 Ppingzhuang, 12 Zhangjiakou, 13 Daqin mountains-Wula mountains, 14 Tangshan, 15 Chengde, 16 Beijing, 17 Xuanhua-Yuxian, 18 Daton- Ningwu, 19 Hedong-Weibei, 20 Shenmu, 21 South east Ordos basin, 22 Huangling-Longxian, 23 West Ordos Basin, 24 Helan mountains, 25 Jingyuan-Jintai, 26 Qinshui-Linfen, 27 Eastern edge of the Taihang mountains, 28 West Hanan, 29 North Huang He, 30 South west Shandong, 31 Xuzhou-Huaibei, 32 Huainan.
NW North West region: 33 Qilian, 34 North Qilian corridor, 35 North Qaidam, 36 Turpan-Hami, 37 Yanqi, 38 Junggar, 39 Ili, 40 North Tarim, 41 Wuqia (Ulugqat, 42 South west Tarim.
SE South east region: 43 Lianyuan-Shaoyang, 44 Chenzhou-Zixing, 45 Lianzian-Qujiang, 46 Pingxiang-Leping, 47 Yong'an-Xingning, 48 Bose, 49 Nanning, 50 Changpo-Changchang.
SW South west region: 51 Longmen mountains, 52 Guangyuan-Wangcang, 53 Daba mountains, 54 East Sichuan, 55 Ya'an-Yingjing, 56 Enshi-Changyang, 57 South Sichuan - North Guizhou, 58 Luipanshui, 59 Kunming-Kaiyuan, 60 Panzhihua (Dukou)-Chuxiong, 61 Zhaotong.

As in China to a large extent newly opened up deposits have been worked, the average depth of mines is relatively low. In 1958 it was 218m. with mines that came under the jurisdiction of the ministry for the coal industry, on which the following information primarily is based. The average depth of the vertical shafts reached 254m. and the average depth of inclined shafts 202m. The largest vertical depth encountered was 700m. Today more than 90% of Chinese bituminous coal mining is done by deep mining, at an average depth of 400m. with a maximum of 1075m. 45% of the worked seams are more than 3.5m. thick, only 11% are less than 1.3m. 75% of the seams are flat, 25% sloping.

Development of bituminous coal mining in China

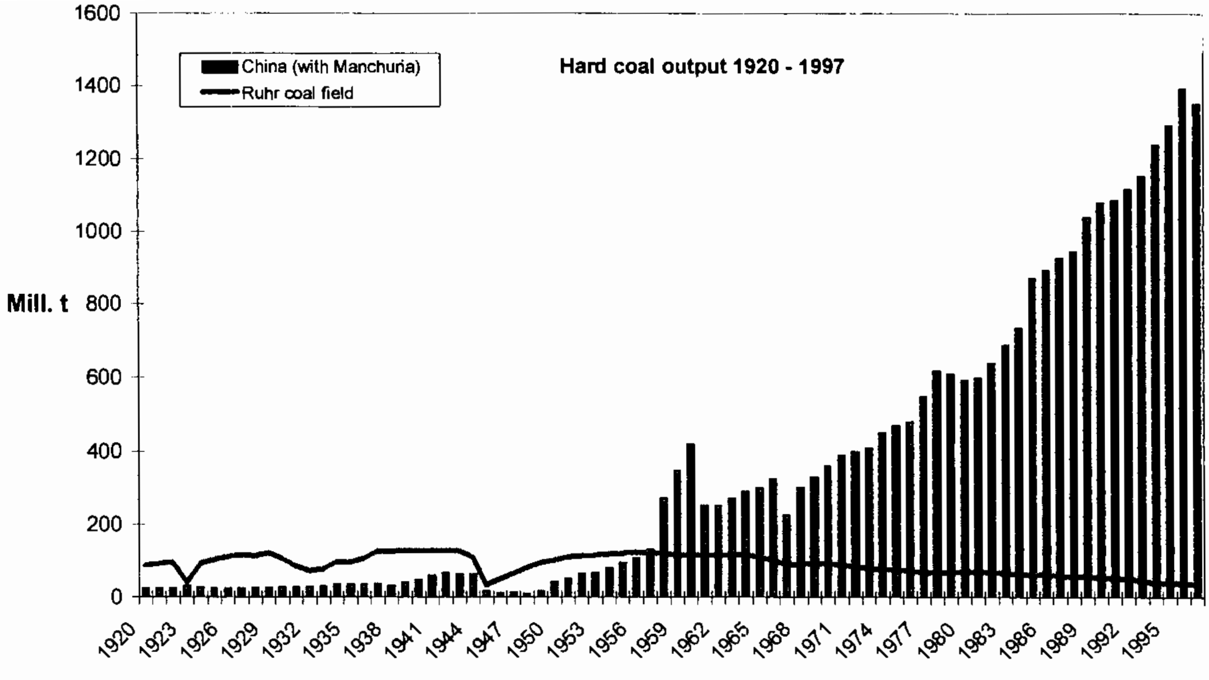
China is the oldest coal country in the world: for more than 2000 years coal has been mined there. News of this came to Europe in 1292 from Marco Polo's East Asia travels. He reported that the Chinese burnt "black stones". But although knowledge on the uses of bituminous coal was already very old, coal did not have a very strong influence on industrial development in China until the 1950s.

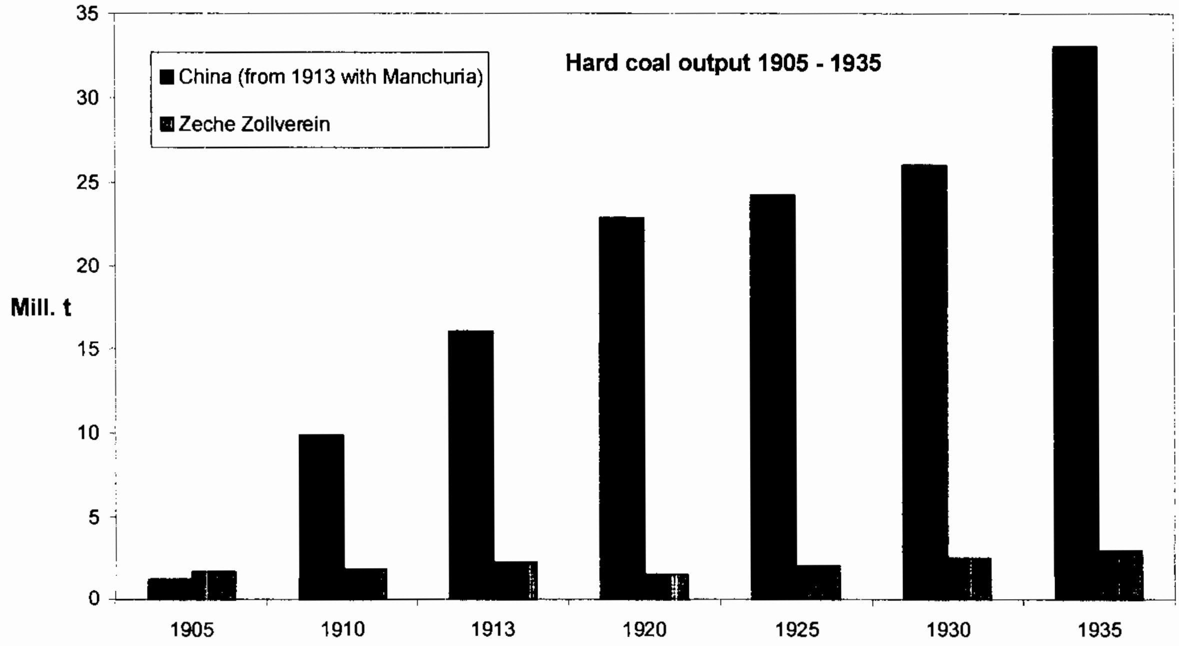
Before the People's Republic was founded (in 1949), coal mining was very underdeveloped because of the country's economic dependence on foreign capital, if you disregard the mines in Manchuria which were under Japanese ownership at that time. By 1949 coal mining was only developing very slowly. In the 30s it varied between 25 and 30 million tonnes per year and during the war year of 1942 reached its highest level before the founding of the People's Republic with 62 million tonnes. 49 million tonnes of this came from the Japanese owned areas in Manchuria and North China. In the civil war year of 1948 output fell to 14 million tonnes. However, by 1952 the previous record of 1942 had been exceeded with 64 million tonnes.

Coal was always the most important primary energy source in China. When, after the founding of the People's Republic their growing need for the iron and steel industry, for energy production and for train and steam ship journeys had to be guaranteed, it was necessary to reorganise and re-develop the mining industry completely. Large mines and industrial projects that were important for building up the national economy came under the current ministry for industry in the central government i.e. the ministry for the coal industry, that exercised central control over the operations. Few significant mines were under the local industrial administration or the communes. The main operational unit is the coal pit or the open cast mine.

The coal pits that were under the control of the ministry for the coal industry were grouped together in trusts following the Soviet pattern and these in turn were united into combines.

The development aims for coal mining changed greatly according to ideological guidelines. During the first five year plan large, modern industries and mines with a high level of technology were aimed at. Many small, old already exhausted mines had to be closed down because they were uneconomic. The main investment flowed first of all into building up the important coal mining centres of North East and North China; in second place was the development of mines in the North West and South West. Administratively a high degree of centralisation of power was evident under the control of the ministry for the coal industry.





The revitalising of coal mining in small and very small mines began with the "Great leap forward" phase. With this the failing supply mainly of local industries and populations but also those areas with coal that still did not have large mines and were exclusively dependent on supply, were to be alleviated.

At the peak of mass mobilisation 20 million men alone, mainly farmers, were used for coal mining. As a result of this the number of small coal pits was to rise in the autumn of 1958 from 20,000 to 100,000. Output reached 347.8 million tonnes in 1959 and may have reached 425 million tonnes in 1960.

In the following consolidation phase the most important rebuilding in mines was only deferred temporarily in spite of the priority treatment of agrarian problems. However, a large number of the small mines and those old mines that had only recently been operating again, were once again closed down. Others were extended to form medium sized mines. During the cultural revolution a new campaign was started to decentralise output with the opening of many small mines with the smallest reserves.

The upward development that started in 1963 was once more interrupted by the effects of the cultural revolution in 1967, It was not until 1971 that the output and performance levels of 1958/1959 were reached again and conditions for a new, favourable development period created. Thus China is in third place in the world for coal output behind the USA and the USSR. Only the broad outline of development of new mining projects in the 60s is known. In 1961 with the "Great leap forward", decentralisation that had been introduced in mining declined. At that time new building had to be restricted to adaptation and consolidation. Activities were limited to the development of deep seams and intensifying the mining. Altogether in this year about 150 shafts were drilled deeper. In 1963 development of new mines began once more and even 67 medium sized and larger mines were developed.

As well as a number of pits with an annual capacity of between 210,000 and 750,000 tonnes, in 1964 in the pit groups of Pingtingshan (Honan), Tatung (Shansi) and Kailan (Hopei), pits with an annual capacity of 1.2, 1.5 and 1.8 million tonnes respectively were brought into operation. This is the absolutely highest capacity for new plants known since 1960. In total in 1964 the annual output capacity was increased by 6 - 7 million tonnes.

In 1965 16 newly created mines with an annual capacity of between 0.5 and 0.9 million tonnes, i.e. with a total capacity of about 10 million tonnes per year were to speed up output. From the provinces of Szechwan and Shansi it was known that by opening a larger number of small pits with an annual capacity of between 0.03 and 0.15 million tonnes the output volume could be increased by 3 or 7 million tonnes/year. In the Fushun group hydraulic shaft hoisting equipment in a shaft 600m. deep with an hourly performance rate of 100 tonnes was brought into operation. In this coal could be extracted to a particle size of 120mm. With 2.45 tonnes/mh the hitherto highest value in underground mining performance was achieved in the Shansi province.

During the Cultural Revolution years new building activities were once again pushed into the background. In 1966 nine shafts with a total capacity of 5 - 7 million tonnes/year output were mentioned as being built. In 1967/1968 there were reports of five shafts being put into operation with a total yearly output of 2.5 - 3 million tonnes and a treatment plant in the Kailan coal field with an annual processing output of 3 million tonnes.

Since 1969 the government has been promoting once more the development of local small industry, especially the supply industry for farming. Development of the coal industry has therefore been stagnating. Only one mine with a yearly output of 1 million tonnes in the Anhwei province and eight other mines of unknown capacity in other provinces have been put into operation.

Since 1970 they have concentrated their efforts mainly on opening up mines in South China, first of all to ease the supply of fuel that has been stretched for years and secondly to reduce dependence on coal transport from the north. So they began once more to re-develop the coal industry by raising capacity in the old mining areas and by building new mines. In this year four plants were commissioned with a total yearly output capacity of about 2 million tonnes and a treatment plant with a yearly throughput of 1.2 million tonnes/year. In 1971 these efforts were stepped up but we do not have any further details. In any case by 1971 20 larger pit groups supplied more than 2 million tonnes of coal.

After constantly increasing coal production the People's Republic of China has been the largest coal producer in the world since 1985. As a result of their rapid economic growth their energy requirements have also increased. Because 75% of the primary energy needs in China are covered with coal, coal production had to be greatly increased. In 1988 this amounted to a total output of 946.46 million tonnes of bituminous coal, in 1996 an output of more than 1.4 billion tonnes was reached. In 1997 production went down slightly to 1.35 billion tonnes. The current annual output of bituminous coal of 1.2 billion tonnes/year should be reduced by about 250 million tonnes/year in subsequent years.

The total number of Chinese mines is currently estimated at more than 200,000, many of which are illegally operated and family mines. Of real significance are about 90 important main mines (open cast and deep mines), two thirds of which are operated at a profit. The capacity of these mines amounts to 0.6 to 4 million tonnes/year (deep mining) or 3 to 15 million tonnes/year (open cast).

Within the restructuring and slimming down of the Chinese state apparatus in March 1998 the ministry for the coal industry was dissolved. The coal area now comes under the state commission for economics and trade.

Centrally run state mines and local mines are separated according to ownership and the places they supply.

The 90 centrally run state mines are under the direct control of the State Commission for Commerce and Trade and in 1997 with an average output capacity of 700,000 tonnes/year and a total output of 527 million tonnes, produced 39% of the total Chinese output. In spite of modern technology in new mines and high safety standards compared with other Chinese mines, only two thirds of these mines were profitable. By the turn of the century these state run operations should reach profitability by using efficient technology, introducing competitive pricing and reducing manpower drastically.

In 1997 216 million tonnes of coal was mined in 2,600 state mines that are under the control of the provinces or counties. The capacity of these mines is between 150,000 tonnes/year and 450,000 tonnes/year. All mines must operate on a commercial basis so that in the interests of rationalisation unprofitable state mines are closed.

The steep increase in Chinese coal production in recent years is due to the local, privately or collectively run small mines. Officially about 8,000 of these mines are known but the actual number is much higher. The coal mines have capacities of less than 30,000 tonnes/year and some are only operated seasonally. In 1997 608 million tonnes of bituminous coal (45% of China's total output)was extracted from these small mines. Advantages like being responsible for their own output, low production costs and market orientated pricing are set against a low level of mechanisation, insufficient safety measures, wasteful use of resources and pollution of the environment.

In order to reduce the current yearly output by the above amount of bituminous coal, by the end of 1999 just under **26,000** mines will be closed. Amongst those affected will be about 11,200 small mines without mining permission, 400 small mines which mine within the state owned fields, about 6,900 illegal mines without extraction permission or a valid operating plan, 3,200 private mines with poor management, 600 mines with bad quality coal and 3,300 mines which mine within the state owned fields with valid operating plans.

Just by closing 40 mines which have exhausted their resources or produce with too high average costs and by making 14 coal companies bankrupt, 260,000 - 400,000 workers will lose their jobs.

The increase in domestic bituminous coal production occupies a high place in current economic planning in the People's Republic of China. One of the largest projects is the development of the Shenfu-Dongsheng bituminous coal field in the province of Shanxi with estimated reserves of 224 billion tonnes. Included in this project is the construction of two train lines, a port and the necessary energy infrastructure, so that the whole project represents the second largest after the construction of the "Three gorge barrage dam" and probably the largest coal project in the world. The output of 30 million tonnes/year that has already been reached should gradually increase to 100 million tonnes/year and by 2003 50 million tonnes/year should be mined.

Currently the new Shenyu coal field is being opened up. The Shenyu area is in the border area between the Shanxi province and inner Mongolia. This area contains the largest bituminous coal deposits in the People's Republic of China. The seams are at a depth of between 150 - 400m and are incredibly thick. In 2000 the first mines should have begun to be set up.

Technical monuments

There is almost no information about technical monuments in the area of Chinese bituminous coal mines. Travellers and those employed by mechanical engineering and consulting firms who have travelled around China report, however, that they have not come across any notable mine architecture. This must be checked but many factors point to the accuracy of these judgements.

Chinese mine groups and large mines could not and cannot usually be compared even today with modern large plants in the Western European sense. They are often a combination of a number of mines that have their own winding shafts and sometimes even surface operations. Combining small and medium sized mines however, often only provides a joint surface operation. Many mines have mining operations even in the seam crops with independent conveying equipment from which the common surface operation or the users are supplied directly.

The various conditions under which Chinese mining is operated means that there is no uniform equipment set up. In small mines even today the coal is extracted with picks and shovels and transported in wooden trucks while for example for mine ventilation wooden box fans are used. On the other hand the large mines are equipped with modern extraction and transport methods and the work is largely mechanised. On the whole, though, the level of mechanisation in Chinese coal mines is low which has an effect on productivity which is 50 times lower in China than in Australia.

Of special significance for the progress of mechanisation in mines were developments in Chinese mining mechanical engineering. In the 50s a large number of mine workshops grew up to carry out repair work and manufacture simple mechanical equipment. Some of these workshops soon changed to copying foreign mining equipment. Since 1960 they have been increasingly developing their own machines. These workshops which had grown up mainly in the area of the large mining groups of large operations, were finally developed into proper machine factories with series production. In this way factories grew up in all extraction centres which conducted special developments. The smaller workshops were also extended and are able to supply mines with other mechanical mining equipment. They obtain their semi-finished products from local iron and metal industry works.

All this information probably means that it is not possible to compare Chinese coal mines with Zollverein mines. The lack of infrastructure in China in the early part of the 20th century, the occupation of the giant empire by the Japanese and the destruction during the Great War and later will not have led to the construction of a mining operation like shaft plant 12 in the Zollverein coal mine. Nothing is known of a shaft plant set up according to the "German" pattern in the bituminous coal fields in the colony of Tsingtau. While the central shaft plant 12 was being built in the Zollverein mine this German colony had long been handed back to the Chinese again. You will also not find in China any mine that is comparable in quality or importance to the mines in the Zollverein.

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Short notes in: Glückhauf 134, 1998, notebook 3, page 71; same 135, 1999, notebook 1/2, page 8;same 135, 1999, notebook 3, page 69; same 135, 1999, notebook 6, page 290; same 135, 1999, notebook 7/8, page 448; Harnisch, Hans/ Gloria, Hans Günther: Die Energiewirtschaft der Volksrepublik China,(Energy management in the People's Republic of China) in: Rohwirtschaft International, vol. 1, Essen 1974(International raw materials management); Kelter, Dietmar: Kohle, in: Federal unit for geoscience and raw materials (Hrsg,):Reserven, Ressourcen und Verfügbarkeit von Energierohstoffen 1995,(reserves, resources and availability of raw materials for energy), Hanover 1995, Pages 273 - 388;same/Lenz, Reinhard/Erhardt, Robert: Kohle und Torf,(coal and peat) in: Federal unit for geoscience and raw materials (Hrsg.): Reserven, Ressourcen und Verfügbarkeit von Energierohstoffen 1998, Hannover 1999, Pages 217 - 294.

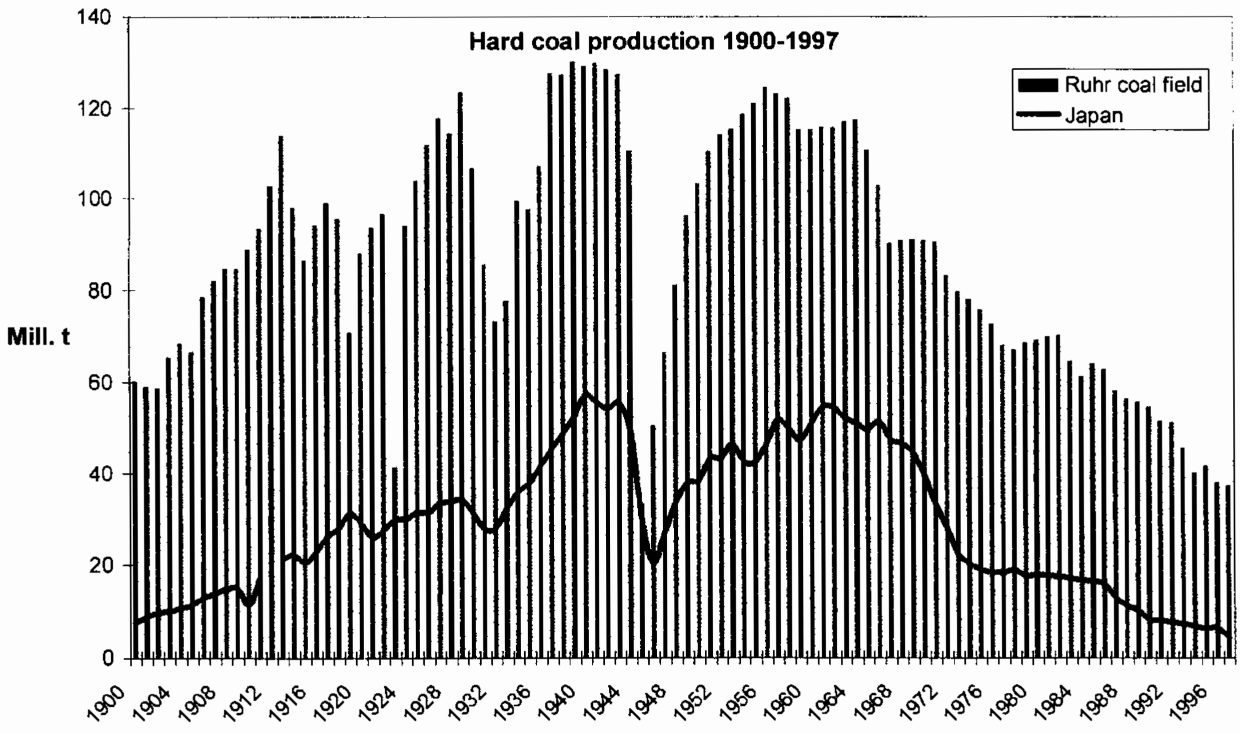
2.6.4.2 Japan

Japan has 612 million tonnes SKE of workable extractable hard coal reserves. Japan's most important coal fields lie firstly in the south west of the country, to the north of Kyushu and in the extreme west of Honshu, and secondly on Hokkaido in the north. A further deposit can be found in the north east of Honshu. Most of the once important coal fields are near the coast. The coal fields of Ishikari, Kushiro, Joban, Ube, Omine, Chikuho, Fufuoke, Miike, Sasebo, Sakito-Matsushima, Amukasa were economic.

The seams in the north Kyushu coal field are flat and only disturbed by geological block shifting. In parts of Hokkaido they are heavily folded. Therefore the fields in north Kyushu were exploited mainly by tunnelling and in Hokkaido by shafts. The seams often continue under the sea and were also mined under the sea in the mines at Taiheiyo in the Kushiro (Hokkaido) coal field, in the Ube coal field (Honshu) and at Miike, Sakito-Takashima (north Kyushu).

Development of bituminous coal mining in Japan

According to tradition the first coal reserves were discovered in the 15th century in north Kyushu, when a farmer lit a fire on a mountain for warmth and found to his amazement that the ground had also begun to burn with black stones. You will find more credible information by the 17th century where it was reported in a topography about "burning stones", which were dug up and used for fires. However, these "burning stones" were only used locally and were not distributed further afield. It was not until a shortage of wood forced the use of coal in the southern smelting works on the salt flats of the inland sea and led to greater demand at the beginning of the 19th century and thus to the development of coal mining. If the coal up till then had been, in the truest sense of the word "dug out" by farmers with simple equipment in less work intensive seasons, mining now became specialised, when even the trade of the feudal tenure holders was regulated and put into the hands of wholesalers. Bituminous coal was not only used in the southern smelting works but also in the first early factories during Japan's "industrial apprenticeship" between 1850 and 1868. Even foreign steamers profited from the coal reserves in Kyushu after the land was opened up in 1853/54. They refuelled with local coal and often complained about its bad quality.



After the Meiji restoration in 1868 the new government claimed the mines for itself and took the existing mines under state control. At this time coal was the fourth most important export after silk, tea and copper. About half of the coal mined went abroad, mainly to China or South East Asia. Of the other half in the next two decades about a third of domestic use was for steam ships, a further third for smelting works and only a fifth for the still young industry. The period under state control was important because at this time, largely with the support of foreign specialist workers, modern technology in building shafts with drainage, ventilation and extraction was introduced at least in the larger mines. Mining itself was still done for a long time with simple equipment like wedged hoes.

Profitability problems may have been one of the reasons for the sale of the state mines in the 1880s. Even traditional business families like Mitsui and Iwasaki (Mitsubishi), who up until then had adopted a wait and see attitude towards industrial efforts now committed themselves to mining. A period of concentration of capital but also combining smaller mines began. As well as large trading families, self made entrepreneurs rose to local size from the coal fields. In spite of that small and very small mines still existed. The result was a sort of double structure with different capital structure, working organisation and technical equipment. State measures were limited to support with surveying from which larger, more profitable areas for mining arose.

In the first quarter of the 20th century coal mining took a rapid upswing which culminated in the boom of 1916 - 1919, the "Golden Age of Coal Mining". The demand for coal had risen mainly because of the rapidly growing local industry, which took 60% of production. Export with its share of about 10% had lost significance. Because of this expansion technical changes took place. Electrical power units were increasingly being introduced instead of steam engines. This had effects on methods of transport underground where the conveyor belt gradually replaced the trucks. Even the mining methods themselves changed. They went from building pillars to building props but the traditional wedged hoes were not finally replaced by mechanical mining tools like cutters until after the crisis of the 1920s and the rationalising measures that followed as a result. In spite of that some work processes still had to be done by hand, the picture of the sorter in the treatment and sorting plant bears witness to this.

In contrast to ore mining which required workers with a certain level of training, often uneducated or semi-skilled workers found employment in coal mines, especially in the less important mining jobs in earlier times. The upswing in coal mining in the last third of the 19th century unleashed a stream of jobs in the coal fields. The different type of work available underground led to whole families being employed in the mines, and men and women, but also children were used as teams at the coal face. While hewing the coal out remained men's work, the women were used for hauling it around. The fact that seams were not very thick in many mines meant that hewers and haulers could only work on their knees or bent over. In this way the sledges which often weighed more than 250 kg and later the trucks which could be up to half a tonne had to be pushed partly over steep stretches up to the surface. By the turn of the century shift working started. The daily shift was ten or twelve hours, but the expansion of the mines and the great distances that had to be covered to reach the coal face often meant that much more time was spent underground. Although even before the First World War there were the beginnings of work protection regulations for women and children, women did not finally stop working underground until after the crisis of the 1920's and the wave of rationalisation and mechanisation that arose from this. A law that came into force in 1933 forbade women to work underground.

Company owners tried to overcome the ever growing crisis in coal mining first of all by forming cartels that should have prevented the ruinous competition between companies, but only met with partial success. After the recession of 1920, for the first time a nation wide association of coal mines was created but this only had limited possibilities for control. It was not until after the world economic crisis that at the beginning of the 1930s, with the threat of state control, a coal union was formed. But in spite of a great deal of opposition this organ soon became an instrument of the government that at this time was leaning more towards state control of industry mainly in order to increase production of arms in certain areas. Continuing central administration during the economic conditions of war (1937 - 1945) led to production, distribution and consumption of coal being subject to strict state control. The demand for higher production on the one hand and the lack of manpower on the other during the Second World War led first of all to a partial lifting of the ban on women working underground but then to the use of manpower from the colonies or occupied territories. Mainly forced labour from Korea was used in atrocious conditions. In 1944 a production high was reach but at the end of the war demand rapidly went down.

In spite of a policy that directly after the war placed special value on increasing production of important goods for the people, it was more than ten years before the pre-war production level was reached. There had first of all been fear of being very dependent on imports which was responsible for the preference of coal as the most important energy source at the time when Japanese industry was being revived. Cheaper oil, however, was an additional competitor for coal to which the mining companies reacted with increased rationalisation and mechanisation and also by laying off men and closing uneconomic mines. The consequence was clashes between companies and miners. The long lasting strikes in the Miike mines in 1953 and 1960 have become famous.

Although the state had withdrawn from direct control of coal mining after the Second World War, they tried to save this branch of industry in the 1950s with a range of state measures. But the fact that all these plans had failed became clearer and clearer shortly after 1960. Coal mining "the sick man of Japanese industry" could no longer be saved even though in 1961 the largest output since the Second World War was reached with 54.5 million tonnes.

Mass lay offs and closures mainly of small and medium sized mines was now the order of the day. But the increasing energy revolution soon brought difficulties even to the larger mining companies. Even the oil crisis of 1973 as a result of which they thought more about domestic resources, but also thought about the increased import of coal and in addition developed plans for refining coal, e.g. liquefying it or turning it into gas, brought no long term revival of the Japanese coal industry. The annual output decreased dramatically. Even attempts in the 1980s to bring new mines in the coal fields of north Japan into operation with the help of the latest technology failed. A visible sign of the end of coal mining was the closure of the Takashima mine. It had been Japan's oldest mine, its name linked with the industrial upsurge and modernisation of Japan, but at the end of 1986 it had to be closed although it was one of the most modern mines in Japan at this time. Other still producing mines followed. In 1997 the Miike mine in the south of Japan was closed, so that today across the country only two coal mines are in operation. These are the Ikejima mine in the south and Taiheyo in the Kushiro coal field in the north which were recently modernised with massive investment from German suppliers and for the time being experts should remain. Although in the mines sometimes record amounts are mined, Japan's coal production in 1997 was still only about 4.3 million tonnes.

Technical monuments

Monuments of mines from the 1920s and 1930s that could be compared with the surface plant of shaft plant 12 in the Essen Zollverein mine are not known. The economic development of Japanese coal mining does not lead us to expect the existence of such mining facilities. The output statistics in the 1920s and 1930s also prove clearly the superiority of the Ruhr mines compared with the Japanese. In the Japanese coal mining industry there has not been a mine that had a comparable performance to the Zollverein mine.

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2.6.4.3 India

More than 51 billion tonnes SKE of workable extractable coal make India one of the coal richest countries on earth, but the amount of high quality bituminous coal is small. Most of the coal reserves can be extracted by open cast mining.

The often highly volatile coal reserves are mainly in the central and eastern part of the country. The most important deposits are in the states of Bihar and West Bengal with the Jharia and Raniganj coal basins. The coal reserves consist of a large number of smaller basins which are combined into five main basins:

1. Damodar East and West (West Bengal- Bihar). In Damodar East coal is of the coke and boiler coal type and is of good quality at a depth of between 1200 and 1500m. More than 60% of India's total reserves are concentrated up to a depth of 1200m.

2. In the Godwari basin (Andra Pradesh) there are deposits of highly volatile bituminous coal.

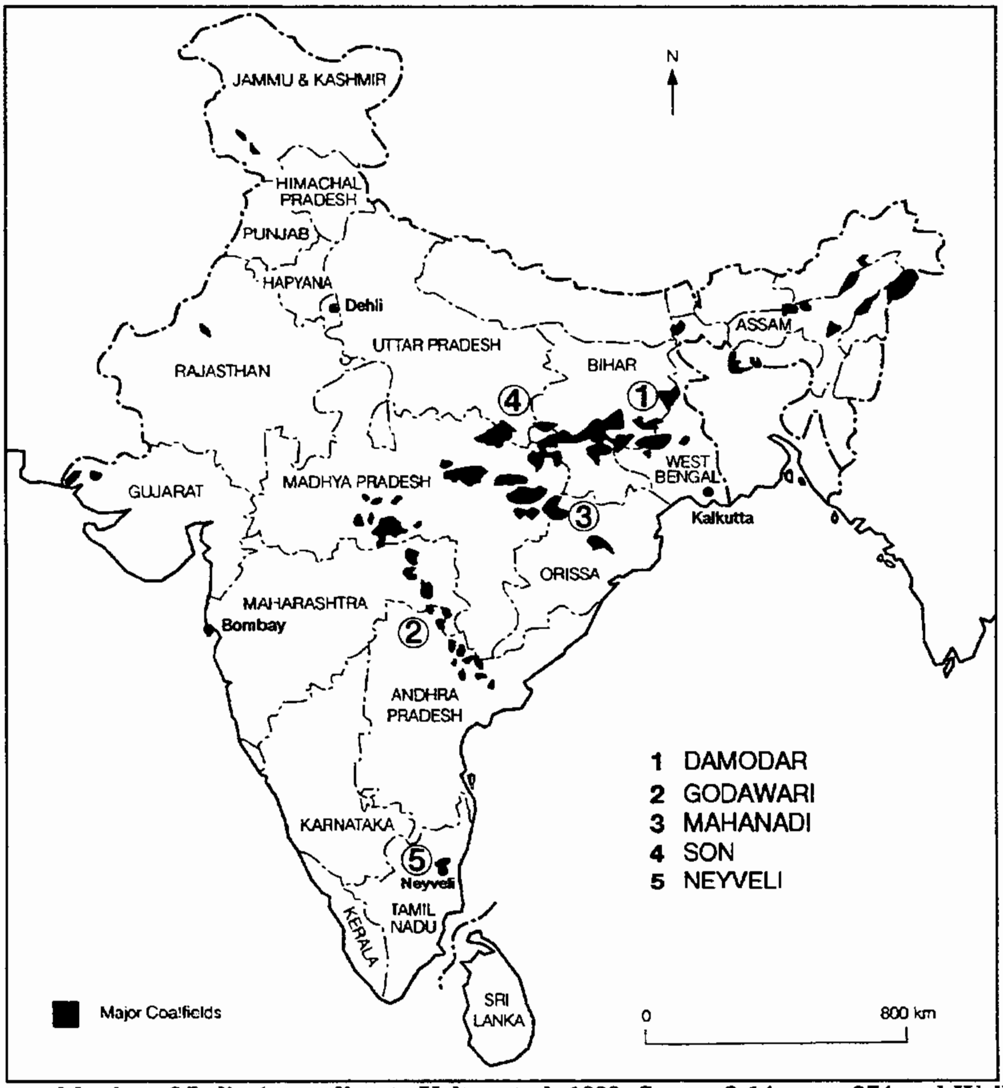
3. In Mahanadi (Orissa) highly volatile coal reserves with sometimes very high ash content are mined.

4. The Son basin (Madhya Pradesh) contains highly volatile bituminous coal.

5. In South India in the state of Tamil Hadu at Neyveli there are reserves of soft brown coal.

Otherwise highly volatile bituminous coal is mined at Makum in Assam.

Development of coal mining in India
The first attempts at coal mining in India were made by the British at the end of the 18th century (1774 Raniganj). After the discovery of the coal fields, William Jones, "the father of modern coal mining in India" opened up his first mine in Raniganj. In the 1820s various companies started operations in the Raniganj coal fields. Mining increased greatly after the building of the railways. In 1862 coal mining was started in Madhya Pradesh too, in 1872 in Andhra Pradesh and in 1881 in Assam.

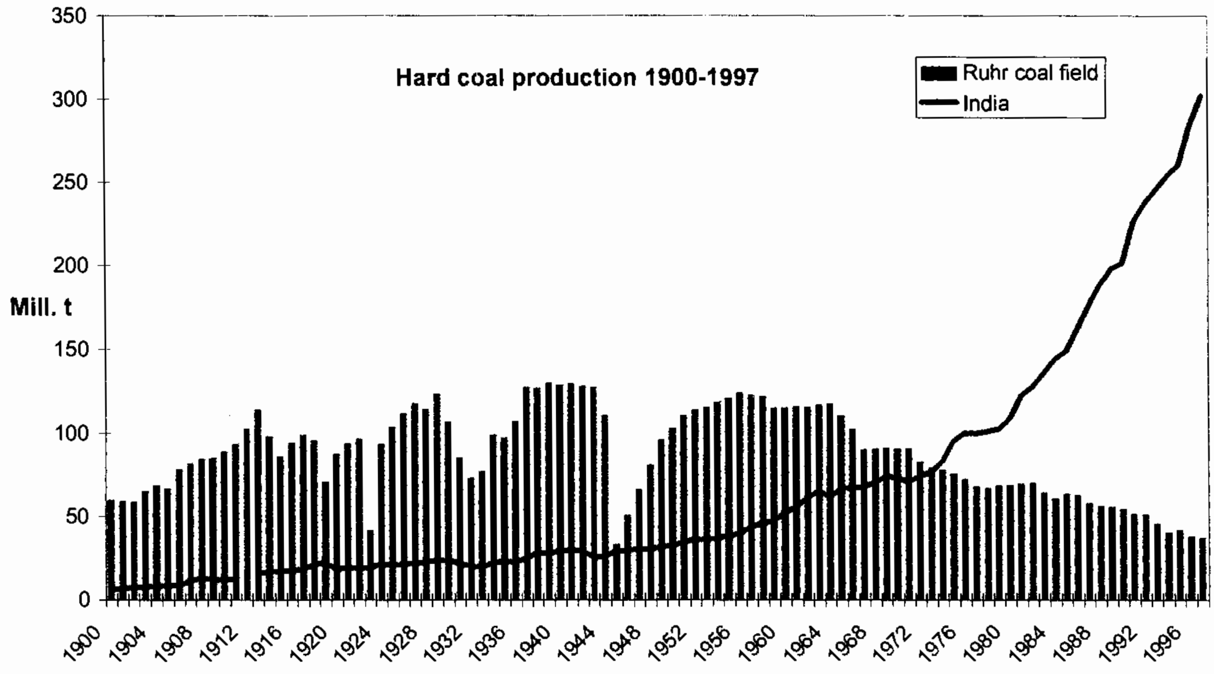


The main coal basins of India (according to Kelter et al. 1999, figures 3-14, page 274 and Walker 1996, figure 14,page 24)

In 1900 6 million tonnes of coal was mined in Indian coal fields. In 1945 they reached 30 million tonnes and in 1960 more than 52 million tonnes; in 1952 862 mines were in operation of which 667 (which produced 28% of India's total output) had no electricity. In 1977 there were 356 mines in operation of which 44 were open cast mines. The majority of deep mines were then at depths of between 100 and 400m. The deepest mine reached 675m. Usually coal mines did not produce much and were not highly mechanised.

Coal production per mining area in 1000t (from: Coal production of the world in figures 1958 and 1961)

Mining area	1952	1953	1954	1955	1956	1957	1958	1959
Assam	501	491	497	537	576	589	573	652
West Bengal	12267	10381	10763	11522	11472	13893	14474	15198
Bihar	17753	19248	19382	19732	20413	21443	22164	22708
Orissa	465	498	528	561	612	541	542	619
Madhya Pradesh	3507	3535	3672	3802	4086	5132	5479	5630
Hyderabad	1457	1352	1527	1565	1721			
Rajastan	49	33	30	29	26	18	12	25
Vindhya Pradesh		885	965	1077	1161			
Andhra						1950	2151	2266
Bombay						634	671	684



An increase in production was clearly shown by the 1950s. With the increase in capacity, especially in the 1970s 42 deep mines and 24 open cast mines were worked as well as 12 new treatment works brought into operation. Special emphasis was put on the development of "secluded coal fields" outside the Bihar Bengal coal fields. From 1971 - 1975 production was increased by 24 million tonnes to almost 96 million tonnes/year. In 1980 production went up to 109 million tonnes/year, in 1990 it was almost 202 million tonnes. In 1997 with a yearly output of about 300 million tonnes, India was the third biggest coal producer in the world after China and the USA.

Most of the production was used by the country itself for energy production. India's energy requirements were 60% covered by coal. Because of the high ash content (40% and more), the coal is not competitive on the export market.

Coal mining is almost completely in state hands. The largest (state) coal company is Coal India Ltd. (CIL). After the reorganisation and closure of unprofitable mines it currently still operates 510 plants from a total of 937 state mines, of which 183 are in Bihar and 111 in West Bengal. Coal India Ltd. dominates production with about 630,000 workers and in 1997 was the leading world coal producer with an output of more than 260 million tonnes. Private mines only have a 1% share of Indian coal mining.

It is remarkable that the daily output per man per shift has not changed for 15 years. It is about 0.56 tonnes and is therefore a tenth lower than in Germany. This can be put down to the low level of mechanisation. Open cast mining in India shows an output of about 4.7 tonnes/man and shift.

In order to reach production targets and keep costs low, open cast mining is preferred today to deep mining. Whereas in the middle of the 1970s about three quarters of coal production was from deep mines, in the middle of the 1990s it was only about a quarter.

Technical monuments
Hitherto there has been no knowledge about technical monuments in coal mines in India. Therefore we must assume that only individual monuments are available and nothing of the order of shaft plant 12 in the Zollverein mine. From mining's early days, which was under English influence, no architecturally outstanding mining facilities may have been erected in analogy to the relationships in Great Britain, because the bulk of investment in colonial times was put mainly into extracting large amounts of coal rather than into building surface facilities. Also the output in the 1920s and 1930s was nowhere near the level of the Ruhr region mines. Today we know by visiting and touring them that Indian mines only pay lip service to safety and that (even large-scale) accidents are the order of the day. Lack of investment and just thinking of output are the main reasons for the neglect of the mines. With this background no example in the Indian coal mines can be expected to be comparable with the monument landscape of the Zollverein mines.

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2.6.4.4 Indonesia

Indonesia has about 2.2 billion tonnes (1.4 billion tonnes SKE) of workable extractable reserves of bituminous coal and 3.1 billion tonnes (0.9 billion tonnes SKE) of soft brown coal. With a production of 47.4 million tonnes of hard coal in 1997 Indonesia took 14th place in the world of coal producing lands.

The large coal deposits in the country lie in the west and south of Sumatra and in the east and south of Kalimantan. Sumatra has about 60% of the coal reserves and Kalimantan 40%. The main coal regions are:

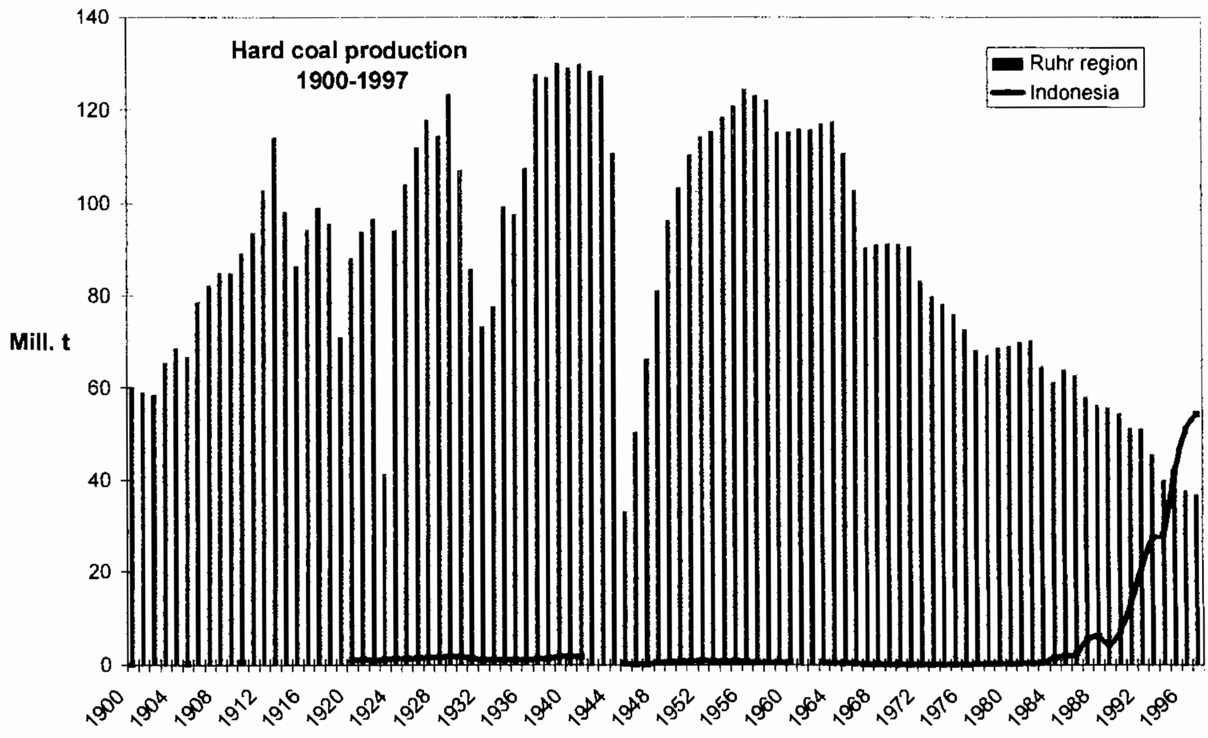
West Sumatra: in the Ombilin reserves highly volatile cokable coal is mined both by deep and open cast mining in up to three flat seams of a maximum thickness of 10m. After Ombilin a larger open cast mine can be found at Parambahan.

South Sumatra: In Bukit Assam there are large reserves of matt brown coal which can be extracted using open cast mining techniques. There is also anthracite locally.

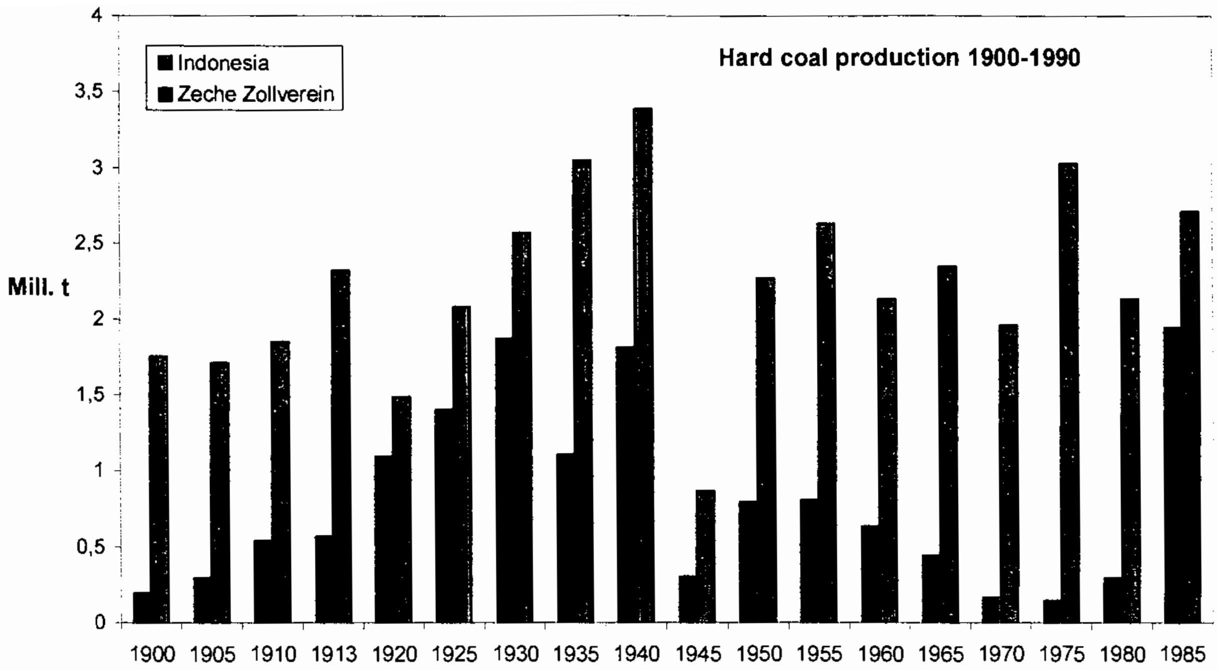
Kalimantan: in the north east and south east lie the greatest coal potential of the country, that up till now has only been partially exploited in depth. Flat open cast seams reach a thickness of 6m. In the Kaltim Prima region high quality boiler coal has been surface mined since 1991.

Development of coal mining in Indonesia

Coal mining has been going on in Indonesia since the middle of the last century. By the middle of the 1970s about 60 million tonnes have been mined. This output and the performance of output figures shows clearly the comparatively low standing of Indonesian coal mining in the past. In 1940 output was 2 million tonnes and this reduced rapidly after the Second World War to less than 200,000 tonnes in 1968. At first output remained at this level, but since then, with the constant growth in energy use, coal production has greatly increased because of continued electrification and industrialisation of the country and by increasing export mainly to Asiatic lands. In 1985 output was 1 million tonnes and increased further to 7 million tonnes (1990) and then very considerably to 54.5 million tonnes in 1997. Further large rates of increase are planned.



Indonesia's coal exports have increased considerably in the last few years and reached more than 41 million tonnes in 1997, making Indonesia 4th of all coal exporting countries. The growing domestic energy requirements should probably be covered by the substantial amounts of coal available 95% of which can be surface mined cheaply.



Technical monuments
As coal mining in Indonesia is still in its infancy, in the 1920s and 1930s it still did not play a very large economic role and the deposits were largely surface mined, there can be no monuments of the order of the Zollverein mines in Indonesia.

Literature:
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2.6.5 Africa

2.6.5.1 South African Republic

The South African Republic takes fifth position in the world with 33.6 billion tonnes SKE of workable, extractable hard coal reserves and in 1997 with an output of more than 172 million tonnes SKE of mined hard coal was in the same position for production.

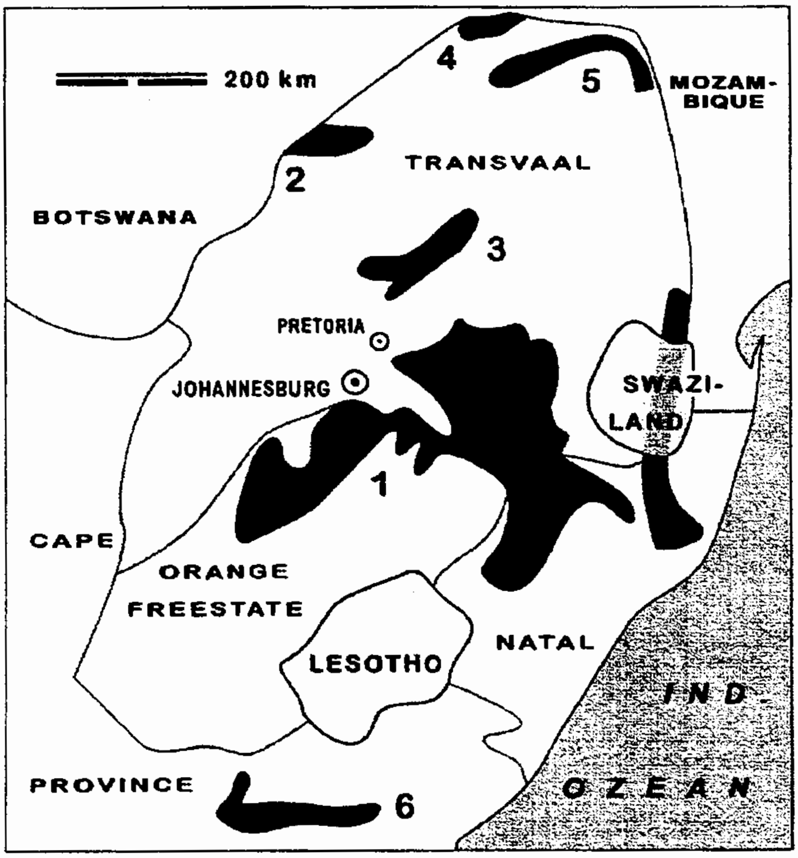
The coal reserves are concentrated in the north east of the country around the capital Pretoria and on the borders of Botswana, Zimbabwe and Mozambique. They belong to the Gondwana coals of the southern continents which were formed at the end of the paleozoic era under the same conditions as those in South America, India and Australia. There are three different coal provinces:

1. The Great Karoo basin with connecting deposits in North Orange, South Transvaal and North Natal. Here most of the reserves are located and also the traditional mining fields of the country. Lower quality coal comes from Orange, better quality (coking coal and anthracite) from Natal.

2. In central and northern Transvaal you will find widely scattered individual deposits with coke and coke mix quality coal. The larger ones are the Waterberg Coal Field, the Springbok Flats Coal Field, the Limpopo Coal Field and the Soutspansberg Coal Field.

3. In the Molteno-Indwe basin in the north east of Kap province are thin seams of ash rich lean coal up to anthracite, which were mined before 1948.

Characteristic of the country's deposits are small tectonic disturbances, flat and not very deep. Much more than 90% of economically extractable reserves are less than 200m deep.

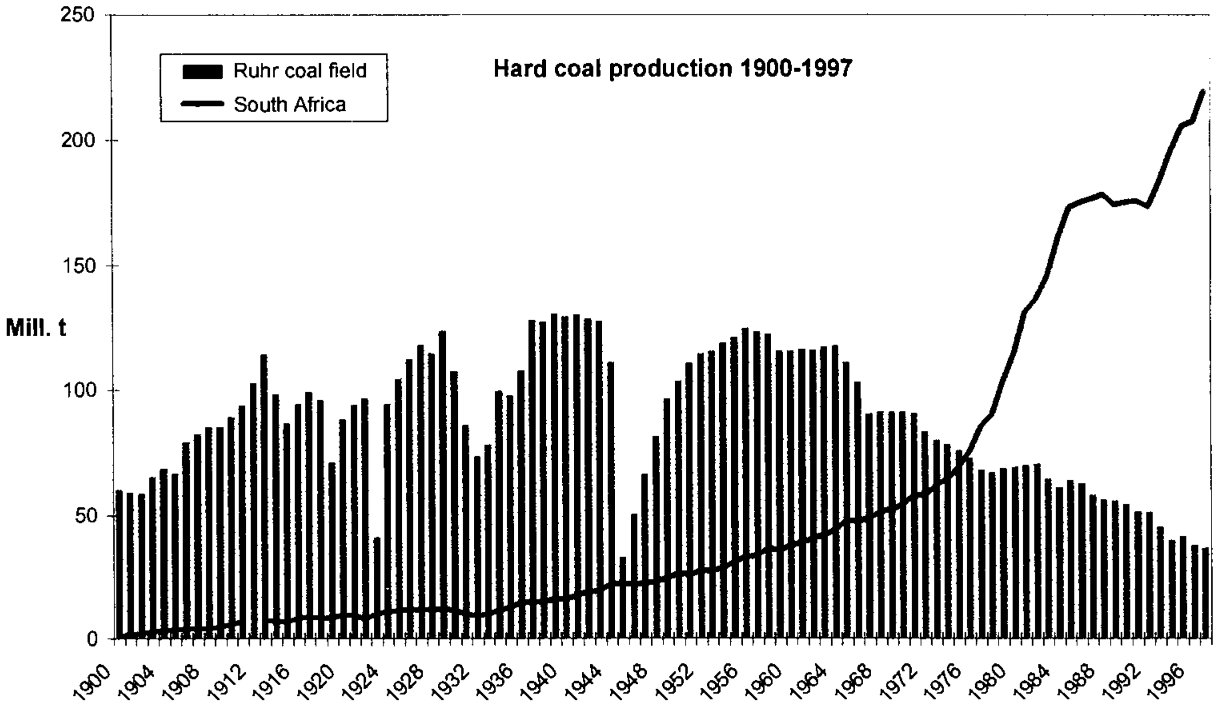


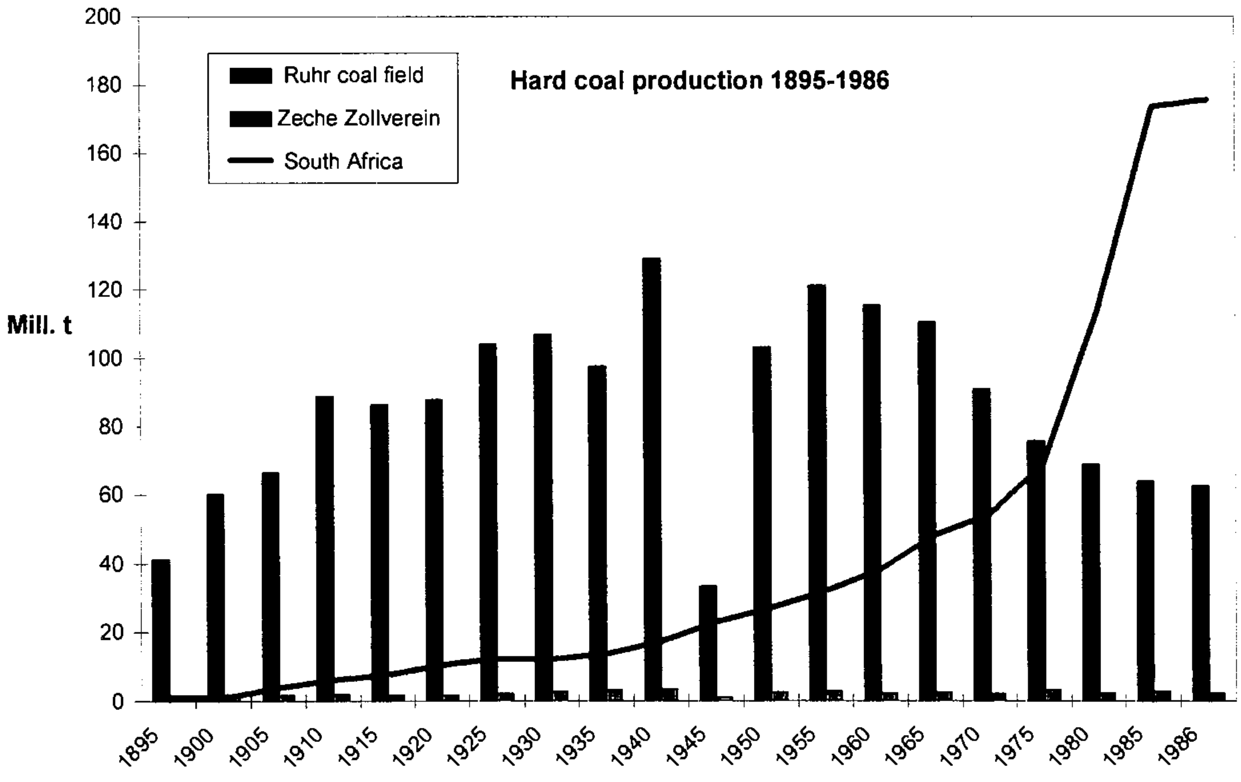
The main coal basins of South Africa (from Kelter et al. 1999): 1. Great Karoo, 2. Waterberg, 3. Springbok Flats, 4. Limpopo, 5. Soutspansberg, 6. Molteno-Indwe.

Development of coal mining in the Republic of South Africa

The first records of the discovery of coal east of Cape Town in the Fransch Hoek Valley by Europeans come from 1699. But long before this time coal was used by the indigenous population for smelting ore and for the manufacture of weapons and tools.

The first coal mine in the Molteno-Indwe coal field in the Cape region dates from 1864 and supplied coal to Cape Town. However, it was not an economic success. The bad coal quality and the long difficult transport from the coal fields to Cape Town made the operation insecure and uneconomic. The mine would probably have been closed sooner if diamonds had not been found in Kimberley in 1870. The sudden demand for coal allowed the mine to continue its existence until the better Transvaal coal started to compete. With a sort of "stop go" production the mine remained in operation until it was finally closed in 1950.





Coal reserves were discovered in Natal in 1840, in Transvaal and the Orange Free State, some years later. The demand for coal was only irregular at first and so mining was correspondingly not very extensive. Coal was transported to Durban for ships. The discovery of the Kimberley diamonds and the gold deposits at Witwatersrand also brought changes to the coal industry: steam power and electricity were needed to an extent that had never been known before. Coal mines arose in the area of Witbank (South Transvaal) and North Natal in large numbers. Accordingly production leapt and was steadily increased: in 1889 28,700 tonnes of coal was produced in Natal, in 1905 1 million tonnes and in 1920 the country's output exceeded the 10 million tonnes barrier. Measured by the technical achievements in coal mining in Europe, coal mining in South Africa lags way behind. Even transporting the coal from the fields to the buyer takes a long time and is done under very difficult conditions.

In the early days of South African coal mining there arose a large number of coal companies. The advantages of combining were soon recognised and the coal industry was organised according to the same centralised "mining house" principle as gold mining. In the 1970s 70 coal mines were in operation in the Republic of South Africa and almost all of these belonged to one of six mining companies.

The Republic of South Africa produced more than 54 million tonnes of bituminous coal in 1970. Up until 1972 nearly all the coal production was used by South Africa itself. Coal export up until then had not been an economic proposition because of insufficient infrastructure and the long distances it had to be transported to reach its markets. This all changed with the construction of the Richard Bay Port which was finished in 1976 and extended to cope with an annual capacity of 54.5 million tonnes in 1991. Coal was transported from the main production areas to Richard Bay by a 600km long railway line. Production rose by 1988 to more than 178 million tonnes. In subsequent years production stagnated for a time and it was not until 1993 that it rose again (184 million tonnes); in 1997 more than 220 million tonnes of coal was mined.

The coal mines of the Republic of South Africa are today concentrated in the Witbank field in eastern Transvaal, although mining is tending to move from Witbank in an easterly direction. Coal production is moving more and more from deep mining to surface mining. Today about 50% of production is mined in this way which means the closure of deep mining pits and the subsequent laying off of personnel. Currently about 60,000 people are employed in the South African coal mining industry.

Three companies, Ingwe Coal, Amcoal and Sasol dominate the market with 80% of total production. There are also still small mines with a monthly output of between 1,000 and 5,000 tonnes. In 1997 Ingwe Coal was the fourth largest coal producer in the world with 68.1 million tonnes. and the world's largest coal exporter.

The country still uses the majority of its coal output itself. In 1996 the South African domestic market bought 150 million tonnes. 83 million tonnes of this went on electricity production and 52 million to industry (including coal liquefying). Sasol, the world's largest producer of liquid coal products (benzine, oil), extracts the raw materials in its own mines.

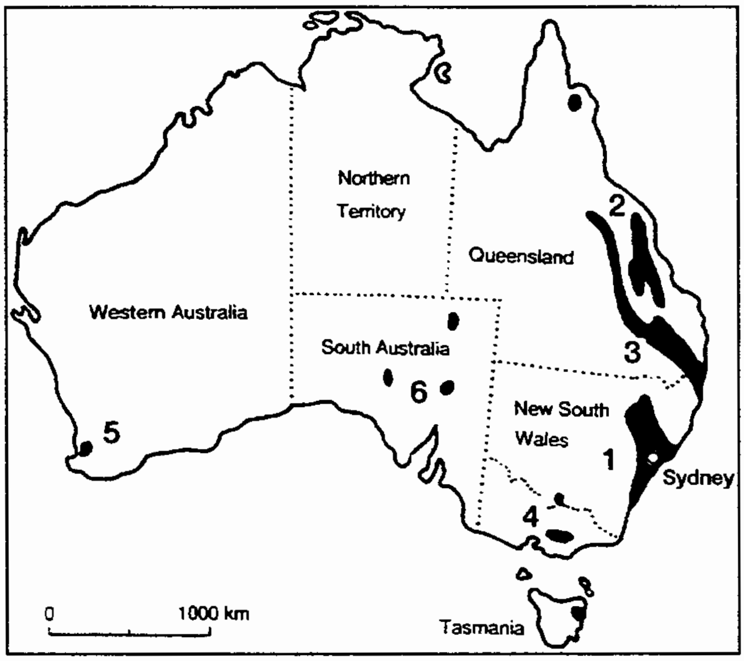
Although the country uses most of its coal production the Republic of South Africa is the third largest export nation for coal. In 1997 64 million tonnes of mainly boiler coal was exported. The main customers were countries from the European Union.

Technical monuments
Technical monuments in coal mining are not known. We cannot therefore expect monuments of the order of the Zollverein mine. In 1920 coal production in the Republic of South Africa as a whole exceeded the 10 million tonnes barrier for the first time. At this time the Zollverein mine alone was producing 1.5 million tonnes, almost a seventh of South Africa's output! The economic mining significance of the Essen mine with its infrastructure and the South African coal industry that was growing up in the 1920s and 1930s cannot be compared with each other and were diametrically opposed.

Literature:
Devenish, John: Coal. Pride of South Africa 17, Cape Town 1975; Kelter, Dietmar: Kohle, in: Federal unit for geoscience and raw materials (Hrsg,):Reserven, Ressourcen und Verfügbarkeit von Energierohstoffen 1995 (reserves, resources and availability of raw materials for energy), Hanover 1995, Pages 273 - 388;same/Lenz, Reinhard/Erhardt, Robert: Kohle und Torf, (Coal and peat) in: Federal unit for geoscience and raw materials (Hrsg.): Reserven, Ressourcen und Verfügbarkeit von Energierohstoffen 1998, Hanover 1999, Pages 217 - 294; Jahrbücher für Bergbau, Erdöl und Erdgas, Petrochemie, Elektrizität und Umweltschutz, Essen (Year book for various energy sources).

2.6.6. Australia

With 49.2 billion tonnes (44.3 billion tonnes SKE) of workable, extractable hard coal reserves, Australia occupies fourth place in the world. In addition to this there are 41.2 billion tonnes of workable, extractable brown coal reserves which will give Australia in the long term an important position as a coal exporter. Most of the hard coal reserves consist of coals of the Gondwana type from the Permian age 95% of which lie in New South Wales and Queensland, where most of it is currently mined today.



The main coal basins of Australia (from Kelter 1995, figure 5.14, page 341): 1 Sydney, 2 Bowen, 3 Clarence-Moreton, 4 Latrobe Valley, 5 Collie, 6 Leigh Creek.

In the eastern part of New South Wales the Sydney basin stretches over an area of 500km by 150km. It consists of the Hunter, Newcastle, Southern, Western and Gunnedah fields. The seams lie in deposits that are little disturbed and not very deep with mostly flat incidences. In the south west part of the Sydney basin there are seams of up to 30m thick which reach the surface.
The mines which were set up in the 19th century originally as deep mines were only converted into large surface mines in the last 35 years. In 1993 65 mines produced a total of 85 million tonnes of coal. In 1996 the state of New South Wales produced 105 million tonnes of coal of which about 50% was surface mined.

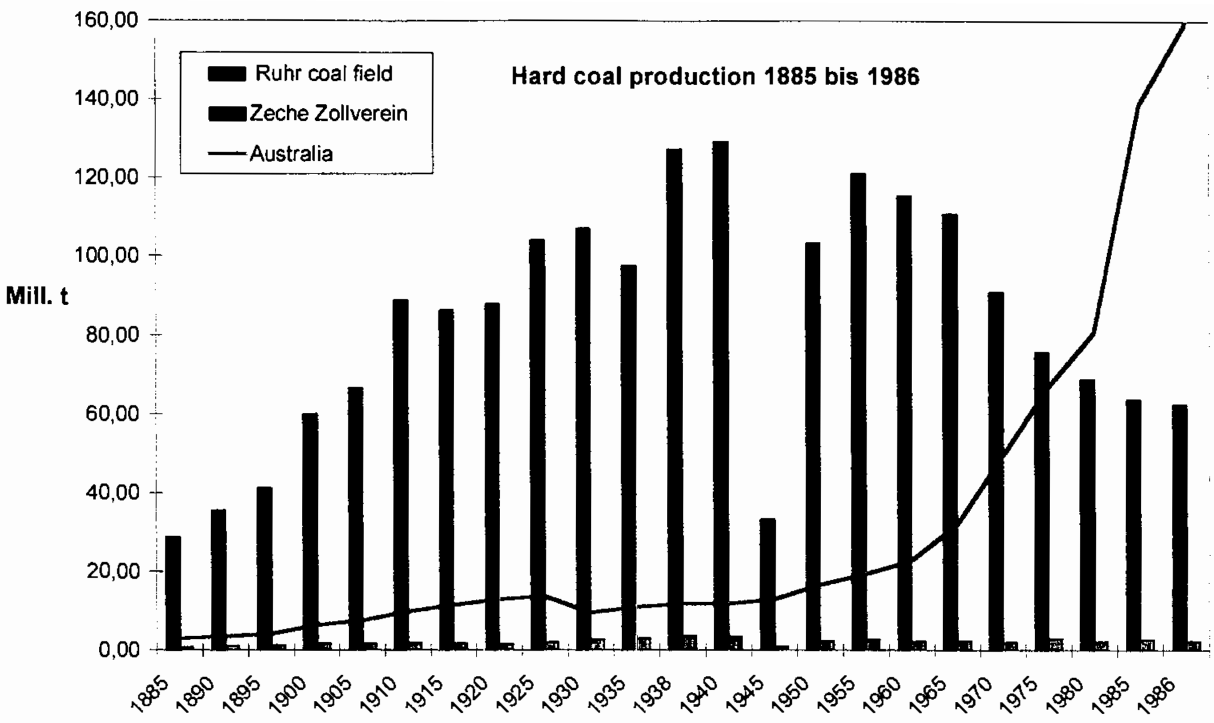
The Bowen basin in eastern Queensland extends over an area of 550km in length and 250km maximum width parallel to the coast. The seams which sometimes contain anthracite have a maximum thickness of 10m. Directly outside the western edge of the Bowen basin lies the isolated field of Lair Athol with four gas coal seams of which one is 35m thick and can be surfaced mined. In the Bowen basin in 1993 altogether 42 mines produced 86.2 million tonnes coal. In 1996 in Queensland 103.3 million tonnes was mined, 90% of it surface mined.

In the Collie basin in the south western part of Western Australia about 6 million tonnes of hard brown coal is mined in three surface mines and two deep mining operations. As well as the Collie basin Western Australia also has five other coal deposits: Hill River, Vasse Shelf, Irvin River-Dongara as well as the Welga and Boyup basins.

There are further coal deposits in the southern part of Victoria and in South Australia and Tasmania.

Development of Australian coal mining

The history of Australian coal mining goes back to 1791 when a group of escaped prisoners stumbled on pieces of coal at the mouth of what is today the Hunter River. Soon afterwards more and more coal reserves were found along the east coast of Australia right down to Tasmania, so that gradually a simple mining industry grew up and in 1799 the first coal could be exported. In 1830 the amount of coal produced exceeded the 1000 tonnes barrier for the first time. In 1873 the 1 million tonnes barrier was reached and around 1900 the output was about 6 million tonnes. By the end of the 1920s output had risen to more than 13 million tonnes only to fall again to 8 million tonnes during the world economic crisis. Since then, except for during the Second World War and a short time at the beginning of the 1960s, production has increased constantly. Since the middle of the 1960s the Australian mining industry has concentrated on export as well. As a result of the energy crises of 1973 and 1979, interest in Australian coal reserves increased considerably and at the beginning of the 1980s Australian coal production with well over 90 million tonnes a year had reached the level of the German coal mines that were going down at the time, although at this time more than 50% of saleable Australian coal was being exported. By 1984 Australia had grown to be the world's largest coal exporter. Of the annual output of saleable hard coal in 1993, just under 182 million tonnes, 70% went to export. In 1997 from 262.2 million tonnes of total Australian coal output, 157.5 tonnes was exported. As exports rose, coal was increasingly being surface mined instead of deep mined. In 1959/1960 the amount of coal that was surface mined was around 10%. 20 years later this had risen to more than 50%. In 1996 the amount of saleable hard coal surface mined in New South Wales and Queensland together was about 70%.



The economic position of coal producers has worsened. The return on shareholders' capital is low (1997 0.3%) and the average profits are 0.60 A$, so that important coal producers like the Australian BHP, the AMP Society and mainly US groups like Exxon and Arco, have dispensed with output capacities or want to. Australian output by BHP is currently declining. Broken Hill Proprietary's deep mine in New South Wales with a drop of 37% is mainly responsible for this. Another reason for this is the sale of the Mount Owen Mine. Another reason that is forcing the companies into action is the opening up of new mines which are cheaper to work. And so 40% of the current capacity which was 155 million tonnes/year in 1996, is now for sale. But in contrast there are firm plans for new capacity of 25 million tonnes/year by 2002. As well as that by closing uneconomic mines and reducing personnel, the performance capability of the Australian mining industry should be further increased. In 1997 the number of mining workers was 24,000.

Technical monuments

The relatively young Australian coal mining industry cannot be compared with the Ruhr mining industry within the scope of this study. If you compare the annual output of both fields in the last three decades of the last century the Zollverein mine alone at this time reached more than a quarter of the output of the whole Australian coal mining industry. The deposit specific conditions in Australia have meant that no large mines "in the German form" with outstanding monumental architecture have been built. The mine facilities are without exception young and are usually surface mines and set up according to requirements for short term aims with profitability as the main focus. As a result there are in Australian no coal mines that could be even distantly compared with the Zollverein mines.

Since 1970 in Australia a significant commercially orientated tourist industry has been developing, which includes mine visits in its programme. Some deep mines can be toured by visitors - but it is mainly ore mines, the Wonthaggi State Coal Mine (in Victoria) and the Coal Creek Historical Town of Korumburra (in New South Wales) or the Coal Mines Historic Site at Hobart (in Tasmania) that tell the story of Australian coal mining. But it must be stressed again that there are no mining facilities in Australia comparable with the Zollverein mine.

The mines for visitors only give a very limited view of the original construction - they are orientated in their appearance and in their aims towards commercial targets.

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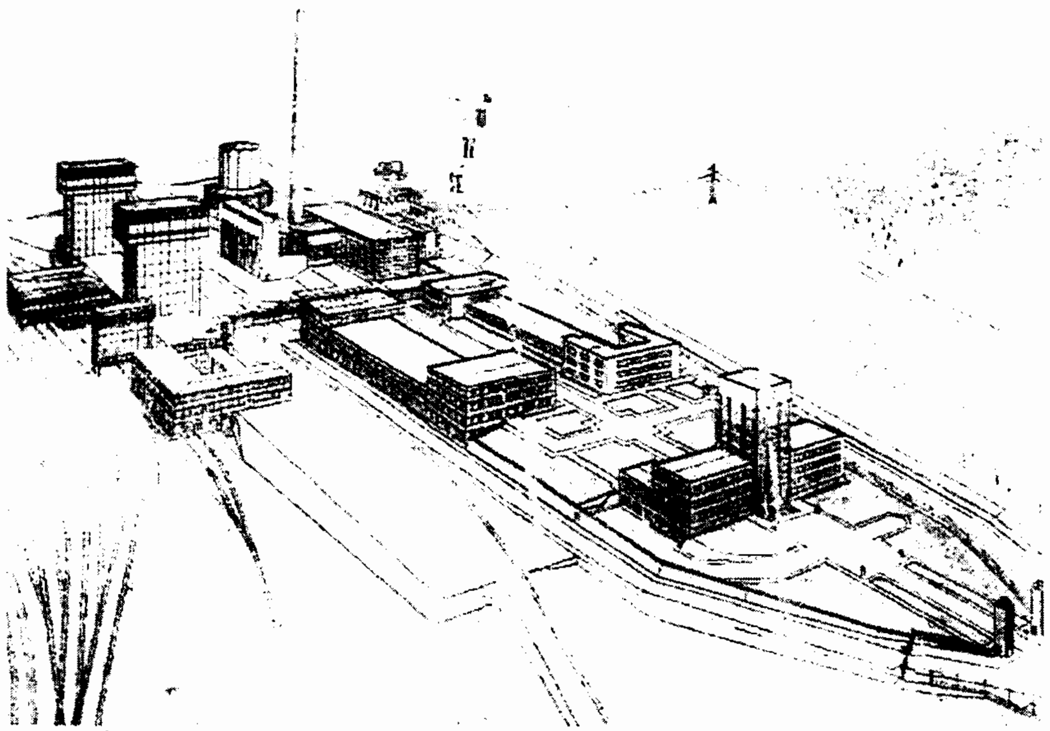
Brown, Ivor J.: Mining and Tourism in Southern Australia., in: Industrial Archaeology Review 12, 1989, no. 1, pages 55-66; Diessel, Claus F.K.: (1979): Der Kohlbergbau Australiens (Coal mining in Australia)in: Glückauf 115, 1979, book 2, pages 73-78; Esser Friedrich H./ Stolte. Gerd: Die Errichtung neuer Steinkohlenbergwerke in Australien, dargestellt am German Creek Project (Setting up new coal mines in Australlia represented by the German Creek Project) in: Glückauf, 117, 1981, book 11, pages 647-655; Kelter, Dietmar: Kohle, in: Federal unit for geoscience and raw materials (Hrsg,):Reserven, Ressourcen und Verfügbarkeit von Energierohstoffen 1995 (reserves, resources and availability of raw materials for energy), Hanover 1995, Pages 273 - 388;same/Lenz, Reinhard/Erhardt, Robert: Kohle und Torf, in: Federal unit for geoscience and raw materials (Hrsg.): Reserven, Ressourcen und Verfügbarkeit von Energierohstoffen 1998, Hannover 1999, Pages 217 - 294; Smith, J.F./ Eng, C.: Coal, in Mining and Minerals Annual Review, London 1997, pages 101-106.

2.6.7 Coal on earth and technical monuments – a summary

If you take an overview of coal deposits on earth you come to the clear conclusion that the Zollverein mine must be considered with every justification as an outstanding technical monument with international significance in the world today. The surface facilities of this mine in shaft 12 are without comparison anywhere in the world. The dimensions of the whole mining plant, the stylish uniform planning and the aesthetics of the architecture, the sometimes monumental, sometimes restrained character of the buildings as well as the functional use of the technical requirements of an imposing mining plant make this architectural ensemble a great success in the history of mankind. In no other coal field on earth was a similar mining facility being created at the end of the 1920s or has been retained. The shaft plant at Zollverein 12 is with every justification to be considered the incunabulum building in the history of mankind.

Of course there are mining plants with similar claims to architecture. In the Ruhr coal field itself we must not forget the older mines of Zoll 2/4 in Dortmund and the lost surface facilities in the Jacobi mine in Oberhausen, the Warndt mine in the Saar coal field, the impressive shaft plant of the Karl- Liebknecht shaft in Oelsnits in the coal field of Saxony, and in Belgium the still existent or partially traditional mines in Bois-du-Lac, Le Grand Hornu and Bois-du-Cazier. In the French coal field in the Nord/Pas de Calais, several very impressive plants have been razed to the ground after closure, but we still have an important example of a mine planned in a uniform fashion with the Fosse Delloye in Lewarde that has been converted into a mining museum and research centre. Thus all the monuments mentioned tell the story of another age in the building of mining plants and are impressive - with the exception of the Dortmund example and Le Grand Hornu - because they are not plants "from the same mould".

Only the unfortunately extensively ruined coal mine at Faulquemont in the Lothringen coal field could have been compared with shaft plant 12 at the Essen Zollverein mine. The Faulquemont mining company was founded in 1920 by a French steel group. They built the mining facilities from reparation payments of 300 million FF from German firms. The mining plant, which was considered the most modern before the Second World War, started production in 1936 but had to be closed in 1974. At this time the daily output was about 1250 tonnes. The mine facilities for the Lothringen mine were built by the architect Joseph Madeline between 1933 and 1935 quite clearly in the Essen pattern. He used similar axial symmetrical links to the buildings and recognised when he received the architectural drawings from Schupp and Kremmer, the purposeful installation of the Zechenstrasse on the chimney of the power station. But unlike the Essen mine the two conveying plants were designed as mining towers and arranged on the side of the Zechenstrasse. In England it was the (now extensively converted) Coventry mine that had an architecturally imposing mining facility - rather like the German, specifically Westphalian pattern.



Faulquemont, Faulquemont mine: sketch by J. Madeline (around 1930). (From Cook, A./Hourte, A.-C.: Patrimoine et culture industrielle en Lorraine, Metz 1996, page 91) (Patrimony and industrial culture in Lorraine, Metz 1996).

Remarkably you don't find any comparable plants anywhere in the mining countries of Europe. You do not find anything comparable with the Zollverein mine in England or Poland or Czechoslovakia where you could have expected similar types of mines. The most impressive monument is to be found in Walbrzych in Lower Silesia with the Julia mine and in Ostrava with the Landeck mine. Both countries were under German rule until 1918 and these imposing mines could have been compared with the Zollverein mine but now they are only maintained in a very rudimentary fashion. Further east, i.e. in Ukrainian and Russian territories, the surface facilities of mines were only laid out with a purely practical viewpoint and aesthetic considerations were largely ignored. This principle also applied to the mines in Asia, Africa, America and Australia.

If you ask why such costly and prestigious mining facilities only arose in Central Europe and especially in German speaking areas, then clearly historical and traditional reasons must be brought into play. Quite clearly "mining", which for centuries has been of crucial importance in the social life of Central Europe for economic life and as a characteristic of the whole culture, has played a more important role there than in the "younger" countries of the world. And quite obviously it was the (older) metal ore and salt mines that laid the foundations first of all for the general esteem of the (younger, but compared with ore mining, more important economically) coal mines in man's consciousness.

The German speaking areas have influenced mining with their technology, language and culture and there has always been an aesthetic component in German mines. Therefore it is no wonder that such expensive shaft plants like shaft plant 12 in the Zollverein mine have arisen. It is only a logical development of the imposing establishments built when mining started under the strong personal influence of self-confident leading figures in commerce and industry and mining magnates. The way business leaders thought in non-German speaking coal fields was completely different. They thought less of "beautiful" architecture and restricted themselves to creating surface facilities strictly according to need.

The Zollverein mine however, is not only a significant architectural collection, but also a high performing mining operation. With its output and number of employees in the late 1920s and 1930s, the Zollverein mine was one of the largest and most modern mines in the world fitted with the latest technology. For a time the central shaft plant at Zollverein 12 was even the most productive in the world. And so the Zollverein mine monument must in this respect be considered "unique". And as technology and commerce are part of the many facets of mankind's culture, the unique importance of the Zollverein mine is due to the sum of the qualities of this monument - it is indeed undoubtedly a part of the international cultural heritage of man.

3. The Industrial Monument Landscape of the "Zollverein Colliery"– Its Context

The Zollverein coalmine was in operation for over 140 years in the northern district of Essen: When mining commenced in 1851 the Zollverein colliery was the most northerly coalmine in the Ruhr area – an industrial pioneer. An extensive network of drifts, which reached a final length of approximately 120km., developed underground, whilst at the surface the extraction of the rich, excellent reserves of gas coal and bituminous coal had consequences which revolutionised and caused a manifest re-structuring of the area surrounding the coalmine. For centuries small farmers and crofters had utilised the agriculturally based district on the banks of the Emscher, which in the area of the subsequent mining area never had more than 500 inhabitants. As the seasons changed, they tilled their small fields and kept their cattle and swine, and time passed over this area without any significant changes.

The year of 1847 brought the first real radical changes to the lives of the inhabitants: First of all, the Cologne-Minden railway company opened its new stretch of line on the 15th. May and cut through the farmers' fields which had been lying undisturbed until that point; and secondly, work on sinking the Zollverein shaft was begun on the land of a farmer called Bullmann: These activities provided the impetus for the wholesale development of the area, both above and below ground, and led to a landscape which was extensively changed and moulded by these circumstances: Houses, apartments, hostels appeared, housing estates, churches, a hospital, schools, nurseries, cemeteries, works railways, slagheaps, coking plants and much more; the infrastructure required by the coalmine was built or financed. The Zollverein colliery became the most important employer in the area and developed into the focal point of the lives of the people who lived in the shadow of the pit heads and slagheaps. The population density increased: Almost 50,000 people live in this area today, a fact which fully justifies the following statement: The Zollverein colliery permanently changed and moulded life and work in the northern districts of Essen; a cultural landscape, which can be explained by the underground operations of a coalmine, of a particular form and significance has arisen out of a natural landscape and has been developed. The deposits and the coalfield itself have, so to speak, forced themselves to the surface, the industrially-stamped cultural monument landscape of "Zollverein" has been determined by the operational plans of the coalmine with the same coordinates, and the boundary lines of the mine are identical with the borders of the cultural landscape. These facets of the relationship of dependency can still be seen and verified today by virtue of the cultural monuments which have been preserved in the landscape of this unique belt of land: The monument landscape of the Zollverein colliery is a document of cultural and historical importance regarding the dependency of a surrounding area on a coalmine unequalled in the world, and is therefore fully justified for inclusion in the world cultural heritage of humanity.

The "industrial culture landscape" of Zollverein colliery

The landscape is bordered spatially by the boundaries of the former Zollverein coalmine from 1847 to 1986. During this period the landscape was transformed from a sparsely populated agricultural area into an extremely densely populated industrial area. It has become a typical core district of one of the largest industrial concentrations of population in the world.

The industrial culture landscape of the Zollverein colliery has been formed and permanently moulded by a series of measures and factors: habitation and supply, the development of housing estates and the construction of living quarters for mine workers, the communal commitment of the Zollverein coalmine, the railway buildings and also changes in the ground levels at the surface.

Habitation and supply, the development of housing estates and the construction of living quarters for the mine workers

Each mining installation encloses an framework which cannot be separated from the overall picture and its comprehension: Included primarily here are the housing estates for the workers. The development of works housing construction stretching back over 150 years can be seen in its seldom met, almost "picture-book" aspect in the surrounding area of the Zollverein colliery. The living conditions of the workforce and also the endeavours to improve housing situation and, thus, the quality of life, can be experienced in this broad spectrum of housing which ranges from early estate-style construction up to the apartment blocks of the most recent past.

The various styles of housing and the way the estates are planned around the Zollverein colliery convey the prominent social-historical and cultural- historical importance of this type of preservation project to an extraordinary degree: It is an indispensable component of this industrial culture landscape, which "is brought to life" from the network of relationships inherent in the worlds of work and domesticity, and which manifests itself in the architecture.

Social progress, and the promotion of a communal way of life are, not least, depicted in the buildings, which stand for a reasonable way of life and for communal social attitudes. Thus, the cooperative institutions and the works welfare facilities also act as proof of the ways in which the Zollverein coalmine influenced the communal life in the area. Making everyday life outside work easier in this way was to have created a community which was sympathetic to the works and eager to work. In this respect the establishment of social facilities can also be seen as an indispensable element within the context of an industrial work and leisure culture.

The first phase of **housing estate development** in the mining area of the Zollverein colliery took place during the period from 1847 to 1918. Once the extraction of coal had commenced from the Zollverein pits, the workforce grew constantly. Living areas had to be created; because other building companies did not take on the work, Zollverein began constructing workers' quarters itself. The development of the estate was carried out in conjunction with the operational plans of the coalmine, but, in spite of the colliery's high level of commitment in the construction of workers' housing, nowhere near enough apartments could be produced for the members of the workforce. The colliery obtained larger areas of building land through the purchase of farms and crofts in the immediate area around the pitheads; thus, for example, Hegemann's farm with 185.5 acres of land was bought on the 15th. April 1856, and Ottekamp's croft with 52 acres was purchased one year later (1857).

In 1860, when 720 miners were employed at the coalmine, 146 apartments were available and ready to move into. The new estate was constantly being expanded and as the "Hegemannshof estate", gained its own social and urban identity, which even found its way into official language usage. More estates were built in the ensuing years: the Ottekampshof estates, Estate Nr. 3 and the Beisen estate. As the largest estate in the area, the Hegemannshof estate had grown to a size of approximately 90 hectares by the turn of the century.

The concept of the estate in terms of urban development was characterised by the choice of house style, the size of the gardens and the arrangement of the houses into parallel streets. The predominant house style was the so-called "four-in-one", in which the cross-shaped ground plan of the house permitted maximum utilisation with four apartments. These houses had separate entrances with a living area ranging from $50m^2$ to $60m^2$. The brickwork, made from rough fired bricks or from bricks from the colliery brickyards, characterised the visual aspect of the estate houses, and each residential unit comprised around 45 rods of land ($\approx 640m^2$), including the area of the house itself. The generously sized gardens served to provide the basic needs of the miners and were meant to assist in recruitment and then as a binding agent to the colliery: On account of the extremely high fluctuations in the workforce which were still usually the case at the turn of the century, this function was important because the coalmine urgently needed a permanent base workforce of experienced miners to ensure smooth underground operations. The size of the gardens also determined the way in which the construction land was utilised. An area of $4 \times 640m^2$ was required for one house. The intervals at which the houses were spaced and also the intervals between the streets which ran parallel to each other were determined by this dimension.

After the turn of the century the Zollverein coalmine altered the structure of its houses by employing architectural features borrowed from garden city estates: Thus, a series of new houses appeared in Roonstrasse and Theobaldstrasse.

With regard to the **development of the Katernberg suburban centre**, the amount of land owned by the colliery in 1876 was only 14.6497 hectares, but by the time of World War II this had increased to 721.4913 hectares. Nevertheless, it became clear that such a generous utilisation of land, as found in the Hegemannshof estate, could no longer be carried out in order to house all of the miners, as the workforce had, in the meantime, grown to 5,000 men.

Meanwhile, private business people had also moved in half-way along Katernberger Strasse, between the Hegemannshof estate and the pithead. The colliery supported this development of the new suburban centre of "Katernberg" and placed some open land at the disposal of the district council to be used as a marketplace. In the same way, it also promoted the establishment of a post office, a doctor's surgery and last, but not least, a church. The Zollverein coalmine purchased almost all the property in a broad band stretching for almost 1.5km around the new centre.

The old, pre-industrial footpaths and roads remained to form the base for the urban development street plan. However, the structural intentions of the estate planners established a new path and road system in the spaces between these roads.

A new development appeared between the years of 1918 and 1945. In the first crisis-hit years after World War I had been lost, building activity could only progress slowly. At first, the extremely acute shortage of housing remained, and after 1921 the "Trust Company for the Construction of Miners' Housing"[1] became active in Katernberg. It erected an estate to the west of Viktoriastrasse which clearly differed from the older estate concept. The houses were more richly varied in their form and required considerably less space because the gardens were clearly smaller in size. And in 1928 the "Ruhr Housing Construction AG"[2] built ten prefabricated houses in Dirschaustrasse which were clad in steel plate and which, as "steel houses", attracted considerable attention.

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[1] *German Title*: "Treuhandgesellschaft für den Bergmannswohnungsbau"

[2] *German Title*: "Ruhrwohnungsbau AG"

The architects, Fitz Schupp and Martin Kremmer, who had been employed as consultants for the mining operations of the Phoenix AG and later for those of the Vereinigten Stahlwerke AG since the mid-Twenties, also had an influence in the housing construction activities of the Zollverein coalmine: They designed and built some residential houses on Heinrich Lersch-Strasse, Gaudenzstrasse and on Distelbeckhof. At the end of the Twenties the colliery could offer all salaried staff and officials an apartment, but the situation for the miners themselves was characterised by a crass imbalance: Only about 3.000 apartments were available for a workforce of around 8.000 miners. In 1934, in the course of the re-structuring of the Vereinigten Stahlwerke AG, the combine founded its own housing construction company: the "Rheinisch Westfälische Wohnstätten AG": This company took over the houses belonging to the Zollverein colliery, although occupancy and consultation rights for new construction projects remained with the Zollverein.

The area of the coalmine suffered relatively little damage during World War II.

During the years 1945 to 1986 the housing construction companies created new estates on a large scale using multi-storey apartment blocks in the remaining gaps which contained building land. Thus, the Kaldekirche estate was built on Pfeifferstrasse in the years 1951/52 according to the designs of the architect, Wilhelm Seidensticker: The two-storey rented houses are, in the spirit of the former architectural intentions, comparatively lively in the structure of their furnishings and of their arrangement, but there was now no provision made for garden areas, instead of which broad green areas were substituted, as the economical utilisation of space now had to be guaranteed.

The Westerbruch estate also appeared in 1951/52. It is characterised by the comparatively high structural quality of the apartment blocks, and is the only contemporary estate located in the area of the Zollverein industrial culture landscape which uses brick throughout as the construction material. Thus, the houses fit in particularly well with the image presented by the existing historical estates and buildings. The house entrances and balconies were emphasised as a preference in the overall structure.

The Kapitelacker estate, built in the years of 1953/54, lies at the foot of the Kapitelberg. The two-storey rented houses with their simple, economical facades were arranged in such a way that resulted in a varied ensemble of squares, open areas and roads.

Other estates, like the ECA estate in Schonnebeck, building developments on open areas in the Beisen estate and the early area developments in the vicinity of the Hegemannshof and Ottekampshof estates all followed.

The small "Glück Auf" estate grew up in a spirit of neighbourhood self-help during the years 1952-55; it grew from an original figure of 47 smallholdings to 141 smallholdings containing 282 apartments. Its single-storey houses with their high saddle roofs facing the street and their eaves running along the roofs can be entered through the entrances placed at the side and are designed to cater for two families. The Zollverein coalmine provided active support in the construction work: It provided the bricks, which had been used to protect against air raids during the war, for the housing construction.

The so-called Pestalozzi villages were built in order to be able to manage the increased requirement of the coalmine for young people through its systematic recruitment of apprentices. From 1953 to 1955 the first village unit, "im Grund", was built with 15 two-family houses for 30 Pestalozzi families. Six young miners recruited from other regions of the former Federal Republic lived in each half of a house, along with a married couple who acted as parents. The single-storey houses with their high saddle roofs were placed on quiet winding roads and squares, and this is how the estates received their "village" character which has grown historically.

The Neuhof was the Zollverein coalmine's second Pestalozzi village. In addition, the Evangelical Church of St. Albertus Magnus and a large community centre were also built here, in order to take into account the social and religious needs of the village community, which was composed of young people beset with problems.

In 1958 7.061 apartments were available for a workforce of 8.000 miners.

Were one to enquire about the **preservation of the miners' housing and the estate development"**, it would be possible to establish that significant examples from all three phases of the miners' housing and the estates themselves have been preserved in the Zollverein industrial landscape.

1. In the area of the former Hegemannshof estate, there are houses in the Meerbruchstrasse, the eastern side of Bolsterbaum, the Schalker Strasse, Termeerhöfe and parts of Viktoriastrasse as well as Zollvereinstrasse which have been preserved and, as a rule, in a condition which, although in need of restoration, is close to the original. The same applies for the preserved estate houses of Otteskamphof, im Drokamp, Nienhauser Busch and parts of Josef Oertgen Weg.

The estate houses on Röckenstrasse and Kraspothstrasse close to the Zollverein pithead 3 have been renovated from the point of view of preservation care in 1995. The residential houses of Estate Nr. 3 on Schlägelstrasse, Eisenstrasse and Ückendorfer Strasse have been preserved in their original condition.

The estate on Theobaldstrasse and Stiftsdamenwald has been renovated with the loss of a some façade detail.

Due to area development measures taken during the 50's and 60's, the western part of the Hegemannshof estate was demolished and replaced with multi-storey apartment blocks, and the same applies to the central area of the Ottekampshof estate.

2. The houses to the west of Viktoriastrasse, which were built in the period between the wars and are also known as Distelbeckshof, have been preserved, façades and details only having been lost in a few places through private renovations.

3. The "Glück Auf" estate to the west of Distelbeckhof was built by the miners themselves in a neighbourhood self-help scheme: These houses were in private ownership right from the start. They have been preserved, but in some cases have been changed considerably according to the tastes and financial means of the occupants.

4. On Pestolozzistrasse and Neuhof, the Pestolozzi villages have been preserved in great detail, the architects' concept of urban development still creates a special atmosphere almost on a par with the feeling of safety and security which is to be found in a real village.

5. In order to be able to satisfy the great need for apartments in a limited amount of space, the housing construction companies built estate complexes with multi-storey apartment blocks in the middle of broad green sites; the Kapitelacker estate has been preserved in its original state, although it is in great need of renovation. The same situation applies in the case of the Kaldekirche estate located to the west of Zollverein pithead 12.

The Westerbruch estate has also been handed down as a historic document of this building work, the Kapitelacker estate is in urgent need of renovation. On the other hand the ECA estate has been privatised and its original appearance has been altered. The apartment block complexes in the former Hegemannshof. Ottekampshof and Beisen estates are still in their original condition.

The housing construction programme for the miners, in its 140-year historical longitudinal section, is visible in way which is unique. The respective social living conditions are essentially documented in the housing situation of the people involved. This allows facets of the richness of the domestic world, as opposed to the world of work, to be recognised. The estates located in the area of the Zollverein coalmine can be included amongst those monuments of exceptional social-historical and cultural importance. The complete nature of the Zollverein's miners' estates which have grown together count as one of the internationally outstanding monuments and forms a central component of the industrial culture landscape of Zollverein colliery.

The **development of the Katernberg suburban centre** can also still be understood today because of its continued existence as a monument.
Almost all of the total number of historical residential and commercial premises still exist along Katernberger Strasse and in the vicinity of the Catholic church. The facades of the upper storeys have been overwhelmingly preserved in their structural detail, although the views of the commercial premises have been subjected to considerable alteration.

The marketplace, characterised by the post office, the Evangelical church and the former town hall has been preserved in its form as the open area which was gifted to the district council by the coalmine.

The network of roads with its pre-industrial layout can still be seen in its entirety, the only significant difference being represented where the Katernberger Strasse leads underneath the former Cologne-Minden railway line (next the Katernberg South railway station).

Communal commitment and its monuments

The colliery cooperatives supplied domestic and manufactured goods at low prices. The profits realised from the sale of goods was handed back to the customers at the end of the financial year in the form of a dividend, the level of which was determined according to the amount of goods purchased. By 1895 the coalmine was already providing three sales points: Cooperative Nr. 1 was located close to pithead 1/2, Cooperative Nr. 2 was at the southern end of the Ottekampshof estate and Cooperative Nr. 3 was located at the edge of the Hegemannshof estate.

By 1914 the number of sales points had doubled: Added to the total complement were Cooperative Nr. 4 next to pithead 4, Cooperative Nr. 5 next to pithead 3 and Cooperative Nr. 6 next to pithead 6.

In 1928 almost 5,000 works employees were participating in the cooperative's turnover, i.e. more than two thirds of the workforce had accepted the coalmine's offer. When the colliery was taken over by the Vereinigte Stahlwerke AG, the cooperative was transferred into the combine's ownership too. During the re-structuring of the combine in 1934, Vereinigte Stahlwerke AG founded the independent works company, the "Domestic Supply Company of Westphalia"[3], which assumed responsibility for the cooperative facilities of the Zollverein colliery.

Many cooperative institutions closed in the fifties on account of the powerful competition created by the new supermarket chains with their self-service shops, and in the seventies the PLUS retail group took over what remained of WEHAG's so-called Wedi-Markt shops.

From the mid-1920s the colliery became committed to the **welfare** of its workforce and their families. Thus, trained welfare workers, who answered directly to the colliery manager, helped and provided support in cases involving economic, health and child-rearing problems. In 1928 the colliery installed its first welfare office in a small workshop at the entrance to pithead 1/2; a second welfare office was opened close to pithead 3/7/10 in 1934. In 1938 it was possible to transfer the first welfare office to a new building: The old Schulte farmhouse on the Hege was converted according to Fritz Schupp's design and two supplementary extensions were built onto the premises. In 1953, close to pithead 3/7/10 the Zollverein colliery built a new, large works welfare facility, the brick building of which was also designed by Fritz Schupp.

At the start of the 1960s the commitment of the Zollverein colliery in the sector of works welfare came to an end.

Cooperative Nrs. 4 and 6 have been preserved as **monuments and documents of the colliery's communal commitment.** Cooperative Nr. 4 on Josef Oertgen-Weg, built in 1900, was initially housed in the left-hand half of a three-storey brick-built structure on the corner of Katernberger Strasse. After being destroyed in the war, the house was re-built in 1948 and since that time the cooperative utilised the whole of the basement. Today the rooms are used as sales storage area by a carpet firm, but the view of the building is original in its detail.

Cooperative Nr. 6 is a two-storey construction with a symmetrical façade structure, the white-washed façade is lined with red clinker bricks around the door and window frames. The cooperative rooms are today used by an electrical shop.

Nowadays, the former works welfare office Nr. 1 on Viktoriastrasse has a similar function: A community practice of doctors and solicitors work in the building. In converting the building to its new use, the building complex was renovated in a private initiative, which retained the original appearance and detail to an exemplary degree.

The buildings of welfare office Nr. 2 are currently being used to provide accommodation for asylum seekers. The two-storey brick-built structure dating from 1953 has been extensively preserved in its original condition, but is currently in a bad state of repair.

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[3] German Title: "Westfälische Haushaltsversorgungsgesellschaft" (WEHAG)

The Railways

The financial success and economic functionality of the coal and steel industry in general, and of the coalmining combine as well as those of the coke and steel production industries in particular, were and still are to a large degree dependent upon trans-regional transportation connections on the one hand, and upon the transport infrastructure on the other. In the process, the historical routes of the Cologne-Minden Railway, founded around the middle of the 19th. century, and the Bergisch-Märkische Railway proved to form the ideal prerequisites for the future prosperity of the Zollverein colliery.

The works railway lines guaranteed the necessary internal traffic network and connection to long-distance rail networks, and also, above all, to the Rhine-Herne canal. Determined by operational requirements, the railway routes cut through the landscape, connecting the centres of industry and "separating" the housing estate areas. This characteristic of a landscape determined by industry can be particularly well observed at Zollverein, the railway forms a decisive structural characteristic in the industrial culture landscape of Zollverein colliery.

As the first railway line through the region, the routing of the Cologne-Minden Railway was the decisive factor in the location of the Zollverein colliery. Pithead 1/2 was located only about 500m away from the track and in May 1847 the stretch of line from Oberhausen to Hamm was opened: Its route lay on an east-west axis right through the coalfield. With its short branch track, the colliery was connected to the rail transportation system right from the beginning. In 1887, i.e. just 40 years later, the first passenger railway station was built for the Katernberg district.

In 1874 the Emscher valley line of the Bergisch-Märkische Railway opened its railway line with a route which passed to the north of the Cologne-Minden Railway; the new railway line cut through the north-western corner of the Zollverein coalfield. In 1901 the passenger railway station, Katernberg North, was built.

The Zollverein colliery used both of these important railway lines for its own purposes and connected its own works railway lines. In order to reach pithead 1/2, a 500m length of track to the Cologne-Minden railway line was sufficient, and this was carried out at the beginning of the colliery's life. When work commenced on sinking shaft 3, the colliery laid a branch track to pithead 1/2; this stretch of line came into operation in 1880. Concurrent with the commencement of the work of sinking shaft 4 in 1891, a branch line leading to the Emscher valley line belonging to the Bergisch-Märkische Railway was laid. During pithead 6/9's initial years of operation, the extracted coal was transported in trucks using a rope-drawn installation over a long bridge to the processing plant of pitheads 1/2, a connecting track has also existed between these two pitheads since 1913.

In the future the colliery linked its railway tracks to each other. In 1922 a new track between pitheads 4/5/11 and 1/2 produced the last missing connection needed in order to link all the pitheads together. When, in 1921, the Zollverein colliery entered into a working agreement with the Phoenix AG steel company for mining and steel production – and thus with the Nordstern colliery, a connecting line was created leading to the Nordstern port on the Rhine-Herne canal in the years 1924 to 1926. When, in 1926, the Zollverein was incorporated into Vereinigte Stahlwerke AG, the railway network was extended by a branch line leading from the Zollverein pitheads 3/7/10 to the neighbouring Bonifacius colliery in Essen-Kray, thus creating a connection to the eastern rail network of the combine.

Today, the railway routes of the former Cologne-Minden Railway form an integral component of the track network of the German national rail company, Bahn AG, and is used for long-distance traffic, tram traffic and for goods transportation: The connection is an important East-West route which goes right through the Ruhr region, and is heavily used. The former railway station at Katernberg South has been replaced by a tram station.

The branch line leading from the former Cologne-Minden Railway to the Rhine-Herne canal via pitheads 1 and 4 still remains; three signal boxes and two railway crossings and ten bridges are also included in this stretch of track. The route from shaft 1 to the Bonifacius colliery via shaft 3 remains, along with its four bridges, and is to be converted into a cycle path.

The former Bergisch-Märkische line is used by Bahn AG for goods traffic.

Of the works railway yards for the pitheads and the coking plant, only a few lengths of track remain in the area of Zollverein pithead 12.

Changes in ground levels at the surface

First to be mentioned in this respect are the **two slagheaps formed from shaft sinking and mining operations respectively**. The oldest Zollverein slagheap lies to the east of pitheads 1/2, which was produced as the shafts were sunk in 1847. This slagheap was landscaped with acacias around 1895 and was used as a leisure facility for the colliery officials who lived in direct proximity to the entrance of the mine. Because of its vegetation, this slagheap also became known as the "green slagheap". This slagheap, Zollverein colliery's oldest, has been preserved. Nevertheless, the stock of trees planted at the end of the 19th. century have become too old. An extremely small proportion of the embankment at the southern end had to be cleared in 1992 because of a fire on the slagheap.

At the same time as the first, a second slagheap was formed to the west of shaft 1/2 which was used as the mine tip. Since 1932 areas have been created for tailings pond operations: boiler ashes and coal slurry from Zollverein pithead 12 were dried out there. This slagheap became known as the "black slagheap".

This slagheap remains unchanged: Landscaping the areas concerned has been allowed since about 1970 and, to a small extent, has been promoted by the planting of trees. Today, the site is a project for the sensitive development of its ecological, aesthetic and industrial historical potential within the framework of the Emscher Park IBA International Building Exhibition.

Another slagheap was produced close to pitheads 3/7/10 after the first shaft was sunk in 1880: This one was partially cleared in 1958 in order to create building land for mineworkers' housing. The eastern embankment of the slagheap remains and, together with the bordering area of subsidence in Beisen forms a landscape of hills which has been moulded by industry.

Yet another slagheap was also formed at Zollverein pithead 4/11 after the shafts were sunk. Because the coal was extracted from steeply inclined seams at this pithead, the worked-out face areas also had to be extracted: And this is the reason why the colliery had a particularly intensive tip operation there. In 1930, when a neighbouring landing strip was closed down the Zollverein colliery used this location to create a large slagheap which was also used by other coalmines. In order to guarantee national energy reserves, large quantities of coal were stockpiled to the west of slagheap 4/11; in 1993 this shagheap was cleared.

Nowadays, the slagheap at pithead 4 is a large "table mountain": it is used as a local leisure area and has been opened up with footpaths, the neighbouring trotting racetrack operates a training track on the slagheap.

The coal removal operations of the Zollverein colliery have caused **subsidence in the ground level** of more than 25m in places. A trough of subsidence, caused by the removal of coal, is produced above each area of extraction, at the edges of which strains occur and at the centre of which pressures are formed, and this is also the case in the Zollverein coalfield: As well as open areas, houses and roads have also had their levels altered. If houses were damaged by extreme mining subsidence, they often had to be demolished as it was no longer possible to live in them, railway tracks, bridges and other structures also had to be raised in order that they did not lose their function.

Thus, for example, in the central section of Schlägelstrasse, both the road and also the houses are subsiding in a southerly direction, in the suburb of Beisen the ground surface level has clearly subsided by more than 20m on account of the extremely intensive coal-extraction operations around pithead 3. In Kraspothstrasse and "Auf der Reihe", the older houses are currently leaning at an extreme angle, and the inclination eastwards of Kraspothstrasse itself demarcates the edge of the subsidence trough.

The extremely high works railway bridges over Grundstrasse and Bonnekampstrasse document the fact that the track level has had to be adapted to meet the functional requirements for railway operation by raising the line over the subsidence trough.

The Zollverein colliery coalfield is located in the area of the Emscher flood plain, in which numerous large-scale sump areas were already in existence before the coalmine, because the drainage of ground water via waterways with a natural incline could not always be guaranteed. The subsidence of the ground surface has clearly led to a worsening of **drainage conditions**. The greatest subsidence occurred in the eastern sector of the coalfield, as a consequence of which the main outflows became waterlogged and collected a body of water which was not able to drain off. Because conditions of hygiene also deteriorated accordingly as a result of this, epidemics of typhoid, cholera and dysentery broke out in the second half of the 19th. century.

For this reason, the Zollverein colliery started to regulate the drainage system early on. But in 1904 the conditions in the connected drainage area of the Emscher region threatened to become so uncontrollable that an comprehensive, overall concept was urgently required. The municipal councils, coalmines and other institutions concerned with this problem founded the Emscher Co-operative. A system of drainage channels was dug in the Zollverein mining area which led to the main drains which comprised the Schwarzbach, the Zollverein Trench, Stoppenberger brook and the river Berne. If the level of the main drains was reduced below the level of the Emscher by mining subsidence, then the water was drained artificially by means of pumping stations. In 1934, 168 hectares of low-lying land in the mining area was being drained artificially.

Nowadays, the Emscher Co-operative operates three pumping stations to facilitate the drainage of the low-lying areas which have been created by the mining industry:

- The “Essen-Schonnebeck” pumping station, built in 1977, drains a catchment area of 119 hectares with its four pumps, the water is drained, via the Katernberger brook, into the Schwarzbach, which in turn flows into the Emscher.
- The “Essen-Beisen” pumping station uses five pumps to drain an area of 175 hectares; this installation was also built in 1977. Its greatest water transportation capacity is 5,300l/s and the water is pumped to the “Gelsenkirchen-Zollverein Trench” pumping station which lies further to the north.
- The “Gelsenkirchen-Zollverein Trench” pumping station was built in 1968 for a catchment area of 344 hectares. The plans for the pumping station were made on the basis of the coal-extraction operations in the area of Zollverein pithead 4, but this pit was closed down in 1967. The catchment area today comprises 133 hectares, and the water is drained into the Scharzbach through a pressurised feed.

All the pumping station buildings are standard functional structures. In each case a small protective building with a flat roof stands on a very deep bed of concrete for the piping and pumps. A section of a brick-built outlet channel amounting to approx. 500m remains intact at the Essen Schonnebeck pumping station; this documents the drainage regulation work carried out by the coalmine before the Emscher Co-operative came into being.

Summary

Any changes in the landscape after the coalmine was closed down in 1986 have been extremely slight, thus far, no demolition measures or site restorations have destroyed the structure of this landscape which was created by industry.

The Zollverein colliery industrial culture landscape is of outstanding cultural significance, because it documents the appearance, development and function of an industrial landscape dominated by industrial operations in a unique and exemplary manner.

The Zollverein coalmine influenced the life of the local community both directly and indirectly: co-operatives and works welfare offices provide particular examples of this extremely complex history. As an example of the intervention of industry in communal life, with the intention of establishing a functioning and works-friendly community, they form important examples of the promotion of communal life by industry and, for this reason, are of primary significance for the industrial culture landscape of the Zollverein colliery.

The underground drift of the Zollverein coalmine

The working environment and the work underground is of particular social and industrial historical significance for the Ruhr and its inhabitants even today. For the monument and the monument landscape of Zollverein colliery they are only meaningful in the sense of looking back, and in the possibility of providing explanations for events associated with the monuments; as regards the preservation and maintenance of the monuments they are of no significance as the drift is inaccessible and the original workplaces can no longer be entered. After mining operations closed down the underground excavations were abandoned except for the area around shaft 12 and shaft 2 at the 1,000m level. There, the Deutsche Steinkohle AG (DSK) operates a central water pumping station. Each day approximately 1,200m³ of mine water is conveyed to the surface by the pumps installed underground. From a connecting traverse heading approximately 500m in length between Zollverein shafts 12 and 2 it is possible to walk along a traverse heading 8km in length to the former Nordstern and Mathias Stinnes collieries.

The Zollverein coalmine is of significance from a geological point of view: In 1928 six coal seams found in the Zollverein colliery drift were assigned the names "Zollverein 1 to 6", and these names were applied throughout the Ruhr.

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4. The "Zollverein Colliery" Monument Landscape – The Coking Plant

The Zollverein colliery coking plant is of quite particular importance to the monument landscape, for here a unique stock of surface installations has been preserved: In Essen, mining and coking plant installations combine to form a splendid ensemble, the preservation of which demands extraordinary efforts from society and from the point of view of monument maintenance. The following section describes the significance of the important parts of the monument – both from a point of view of the art of construction and technical processes.

4.1 The History of the Zollverein Coking Plant

The Zollverein coal deposits found at depths ranging between 200m and 800m primarily consisted of gas and bituminous types of coal, which are extremely well suited for conversion to coke. As early as 1857 there were three charcoal furnaces for this at Zollverein 1/2. With the exception of the gigantic central coking plant located to the north-west of Zollverein shaft 12, none of the coking plants which were built up in succession at the Zollverein mining installations up until the middle of the 20th. century still remain,.

The idea of supplementing the large-scale Zollverein 12 pithead with a large coking plant already existed at the end of the twenties. During the 1940s a ground plan study on the positioning of this coking plant and its spatial-functional connection to the colliery had been developed by Fritz Schupp. According to this project the coking plant would have been built on the site of the mine slagheap with a coal tower on the axis of the conveyor equipment, in an extension to this axis the plans also provided for the construction of a power station. In 1957/58, the company operating the Zollverein colliery, the Gelsenkirchener Bergwerks AG, decided to construct a new large-scale central coking plant in the expectation that the demand for coke would increase and to supplement the Nordstern coking plant. Once again the designer chosen was Fritz Schupp, who could call upon his extensive experience with large-scale industrial installations in the planning and structuring of this plant too, especially as he had been able to design the coking plant of the neighbouring Nordstern colliery in 1927 together with Martin Kremmer.

As a uniformly structured, self-contained installation on the Rhine-Herne canal, The Nordstern coking plant represented an effective creation of modern architecture. With its strictly divided construction modules it represented a high-point in the early sequence of the massive brick-built works of Schupp and Kremmer. Of these structures only the former mixing tower remains, which, in 1960, was incorporated into the Nordstern colliery installations as a coal bunker.

Having decided to retain the large mine slagheap, which was rising between the colliery and the coking plant, a large site on the other side of the slagheap close to the Cologne-Minden Railway was selected as a location for the Zollverein coking plant. The coking plants, with its batteries and its main development road, stretched out parallel to the railway line, by means of which an optimum railway connection for bringing in coal from other places and for transporting away the coke produced was attained. The coal mined at Zollverein 12 was conveyed over the mine slagheap to the coking plant by means of a long transportation bridge.

The constructions and installations of the by-products plant were positioned along a grid-shaped development network, the basis of which was formed by the long row of coke furnace batteries. Two of the three connecting roads are axially aligned to the two coal towers, the generously dimensioned network of the development roads took into consideration possible future changes and expansion well in advance.

As was the case for the buildings of the neighbouring Zollverein 12 mining installation, Schupp also developed universally applied construction and structure principles for the coking plant buildings. This installation mainly took the form of reinforced concrete constructions, the outside walls of which were faced in brickwork. Sometimes the brickwork architecture is supplemented by steel structural components. Brick facings and ridges were still, without exception and remaining true to the traditions of the 1920s, laid using the Wendish bond, and the concrete was only visible in a few places.

Just as was the case with the Zollverein pithead 12, the coking plant was also meant to have a production output of gigantic proportions. Initially, a daily output of 5,000t of coke was intended using eight batteries, and it was later possible to increase this output to between 8,300t and 8,500t by means of two additional batteries which were installed in 1972/1973. In order to be able to produce this output, the technology was linked to a development which began in the 1920s with the construction of large-volume furnaces, and the by-products plant was also designed for a high processing capacity accordingly. Analogous to the mining installation, the construction of the Zollverein coking plant after operations had begun meant advancing into a new dimension, because it was considered at the time to be the most modern and efficient coking plant in Europe. In 1993 the plant had to be closed down, the buildings and installations dating from the founding of the plant in the years from 1957 to 1961 having been classified as being worthy of preservation. "Landmarks" of the coking plant which are visible from a distance are the six chimneys, arranged in a row and up to 100m in height.

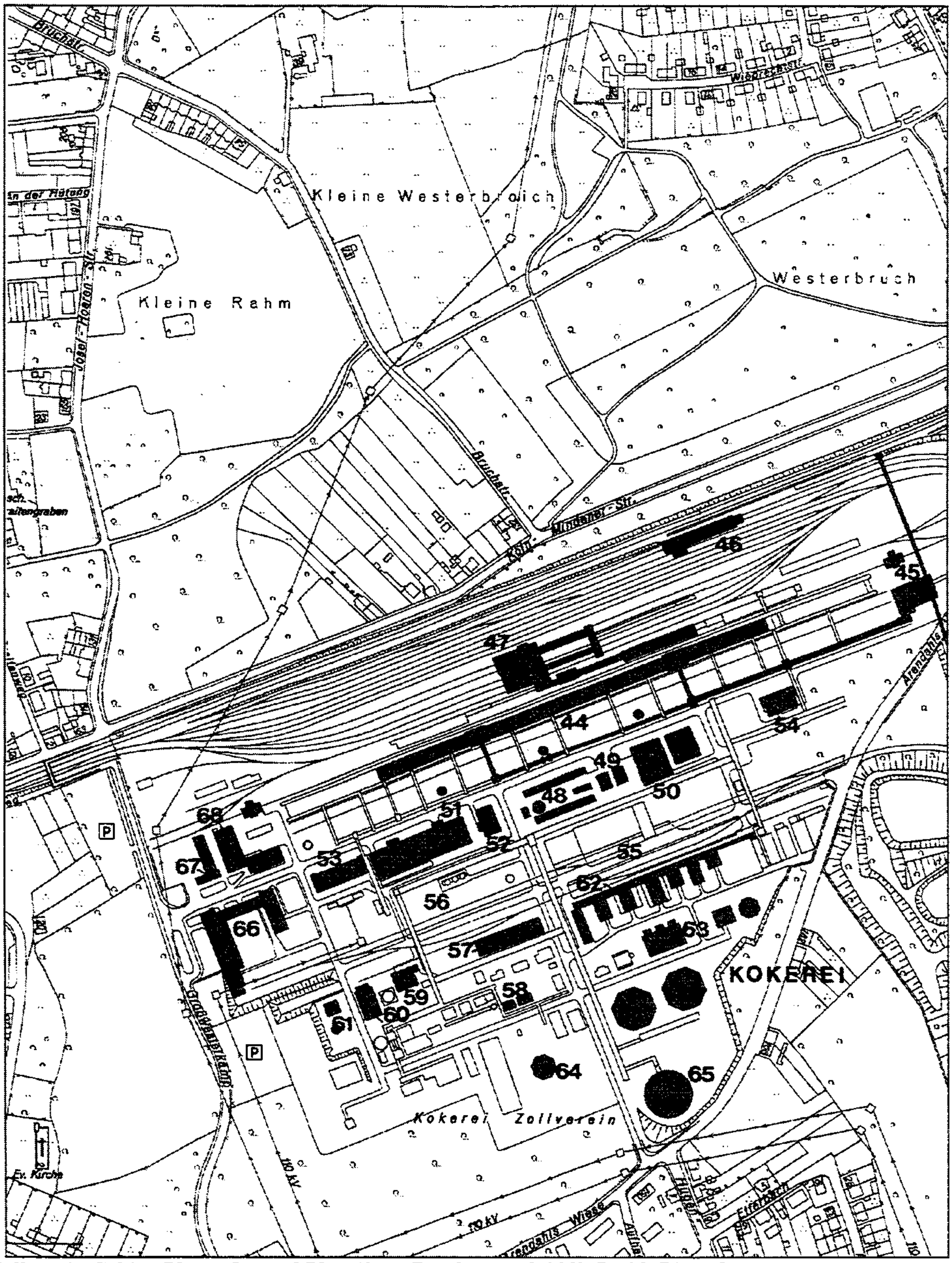
4.2 Description of the Zollverein Coking Plant

Coke Furnace Batteries 1 to 8

The construction of the eight furnace batteries with their 192 furnaces was carried out within three years, having commenced at Easter: batteries 7 and 8 were completed in 1958, batteries 4 to 6 in 1959, battery 3 in 1960 and batteries 1 and 2 in 1961. Composite furnaces made by the Still company were installed, which, as an alternative, could be fired using the gas from the generator plant which was in operation until 1975. The furnaces were 6m high with an average chamber width of 45cm., a chamber length of 12.77m, the effective volume was 32.8m³ and was designed for approx. 28t of wet coal.

Batteries 1 and 2 were renewed by Krupp-Koppers company in 1980, battery 3 was renewed in 1980, battery 4 in 1982 and battery 5 was renewed by the Still company in 1987; until now batteries 6 and 7 have been preserved in their original condition.

Each battery consists of 24 furnaces. The battery end headers are constructed from reinforced concrete, located between the furnace doors are anchor stands made from double-T sections, which extend from the bed of the regenerators up to the furnace ceiling. In each of the replaced batteries a T-shaped girder of considerable dimensions is positioned between the furnace doors; in the case of the original batteries two weaker double-T girders are attached to each of the anchor stands. A short distance below the furnace ceiling, the anchor stands, which extend laterally over the furnace, are connected by means of anchor cables. Five longitudinal anchors located between the battery end headers on the same plane stabilise the construction.



Zollverein Coking Plant: Ground Plan (from Buschmann [1998], P.428, Ill. 445)
44 Coke furnace batteries 1-8; 45 Mixing plant; 46 Unloading point and deep bunker; 47 Coarse and fine coke sieving plant; 48 Pre-cooling / pre-cleaning plants; 49 Tar extraction; 50 Phenol extraction; 51 Ventilation and compressor house; 52 Control room; 53 Switchgear station 1; 54 Switchgear station 2; 55 Ammonia plant; 56 Tar loading station; 57 Pressurised gas treatment plant; 58 Sulphuric acid – wet catalysis; 59 Fine gas purification; 60 Gauge station; 61 Water gauging and distribution centre; 62 Powerhouse, so-called comb building; 63 Fan coolers / cooling towers; 64 Gas flare; 65 Gas storage tank; 66 Administration and locker-room building; 67 First-aid station; 68 Workshop and stores.

One of the typical features of coking furnace construction employed by the Still company are the heavy frame-like trusses, which project through the outer walls of the main walkways with their inclined supports: These angled trusses extend underneath the ceiling of the main walkways as far as the anchor stands and then continue as ties between the regenerators and furnaces, i.e. they extend laterally beneath the furnaces.

To the south, the main walkways are located directly above the floor level and off to the side of the batteries in a steel framework construction. The flue gas valves which are housed in the main walkways are connected to the switching facilities at the battery end headers via rods.

On the southern side, the vent pipes with their associated collecting mains are raised above the batteries. Branch pipes extend from these over the rail tracks to the coke ram machines and lead into a collection line, which is fed alongside the main development road parallel to the batteries. The four chimneys, 60m high, form part of the coking furnace operation and they stand in a row alongside the collection line.

Three sets of machinery form the basic installation for the eight batteries and these include coke ram machinery, filling trucks, coke cake guide cars, container trucks and electric locomotives. Two coking towers dating from the time the coking plant was built stand between the batteries. The towers, concrete constructions 44.5m high and capable of holding 2,500t are lined with bricks up to the upper edge of the bunkers. A skeleton construction made out of reinforced concrete and with a suspended steel lattice façade is raised above the bunkers to form the working platform. On the southern side both towers are divided by oriel-type attached staircases, which, like the working platforms, are also faced with steel lattice work, two traversing conveyor belts are located above the bunkers in the head of the towers, which allow the bunkers to be filled with coal in a controlled manner.

Both coal towers are connected to the mixing plant by enclosed transportation bridges constructed from steel lattice work. The conveyor belt bridges, which run at an angle to the working platforms of the coal towers, are connected to a collection transportation bridge, which is positioned parallel to the batteries on the same axis as the collection line for the coke gas, via rigid corner support towers, each of which are located opposite the coal towers. A third rigid corner support tower, previously used for the conveyor belt bridge which branched off to the generator plant, stands at the eastern end of battery 8. An off-set conveyor belt bridge inclines down from here to the mixing plant's coal transfer station which is located almost at ground level.

Included in the battery installation on the northern side are the tracks for the quenching trains, the inclined coke discharge ramps connected to these, and the west and east quenching towers. Both of these quenching towers, which date from 1959, are constructed from reinforced concrete which forms a kind of hood over the tracks in order that the clouds of steam produced in the quenching process can be collected as completely as possible. The actual quenching towers, which are built out of wood, stand next to each of the hoods. Supported by reinforced concrete supports, a platform is raised above the hood, upon which stands a square-shaped steel tank for the quenching water.

After embarking upon the technology of large volume furnaces, which was effected in 1928 with the construction of the Nordstern/Gelsenkirchen coking plant and which can no longer be appreciated because the plant was demolished, the task of documentation thus falls to the Zollverein coking plant. The technological advance which led to the large-volume furnaces can also be seen in the fact that the 6m furnaces of the Nordstern coking plant initially had no successors. Therefore, Zollverein was only the second plant in which this step towards the development of gigantically high furnace chambers dared to be taken. It was only possible to increase the furnace dimensions in the light of the experience gained at the Zollverein coking plant, and 7m furnaces were built for the first time in Germany and Japan around 1970, in order that the Huckingen coking plant with its 7.85m high furnace chambers, until now the largest in the world and one which is still in operation, could be commissioned into service. Simultaneously, the chamber volumes were increased by widening the furnace chambers from 0.45m to 0.55m and 0.60m. This development towards large volume furnaces on the grounds of efficiency and environmental protection can be verified and documented by means of the coking furnaces of Zollverein colliery in an impressive manner.

Mixing Plant

The construction of the mixing plant erected in 1958 consists of twelve reinforced concrete bunkers lined with brickwork, each with an operational capacity of 600kg. An upper storey located above the bunkers is constructed from steel lattice work, and the same applies for a slimmer attached structure which extends the full width of the building, and into which the coal feed bridges lead to the side. To the west of the coke furnace batteries and located off to the side of the building is a low latticed steelwork construction which houses the control panel, an office and rest room. The conveyor belt installations end beneath this part of the building in a square transfer station, which is connected to another inclined belt bridge for further transportation. A staircase with a steel lattice work façade is attached to the south face in the spandrel. Three traversing operational conveyor belts are located on the operations floor. The mixing of the coke-coal is effected by means of six mixing belts complete with belt trucks, which were installed on the floor below the bunkers.

Mixing plants of this type had formed a part of large-scale central coking plants since the 1920s and had the task of ensuring that a coking coal mix of uniform quality was achieved using coking coal of varying quality from various collieries or mining locations. Often constructed in faced concrete (e.g. at the Anna coking plant in Alsdorf, near Aachen), Schupp also subjected the mixing plant of the Zollverein coking plant to the same structural theme chosen once before when the bunkers were faced with brickwork and thus considerable lightened the effect of the gigantic square construction.

Discharge Station and Deep Bunker

The discharge station, which was also built in 1958 for deliveries of coal from other sources, consists of an elongated steel lattice-work hall with two tracks lying next to each other. The railway trucks were pulled into the hall using draw-cable equipment and their contents were emptied into a deep bunker with a triangular cross-section. The coke-coal was then, via a double conveyor belt, subsequently transported to a transfer station which took the form of a square-shaped, steel lattice-work construction. From here, enclosed conveyor belt bridges transported the coal to the mixing plant via a rigid corner support tower. The conveyor belt bridges and the corner support tower are of a steel lattice-work construction, and in parts they were also fitted with supplementary cladding made from trapezoidal sheet plates. In addition to the 4,000t to 6,000t of coke-coal of the Zollverein colliery, for example, another 12,000t to 14,000t of coal from other sources was fed to the coking plant via the discharge station.

Coarse and fine coke sieving plant

The coarse and fine coke sieving plant dating from 1958 is a complex comprising several cuboid buildings of reinforced concrete construction with brick-built outer walls which are all linked together; the whole complex was constructed on stilts to enable railway trucks to be moved underneath on five rail tracks. A longitudinally right-angled part of the building which provides for 14 bunkers protrudes out from the main body of the installation, a part of the bunkers has been developed into a tower-like structure, to which a staircase with steel lattice walls is attached. The fine coke sieving plant with its two sieving lanes is located on the level above the bunkers, the section assigned to the coarse coke sieving plant extends between the bunkers and the coke furnace batteries with its three sieving lanes, which are connected to the western and eastern coke discharge ramps at the header via two inclined conveyor belt bridges. Just off the sieving plant to the east is a elongated square-shaped corner support tower, which is connected to the sieving plant by means of two inclined conveyor belt bridges and, thus, provides a link between the coarse and fine coke sieving plants. Originally, the corner support tower also provided the connection to the generator plant.

By-products Plant

In their constructional and structural layout, the buildings of the by-products plant are the same as the installations found in the coke production area. In the overall positioning, Schupp concentrated parts of the plant with large building volumes opposite the coke furnace batteries, in order to clearly define the main development axis accordingly.

Pre-cooling / Pre-cleaning Plants

The pre-cooling / pre-cleaning plants dating from 1958 and 1973 respectively comprised eight cross-pipe coolers (manufactured by Förster), of which six originate from the time the plant was founded: Each of these has a cooling area of 4,200m² and are connected to the coke gas collection line via a pipeline which extends over the main development road at an angle. The coolers are located in a single-storey plinth structure of reinforced concrete with a brick-built façade, the pumps used to transport the washing water and the ammoniac and tar water precipitated from the gas are located in the plinths. Two pumps are fitted with diesel engines and act as emergency pumps, three are powered by steam turbines and the others by electric motors. Eight electro-filters stand in a row behind the cross-pipe coolers: These comprised of steel plate cylinders on the base level and were of reinforced concrete construction with brickwork façades. Transformers, switchgear and monitoring devices for converting the power supply to 30kV were located in the plinth construction. Pre-cleaning served to remove solid particles and damp in droplet form from the coke furnace gas.

Tar Extraction

Directly to the east of the pre-cooling and pre-cleaning plant, the installation for extracting tar from the tar water (1957-1961) is connected to the collecting mains and the pre-cleaning plant. The installation consists of two pressurised tar separators with rinsing containers and pre-clarification containers, three tar containers, each with a storage capacity of 800m³ and three coal water containers.

Phenol Extraction
Phenol extraction (1959) had been systematically carried out by the Emscher Co-operative since 1928 in the Ruhr by means of its own installations at coking plants, whereby the construction and operating costs could be approximately covered from the sale of the product. And that is how it was also done at the Zollverein coking plant. On the line of the main development axis there is a single-storey reinforced concrete construction faced in brick which houses the pumps and the switchgear, behind which the high steel cylinders of the washers and strippers are raised. Phenol is washed out of the gas water in this operational plant. The primary function of extracting the phenol is to purify the waste water from the coking plant, which in turn helps to reduce pollution in the rivers and brooks.

Ventilation and Compressor House
The ventilation and compressor house, which dates from 1958, was of reinforced concrete construction with a brick façade, in the centre of the building there is a long hall with steel trusses forming a solid structure and which rests on reinforced concrete supports above a base level. The supports bear struts for crane lines, and the hall is lit by means of three square, slim, high horizontal windows in the gables and square windows located above the crane tracks. A lower building for transformers on the ground floor and gauge facilities on the upper floor is located just off the hall on the main development axis. The staircases are alongside and are of the oriel-type.

Included in the equipment are six GHH ventilators in three lanes, of which three are driven by electricity and three by steam, the seven compressors are divided into two turbo-compressors and five screw-type compressors. Switch panels and monitoring equipment was positioned to the side and along one of the hall's longitudinal walls in glazed housings. Connected to the ventilation and compressor house via a bridge is the control room (1958) on the upper floor of a cuboid-shaped, two-storey reinforced concrete construction with a brick façade. Moreover, offices are located in the building itself, and the heating centre is on the ground floor.

Switchgear Stations 1 and 2
Also connected to the ventilation and compressor house via a bridge is switchgear station 1 (1958), a reinforced concrete construction with a flat roof and brick façade. At the corners of the frontal façade, the frontal, fully-glazed staircases are slightly off centre. Large steel-plate doors lead to the transformers which are located behind them on the ground floor, switching cabinets are located on the upper floor. The outdoor switchgear and transformer installations of the RWE are located behind the switchgear station.

The eastern end of the construction line is bordered by switchgear station 2, built in 1958 and which comprised a switchgear and machinery station analogous to the western switchgear station 1. However, this reinforced concrete construction with its flat roof and brick façade only has one staircase and eight steel-plate doors for transformers on the ground floor. The switchgear station formed part of the generator plant which was demolished in 1975.

Ammonia Plant
The three-section complex making up the ammonia plant built in 1958 consists of the actual ammonia plant and also the salt store and loading station. The buildings of the ammonia plant and the loading station were constructed out of reinforced concrete with flat roofs and brick

façades, the salt store – a reinforced concrete hall with a saddle roof -, which forms an intermediate section is one of the few buildings in which the concrete was not faced. Strong pillars tapering towards the tops and horizontal square windows under the eaves divide the façade, the loading station projects out of the line of the other two structures and in this area was supported by two strong pillars of such a type which allowed railway trucks to be moved below.

Tar Loading Station

The tar loading station (1958) was originally positioned in line with the ammonia plant by utilising the railway track used for salt loading. The loading station consists of a reinforced concrete construction with a protective roof which in cross-section is T-shaped, approximately halfway up the height of the supports an operating platform is provided, which is accessed via a single-flight set of steel stairs. The railway tracks and the signal-box positioned to one side have not been preserved.

Pressurised Gas Treatment Plant

Benzene and hydrogen sulphide was extracted from the coke furnace gas which had been compressed to approximately 9 bar by the compressors in the compressor house in the pressurised gas treatment plant (HP plant; 1958): The purified gas was subsequently of town gas standard and was pumped into the network of the Ruhrgas AG, Essen. An important component of the pressurised gas treatment plant is an outdoor installation with pipe coolers, gas heat-exchangers, H_2S washers and benzene cold washers set up in two lanes. In the pipe coolers, the gas was cooled from approx. 80°C to 20°C using water as the coolant.

Two H_2S washers (steel cylinders with bell bottoms) followed in the course of the process, in which the gas was treated with a potash alkaline solution. After going through the fine purification process, the gas finally reached, via pipe coolers and gas / gas heat exchangers, the benzene cold washers which, like the H_2S washers, were constructed as high steel cylinders with belled bottoms. A calcium chloride solution cooled to approx. –16°C served to act as the alkaline washing solution.

The processing of the benzene water which resulted from the outdoor plant, the processing of the potash alkaline solution and the cooling of the calcium chloride solution was carried out in a long cuboid building, the technical equipment of which has a prominent location on the roof areas. The single-storey reinforced concrete construction with outer walls of brick was split up into three separate buildings of equal size. The façades to the sides were almost symmetrically constructed with square horizontal windows under the eaves and steel-plate double doors framed by window hinges.

The eastern section of the building given over for potash processing comprises two-storeys in parts. The 20m high steel cylinders of the potash strippers are raised above the roof, in which hydrogen sulphide in the form of steam is stripped from the potash alkaline solution. In front of the strippers stands a four-storey shelf-like steel construction which would originally have been completely open and was subsequently clad with trapezoidal plates. The coolers, in which the hydrogen sulphide was extracted in liquid form, were located on this "shelf". In addition to the pumps for the whole HP plant, the equipment for regenerating the potash was also housed within the plinth in this section.

Five vacuum pumps manufactured by the Frankenthal company based in Balcke and dating from 1958 are installed in the central section of the building for the operation of the potash strippers and the associated coolers. They were driven by electric motors via transmission belts and flywheels.

The western section of the building houses the replaced refrigeration plant for the production of cooled alkaline washing solution for the benzene cold washers and distillation equipment needed to continue the processing of the benzene extracted in the outdoor installation. A three-storey, open steel construction towers above the roof of this part of the building. This is to house the distillation columns required to process the benzene.

High pressure plant of the type described has been installed in the coking plant since the mid-thirties. Its introduction is related to the development of remote town gas networks, the operation of which required storing the purified gases under high pressure. Producing the pressure with compressors could actually take place after the gas purification process (as happened at the Alsdorf Anna coking plant), in which case the deployment of the compressors directly after purification had the advantage that the size of the benzene washers could be considerably reduced and the hydrogen sulphide extracted by this means could be utilised for the extraction of sulphuric acid.

In terms of technological history, the high pressure plant at Zollverein is an important variant to the earlier type of constructions used for benzene plants in its notable manner of construction using the realised combination of sealed plinth constructions with steel constructions on top.

Sulphuric acid wet catalysis

Sulphuric acid wet catalysis (1959) was initially developed in the 1930s. In 1934 the company known as the Metallgesellschaft AG, based in Frankfurt am Main, patented this process. By 1945 the Lurgi company had built around 26 plants and also supplied the Zollverein coking plant.

The sulphuric acid wet catalysis of the Zollverein coking plant is located in the same block as the pressurised gas treatment plant and is directly connected to this plant from a functional viewpoint. Here the hydrogen sulphide extracted in the H_2S washers was converted in sulphuric acid (H_2SO_4), at a concentration of 78%.

The plant consists of a blower area with a switchroom, two incinerators with waste heat boilers, a contact tower above a single-storey plinth construction and a trickle cooler. The blower area is an open reinforced concrete hall, the attached switchroom has brick-built outer walls. The blowers serve to feed the clouds of hydrogen sulphide coming out of the pressurised gas treatment plant into the incinerators.

The incinerators, which are installed outside, comprise horizontal steel cylinders above support pillars, which were clad with fire-proof material on the inside; the hydrogen sulphide was ignited over burners in the furnaces. SO_2 is produced At a temperature of approx. 990°C together with steam. Waste heat boilers, in which steam was produced by utilising the heat from the furnaces were directly connected to the furnaces. Standing directly next to the incinerators is the contact tower, which is an upright, welded steel cylinder: Here the SO_2 from the incinerators was converted into SO_3 by means of a catalytic converter.

The condensation tower is built onto a single-storey construction made from reinforced concrete with brick-built outer walls. It is a standing steel cylinder with an operating platform attached just below the tower head, in which sulphuric acid (78% concentration H_2SO_4) could be extracted from the SO_3 by means of condensation.

In the final stage of the process, the acid was then cooled in cast-iron pipes in the trickle cooler using water poured on from outside and was then transported, via an intermediate container, into a 300m³ tank which was positioned next to the tar loading station.

Fine Gas Purification and Gauge Station

The fine gas purification was a subsequent development (1958). The transfer of coke furnace gas into town gas networks had played an important role stretching right back into the 19th. century: Mind you, a prerequisite for the utilisation of this gas for lighting and household purposes was the removal of the sulphur from the gas. Ever since the time of an invention by Franz Lenze in the mid-1920s, there had been tower purifiers the first examples of which were built in Alsdorf (Anna/Alsdorf coking plant) and Hamborn (August-Thyssen coking plant) in 1927/28. In contrast to the tower purification plant in Alsdorf (demolished in 1995), Schupp did without the external effects of the purification towers and completely enclosed them in a building. The impressive aesthetic qualities of the Essen fine purification plant results from the contrast of the body of the building to the filigree elements of the cranes.

The fine gas purification plant was structured in the form of a cuboid steel lattice-work hall, to which a low side tract with crane equipment for feeding the purification towers with iron ore and, on the opposite side of the façade, a somewhat off-set staircase have been attached. Above the building there is a moveable loading bridge which allows containers to be moved in and out of the purification towers; in the hall interior there are four rows, each containing three purification towers built to the height of the building and constructed from welded steel plate.

The gauge station forms part of the fine gas installation. It is a single-storey reinforced concrete construction with a flat roof and brick façade, horizontal square windows are located under the eaves. Inside stand six rotary displacement gas meters, which measured the quantity of gas transferred into the Ruhrgas AG network.

Other Operational Installations

Other buildings forming part of the Zollverein coking plant include a water gauging and distribution centre (1959) for measuring the amount of water taken from the mains water supply and its distribution, and the powerhouse (the so-called "comb" building; built in 1959), in which, from east to west, switching station 3, the Ruth's storage facility, pumping stations 2 and 3, and also the de-carbonising and water softening plant were housed.

Fan coolers and cooling towers (1958) were arranged in two rows for the purpose of water cooling. The three fan coolers are of reinforced concrete construction, which was originally intended to be faced with brickwork. The western cooler was fitted with six fans, and the eastern with four fans. The three eight-cornered free-running coolers of the Balcke construction type are raised over reinforced concrete cups with their riveted steel construction, cement fibre plates line the inner drip installations made from wood. A gas flare (1959) was built in the form of a steel-plate chimney with a height of 18m and a diameter of 17m. The casing, lined with fire-proof material, is raised on steel supports resting on foundations made from reinforced concrete. The ground flare (built by the Lurgi company) serves to burn off any excess purified gas in the event of malfunctions in the remote gas acceptance installation or for flaring off raw gas in the event of operational malfunctions.

The coking plant also had at its disposal a single-stroke telescopic gasometer (built by the Klönne company in 1959) with an storage capacity of 20,000m³ of gas.

Finally, also included in the building stock of Zollverein colliery are the administration and locker-room building, initially built in 1958 for 500 miners and 50 mine officials, with its nearby gatehouse for security personnel, a first-aid station built in 1960, and also a workshop and store (1958).

The Zollverein colliery is one of the most important mining installations and forms part – as is attested to below – of our world cultural heritage; At the same time the coking plant is an inseparable part of the whole plant. The preservation of such a completely preserved functional complex in such a small space is a historical stroke of luck, which is not to be found in any other site of this nature in the whole of the coalmining industry. The technical mastery which was realised in the Zollverein colliery, and which simultaneously provides proof of the economic power of West Germany and the high levels of output attained by the Ruhr mining industry in the post-war period, and also the craftsman's perfection in its construction, lends this monument a high intrinsic value over and above the ensemble concept.

For the "Zollverein Coking Plant" monument, this means the following: For a distance of approximately 1km, the furnace chambers of the Zollverein central coking plant, along with their associated technical equipment, line up to form a powerful architectural creation, which, in its size and completeness, is one of the most splendid installations in the whole of Europe. The path of the coking coal from the mixing tower via the feed towers and trucks has been preserved in every detail here, just like the furnaces with their ram machinery, the coke quenching plant, the sieving plant and the loading station are still there to form an impressive overall picture.

It must be considered as an extraordinary stroke of good fortune that the complete installation for gas extraction and other products processed from coal and coke continue to exist on the spacious site of the coking plant. Particularly included here are the tar and phenol production facilities, the ammonia plant, the sulphuric acid wet catalysis and the fine gas purification plant.

Simultaneous to this development, as the most modern coking plant facility in Europe began operation in 1961, the first great steel crisis, and its attendant drop in demand for coke, forced the closure of the Nordstern coking plant. Thus, this dormant complex of the Zollverein colliery, with its four chimneys in a row, dominates the landscape like an eternally valid architectural sculpture on a grand scale, a work of art which bears witness to the achievements of technology in such a manner as to emphasise these achievements. Together with its imposing network of pipelines, this ensemble of structures and equipment has the effect of providing an architectural forerunner of those construction ideas which, for example, were soon to be realised in buildings like the Pompidou Centre in Paris.

4.3 Present-day Use of the Coking Plant

As a part of the industrial history of the Ruhr, the Zollverein colliery should be open to the public so that they can also share the experience: It is being developed – along with the surface installations of the Zollverein colliery – into one of the region's cultural centres. It is the most important monument of the recently established "Foundation for the Preservation of Industrial Monuments and Historical Culture" in North-Rhine Westphalia.

In the future the coking plant will be available as an exhibition site. Since May 1999 it has been the site of the "Sun, Moon and Stars" exhibition which is being held within the framework of the Emscherpark International Construction Exhibition; This exhibition describes, with the aid of a themed route over conveyor belt bridges, by using paths through the coke furnaces, taking looks into the chimneys and with a trip on a "sun wheel", the "Story of Coal" and its effects on and for the benefit of mankind.

The plant, over 600m long and with approximately 300 coke furnaces, is being developed by means of an industrial teaching route within the framework of the exhibition, a light show production at night by the British lighting architects, Speirs and Major, shows off the architecture as a night-time experience, enveloping0 it in red light and allowing the chimneys to radiate and be lit as a visible symbol in the distance.

A solar power plant has been constructed on the upper side of the almost endless row of coke furnaces: The roofs above the quenching track halls which are south-facing were suitable for this, other places which can be used have created a potential for a 2MW solar power plant, upon which the demand of also being a work of art is simultaneously imposed. The first section of the power plant with an output of around 120kW was put into operation at the opening of the exhibition in May 1999, but the solar plant is designed as a "growing power plant" and is to be constantly expanded: In the course of the exhibition the visitors should make a contribution to the growth of the power plant and contribute to the expansion by purchasing components. In doing so they will simultaneously demonstrate their commitment to the transition from coal to the age of solar energy.

4.4 Technological Monuments of Coking Plant Processes

Up until now the history of town gas production has already been described many times and sometimes in extensive detail, however, the technological development is not being sufficiently documented by means of technological monuments. Although the problem and the necessity of having to leave testaments of this technology for our descendants has been recognised early on, preservation has been restricted to smaller installations, e.g. single coke furnaces. The present time is the first time that an attempt has been made to renovate and find new uses for such large-scale examples of the coking plant industry, which, from the point of view of restoration, are difficult and expensive to preserve. A few prominent examples of technological monuments and witnesses to the era of town gas production and the coking plant industry are presented in the following.

Monuments to Charcoal Burning and Tar Distillation

There are still a few monuments in existence which serve to document the charcoal burning craft and tar distillation technology as the predecessors of coking plant technology. In this respect the partially reconstructed tar distillation plant which lies on the eastern bank of the river Warnow in **Rostock-Wiethagen** deserves a first mention: It is the only site in the North German coastal region which can document the tar extraction process which was so important for shipbuilding.

The production plant used for the manufacture of tar was built in 1838: In 1851 the tenant at that time was to take part in the World Exhibition in London and, on account of the quality of the tar, to receive larger orders. Forming part of the plant were two tar furnaces, the tenant's living accommodation and a half-timbered barn. The two furnaces, which were built using bricks, have been constructed according to the double-skin principle: The high resin content conifer wood to be distilled was stacked in the inner skin, the aperture was closed and the fire was ignited through the fire-hole. After 48 hours the tar would begin to flow into the so-called tar trough as a viscous, dark-brown mass. A fire lasted for four to five days and charcoal was produced as a by-product.

The last "schmeer" furnace in Hesse (next to the lace mill) is preserved close to **Kirdorf**, in the vicinity of Alsfeld. The skittle-shaped incinerator has a brickwork casing made from rough bricks which is roughly covered with a clay render. The actual "distillation furnace" is located inside this, and with a diameter of approx. 3m and a height of around 2.3m is also built from bricks with a clay coating. This inner furnace has five apertures. Similar to the process in Rostock-Wiethagen, the wood material to be distilled was stacked between the two brickwork skins and the fire was ignited in the inner furnace, and the distillate ("schmeer") was caught in a circular ditch. To the west of the firing plant lies the burner's shed. The schmeer furnace was in operation from around 1905 to 1948 and is protected as a technological monument.

An important documentary site to the refining of central German brown coal is the **Groitzschen tar distillation plant:** As the most important production branch of the chemical refinement of coal, brown coal distillation started to expand around 1830 at the edge of the Zeitz-Weißenfelser district in central Germany. The brown coal found there produced particularly high yields of tar, paraffin, solar oil and other distilled products. The brown coal distillation industry which developed in central Germany is characterised by three stages of development from a technological standpoint: Up until around 1870 horizontal retorts, a discontinuous operation using charging methods and indirect heat transfer dominated, from about 1870 to around 1935 the so-called Rolle furnace was used, which had been developed by a chemist called Rolle, a shaft furnace, which guaranteed continuous operation with indirect heat transfer and a correspondingly higher output at level of heat balance which had admittedly not yet reached its optimum value. From about 1935 the Lurgi distillation plant with continuous operation and direct heat transfer and which was developed outside the brown coal industry came into use.

The expansion and the golden age of the chemical refinement of brown coal in central Germany are both historically and causally connected to the Rolle furnaces. Apparently, the last Rolle distillation plant is preserved in the ruins of distillation house I, which was built in 1890 and is located in direct proximity to the railway yard at Groitzschen: In the midst of a brickwork architecture which has a monument-like effect, the brickwork blocks of two 7m high batteries of distillation furnaces, which were increased to 12m in 1920, can still be seen. Accordingly, another floor was added to the building. In 1954 the roof and walls of the upper floor were demolished, and in 1975 the northern outer wall followed suit. However, together with the furnace batteries and also the southern and western outer wall, the larger part of the historical elements of the building remain. From a technological point of view, the furnace batteries with their brickwork smoke flues and fire-clay cylinders, the inspection apertures and furnace bodies, including the coke channels and tar collection mains, are of particular importance. It is planned to give this technological monument of national importance special recognition by including it in the "Brown Coal Road" programme.

In Central Europe – mainly in the United Kingdom and in Germany – a few historical gas works exist which have been preserved after they were closed down, and, in this way, are able to document the production of town gas from coal. However, completely preserved installations are rare, in most cases the gas works operated by the utility companies were razed to the ground after gas supplies were converted from town gas refined from coal to natural gas.

Two good examples of completely preserved, but admittedly relatively small municipal gasworks are to be found in the United Kingdom: In the town of **Fakenham** (Norfolk), located about 40km to the north-west of Norwich, there is the first notable example dating from 1846, which today is under the protection of English Heritage. The town of **Biggar**, located approximately 40km to the south-west of Edinburgh, has preserved its gasworks, built in 1858 and expanded in 1879, as the Biggar Gasworks Museum and has made it subject to a preservation order. The gas storage vessels originate from the years specified above, whilst the preserved retort house with its horizontally arranged retorts dates from 1914.

The large-scale and high-output **Athens gasworks** was built in 1862 at the junction of Piraeus, Persefonis and Voutadon streets and has been partially preserved after it was closed down. It has, *inter alia*, two retort batteries arranged at right-angles to each other; tar distillation vessels are located above the retorts. The small machine house has two Belgian steam engines for driving gas pumps which were manufactured in Berlin. The cooling house and pumping house are to be found to the north-west of the machine house, as well as a floating bell gas storage vessel decorated with ornamental ironwork. Other floating bell gas storage vessels and buildings, whose equipment and fittings have been partially preserved, demonstrate the technology of gas production in the second half of the 19th. century in an impressive manner. The future of this important technological monument is uncertain.

The small gasworks located in the Brandenburg town of **Neustadt an der Dosse** (Kyritz district) is one of the last remaining witnesses to the history of gas production in Germany, which lasted for about 150 years, and until it was closed down in September 1980 it was one of the oldest coal de-gassing plants still in production in Europe.

On the 24th. June 1902, the town of Neustadt an der Dosse submitted an application to the district committee of the Ruppin district for the granting of a concession to operate a gasworks, which was conferred on the 11th. November 1902. Soon afterwards construction work on a gasworks with a floating bell gas storage vessel began in front of the Havelberger Gate and in 1903 the plant was put into operation. The principal use of the gas produced was for gas lighting, but in the end coke extraction became the primary product.

The gasworks included the furnace building with two horizontal retort furnaces, a quenching tower, coal sheds, the gauge and apparatus room with sulphur purification plant, the tar pit area, the gas storage vessel and the coke separation plant. In addition to the two retort furnaces, the main technical equipment consists of the water pipe cooler (1898), impeller-driven suction equipment (1902) with a transmission drive and an rated output of $150m^3/h$, the tar separator (about 1920), a standing ammonia washer with built-in wooden trays (1898), two station gas meters (1962) for $200m^3/h$, the town pressure regulator and the sieving lane for coke separation (1903). The gasworks itself was built in red brick in historicised architectural forms.

The core pieces of technical equipment remaining in the Neustadt gasworks are the two horizontal retort furnaces, each of which consists of six retorts. They themselves consist of a lower and upper furnace. The lower furnace houses the generator for heating the retorts and the recuperator (heat exchanger), whilst the upper furnace consists of the brickwork which surrounds the retorts, the sleeve and the retorts themselves. The fuel fed to the retorts, i.e. the coke from the retorts, was gasified with the aid of primary air. Steam, which was produced by vapourising water in the generator in the lower section, was added to the primary air. The generator gas was pushed through the heating gas channels and burned with the recuperatively pre-heated air. The smoke gases streamed around the retorts, giving off a portion of their heat to the retorts in the process, and were then fed into the recuperator, in which they gave off another portion of their considerable heat in order to pre-heat the air. Finally they reached the chimney via a smoke flue.

The quantity with which the retorts were filled varied between 200 and 300kg, the coking or process time for charging the retorts amounted to around six hours. The temperature of the coal gas being drawn through the vent pipe was about 500°C and was cooled by a direct water sprinkler system in the collecting main.

The floating bell gas storage vessel, made from steel and with a single-stroke, next to the furnace building has a storage capacity of $550m^3$. The daily output of the gasworks was approximately $1,100m^3$ of gas, and the plant had to be operated for twelve hours per day in a three-man operation. Each of the two furnaces was operated with six retorts, charging the plant was done manually. As there was no railway connection, the coal had to be transported by truck.

The Neustadt gasworks represents a rare, complete example of a gasworks from the 19^{th}. century using methods of gas production which can be almost referred to as "classic".

Gas Storage Vessels

Included among the most impressive, but also the most endangered technological monuments of town gas storage systems are the gas storage vessels: These installations, originally indispensable in the provision of an uninterrupted supply to the towns, became obsolete as the security of supplies increased with the excess supply of energy, and large numbers fell victim to the demolition ball. The brickwork storage vessels from the early period of storage vessel construction are of extraordinary importance and also aesthetic charm.

The four monumental gas storage vessels located on the right-bank of the Danube canal form an impressive group of structures and have, on account of their extraordinary appearance, become symbols of the **Simmering** district of the city of Vienna. As technological monuments they are of international importance and are considered to be the best examples of this type of monument.

Until the first municipal gasworks was built in Simmering, the gas supply in Vienna was exclusively in the hands of private companies. A programme for the drawing up of an appropriate project was first of all set up by a resolution of the district council on the 20th.

May 1892, and then an international competition was put out to tender, in which first prize went the Berlin engineer, Schimming. In order to work out the details of the project, Theodor Herrmann, a "technical consultant in matters relating to gas", was engaged at the end of 1893. However, this draft was also revised in its essential parts in accordance with several reports by foreign experts. On the 27th. October 1896, the construction of the gasworks in Simmering was finally approved and the management of the construction was handed over to the city's direct works department under Franz Kapaun.
Numerous national and foreign companies were involved in the design and execution of the extensive installations. Thus, on the 17th. December 1896, the main ground and construction work for the four storage vessel structures was transferred to the Vienna Union Construction Company; it was then possible to have the first sod cut by the 28th. December. Responsibility for the design of the iron storage vessel bells was awarded to the company of Ignaz Grindl, who commissioned the companies of R. Ph. Waagner in Vienna, the Berlin-Anhaltische Maschinenbau AG in Berlin, the Kölnische Maschinenbau AG in Cologne-Bayenthal, the steam boiler and gasometer factory formerly known as A.-Wilke & Co. based in Braunschweig and the company of F.A. Neumann based in Eschweiler, with the supply and assembly of individual storage vessel components. The Gridl company also built one of the four storage vessel roofs, whilst the others were made by Antol Biró, Albert Milde & Co. and R.Ph. Waagner. On the 17th. July 1899, all four storage vessels were ready for operation and it was possible to inaugurate the new gasworks on the 31st. October.

The gasworks, which was subsequently expanded on numerous occasions, was heavily damaged in World War II; today only the four storage vessels, the water tower and the administration buildings still exist; the gasworks itself has been closed down.

The four brick-built storage vessel buildings are cylindrical structures which stand in a row behind each other and each have an outer diameter of 64.90m; the upper ledge lies 39.42m above ground level. The dome-shaped roofs form a circular segment in cross-section, the radius of which is 43.50m and the height of the columns is 13.33m. The tops of the lamps fitted on the top are 67.38m above the raised ground level. The façades are made up of faced brickwork. The pilaster-like outer columns correspond to the iron guide stands for the storage vessel bells inside.

The four storage vessel buildings were all finished in exactly the same way: A 12m high ring of brickwork with an internal diameter of 62.80m, and which serves as a water basin, was erected over a concrete foundation which is 1.7m thick and chased upwards. This brickwork is 5.40m wide at the base and 1.65m wide at the crown. Rising above this – in a brickwork thickness which ranges from 1.6m to 0.9m – is the actual storage vessel building, which has been laid with bricks using mortar. The dome-shaped roof with its cantilever span of 63.60m is of iron construction using Martin flow iron according to the Schwedler system and has a wooden skin with zinc plate roof covering.

Each of the four 33.60m high, iron storage vessel bells is fitted to 18 vertical trellis stands and is immersed in the basin which is filled with 30,000m³ of water. The bells consist of three cylindrical sections of 58.20m, 59.10m and 60.00m diameter and fit into each other telescopically. Each gas storage vessel has a storage capacity of 90,000m³, and the gas pressure amounts to a head of water of 213mm when the bell is full. The interior of the building is accessible for the purpose of carrying out checks via iron, ladder-like stairs and galleries along the walls.

Brick-built gas storage vessels were also built in the New England states and in New York in the 1870s and 1880s: twelve of them remain, the most impressive being the one which belonged to the **Troy** Gas Light Company and which dates from 1873. This gas storage vessel, of conventional construction and with the gas bell in the interior was designed and built by Frederick A. Sabbaton and holds around 100,000m³ of gas. Its outer brick skin demonstrates a historical architectural concept in its typical structural and decorative forms. Meanwhile, the gas storage vessel has been taken out of commission and is now used as a garage.

Brick-built gas storage vessels used for storing town gas were also constructed in large numbers in Germany: The demolition of the gas storage vessels on Prenzlauer Berg in Berlin, carried out with the large-scale participation of the general public was an unforgettable experience, but important examples also remain preserved.

The gasworks in **Stralsund** began operation in 1856, and in 1960 gas production based on coal was brought to a halt. On the operational site close to Rügendamm, it is still currently possible to find three storage vessel structures located within a compact area, which convey an impressive overview of the constructions of low pressure gas storage vessels up until the start of the 20^{th}. century.

So-called gas storage vessel I dates from the year 1856 and was built in the form of an octagon with yellow brickwork and pilaster decorations. Arched windows and coupled slit windows provide the light for the interior of the building, the machine room was built onto the southern longitudinal wall in the form of a wing with a saddle roof section. Until 1909 two floating bell gas storage vessels were located inside the octagon, each having a storage capacity of 250m³: At that time these were then replaced by two telescopic floating bell storage vessels, which each had a storage capacity of 950m³ of gas, but the surrounding structures were retained. The storage vessels were dismantled after the gasworks was closed down.

In the immediate proximity of the first gas storage vessel, a three-storey cylindrical brick construction with a diameter of 18m and a height of 22m was built in the course of the expansion of the Stralsund gas supply plant in 1904. A Schwedler dome spanned the vessel with a storage capacity of 4,000m³ of gas. The bell could be moved into the cylindrical sections twice for a distance of 6m. The state of preservation of the conversion, the water container, the cylindrical sections and the technical equipment, which is extremely good even today, results from the fact that the storage vessels were used to store the gas produced by an oil fission plant until 1972, and then finally as a reserve storage facility for the supply of natural gas to the Hanseatic city until 1989.

One more installation to be pointed out is the gas storage vessel dating from 1914, which was built as a steel skeleton structure and has a storage volume of 10,000m³ of gas. With a diameter of 25m and its twin telescopic cylindrical elements, this storage vessel is one of the largest in Mecklenburg-Vorpommern. This one, too, was used as a reserve storage facility for natural gas.

The various types of gas storage vessels built on one easily comprehensible area thus demonstrate the technological history from the years 1856 to 1914 in an impressive manner. However, the future of the Stralsund storage vessels is uncertain, there are doubts about the permanent preservation of the site.

The expanded gasworks installation in **Dresden** located between Winterbergstrasse and the railway line has three brick-built gas storage vessels and one dry gas storage vessel: This most recent storage vessel construction in Dresden brought to an end a tradition which began in 1828. At that time, the first gasworks to be built by German engineers had been constructed in Dresden, after British companies had created other supply facilities of this type in Hannover and Berlin.

At the entrance to the works stands the massive outwardly well-preserved circular structure of the gas storage vessel, which was built in 1878 according to the design of Theodor Friedrich and which is today used as a storage facility for liquid gas. Behind its outer wall, made from brick and decorated with arches, and under the steel dome crowned with lamps the storage vessel bell was once raised and lowered.

To the right and opposite, and outside today's operational site, another second gas storage vessel dating from the first phase of construction of the gasworks (up until 1881) can be discerned in the superstructure of a gymnasium. The buildings of the former water treatment plant with its representative double tower façade and water tower, which towers above and accentuates the works yard, also originate from the same time.

However, what towers above the whole of the installation and the skyline of eastern part of Dresden is gas storage vessel III. This gas storage vessel is an important witness to the modern industrial architecture of the time around 1900. It was built in the years 1907/1908 by Hans Jacob Erlwein (1872-1914) and combines aesthetic and monumental effects purely by virtue of his emphasis on the functional and material aspects. In this respect it is clearly elevated above the other two smaller gas storage vessels built by Hasse and Friedrichs.

The structure is like a standing cylinder with a ball segment placed on top, upon which a ventilator lamp is raised like a crown. The monumental effect is particularly emphasised by the five attached staircase towers. The façade of the cylinder has a plinth floor, four main floors and also an upper floor, which are only divided by square windows, sometimes in screens. The diameter of the storage vessel amounts to 64.50m, the internal inner height is 75m. The structure of the holder has a volume 135,000m³, whilst the gas bell located within has an effective volume of 110,000m³. The gas storage vessel has been out of commission since 1973.

Included amongst the very high-quality architectural works of Hans Poelzig is the (sulphur) purification plant Nr. III of the Dresden gasworks, a hall-type construction with two spiral staircases suspended from pylons, which even as a ruin still offers an impressive picture.

Other gas storage vessels with brick-built surrounds still currently exist, *inter alia*, in **Stockholm, Leipzig, Zwickau,** and **Augsburg**.

After several decades of research into dry, lightweight gas storage vessels, the Mainz-Gustavsburg works of Maschinenfabrik Augsburg-Nuremberg (MAN) developed the **dry gas storage vessel** in 1915, in which a light-weight tube on a polygonal ground plan is stiffened underneath by a circular continuous foundation and above by a steel framework. Around the years 1925/1930 the company had a virtual world monopoly for the manufacture of these gas storage vessels. Two of the most notable representatives of this type of storage vessel have been preserved in the Ruhr area.

In 1781 the **Gute-Hoffnungs Plant** in **Sterkrade** started production: It developed into one of the most important steel and coal industry companies of the Ruhr. In 1929 the steelworks put into commission the largest gas storage vessel in Europe at that time with a diameter of 67.6m, a height of 117.5m and a storage capacity of 347,000m³ of gas. The Oberhausen storage vessels consisted of 24 double-T bearers as casing corner posts, between which beaded plates 8.8m long and 0.81m high were riveted at a thickness of just 5mm, which sealed the body gas-tight and stiffened it horizontally. A moveable disc floated on the gas, which was blown in and removed from below. This disc was built up from 24 radially positioned framed stanchions which met in the centre. At the ends of each individual stanchions, which had a height of 6m at their outer ends, a steel guide roller was fitted above and below, a horizontal plate cover was fixed to the underside of the stanchions to form the actual seal.

Because the weight of the disc construction was not sufficient to achieve the desired gas pressure of a 300mm column of water, concrete weights were additionally fixed at equal intervals on the disc. A disc edge gasket made from elastic slide strips pressed onto the outer skin under their own weight: These slide strips lay in a groove around the circumference of the disc, which was filled with tar oil so that a seal was formed on the outside by the storage vessel casing and on the inside by a lip on the disc. A small part of the liquid flowed between the sealing strips and the casing into the gas space below the disc and was collected in a circular disc cup: from there the sealing oil was fed through various stages of the cleaning process, in which dirt and, above all, water, which condensed on the walls, was separated from the oil. The oil was then pumped up to the top outside and ran down the walls in the gas-free space above the disc until it reached the disc cup again. This kind of "dry disc-type gas storage vessel" marked the then final stage in the technological development for storing gas produced as a by-product, for example, from a blast furnace plant.

The Oberhausen gas storage vessel remained in operation until January 1945; during repair work in 1946 it fell victim to a fire and was so badly warped that it had to be demolished. Re-construction on the same site was carried out using the components which were still intact and was completed in 1949. In order to make maintenance easier an outside lift and an inner transportation hoist were added at that time. The storage vessels remained in operation until the Osterfeld coking plant was closed down in 1988.

Originally earmarked for demolition, the gas storage vessel subsequently became one of the most important and oft-visited monuments in the Ruhr: As a prominent rendezvous it is being used, *inter alia*, for the presentation of exhibitions within the framework of the Emscherpark International Construction Exhibition, in which a glass lift which travels up to the dome has been installed in the interior. The sensation and experience of this gigantic inner area form one of the most impressive spatial experiences connected with industrial monuments.

The first coking plant at the **Dortmund colliery of Ver. Stein and Hardenburg** was put into operation in February 1900 and continued working until 23rd. July 1919. After the founding of Vereinigte Stahlwerke AG, a new coking plant with 105 furnaces was built as part of the new construction programme in 1927/1928, and in 1930 another 25 were added. In order to even out the gas supply balance and also to efficiently exploit the quantities of coke furnace gas occurring on Sundays, a gas storage vessel for purified gas was built in 1934 in the eastern sector of the colliery site in a joint project with Ruhrgas AG. The storage vessel, which was constructed by the Klönne company based in Dortmund, had a storage capacity of 175,000m³ and was 56m in diameter and 82.5m high. The way it was constructed differed from the MAN dry gas storage vessels in that the Klönne storage vessels were not constructed in a polygonal manner, but were round. In addition to this, the construction of the disc, which had a pronounced dome shape, and the seal of the disc against the storage vessel wall also differed from what had been normal practice until that time. A lift was fitted on the south-western side of the dry disc-type gas storage vessel, and an additional suspended hoist was also available inside the storage vessel, with the aid of which it was possible to move along the storage vessel disc.

After being destroyed in the war, the gas storage vessel was reconstructed in its same form and was again put into operation on the 28th. May 1947. The Minister Stein coking plant ceased operation on the 30th. September 1987, and since then the gas storage vessel, which is visible from a long way off, has served as a storage facility.

High-output Gas Engines

However, not only gas storage vessels should be included amongst the important and expressive monuments of the coking plant industry, high-output gas engines are also worthy of mention in this context. In addition to its use in the areas of lighting and heating, at the end of the 19th. and the beginning of the 20th. centuries there were other, mainly commercial and industrial, areas of application for coal gas. For example, this concerned something which has now gained universal significance, i.e. the exploitation of gas energy in gas motors and so-called high-output gas engines, which were initially developed by Nikolaus August Otto (1832-1935) and Eugen Langen (1833-1895). Actual high-output gas engines, the development of which is closely associated with Wilhelm von Oechelhäuser (1850-1923) and Hugo Junkers (1859-1935), were probably built for the first time around 1900 by the Berlin-Anhaltische Maschinenbau AG (BAMAG) in order to produce electricity for a colliery located in Mähren. Fed by the purified excess gas from 120 regenerator furnaces, each of the three engines delivered an output of about 300 HP. The electricity produced in this way served as a supply for the coke ram machinery and also for the by-products plant. Any residual power was transferred to the coalmine. In 1906, 32 out of 49 German steel mills and 16 coalmines had high-output gas engines at their disposal, which were almost exclusively driven by coke furnace gas.

Of national importance for the monument stock of the Federal Republic of Germany is the **ventilator house of the Völklingen steel mill**, complete with the high-output gas engines still to be found there, which has recently been recognised by UNESCO as part of the world cultural heritage. In the long, elongated brick-built hall-type building, built between 1900 and 1913, in which parts of the original tiling are still intact and which has a total of 28 window pivots, a total of ten units are still standing today, of which seven deserve particular attention because these originate from the first twenty years of the 20th. century. Arched transom windows with ocular openings above them illuminate the interior of the building; two crane tracks on a central support enable any point within the spacious hall to be reached. Additional lighting for the hall is provided by a central glazed saddle roof in the longitudinal axis.

With the high-output gas engines of this ventilation house, the development of the Völklingen steel mill and of engineering underlines the emergence and evolution of high-output gas engines.

Around the mid-1890s, experiments involving the running of gas engines on top gas were begun at various steel works. On the 13th. April 1898 the Röchlingschen works ordered a 16 HP lighting gas engine (Otto type) with an electrical ignition system from the Deutz gas engine factory, which was to be run on top gas. In fact, this machine did not get through the trial operation period, but the conclusion was reached that top gas from the Völklingen blast furnace was a suitable fuel for driving gas engines. On the 27th. October 1889, Hermann Röchling wrote a letter to the Maschinenfabrik Augsburg-Nuremberg (MAN) to the effect that he had heard that the Nuremberg works wanted to start on the construction of larger gas engines, and he informed MAN that such an engine would be required for each of the Völklingen and the connected Diedenhofer Carlshütte plants. Consequently, MAN began construction of these larger engines in December 1898.

Because of the general lack of experience with high-output gas engines, the first engine actually turned out to be unreliable, but development work continued: The gas engine supplied to Carlhütte already represented an improve version, but was still not able to meet expectations. Consequently, in January 1900, the Völklingen plant ordered two single-cylinder engines from the Cockerill company, as well as a twin-cylinder gas blower engine from Cockerill's German licence-holder, the Märkischen Maschinenfabrik based in Wetter/Ruhr. These were heavily-built, single-action machines which were installed in a newly built ventilator house: The first, northern section of today's ventilator house provides a reminder of this stage of development.

During this period, when the high-output gas engines of all other types were still at the experimental stage, the Cockerill machines ran perfectly. They also proved themselves at the Völklingen plant and ran until 1918/1919 and 1921 respectively. The next gas engine ordered by Völklingen was used as a drive engine for the wireline: This one no longer exists. In the meantime, MAN had considerably improved the construction of its machines; led by its designer, Hans Richter, who had also taken part in the trials in Völklingen, MAN had switched to the development of double-action four-stroke engines.

By arranging the components concentrically and by doing without special cylinder heads, it proved possible to create an engine which corresponded to the fundamental principles of steam engine construction in its overall structure. As early as the 14th. July 1903, the Völklingen plant ordered one of these new "Nuremberg gas engines" (DTZG 13) with a cylinder bore of 1030mm, which provided a direct drive for two blower cylinders of 2,100mm. When this engine went into operation in 1905, an order for two DT 11 gas dynamo engines followed on the 11th. October of the same year, and on the 27th. March 1906 came another DT 11 in addition; all three engines were installed in machine house I.

In 1905 Richter moved to the Thyssen machine works and there he developed the DT-13 range of engines. During a visit to Völklingen in November 1906, Richter received an order for two DTG 13 gas blower engines with blower cylinders measuring 2,350mm in diameter. On the 16th. January 1907 the order was extended to include another engine of the same type. In order to house the engine, the ventilator house building, which had already been extended in 1904, was once again extended (1907): Engines 3,4 and 5 still in Völklingen today originate from this time and are the Richter engines mentioned above. They were put into operation in 1908.

Because the two-stroke blower engines proved extremely satisfactory in operation, the steel mill decided to select this type of engine when the ventilator house was extended further (1913). On the 14th. January 1913, the Klein Bros. machine factory in Dahlbruch was awarded an order for two engines of the Körting type; these were the two engines 6 and 8, the remains of which are still there today. Finally, in 1914 another two double-action four-stroke blower engines were installed (engines 9 and 10).

These developments in high-output gas engine construction can be easily understood in an impressive manner and with the aid of the units still preserved *in situ* within the Völklingen ventilator house. Today, there is still an electric blower (year of manufacture 1963), which was taken over from the Belgian Rodange works, located between engines 9 and 2 in the Völklingen ventilator hall, as well as the electric blower 11 (year of manufacture 1954; taken over from the Burbach-Saarbrücken steel mill in 1978) located on the foundations of engine 7 and a compressor dating from the time between 1915 and 1920. Precisely by comparing these relatively small units from more recent times with those from earlier periods, it is possible to gain an understanding of the development of the high-output gas engines in a most impressive manner.

Other good examples of high-output gas engines as technological monuments are to be found at the **Halberg steel mill** close to Saarbrücken. In 1902, in this steel works, which specialised in cast pipes, it had been possible to put into operation the first high-output gas engine driven by blast furnace gas for the production of electricity; in 1906 the works installed its first gas blower in the form of a blower engine, which was directly connected to a blast furnace gas engine. Of the previously rich stock of these particularly impressive technological monuments, only four are still preserved today in Saarbrücken-Brebach.

Engine 9, built in 1912 by the Saarbrücken machine factory of Ehrhardt & Sehmer (type T10; engine nr. 18620) and operated until March 1988, achieved an output of 7,000m³/h of pumped air at a pressure of 7 bar (= 940kW). Both cylinder bores measured 875mm, the stroke was about 1,000mm and the rotary speed was 120 RPM. The stroke volume amounted to 0.56m³/revolution, the flywheel diameter 5,750mm and the velocity at the circumference 33m/sec. The connected engine with an output of 1,360 HP consumed 3,520m³ of blast furnace gas per hour. The overall weight of the gas engine was about 165 tonnes. Engine 13 (engine nr. 40220) is essentially of the same construction, but dates from 1927: It has a cylinder bore of 875mm, a stroke of 1,000mm and a rotary speed of 120 RPM. The output of the engine amounted to 1,640 HP, whilst gas consumption was about 4,250m³/h. The flywheel diameter of the machine was 5,300mm, and it also weighed 165 tonnes.

The two almost identical high-output gas engines 14 (engine nr. 70585) and 15 (engine nr. 70840) are still also in existence: They produced and output of 1,710 and 1,365 HP at a rate of gas consumption of 4,400 and 3,520m³/h respectively. The gas blower output produced amounted to 37,000 and 48,000m³/h, the flywheel diameters measured 875mm, those of the draught cylinders 2,000 and 2,300mm respectively. The rotary speeds were 120 RPM and 100 RPM respectively, the length of the stroke was specified as 1,000mm in both cases.

With its high-output gas engines, the Halberg plant possessed a very impressive testimonial to the engineering of such units: Hardly anywhere else in Saarbrücken is it possible to comprehend in such an impressive way the power of this type of machine, which in the course of time underwent very little change in its structure and form. The permanent preservation of these "engineering fossils" is not assured, but is very desirable.

At the **Hansa coking plant in Dortmund-Huckarde**, which has by now closed down, it is possible to find an ensemble of twin-stage, horizontal piston compressors dating from 1928 and 1939 which have been handed down in their almost original state. The Hansa coking plant was built during the years 1927/1928 as part of the large-scale construction programme of Vereinigte Stahlwerke AG as a replacement for the old coking plants at the Dortmund coalmines of Hansa, Zollern and Germania. The conveniently selected location at the Hansa coalmine facilitated the transportation of coke to the Dortmunder Union blast furnace plant by rail. At the same time it became possible, by constructing pipelines for coke furnace gas and blast furnace gas between the Hansa and the Dortmunder Union plants, to exchange the different gases between the plants. In the end, this exchange was effected with the Westphalia steel mill of Hoesch Stahl AG.

In a reinforced concrete construction clad with red clinker, a square ground plan, a flat roof and eleven square windows in both floors along the longitudinal sides, and three square apertures per floor along the end sides, a total of five piston compressors stand today, occupying the whole of the inner area with their iron structures: Not one machine is missing, the impression today is still the same as has existed at least since 1939: At that time the newest machine, compressor 5, was installed, and in 1942 this machine was put into operation. Even today, i.e. after the machines in the compressor house have been shut down, these giant pistons, flywheels and cast-iron components of the high-output gas engines cannot fail to move the observer. Looking at this ensemble of machinery is one the great experiences it is currently possible to get when working with "old technology" and with what is, by now, historical engineering.

Other high-output gas engines can be found on German soil at the **Georgsmarien steel mill near Osnabrück**, and also at the now closed **Neunkirchen steel mill** in Saarland. One of the two large compressors at the **Neunkirchen-Heinitzer central energy supply plant** was recently presented to the Großrosselner museum in Wendel, the other was scrapped.

Coking Plants

Any plans to preserve coking plants as large-scale installations in their complete state is particularly difficult, after production has closed down, most of the installations are in a relatively bad structural state of repair –caused by the high thermal loads. Nevertheless, it has to be the urgent task of monument maintenance and of society, to at least permanently preserve some of the important coking plants for posterity. Appropriate steps have already been taken, as is verified by the following examples in which it is obvious that the problems associated with preservation increase accordingly as the size of the coking plants increase.

In the USA, coke production on a large scale was begun around 1850, although reports show that its initial beginnings dated from 1837 with the Oliphant Furnace in Uniontown, Pennsylvania. Beehive coke furnaces dominated the picture in the first phase of American coke production, and approximately 7,300 of this type of coking furnace still existed in West Virginia alone around 1900.

The coking furnaces built on a cliff-face in **Richard, West Virginia** around 1904/1905 have been preserved as historical documents of this phase of coke production in the USA. These furnaces, which are grouped together in a battery, are approximately 4m wide in diameter and 2.3m in height, they are built from brick and rough stone and are fitted with iron seals. The coking time amounted to about 48 hours, and the furnaces were filled with around 4.5 to 5 tonnes of coal.

Greymouth, situated on the West Island of New Zealand was settled since 1868 as a result of the discovery of gold deposits and in 1873 the Scot, John Sewell, founded a smelting plant there. The coalmine located in the vicinity of Greymouth, which had been operated since 1848 by Thomas Brunner, was developed from 1864 and in 1868 coke production was started using beehive coke furnaces for the steel mills in Christchurch and Wellington, as well as for the smelting plants in Australia and New Caledonia.

As an outdoor museum, this locality with technological monuments in the form of mining installations and numerous beehive coking furnaces is maintained under the protection of the New Zealand Historic Places Trust.

In addition to these relatively small coking plants, a few large-scale installations also exist, which bring about considerable problems of preservation in their size alone. Here, the **Völklingen steel mill**, which UNESCO has recently declared to form part of the world cultural heritage, is mentioned first of all. Until its shut-down in 1986, the plant operated its own coking plant consisting of four batteries, which was located to the north-west of the group of blast furnaces and which was connected to the bunker facility via an overhead railway. In the following the essential development dates are given for this coking plant, which surely represents, in its scope, the largest historical coking plant under the protection of the monument commission on German soil.

In 1890, the steel mill made its initial plans for coking furnaces, but the building of its own coking plant only became a reality in 1897. At that time an iron coal tower which could hold a 1,000 tonnes of coal was also constructed, which has survived until today as the oldest historic document of the coking plant. One year later (1898) a coal transportation railway was put into operation, and again, one year later followed the start-up of battery 1, consisting of 20 furnaces (1899), which was followed by the construction of the coal washing plant from 1901 to 1903. In 1902 the coking plant was extended by two groups of furnaces with 48 open-hearth furnaces. At the same time it became an autonomous operation after previously being considered as a subsidiary sector of the blast furnace operation. In 1905 the steel mill built battery 2, consisting of 26 furnaces, and in 1906, 72 underjet coking furnaces and a 60m high chimney were ordered. The manufacture of by-products began in the same year for the first time (1906): By 1907 the steel mill had built a sulphate plant and a benzene plant, in 1910 the coking plant was again extended, this time by 46 coking furnaces, and in 1911 approval was granted for the construction of battery 7.

During the subsequent period, all seven batteries of the Völklingen steel mill were constantly being modernised, and the by-products plant was improved and extended. On the 2nd. December 1944 the coking plant had to be shut down. Coke production began again on the 25th. May 1945, not least in order to supply the towns and suburbs of Völklingen, Rockershausen and Bous with gas. The Völklingen steel mill coking plant produced coke for the Völklingen blast furnaces until 1986: On the 18th. June 1986 the steel mill closed down battery 7, on the 24th. June battery 4 was closed down, and on 30th. June 1986, batteries 1 and 2 as well. The continuation of coke production had become unnecessary after the Saar central coking plant in Dillingen was built.

Today, batteries 1/2, 4 and 7 still exist as technological monuments: All of the coking furnaces were built by the Recklinghausen company of Carl Still. Battery 1, which is made up of 32 furnaces, appeared in 1935 and battery 2, which is made up of 36 furnaces, has the same date of origin. Battery 4 has 64 furnaces dating from 1943 and battery 7, which was built in 1959, has 40 coking furnaces. In its prime the Völklingen coking plant supplied about 1,400 tonnes of best, rough steel-mill coke per day.

The Völklingen steel mill coking plant, together with the small **Ilsede coking plant**, is one of the oldest German coking plants still in operation today: They document a level of technology which has long been superseded at other German coking plants which are still in operation. The inclined coke ramp of batteries 1 and 2, the coking tower forming the heart of the plant which dates from 1897, and also the charging facilities of the furnace chambers and the ram trucks can be described as true "fossils".

But the Völklingen coking plant is also of particular technical and historical importance with regard to the furnace construction. In order to be able to treat the coking plant gas with care and simultaneously increase the production of liquid by-products, in 1930 the Still company had a process patented, in which channels were constructed where the coal was inserted into the furnace chambers, which in turn made it possible to draw off the distillation gases quickly. Initially, a new feature of this process was the provision of gasket plugs which made a sure seal between the inner and outer gases, besides this, an extraction pipeline was laid in the furnace ceiling and the gasket plugs and vacuum lines were washed. What proved decisive was that the Still company, from 1930 and after many years of experimentation, was able to set up the inner extraction system in such a way that is could be used in large-scale operations. In doing so benzene yields were increased by 40% in some cases (!). However, this process was only of economic significance if the coal was rich in gas, i.e. for the type of coal which was mainly extracted in the Saar district. The principles of this adapted form, which can be described as a special adaptation specific to the Saarland, can still be seen and understood in the Völklingen coking plant.

Reference should also be made once again to the steel coal tower built in 1897: It is the oldest document of the Völklingen coking plant technological monument.

The **Hansa coking plant**, a large-scale plant located in the Dortmund suburb of Huckarde and built in 1927 to the designs of the architects, Helmuth von Stegemann and Stein, forms, together with the Zollverein coking plant, the last preserved plant from this period in the Ruhr area. The Hansa coking plant changed on numerous occasions due to modifications and extensions, its area covered a total of about 32 hectares.

The first construction phase of the Hansa coking plant (1927 to 1931) formed part of the initial wave of modernisation of the coking plant industry by the construction of coking plants on a large scale. Just before, in 1926, the Vereinigte Stahlwerke AG had been founded by the merging of four large coal and steel companies to form the world's second-largest steel manufacturer. The high coke requirement of this combine demanded the construction of a large-scale, profitable coking plant, which could supply notable quantities of coking gas for heavy industry and for the town gas network through the operation of composite furnaces. The exceptionally large reserves of coking coal in the area of the Hansa mine and close to the Dortmunder Union steel works finally led to the construction of the large-scale Hansa coking plant.

After the coke production installation with two batteries, each with 65 furnaces and a capacity of about 2,200t of coke per day, and the coal by-products plant had been completed in 1927 and 1928, the installations for the treatment of town gas were built between 1928 and 1931. The construction of this plant was completed in 1934 when a gas storage vessel was put into operation.

In the course of the German government's efforts to become self-sufficient, the coking plant was extended during the years 1938 to 1942. A second pair of coking furnace batteries with 160 Koppers-Kreisstrom composite furnaces, and which included a coke-coal tower and sieving plant, was built to the north of the existing coking furnaces and the remaining plants were modernised and extended. The compressor hall was also made larger and extended by five machines. At the same time wholesale changes were made to the chemical installations which included a partial switch-over of the coal by-products plant (Otto system): By virtue of this expansion Hansa became the largest coking plant in the Ruhr and increased its capacity to about 4,800t of coke per day and, thus, to roughly 1.7 million tonnes of coke per year. In 1943, work was started on the construction of a generator house for the production of poor-quality gas from its own coke or low-quality coal as a supplement to the top gas feed from Dortmunder Union's blast furnaces. The last of a total of 16 generators were put into operation in 1955.

In spite of the considerable damage inflicted during World War II, it was possible to re-start the first furnace battery in the summer of 1946, but batteries I and II had to be demolished and in 1950/1951 and in 1955/1956 respectively each of them were replaced by 62 Koppers-Kreisstrom composite furnaces. The administration and social building was modernised and extended from 1958 to 1960. With the aim of being able to provide as much coking gas as possible for the town gas supply, further partial replacement and expansion of the coal by-products installations was carried out around 1955 and also the first stage in the construction of a new compressor house was completed.

In the course of the new order of heavy industry introduced in the Ruhr, in 1964 Hansa took over the gas and coke supply of the Dortmund Phoenix steel works. From there Hansa also acquired the top gas from 1966, when the Dortmunder Union blast furnaces were closed down. Parallel to these developments, the two small storage vessels for poor-quality and high-quality gas located on the coking plant site from 1927 and 1929 were replaced by new constructions at new locations. In 1967/1968, battery 0 with 30 (high-quality gas) furnaces was built to the south of battery I, and batteries III and IV were subjected to a thorough overhaul, which meant that the capacity of the 314 coking furnaces finally amounted to about 5,200t of coke per day or 19 million tonnes of coke per year.

When the coalmining operation at the Hansa colliery was closed down in 1980, the necessary supplies of coking coal were transported in by rail. In 1986 batteries 0 and IV were taken out of production and on the 15th. December 1992, the whole of the coking plant was closed down. Production and parts of the workforce were able to be transferred to the new Kaiserstuhl III coking plant, which had simultaneously started operation on the site of the Dortmund Westphalia steel mill.

After the coking plant was closed down, the threat of demolition hung over the operational installations. But, in the course of a growing awareness of the importance of industrial monuments as witnesses to the social and cultural development of our age, the possibility preserving the whole plant as a technological monument was created: in 1992 the coking plant was entered into the list of monuments of the city of Dortmund. The Emscherpark International Construction Exhibition has played a prominent role in this connection, and since April 1997 the Foundation for the Maintenance of Industrial Monuments and for Historical Culture has had its main headquarters in the former administration building. The preservation and conversion of use of essential parts of the Hansa coking plant are being urged, but any final definitive concept does not exist at this moment in time. But it must be considered a success that, in a first courageous step, the demolition of important parts of the coking plant has been prevented and that time has been gained by this action.

The Hansa coking plant is the last central coking plant dating from the 1920s in the Ruhr which, to a large extent, has been preserved in its original conception and appearance. Its systematic build-up as a new installation and its technical equipment are important witnesses to a stormy period of development in coking plant technology in the first third of the 20^{th}. century: Bearing in mind the social significance of the plant, it is only right that it should be entered into the list of monuments of the city of Dortmund. At the same time, the still unresolved questions regarding the possibilities of preservation and use are not to be linked with establishing the value of a monument which results, *inter alia*, from the evaluation of the "authenticity" and from verification of its form and function from a previous age. The unique ensemble of double-stage piston compressors dating from 1928 and 1939 (see above) are of especial importance in this respect.

Any treatment of this subject would be incomplete without again mentioning the **Zollverein coking plant**: It is of quite particular importance to the German industrial monument landscape, because a unique stock of surface installations have been preserved on its site: In Essen, coalmining installations and the coking plants combine to make a splendid ensemble which documents the **final point** of development in the construction of coking plants in the late 1950s. The preservation of this installation requires extraordinary efforts on the part of society, but with the awareness of the importance of this plant, this part of the Zollverein colliery monument landscape must be recommended to UNESCO for acceptance in the World Cultural Heritage of Mankind.

Summary
Town gas production and the coking plant industry represent important stages essential for mankind's development – of this there can be no doubt. If the maxim which has been represented in society thus far is to continue to have validity and substance, i.e. that important documents must be protected from technical developments too, and preserved, then the technological monuments of town gas production and the coking plant industry also have a right to have their existence protected – do we really want to face the problem one day of not being able to explain to successive generations, how these developments proceeded in the past and how important they were for mankind.

Even if we are all in agreement in the fundamental evaluation of these problems – the problems regarding whether it is at all reasonable to preserve industrial installations of this nature (above all with regard to finance) and regarding what has, until now, been the normal practice of dealing with the existing stock of monuments are difficult to solve. It is obvious that no difficulties arise in preserving individual buildings or machinery on a permanent basis, but the financial and technical problems associated with preservation and restoration are presented all too starkly when considering a permanent documentation of large-scale installations, e.g. the whole of a coking plant. In this respect solutions are awaited with baited breath, solutions which, under certain circumstances, may even have to be established on a global basis, but at least demand a trans-regional consensus. For so much appears to be certain: If we want to do justice to these technological monuments, then we must have a re-think and move away from current practices with regard to the preservation of monuments. New paths must be followed so that technological monuments of town gas production and the coking plant industry can be sensibly converted to other uses or used anew. They form part of a group of rare monuments

and as such attract special, justified interest: In this "learning process" within an international framework, the Zollverein coking plant will not only have a decisive role to play, but it will also assume a sense of awareness of creative and marked importance.

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5. The Industrial Monument Landscape of "Zollverein Colliery" as part of the World Cultural Heritage of UNESCO – A Summarised Tribute

From what has gone previously it becomes clear that the industrial landscape of the Zollverein coalmine, which was created by the hand of man within 150 years, is a unique witness of the complex domestic and working relationships dominated by heavy industry at the centre of one of the largest industrial landscapes in the world.

By virtue of its individual monuments which stand in their structural and historical context, the Zollverein colliery monument landscape symbolises man's work in creating and structuring an industrially-defined living environment. Undisturbed by other industrial companies and without any decisive structural participation from state authorities, the Zollverein colliery was able to plan, implement and dominate this structure. This is why the industrial landscape of Zollverein colliery documents the development of a living environment, which was founded on industrial growth through the rationalised extraction and mining of naturally occurring resources in such a unique way.

Zollverein pithead 12, situated within the monument landscape, is an individual monument of outstanding significance: This pithead was produced in the phase of the greatest, never again to be achieved concentration of national heavy-industrial combines as an investment which was bestowed with all the visionary ambitions of industrial rationalisation. Thus, one of the most basic principles of industrial thinking is focussed onto shaft 12 in a prominent, exemplary fashion. In the formal language of architectural functionalism, the architects, Fritz Schupp and Martin Kremmer, developed this pithead into an ensemble which contains many examples of how form and function have been combined in a masterful and unique manner. The architecture of pithead 12 became the standard for more than three decades and, in the form of successive buildings, has moulded the industrial landscape of the Ruhr and industrial architectural works. And this sequence has mainly remained restricted to Central European regions: No other nation and no other coalmining area have concerned themselves with the relationship and combination of function and aesthetics with the same degree of thought as Germany and the Ruhr, and it has to be pointed out that the "coalmining and steelworking" art and culture on a global measure is nowhere as marked as it is in Central Europe and, above all, in German language areas.

The Zollverein central coking plant attributed to the industrial culture landscape had been, upon its completion in 1961, the most modern and efficient coking plant in Europe. Fritz Schupp structured this installation against the background of his great experience in dealing with large-scale industrial plants. In the same way as was the case with Zollverein pithead 12, function and form are brought together in harmony to become a master work in the structuring of large-scale industrial plants. The technology of the large-volume furnaces 6m in height, which previously had only ever been used once in 1926 in the Nordstern central coking plant designed by Fritz Schupp and Martin Kremmer, was used for the first time, the coking furnace batteries are unique witnesses and documents of this technological history.

The "importance" and the "value" of an industrial monument are not only verified on the basis of artistic and aesthetic reasons, but also on the (mining) economic capacities, for "the economy" forms part of the "culture" of mankind to the same extent as "art" and "technology". With a mining output of 12,000t of usable coal per day, shaft 12 was the most efficient mining installation in the world in international terms of comparison. The position of the Zollverein colliery in the Ruhr and in comparison to the other coalmining areas of the earth clearly verifies the exceptional position of this colliery. In fact, there has not been another coalmine which has been able to combine productivity with an artistic expression of the surface plant in such a conclusive manner. The realisation of this work was a technical masterpiece when the difficult geological conditions of the region are taken into account.

Moreover, the Zollverein colliery industrial culture landscape also forms a unique ensemble in the history of different types of housing estates and landscape structure. The housing estates and social institutions which have appeared since the founding of the mining installation have grown up with the development and structure of the social environment in a town planning context and are, therefore, inseparably connected with the mine and the monument landscape. Other documents which are equally important for posterity are the alterations in the landscape which have been created by the mining activities in the form of slagheaps, areas affected by subsidence, and transportation routes, which have all moulded the living space areas. These monuments have put their stamp onto the environment and, in international terms, make the Zollverein colliery monument landscape irreplaceable: Even today they still mould the landscape and its people in a unique way.

Zollverein shaft 12 and the central coking plant are masterpieces of technology and industrial architecture. The architectural concept of shaft 12 formed the yardstick for the region of Ruhr for more than three decades, even after the structural changes within the region, the winding gear of shaft 12 has remained one of the central symbols of the area and thus symbolises on the greatest industrial population centres of the world.

The Zollverein colliery industrial culture landscape meets the criteria of the implementation conditions of the Convention for the Protection of the Cultural and Natural Heritage of the World. Zollverein pithead 12 is the concrete example of the pattern of an exceedingly efficient coalmining installation and stands as a shining example in the centre of a monument landscape created by mankind.

Data sources of the coal production graphs:

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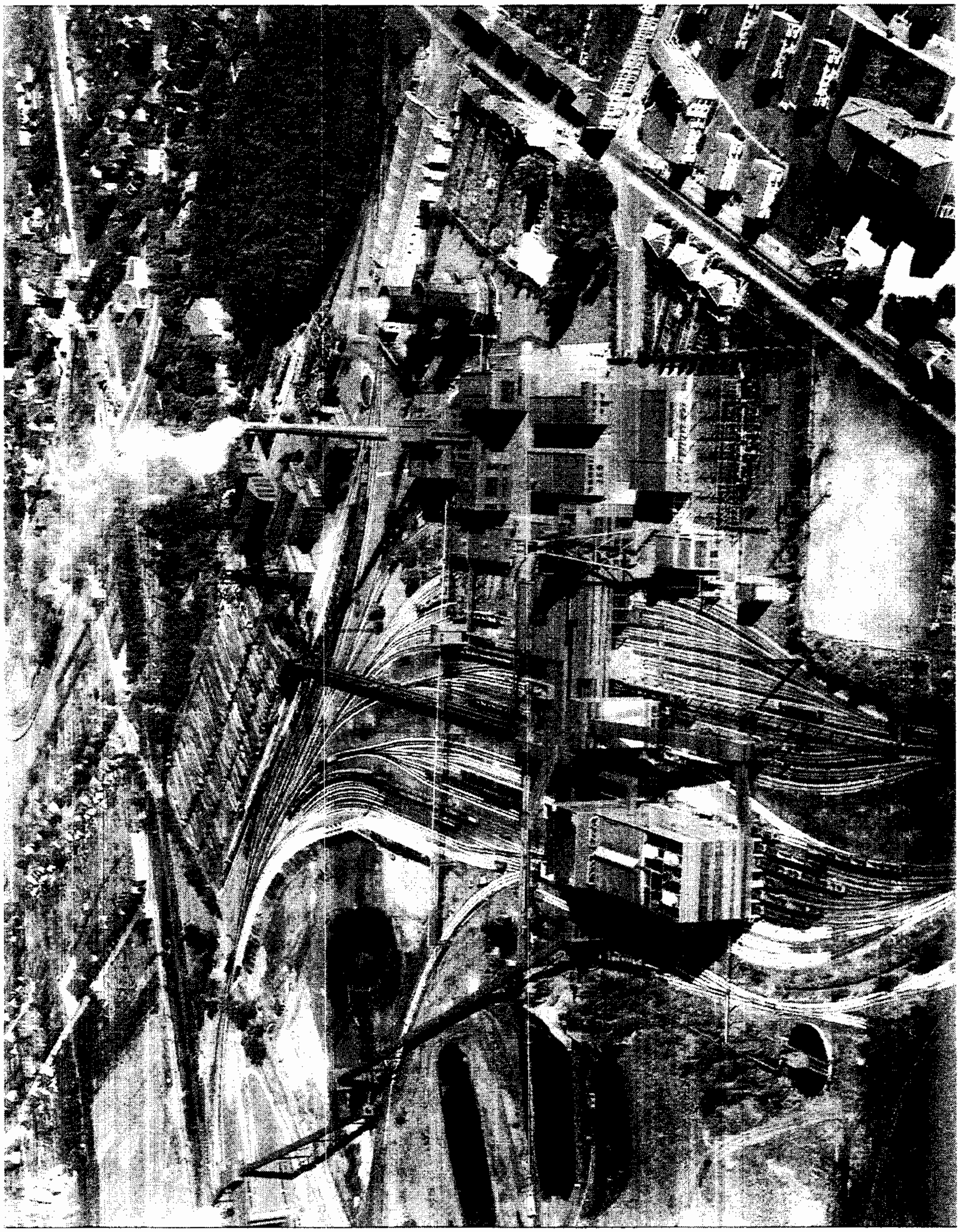
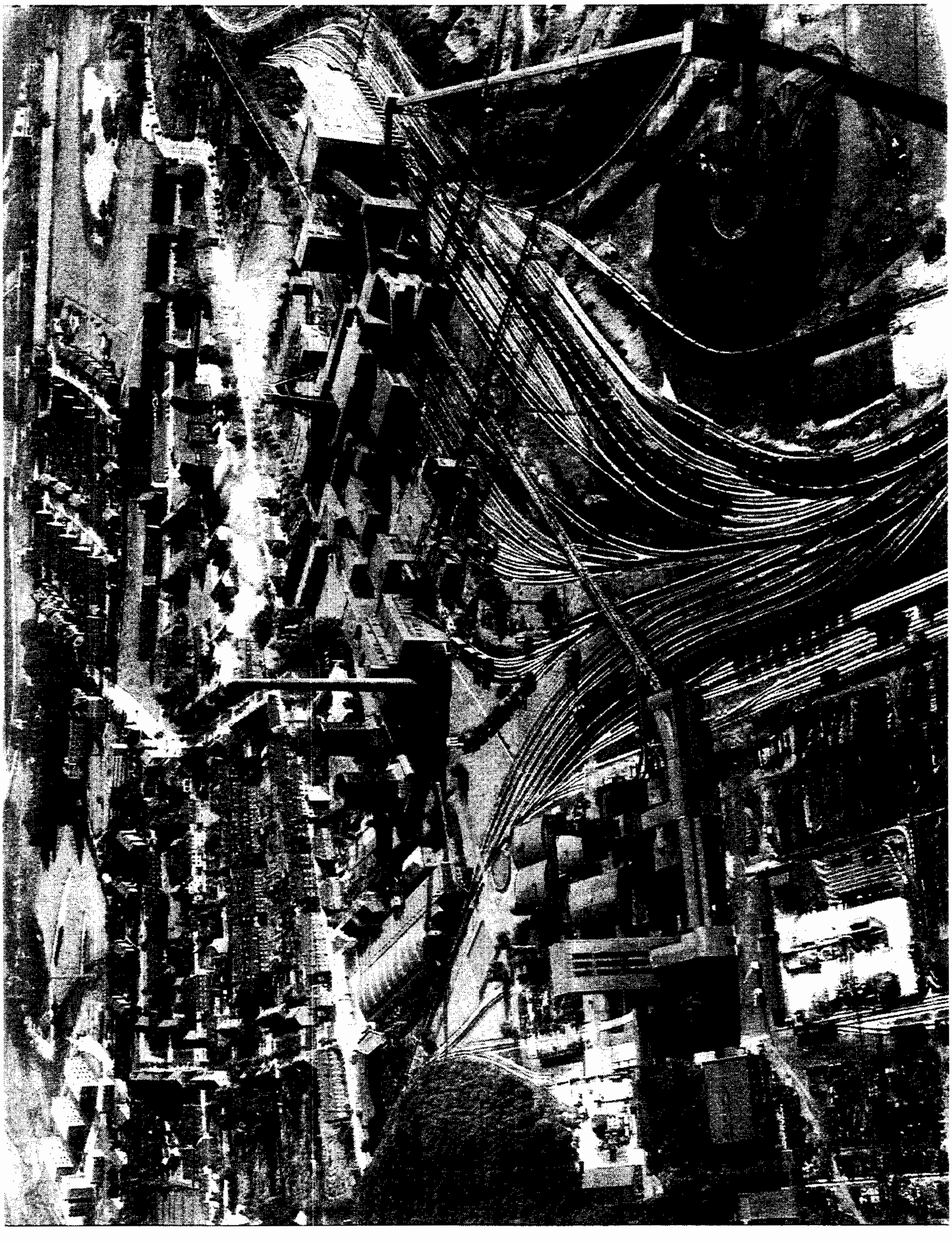
Essen, Zollverein Colliery
Pitheads 1/2/8 and 12
(Photo: W. Moog, Essen)

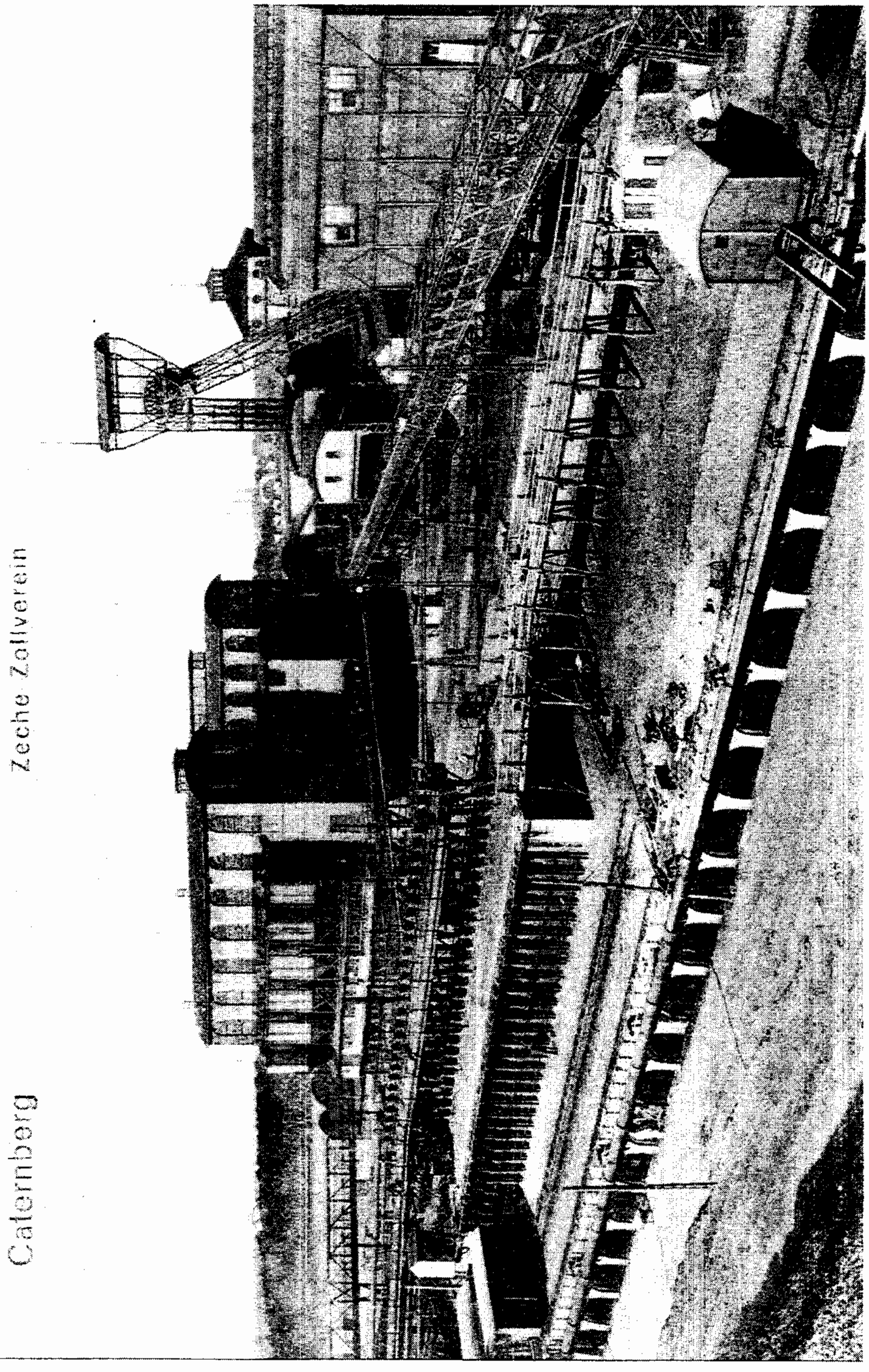
Essen, Zollverein Colliery
Pithead 12
(Photo: W. Moog, Essen)



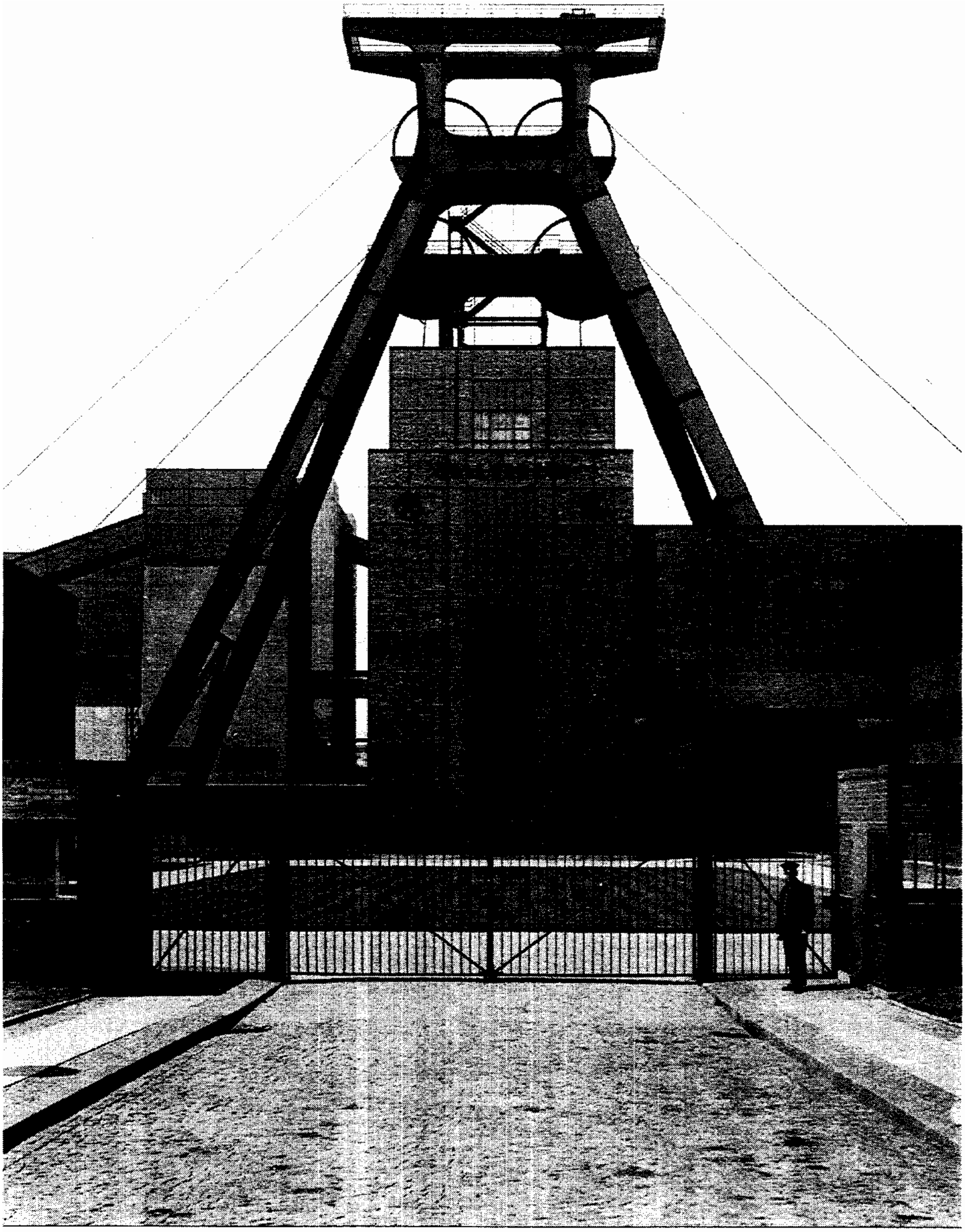
Essen, Zollverein Colliery
Pitheads 1/2/8 and 12
(Photo: W. Moog, Essen)



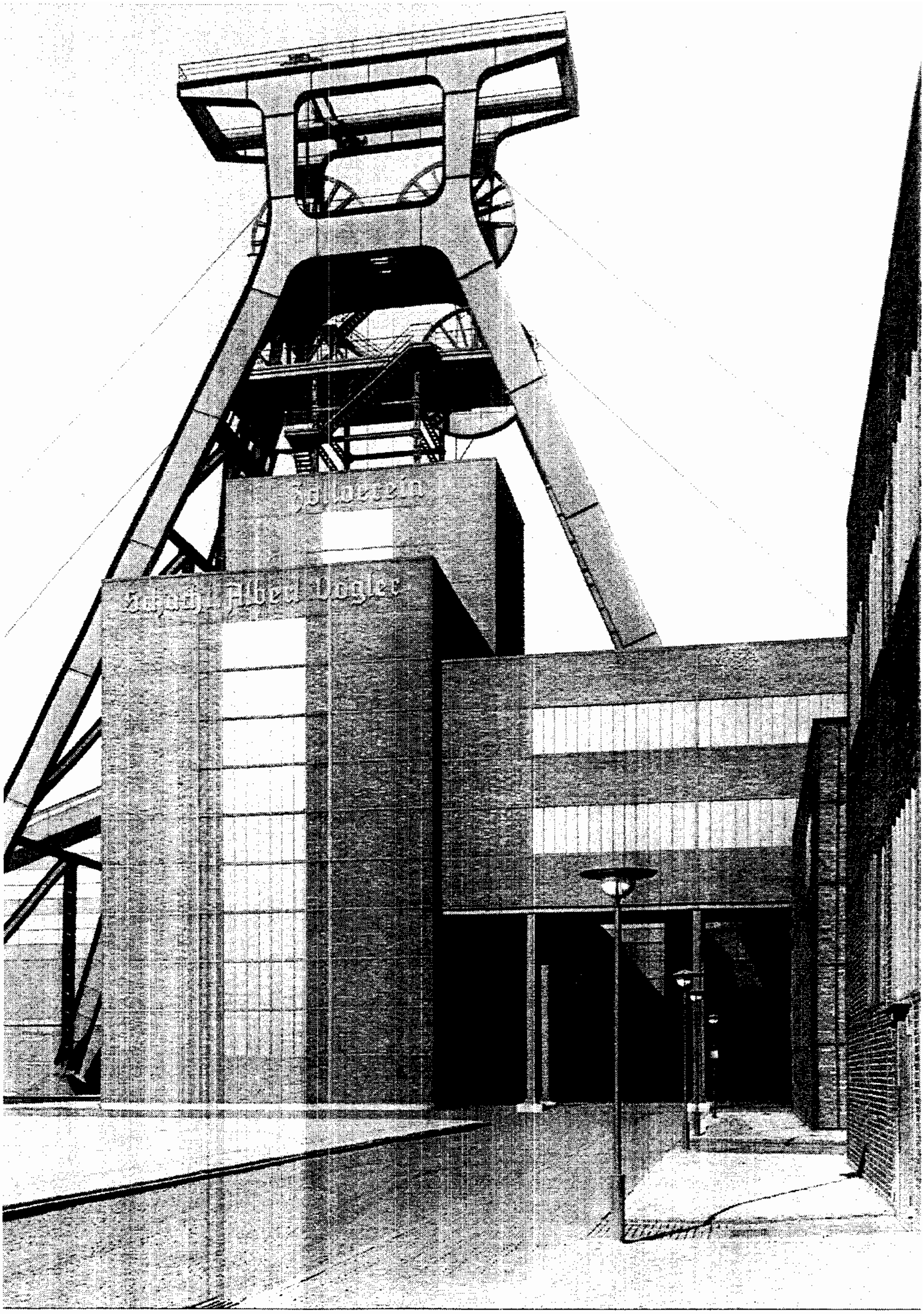
Essen, Zollverein Colliery
Pitheads 1/2/8 and 12
(Photo: W. Moog, Essen)



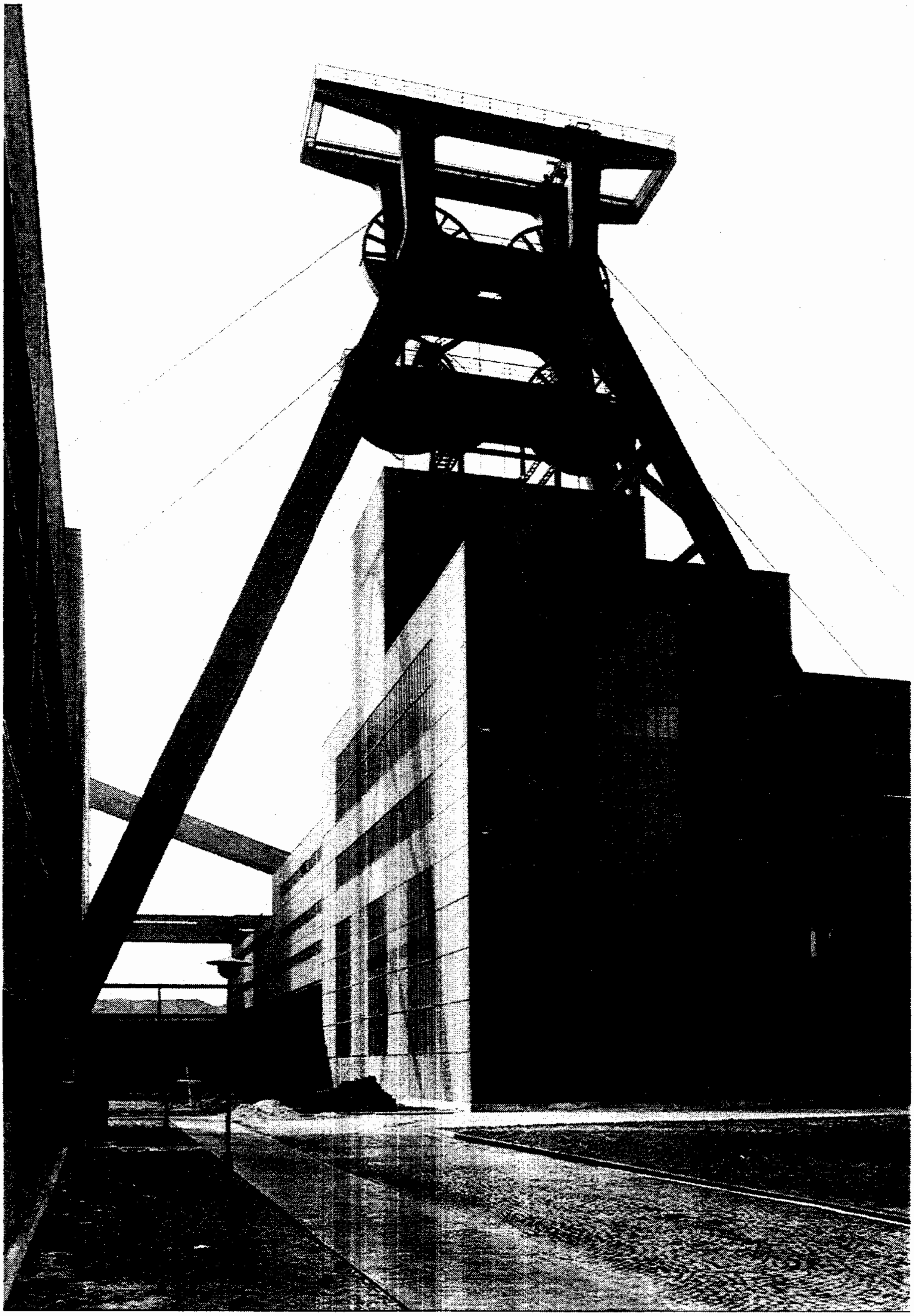
Essen, Zollverein Colliery
Pitheads 1/2/8 and 12, shafts 1 and 2
(Photo: DBM, Bochum)



Essen, Zollverein Colliery
Pithead 12
(Photo: F. Schupp, Essen)



Essen, Zollverein Colliery
Pithead 12, winding gear, Vögler shaft
(Photo: F. Schupp, Essen)

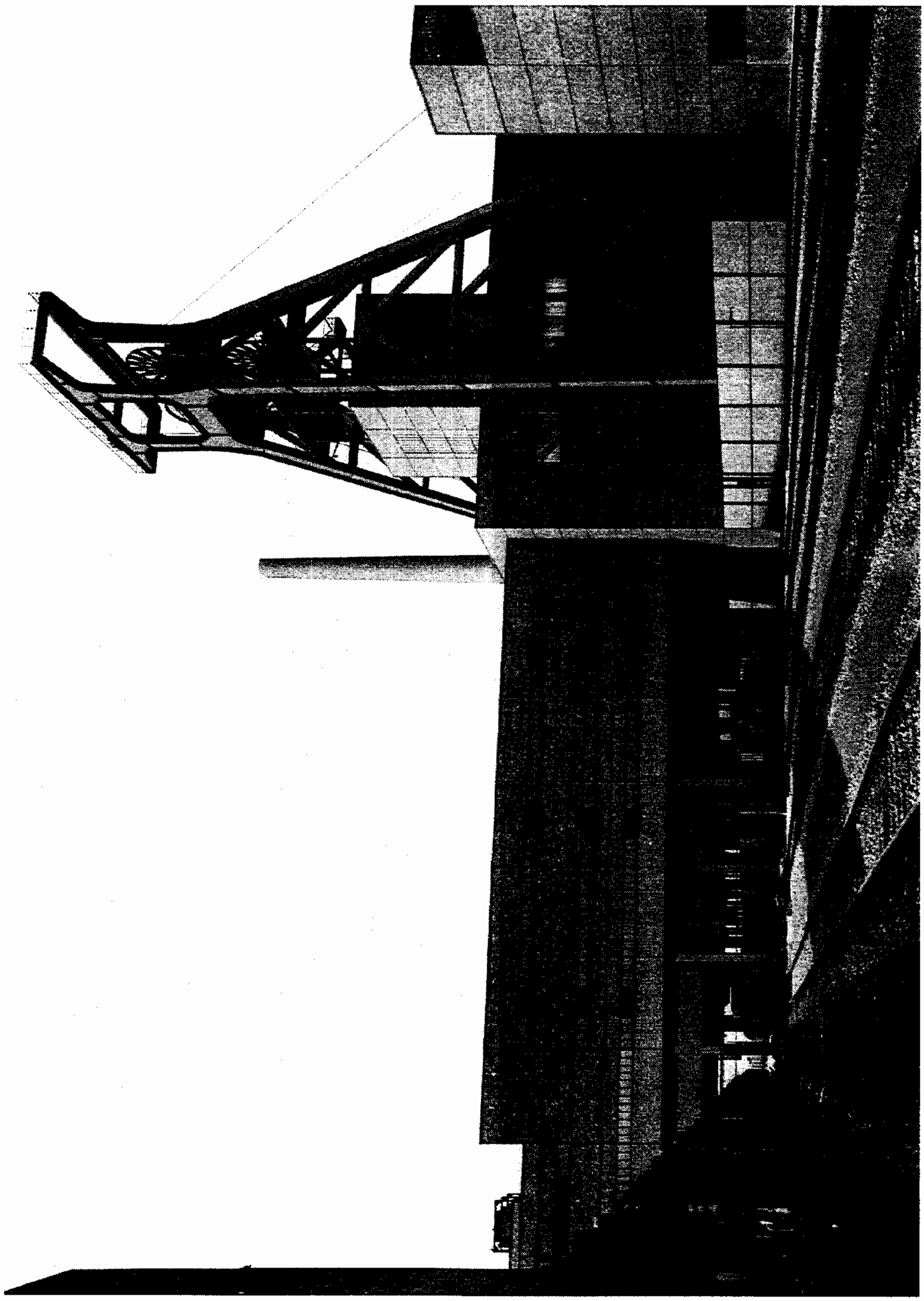


Essen, Zollverein Colliery
Pithead 12, winding gear and shaft building
(Photo: F. Schupp, Essen)

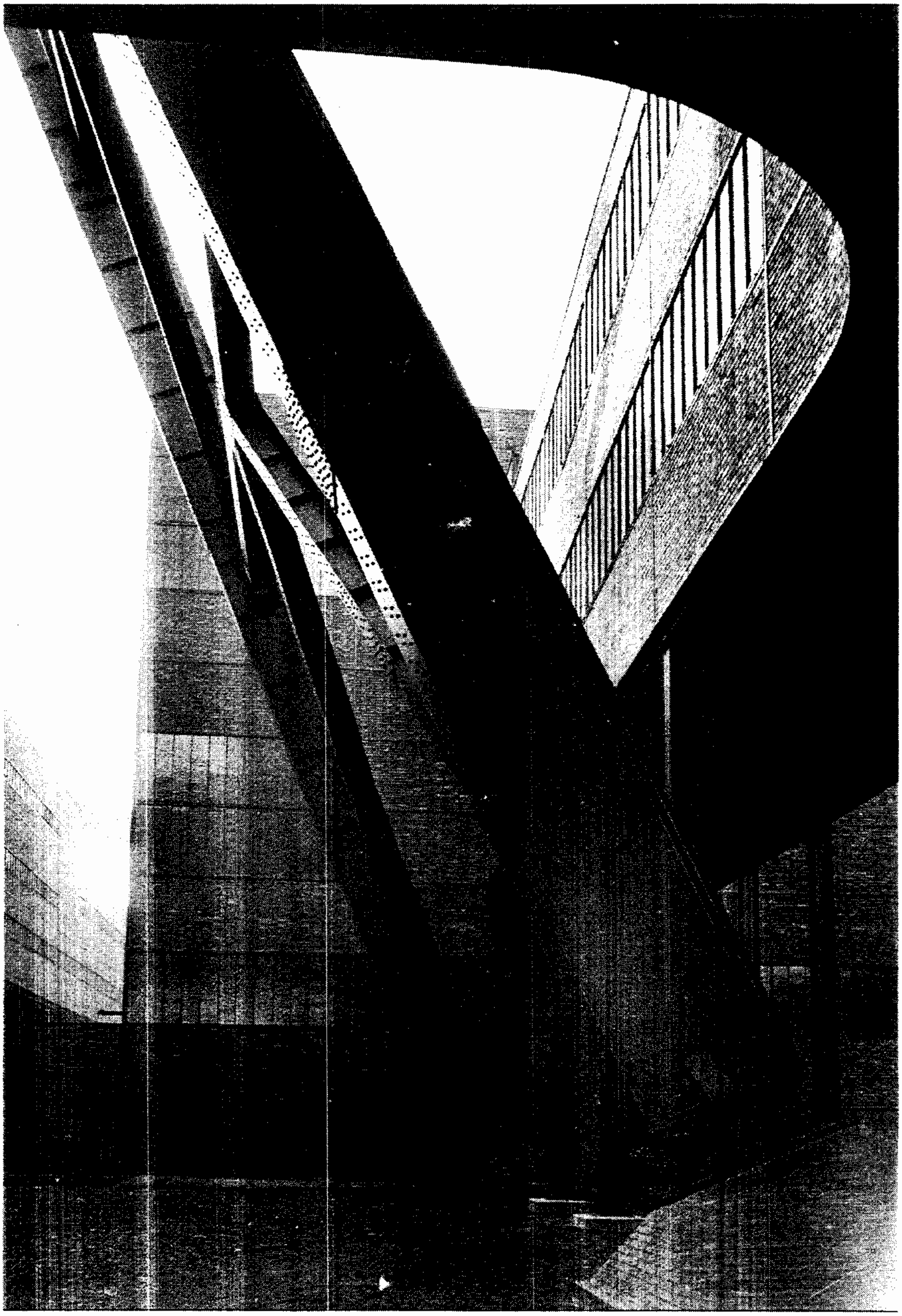
Essen, Zollverein Colliery
Pithead 12, winding gear
(Photo: F. Schupp, Essen)

Essen, Zollverein Colliery
Pithead 12, winding gear, shaft building
(Photo: F. Schupp, Essen)

Essen, Zollverein Colliery
Pithead 12
(Photo: F. Schupp, Essen)

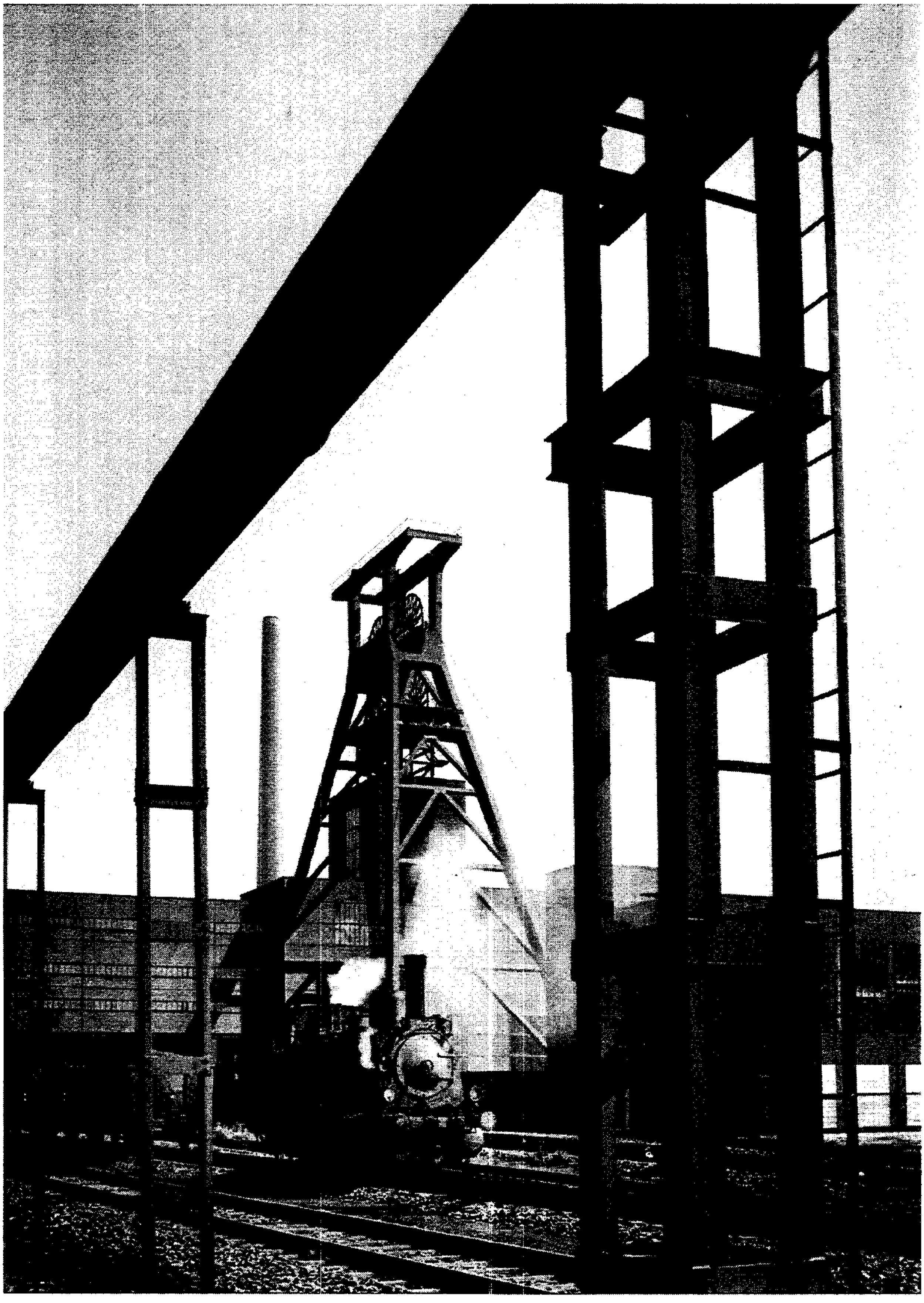


Essen, Zollverein Colliery
Pithead 12, winding gear, loading station, colliery railway line, shaft building
(Photo: F. Schupp, Essen)

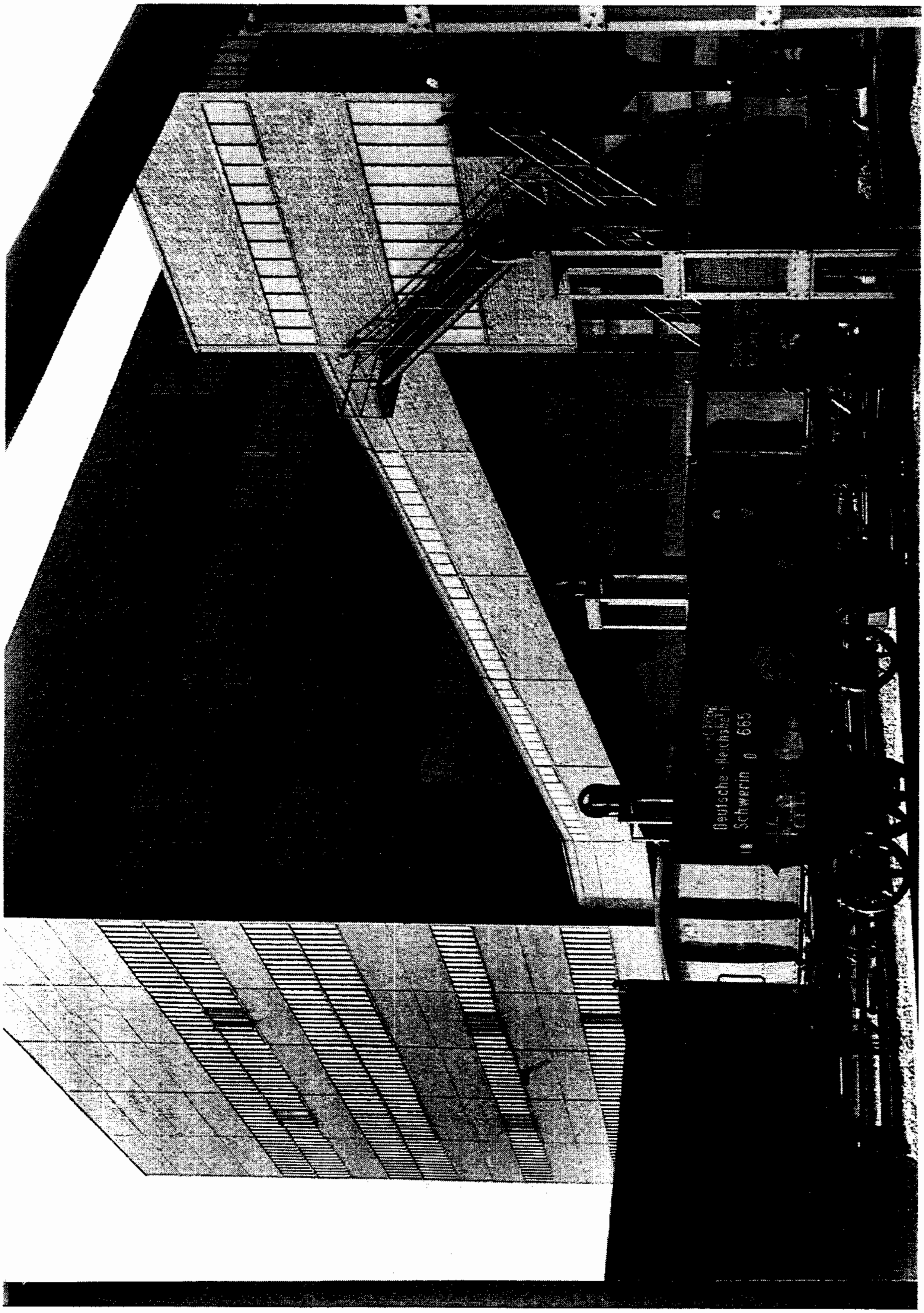


Essen, Zollverein Colliery
Pithead 12, the foot of a winding gear strut
(Photo: F. Schupp, Essen)

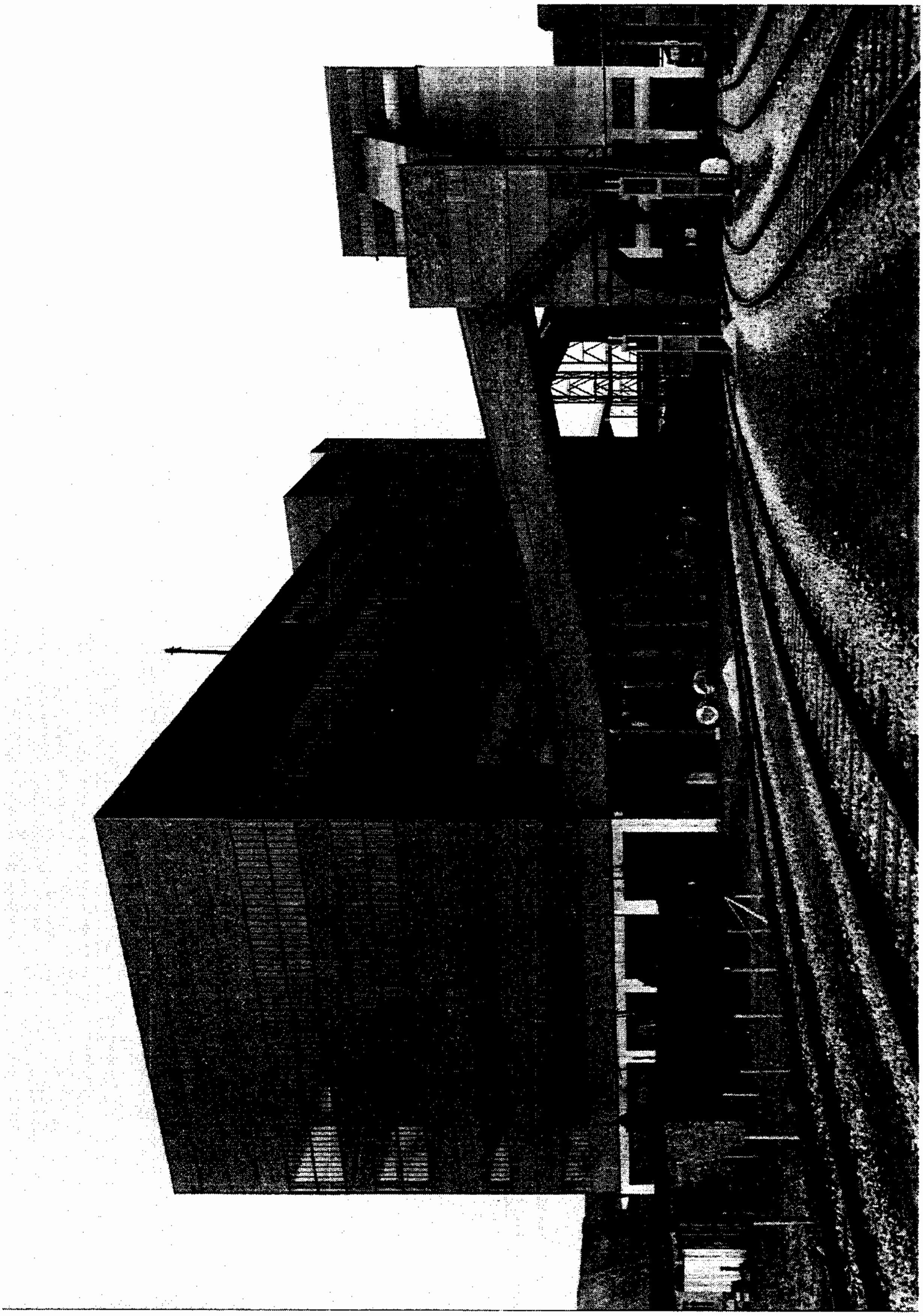
Essen, Zollverein Colliery
Pithead 12
(Photo: F. Schupp, Essen)



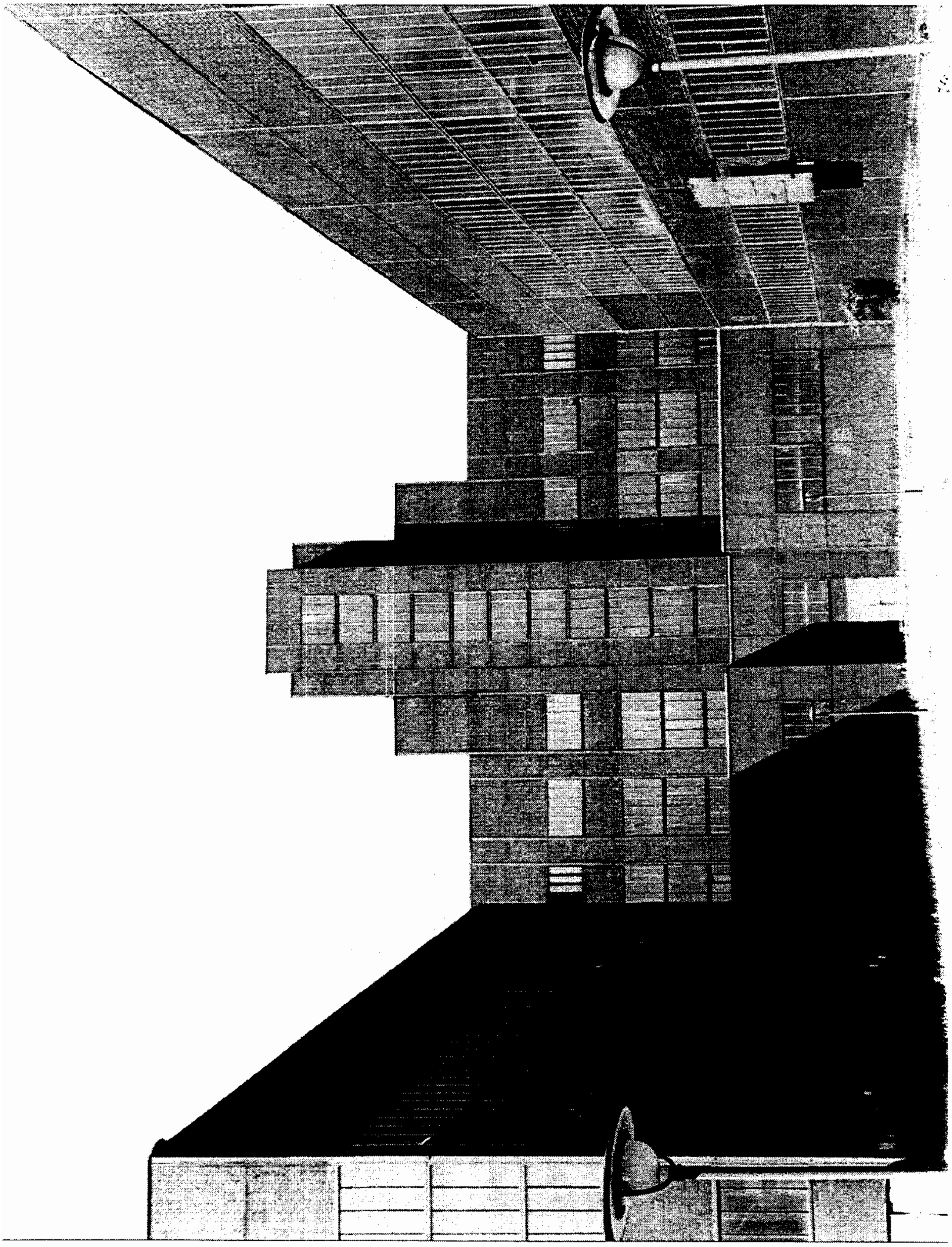
Essen, Zollverein Colliery
Pithead 12
(Photo: W. Stoffels, Essen)



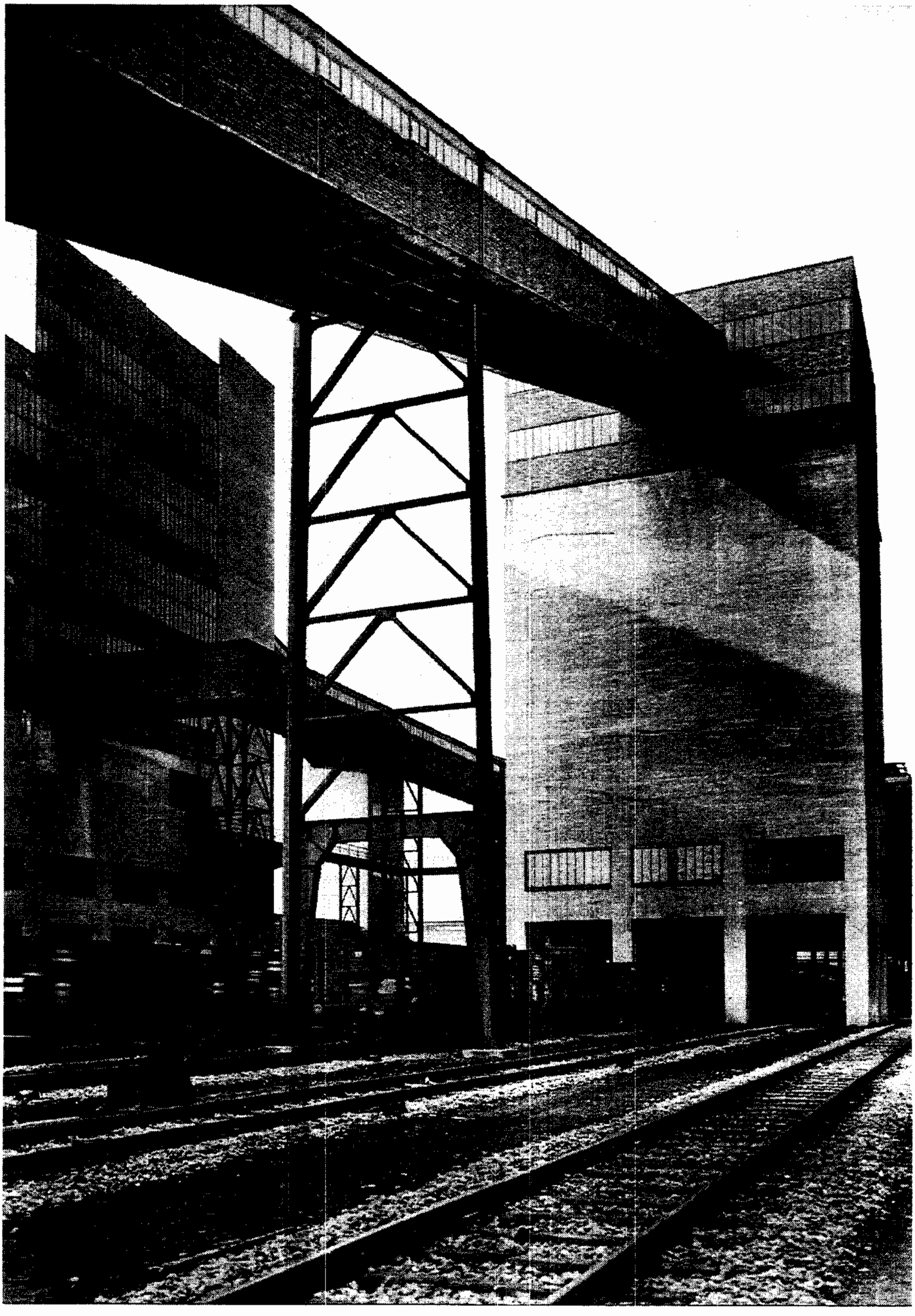
Essen, Zollverein Colliery
Pithead 12, washing plant, loading station, colliery railway line
(Photo: F. Schupp, Essen)



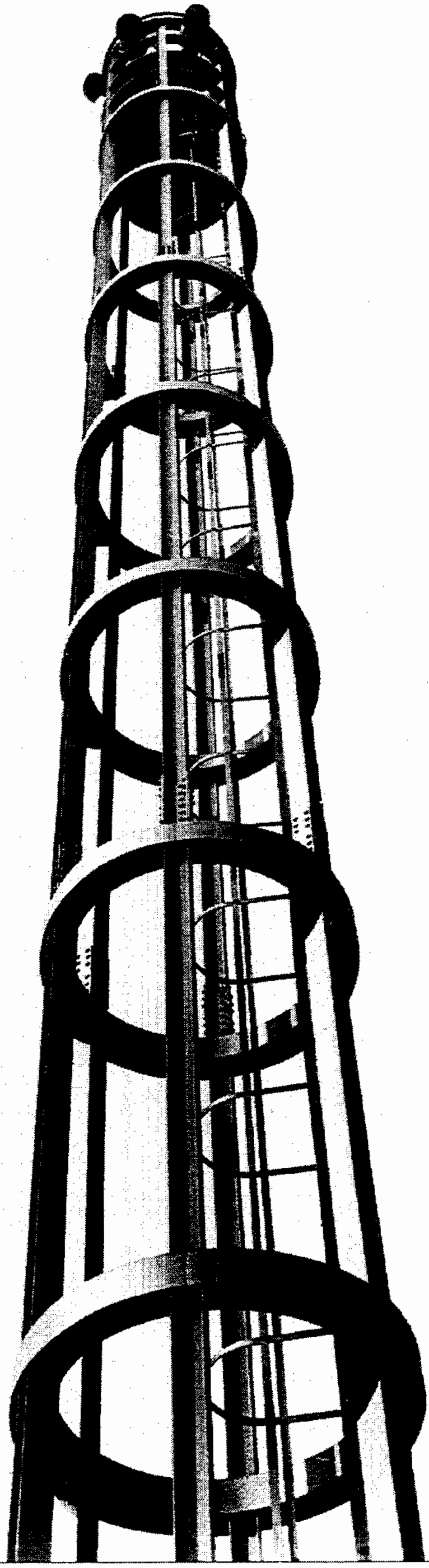
Essen, Zollverein Colliery
Pithead 12, washing plant, loading station, colliery railway line.
(Photo: F. Schupp, Essen)



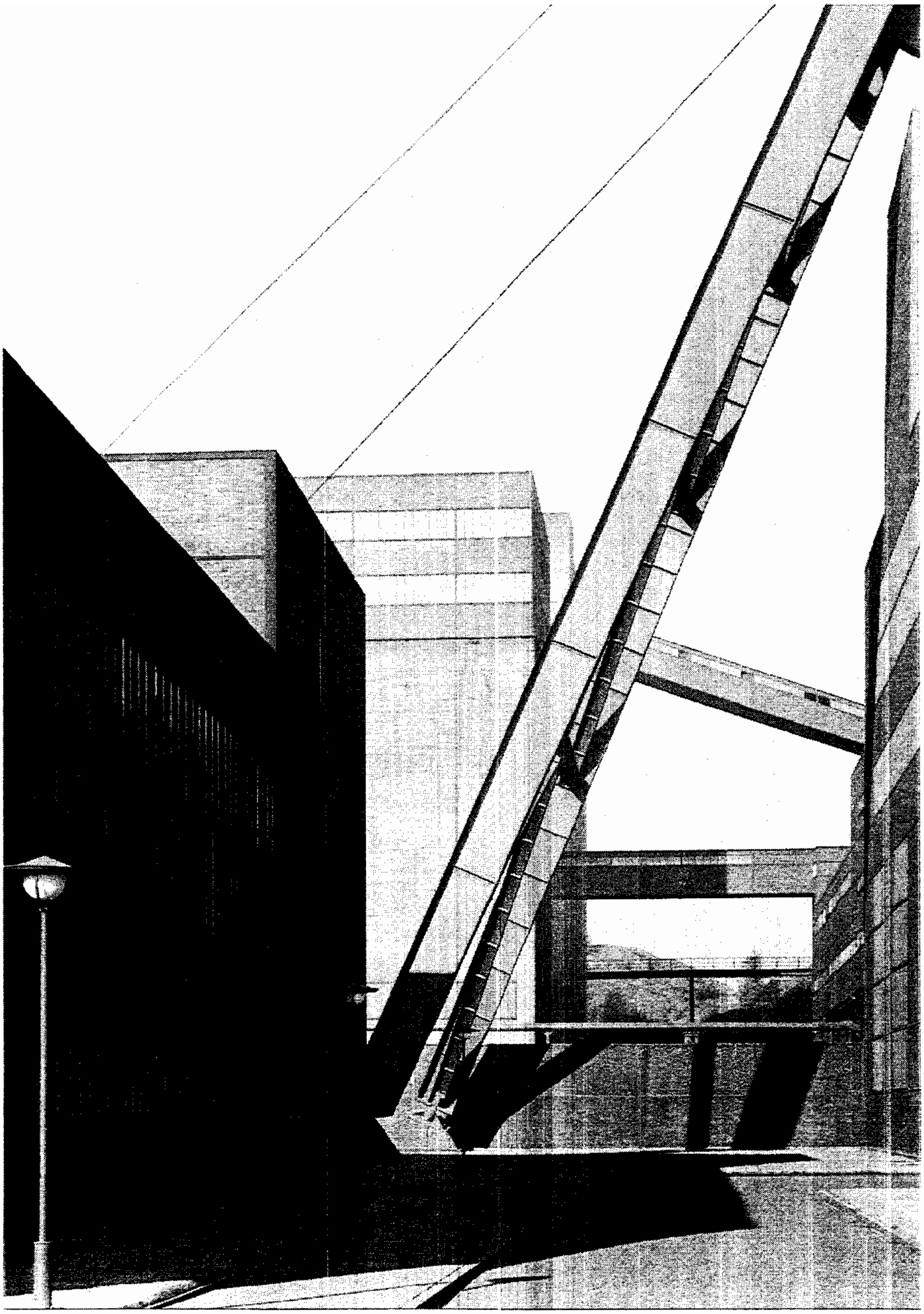
Essen, Zollverein Colliery
Pithead 12, boiler house and compressor houses
(Photo: M. Vollmer, Essen)



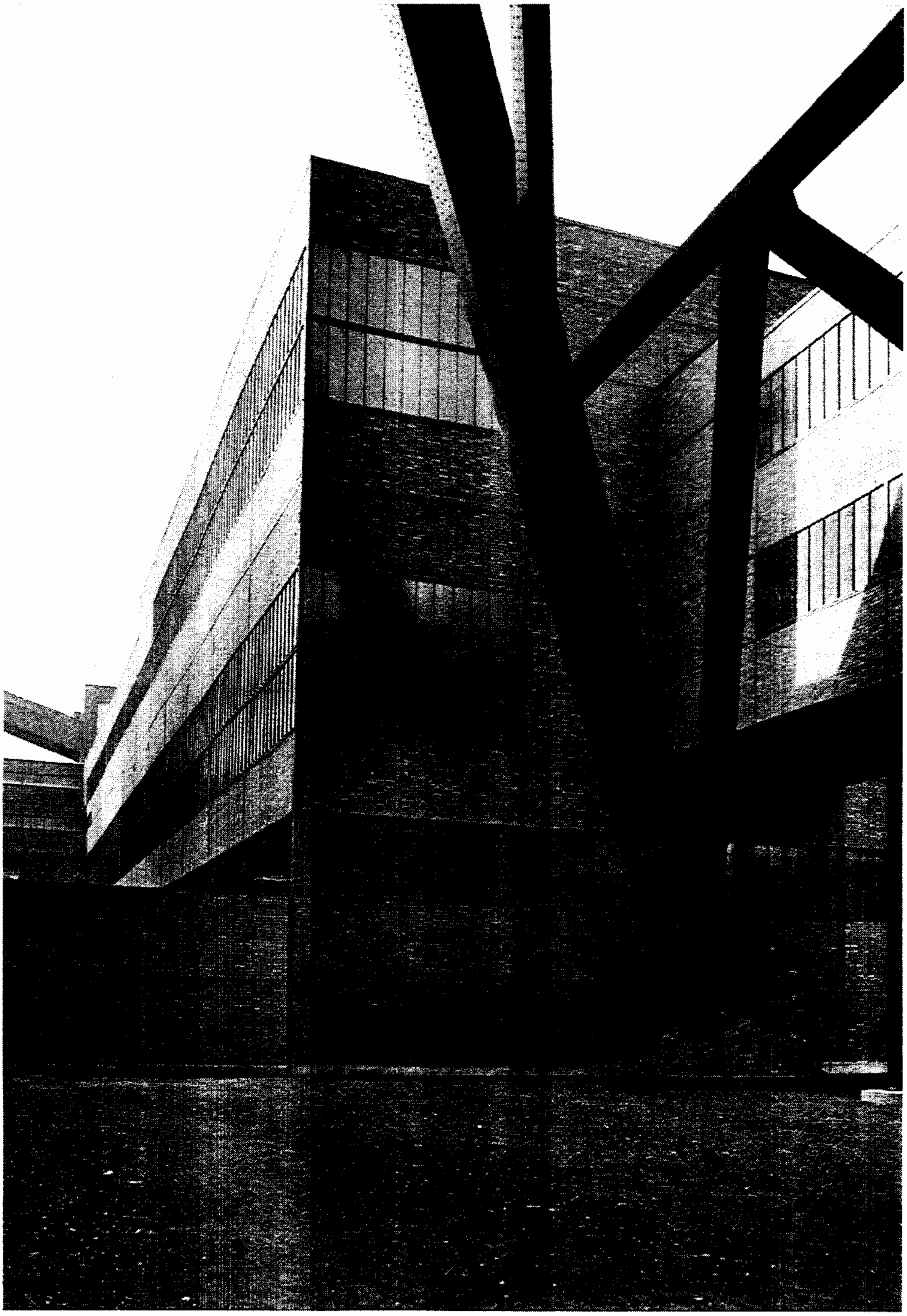
Essen, Zollverein Colliery
Pithead 12, coal bunker, transport bridge, loading station, colliery railway line
(Photo: F. Schupp, Essen)



Essen, Zollverein Colliery
Pithead 12, Overhead light tower
(Photo: F. Schupp, Essen)



Essen, Zollverein Colliery
Pithead 12, the foot of a winding gear strut
(Photo: F. Schupp, Essen)



Essen, Zollverein Colliery
Pithead 12, the foot of a winding gear strut
(Photo: F. Schupp, Essen)

Regulatory regime for the conservation of the
„The Cultural Industrial Landscape of the Zollverein Mine"

The regime for the protection of the cultural industrial landscape of the Zollverein Mine is ensured by the following documents:

1. The decision of the Ministry for URBAN Development and Dwelling, Culture and Sport of the Federal Land of North-Rhine-Westfalia regarding the definition and delimitation of the buffer zone for the cultural industrial landscape conservation area of the Zollverein Mine - in accordance with the § 2 (3) and § 5 of the Law governing the Protection and Conservation in the Federal Land of North-Rhine Westphalia of 11 March 1980.

The buffer zone surrounding the conservation area of the Zollverein Mine is represented on the map submitted to the World Heritage Committee by the Ministry dated from 30 May 2000.

Specific conservation objects:

- Zollverein Mine conservation area including the monuments of industrial cultural heritage - the National Park of Industrial Culture - listed in accordance with § 2 (2) of the Protection Law, the cultural monuments of the suburbs of Katernberg, Schonnebeck and Stoppenberg with the different colonies of miners' housing, consumer and welfare facilities listed in accordance with the § 2 (2) of the Protection Law.

- Historical layout of the cultural industrial landscape area and is corresponding landscape and townscape pattern, plotting of industrial, residential and recreational land and tracing of historical roads and railway communication systems.

- Height of buildings in relation to the scale of the industrial landscape panorama.

- The terrain and is characteristic division - industrial units of mining, including the pits, the pit heaps, the coking plant, the railways - and the residential areas of the historic suburbs and the colonies of miner's housing.

Conservation Conditions:

1.1 All building activities in the buffer zone are regulated according to § 9 of the Protection Law of 11/03/1980 an according to the §§ 30 ff. of the Federal Building Act.

1.2 All changes of use, up keep of buildings, alterations, construction of new buildings and their alterations, terrain changes, communication and traffic alterations must be done with due regard to the conservation value of the whole area. It is necessary to ensure that the historical town-plan structure, the architectural appearance and the unique setting of the different components - industrial areas, railway communication system, residential areas with the colonies - with their scale and panoramas are neither weakened nor destroyed.

1.3 No building alterations which could interfere with or endager the character of the build up area are permitted.

1.4 It is necessary to preserve the historical layout and building composition of each component of the conservation area.

1.5 No new buildings or equipment can be placed in the buffer zone which could interfere with or aesthetically devalue the conservation area; especially hither storage on historical plant buildings, new roads, electricity installations, pollution of water or air, leakage of harmful or dangerous substances, noise, vibrations, smells and all kinds of radiations.

1.6 When considering town-planning, preparation and project documentation, touching the terrain structure, it is necessary to ensure that any alterations do not change the ground-plan, mass, composition, architectural expression or panoramic value of the ensemble regarding the historical value of the whole conservation area.

1.7 New construction activities can only be carried out after being approved by a town planning decision that is in keeping with the historical environment.

2. The decision of the Ministry for URBAN Development and Dwelling, Culture and Sport of the Federal Land of North-Rhine Westphalia, the District Government of Düsseldorf and the Municipality of Essen regarding the definition of the conservation area including the National Park of Industrial Culture and the suburbs of Katernberg, Schonnebeck and Stoppenberg with the different colonies of miner's housing, consumer and welfare facilities - in accordance with the § 2 (3) and § 5 of the Law for the Protection and Conservation of Historical Monuments of North-Rhine Westphalia of 11 March 1980.

The map/ground plan with the delimitation for the conservation area has been submitted to the World Heritage Committee by the Ministry dated from 30 May 2000.

Specific conservation objects:

a) The National Park of Industrial Culture, including the listed monuments of industry in accordance with § 2 (2) and § 3 of the Protection Law - the pits (pit 1/2, 4/11, 3/10, 12 with pithead baths etc.), the coking plants, the railway lines and the pit heaps (of pit 1/2, 12 and also of pit 4/11 on the territory of the town of Gelsenkirchen).

b) The historic districts of the suburbs of Katernberg, Schonnebeck and Stoppenberg with the colonies of miners' housing, consumer and welfare facilites - including listed monuments of culture in accordance with § 2 (2) of the Protection Law and protected areas in accordance with § 2 (3) and § 5 of the Protection Law.

Conservation Conditions/Management Plan:

a) The National Park of Industrial Culture:

2 a.1. All building activites are carried out according to § 9 Protection Law concerning the listed monuments (§ 2 and § 3 Protection Law)

2 a.2. All the listed buildings of the National Park are subject to conservation measures concerning the authenticity of design, material and placement- combined with the priority of revitalisation and change of use towards a didactical, museografical presentation for a rather large of visitors of the former industrial functions.

2 a.2.1. For the long term preparation of a general conservation plan the first step will be a complete scientific inventory of all the existing industrial buildings with all the equipment left - like the coking plant, the „wide side" of the coke ovens, the chemical processing plant etc. - in order to establish al conception for a museografical presentation of the former mining and industrial functions.

2 a.3. All the buildings without educational functions are under changes of use. New uses have been devised already for most of the industrial features, like a theatrical rehearsal stage, the municipal meeting centre, the design office of North-Rhine Westphalia, private art galleries, workshops for retraining the long-term unemployed and last but not least a visitors' restaurant.

2 a.4. The pit heaps listed above are included in the general conservation plan; being planted with trees they are protected as green areas and used as local recreational areas. The pit heap belonging to pit 12 is part of a project for a careful development of the ecological, aestetical and industrial potentials run by the IBA - Internationale Bauausstellung Emscher Park.

2 a. 5. The preserved railway lines will be included in the general management conception for a didactical presentation of the entire area of industrial sites, offering e. g. guided railway-tours for visitors.

2. a. 6. For regular maintenance work and training in conservation practices and techniques a Craftsmen's Guild has been set up by the municipality of Essen an die Regional Development Company.

b) The suburbs of Katernberg, Schonnebeck an Stoppenberg with their historic center, the miner's housing colonies and the consumer and welfare facilities:

2 b. 1 The entire conservation area is protected by the decision of the municipality of Essen approved by the District Government of Düsseldorf an the Ministry for Urban Development and Dwelling, Culture and Sport.

2 b. 2 The protection act consists of a detailed description of all the different areas of conservation including the characteristics of each miners' colony, followed by a list of all the cultural monuments protected al listed monuments in accordance with § 2 (2) Protection Law and all the houses of interest inside the area. A detailed regulatory statute for all conservation activities is part of the protection act. The map showing the delimitation borders of the conservation area is also part of the protection act.

2 b. 3. For the listed monuments of culture inside the conservation area all building activities are carried out in accordance with § 9 of the Protection Law.

2 b. 4. All building activities inside the conservation area are carried out in accordance with the regulatory statute of the protection act related to § 9 of the Protection Law of North-Rhine-Westfalia.

Entwicklungsgesellschaft Zollverein mbH
Zollverein Development Company

Gesellschafterversammlung
Shareholder's Meeting

Aufsichtsrat [1)]
Supervisory Board [1)]

Entwicklungsbeirat [2)]
Development Advisory Committee [2)]

Geschäftsführung
Management

[1)] besetzt mit Vertreter der Obersten Denkmalbehörde
[1)] in this board is send a top representative of the administration for the preservation of historical monuments

[2)] besetzt mit Vertretern der Denkmalpflege
[2)] in this committee are send members of the executive administration for the preservation of historical monuments

ENTWICKLUNGSGESELLSCHAFT ZOLLVEREIN MBH
AUFGABENKATALOG

ZOLLVEREIN DEVELOPMENT COMPANY
CATALOGUE OF TASKS

Gegenstand des Unternehmens ist es, das Zollvereinareal zu einem national wie international bedeutenden Wirtschafts-, Kultur-, Industriekultur- und Tourismusstandort der Zukunft mit einem Schwerpunkt im Bereich Design zu entwickeln.	The object of the enterprise is to develop the Zollverein premises into a nationally and internationally significant location for the future, for business, culture, industrial culture and tourism, stressing the area of design.
Dazu wird die Gesellschaft insbesondere	To this end, the Company will, in particular
- das planerische Gesamtkonzept Zollverein 2010 in Abstimmung mit der Stadt Essen, dem Land NRW, den weiteren Eigentümern und regionalen Akteuren weiterentwickeln und vermarktungsfähig konkretisieren,	- further develop the overall concept in agreement with the City of Essen, the State of Nordrhein-Westfalen, the other owners and regional players, and translate it into concrete terms for the sake of marketability;
- das Gesamtprojekt gemeinsam mit privaten Investoren realisieren,	- realize the overall project jointly with private investors;
- die Planung, den Bau und die Finanzierung der öffentlichen Infrastrukturmaßnahmen und Gebäude abwickeln,	- handle the planning, construction and financing of the public infrastructure measures and buildings;
- die Beantragung, Bewirtschaftung und Abrechnung öffentlicher Zuschüsse vornehmen,	- undertake to request, manage and account for public subsidies;
- die Akquisition von Investoren und die Promotion für das Gesamtprojekt, in Abstimmung mit den Aktivitäten aller Zollvereinakteure, durchführen	- carry out the acquisition of investors and the promotion work for the overall project, coordinating this with the activities of all parties involved in the Zollverein;
- die Immobilienverwertung als Treuhänderin der beteiligten Grundstückseigentümer durchführen, um eine Grundstücksentwicklung aus einer Hand zu ermöglichen.	- carry out the marketing of property as trustee for the involved property owners, in order to enable property development in one hand.
Die Gesellschaft ist zu allen Maßnahmen und Geschäften berechtigt, die mit den in Absatz 1 genannten Gegenständen zusammenhängen oder sie fördern. Sie kann sich zur Erfüllung ihrer Aufgaben anderer Unternehmen bedienen, sich an ihnen beteiligen oder solche Unternehmen sowie Hilfs-, und Nebenbetriebe errichten oder erwerben.	The Company is authorized to take all measures and perform all transactions related to or designed to further the objects stated in paragraph 1. To fulfill its duties it can avail itself of other enterprises, participate in them or set up or acquire such enterprises as well as ancillary and subsidiary enterprises.

Anlage zu UR-Nr.297/2001
Notar Dr. Peter Heinemann

GESELLSCHAFTSVERTRAG

ENTWICKLUNGSGESELLSCHAFT ZOLLVEREIN MBH

§ 1
Firma und Sitz der Gesellschaft

(1) Die Gesellschaft ist eine Gesellschaft mit beschränkter Haftung.
(2) Die Gesellschaft führt die Firma „Entwicklungsgesellschaft Zollverein mbH".
(3) Der Sitz der Gesellschaft ist Essen.

§ 2
Gegenstand des Unternehmens

(1) Gegenstand des Unternehmens ist es, das Zollvereinareal zu einem national wie international bedeutenden Wirtschafts-, Kultur-, Industriekultur- und Tourismusstandort der Zukunft mit einem Schwerpunkt im Bereich Design zu entwickeln.

Dazu wird die Gesellschaft insbesondere:

- das planerische Gesamtkonzept in Abstimmung mit der Stadt Essen, dem Land NRW, den weiteren Eigentümern und regionalen Akteuren weiterentwickeln und vermarktungsfähig konkretisieren,
- das Gesamtprojekt gemeinsam mit privaten Investoren realisieren,
- die Planung, den Bau und die Finanzierung der öffentlichen Infrastrukturmaßnahmen und Gebäude abwickeln,
- die Beantragung, Bewirtschaftung und Abrechnung öffentlicher Zuschüsse vornehmen,
- die Akquisition von Investoren und die Promotion für das Gesamtprojekt, in Abstimmung mit den Aktivitäten aller Zollvereinakteure, durchführen
- die Immobilienverwertung als Treuhänderin der beteiligten Grundstückseigentümer durchführen, um eine Grundstücksentwicklung aus einer Hand zu ermöglichen.

(2) Die Gesellschaft ist zu allen Maßnahmen und Geschäften berechtigt, die mit den in Absatz 1 genannten Gegenständen zusammenhängen oder sie fördern. Sie kann sich zur Erfüllung ihrer Aufgaben anderer Unternehmen bedienen, sich

Appendix to Document Register No. 297/2001
Notary Public Dr. Peter Heinemann

MEMORANDUM AND ARTICLES OF ASSOCIATION

ENTWICKLUNGSGESELLSCHAFT ZOLLVEREIN MBH

§ 1
Name and Registered Domicile of Company

(1) The Company is a limited-liability company (GmbH).
(2) The Company uses the name "Entwicklungsgesellschaft Zollverein mbH".
(3) The registered domicile of the Company is Essen.

§ 2
Objects of the Enterprise

(1) The object of the enterprise is to develop the Zollverein premises into a nationaliy and internationally significant location for the future, for business, culture, industrial culture and tourism, stressing the area of design.

To this end, the Company will, in particular

- further develop the overall concept in agreement with the City of Essen, the State of Nordrhein-Westfalen, the other owners and regional players, and translate it into concrete terms for the sake of marketability;
- realize the overall project jointly with private investors;
- handle the planning, construction and financing of the public infrastructure measures and buildings;
- undertake to request, manage and account for public subsidies;
- carry out the acquisition of investors and the promotion work for the overall project, coordinating this with the activities of all parties involved in the Zollverein;
- carry out the marketing of property as trustee for the involved property owners, in order to enable property development in one hand.

(2) The Company is authorized to take all measures and perform all transactions related to or designed to further the objects stated in paragraph 1. To fulfill its duties it can avail itself of other enterprises, participate in them or set

Aufgaben anderer Unternehmen bedienen, sich an ihnen beteiligen oder solche Unternehmen sowie Hilfs-, und Nebenbetriebe errichten oder erwerben.

of other enterprises, participate in them or set up or acquire such enterprises as well as ancillary and subsidiary enterprises.

§ 3
Dauer der Gesellschaft, Geschäftsjahr

(1) Die Dauer der Gesellschaft ist bis zum 31.12.2010 begrenzt.
(2) Das Geschäftsjahr ist das Kalenderjahr.

§ 3
Duration of the Company, Fiscal Year

(1) The duration of the Company is limited to December 31, 2010.
(2) The fiscal year is the calendar year.

§ 4
Stammkapital, Stammeinlagen

Das Stammkapital der Gesellschaft beträgt 50.000,- € (in Worten: fünfzigtausend Euro.)Das Stammkapital ist in Höhe von 50.000,- € eingezahlt.

(3) Auf dieses Stammkapital übernehmen als Stammeinlage:
- die Stadt Essen (50%) 25.000,- €
- die Projekt Ruhr GmbH (50%) 25.000 €

(4) Über Beitrittsgesuche weiterer Gesellschafter entscheidet die Gesellschaftsversammlung

§ 4
Share Capital, Original Capital Contributions

The share capital of the Company totals € 50,000 (in words: fifty thousand euros). The share capital is paid up in the amount of € 50.000.

(3) The Original Capital Contributions to this Share Capital are assumed by:
- the City of Essen (50%) € 25,000
- the Projekt Ruhr GmbH (50%) € 25,000

(4) The Shareholders' Meeting decides on requests for admission of further Shareholders.

§ 5
Verfügung über Geschäftsanteile

(1) Verfügung über Geschäftsanteile oder Teile davon, einschließlich der Abtretung, Verpfändung, anderweitiger Belastungen oder Teilung bedürfen zu Ihrer Wirksamkeit der vorherigen Zustimmung der Gesellschaftsversammlung.

(2) Mit Zustimmung des betroffenen Gesellschafters ist die Einziehung von Geschäftsanteilen jederzeit zulässig. Ohne Zustimmung des betroffenen Gesellschafters wird ein Geschäftsanteil eingezogen, wenn:
a) über sein Vermögen ein Insolvenzverfahren eröffnet ist,
b) die Zwangsvollstreckung in seinem Geschäftsanteil vorgenommen wird,
c) ein Gesellschaftsanteil einer Gesellschaft oder juristischen Person gehört, im Falle der Auflösung der Gesellschaft oder juristischen Person.

Der betroffene Gesellschafter hat Anspruch auf eine Abfindung in Höhe des Nennwertes des eingezogenen Anteils. Die Abfindung ist einen Monat nach Beschluss über die Einziehung fällig.

§ 5
Disposal of Capital Shares

(1) Disposal of capital shares or parts thereof, including assignment, pledging, other encumbrances or division, require the prior consent of the Shareholders' Meeting to be effective.

(2) With the consent of the Shareholder concerned, the calling in of capital shares is permissible at any time. A capital share will be called in without the consent of the Shareholder concerned if:
a) insolvency proceedings have been instituted against the Shareholder's assets;
b) execution is imposed on his capital share;
c) a capital share belongs to a company or legal entity, in the event of the dissolution of the company or legal entity.

The Shareholder concerned is entitled to payment in the nominal amount of the called-in share. The payment is due one month from adoption of a decision to call in the share.

§ 6
Organe der Gesellschaft

Organe der Gesellschaft sind:

§ 6
Organs of the Company

Organs of the Company are:

-die Geschäftsführung,
-der Aufsichtsrat,
-der Entwicklungsbeirat,
-die Gesellschaftsversammlung.

§ 7
Geschäftsführung und Vertretung

(1) Die Gesellschaft hat einen oder mehrere Geschäftsführer

(2) Ist nur ein Geschäftsführer bestellt, so vertritt er die Gesellschaft allein. Sind mehrere Geschäftsführer bestellt, so wird die Gesellschaft durch zwei Geschäftsführer gemeinsam oder durch einen Geschäftsführer in Gemeinschaft mit einem Prokuristen vertreten

(3) Die Geschäftsführung ist verpflichtet, die Geschäfte der Gesellschaft in Übereinstimmung mit dem Gesetz, diesem Gesellschaftsvertrag, den Beschlüssen des Aufsichtsrates, des Entwicklungsbeirates und der Gesellschaftsversammlung, sowie den Beteiligungsrichtlinien der Stadt Essen zu führen.

(4) Unbeschadet der Regelungen des § 52 GmbH berichtet die Geschäftsführung dem Aufsichtsrat und dem Entwicklungsbeirat gemäß § 90 AktG. Die Berichte nach § 90 Ab. 1 Nr. 3 sind innerhalb von 6 Wochen nach jedem Quartalsende zu erstatten.

(5) Die Geschäftsführung gibt sich eine Geschäftsordnung, die vom Aufsichtsrat zu beschließen ist.

§ 8
Aufsichtsrat

(1) Die Gesellschaft hat einen Aufsichtsrat. Auf ihn finden die in § 52 Abs. 1 GmbH genannten Regelungen Anwendung.

(2) Der Aufsichtsrat besteht aus 6 Mitgliedern. Drei Mitglieder werden von der Stadt Essen und drei Mitglieder werden von der Projekt Ruhr GmbH vorgeschlagen und von der Gesellschaftsversammlung gewählt.

(3) Die Amtszeit der Mitglieder des Aufsichtsrates beträgt fünf Jahre. Der alte Aufsichtsrat führt seine Geschäfte bis zu Bildung des neuen Aufsichtsrates weiter.

(4) Jedes Mitglied des Aufsichtsrates kann sein Amt unter Einhaltung einer einmonatigen Frist durch schriftliche Erklärung gegenüber dem Vorsitzenden des Aufsichtsrates oder gegenüber der Geschäftsführung niederlegen. Die Gesellschaft kann im Einvernehmen mit dem Ausscheidenden auf die Frist verzichten.

- the Management,
- the Supervisory Board,
- the Development Advisory Committee,
- the Shareholders' Meeting.

§ 7
Management and Representation

(1) The Company has one or more Managing Directors.

(2) If only one Managing Director is appointed, he or she represents the Company alone. If more than one Managing Director is appointed, the Company is represented by two Managing Directors jointly or by one Managing Director jointly with an Authorized Officer.

(3) The Management is obligated to carry on Company business is conformity with the law, this Memorandum and Articles of Association, the resolutions of the Supervisory Board, the Development Advisory Committee and the Shareholders' Meeting, and the equity participation rules of the City of Essen.

(4) Without prejudice to the arrangements of § 52 GmbHG (Law on Private Limited Companies), the Management reports to the Supervisory Board and the Development Advisory Committee in compliance with § 90 AktG (Stock Corporation Act). The reports pursuant to § 90 Par. 1 Num. 3 shall be made within six weeks of the end of every quarter.

(5) The Management draws up Rules of Procedure for its work which will be adopted by the Supervisory Board.

§8
Supervisory Board

(1) The Company has a Supervisory Board. The rules contained in § 52 Par. 1 GmbHG apply to this body.

(2) The Supervisory Board consists of six members. Three members are nominated by the City of Essen and three by Projekt Ruhr GmbH. The members are elected by the Shareholders' Meeting.

(3) The term of office of the members of the Supervisory Board is five years. The old Supervisory Board carries on business until the new Supervisory Board is formed.

(4) Each member of the Supervisory Board can lay down his or her office by written declaration to the Chairman of the Supervisory Board or to the Management, observing a period of one month's notice. By agreement with the retiring member the Company can dispense with this notice period.

Ausscheidenden auf die Frist verzichten.

(5) Scheidet ein Aufsichtsratmitglied vorzeitig aus, so wählt die Gesellschafterversammlung auf Vorschlag des Gesellschafters, die den Ausgeschiedenen vorgeschlagen hat, einen Nachfolger für die restliche Amtszeit.

(6) Die Mitgliedschaft im Aufsichtsrat endet mit dem Ablauf des die Wahl begründenden Amtes.

(7) Die wiederholte Wahl von Aufsichtsratsmitgliedern ist zulässig.

(8) Die Vertreter der Stadt Essen im Aufsichtsrat sind gemäß § 113 Abs. 1 GO NW an die Beschlüsse des Rates der Stadt Essen und seiner Ausschüsse gebunden.

(5) If a Supervisory Board member retires from office before full tenure, for the remaining term of office the Shareholders' Meeting elects a successor nominated by the Shareholder who nominated the retired member.

(6) Membership on the Supervisory Board ends with the expiration of the office on which election is based.

(7) The election of Supervisory Board members for repeated terms is permissible.

(8) The representatives of the City of Essen on the Supervisory Board are bound by the decisions of the Essen City Council and its committees pursuant to § 113 Par. 1 GO NW.

§ 9
Vorsitz, Einberufung und Beschlussfassung des Aufsichtsrates

(1) Der Aufsichtsrat wählt aus seiner Mitte, auf Vorschlag der Projekt Ruhr GmbH, einen Vorsitzenden sowie, auf Vorschlag der Stadt Essen, einen Stellvertreter für die in § 8 Abs. 3 festgelegte Amtszeit. Im Falle der Verhinderung werden die Aufgaben des Vorsitzenden durch seinen Stellvertreter wahrgenommen. Scheidet der Vorsitzende oder sein Stellvertreter während der Amtszeit aus, so hat der Aufsichtsrat aufgrund entsprechender Vorschläge unverzüglich einen neuen Vorsitzenden oder einen neuen Stellvertreter für den Rest der Amtszeit zu wählen.

(2) Der Aufsichtsrat wird vom Vorsitzenden oder im Verhinderungsfall von seinem Stellvertreter, so oft es die Geschäfte erfordern, mindestens jedoch einmal vierteljährlich einberufen. Die Einladung erfolgt durch einfachen Brief unter Mitteilung der Tagesordnung, des Tages, der Tageszeit und des Ortes mit einer Frist von mindestens zwei Wochen. Der Tag der Aufgabe der Einladung zur Post und der Tag der Aufsichtsratssitzung sind nicht mitzurechnen. Die Beschlussanträge und Beratungsunterlagen sind der Einladung beizufügen. In dringenden Fällen kann die Einladung auch schriftlich per Telefax mit einer Frist von 3 Tagen erfolgen.

(3) Der ordnungsgemäß einberufene Aufsichtsrat ist beschlussfähig, wenn mehr als die Hälfte seiner Mitglieder an der Sitzung teilnehmen.

(4) Der Aufsichtsrat fasst seine Beschlüsse mit einfacher Mehrheit der abgegebenen Stimmen, soweit sich nicht aus dem Gesetz oder diesem Gesellschaftsvertrag etwas anderes ergibt. Bei

§ 9
Chair, Convocation and Adoption of Resolutions by the Supervisory Board

(1) From its midst, the Supervisory Board elects a Chairman, nominated by Projekt Ruhr GmbH, and a Deputy Chairman, nominated by the City of Essen, for the term of office designated in § 8 Par. 3. If the Chairman is prevented, his duties will be performed by his Deputy. If the Chairman or his Deputy retire from office during their term of office, the Supervisory Board shall elect a new Chairman or a new Deputy Chairman without delay, based on appropriate proposals, for the remaining term of office.

(2) The Supervisory Board will be convened by the Chairman, or if he is prevented, by his Deputy, as often as business requires, but at least once each quarter year. Invitations are extended by simple letter, stating agenda, day, time of day and venue, a period of at least two weeks prior to the meeting. The day of posting the invitations and the day of the Supervisory Board meeting shall not be included in this period. The draft resolutions and the materials for discussion shall be enclosed with the invitation. In urgent cases, invitations can be made in writing, by fax, a period of 3 days prior to the meeting.

(3) The duly convened Supervisory Board has a quorum if more than half of its members take part in the meeting.

(4) The Supervisory Board adopts decisions by simple majority of the votes cast, unless the law or this Memorandum and Articles of Association stipulate otherwise. In a tie vote, the vote of the

Gesellschaftsvertrag etwas anderes ergibt. Bei Stimmengleichheit entscheidet die Stimme des Aufsichtsratsvorsitzenden.

(5) In eiligen und unaufschiebbaren Angelegenheiten können Beschlüsse durch Einholung von schriftlichen oder fernmündlichen Erklärungen gefasst werden, wenn kein Mitglied des Aufsichtsrates diesem Verfahren unverzüglich widerspricht.

(6) Über die Sitzung des Aufsichtsrates und über die im Umlaufverfahren gefassten Beschlüsse ist eine Niederschrift zu fertigen, die von dem Vorsitzenden nach dem Protokollführer zu unterzeichnen ist. Die Niederschrift ist den Gesellschaftern innerhalb von 6 Wochen zuzustellen.

(7) Die Geschäftsführung und die Vorsitzenden des Entwicklungsbeirates nehmen an den Sitzungen des Aufsichtsrates teil, soweit der Aufsichtsrat nichts anderes bestimmt.

§ 10
Aufgaben des Aufsichtsrates

(1) Der Aufsichtsrat überwacht die Tätigkeit der Geschäftsführung
(2) Der Aufsichtsrat beschließt insbesondere über:

1. die Zielsetzung und konkrete Umsetzung der Gesamtkonzeption Zollverein 2010
2. den Erwerb, die Veräußerung und Belastung von Grundstücken und grundstücksgleichen Rechten, soweit im Einzelfall eine in der Geschäftsordnung festzulegende Wertgrenze überschritten wird,
3. die Realisierung von Bauvorhaben,
4. die Entlastung der Geschäftsführung,
5. die Bestellung und Abberufung von Prokuristen,
6. die Geschäftsordnung für die Geschäftsführung,
7. die Führung eines Rechtsstreites von wesentlicher Bedeutung, die nicht dem normalen Geschäftsbetrieb zuzuordnen ist, sowie eines Rechtsstreites gegen Geschäftsführer und Prokuristen,
8. die Beauftragung des Abschlussprüfers,
9. die Hingabe von Darlehen und die Übernahme von Bürgschaften und bürgschaftsähnlichen Verpflichtungen,

stipulate otherwise. In a tie vote, the vote of the Supervisory Board Chairman decides.

(5) In urgent and unpostponable matters, decisions can be made by obtaining written or telephonic declarations, unless a member of the Supervisory Board promptly objects to such a procedure.

(6) A record shall be made of the meeting of the Supervisory Board and the decisions taken by circularizing, which record shall be signed by the Chairman and the keeper of the minutes. The record is to be delivered to the Shareholders within 6 weeks.

(7) The Management and the chairmen of the Development Advisory Committee participate in the meetings of the Supervisory Board, unless the Supervisory Board stipulates otherwise.

§ 10
Duties of the Supervisory Board

(1) The Supervisory Board monitors the activities of the Management.
(2) The Supervisory Board decides in particular on:

1. the objectives and concrete implementation of the overall concept Zollverein 2010;
2. the purchase, sale and encumbrance of land and titles to land, if a value stipulated in the Rules of Procedure is exceeded in an individual case;
3. the realization of building projects;
4. the ratification of the acts of the Management;
5. he appointment and recall of Authorized Officers;
6. the Rules of Procedure of the Management;
7. the conduct of lawsuits of major significance which cannot be referred to normal business operations,
8. and of lawsuits against Managing Directors and Authorized Officers;
9. the commissioning of the Auditors;

bürgschaftsähnlichen Verpflichtungen,

10. die Einstellung von Personal, soweit sie im Stellenplan des Geschäftsjahres nicht vorgesehen ist,

(3) Der Aufsichtsrat kann zu den Vorlagen für die Gesellschaftsversammlungen Stellungnahmen abgeben.

§ 11 Entwicklungsbeirat

(1) Der Entwicklungsbeirat hat 12 Mitglieder. Der Oberbürgermeister der Stadt Essen ist geborenes Mitglied. 5 Mitglieder werden vom Rat der Stadt Essen entsandt. Die Projekt Ruhr GmbH entsendet 6 Mitglieder

(2) Die Amtszeit der vom Rat der Stadt Essen entsandten Mitglieder des Entwicklungsbeirats endet mit dem auf den Beginn der Amtszeit folgenden Ablauf der Wahlperiode des Rates der Stadt Essen. Sie bleiben bis zur Entsendung der neuen Mitglieder im Amt.

(3) Jedes Mitglied des Entwicklungsbeirates kann sein Amt unter Einhaltung einer einmonatigen Frist durch schriftliche Erklärung gegenüber dem Vorsitzenden des Beirates oder gegenüber der Geschäftsführung niederlegen. Die Gesellschaft kann im Einvernehmen mit dem Ausscheidenden auf die Frist verzichten.

(4) Ist ein Beitragsmitglied vom Rat der Stadt Essen wegen seiner Zugehörigkeit zum Rat oder zur Verwaltung der Stadt Essen vorgeschlagen worden, so endet sein Amt vor der in § 11 Abs. 2 festgelegten Amtszeit, sobald das kommunale Mandat oder Amt endet. Scheidet ein vom Rat der Stadt vorgeschlagenes Mitglied vorzeitig aus dem Entwicklungsbeirat aus, so benennt der Rat auf Vorschlag derjenigen Fraktion oder Gruppe, die den Ausgeschiedenen vorgeschlagen hatte, einen Nachfolger.

(5) Ist ein Beiratsmitglied von der Projekt Ruhr GmbH entsandt worden, so endet die Mitgliedschaft mit dem Ablauf des die Entsendung begründenden Amtes.

(6) Die Vertreter der Stadt Essen im Entwicklungsbeirat sind gemäß § 113 Abs. 1 GONW an die Beschlüsse des Rates der Stadt Essen und seiner Ausschüsse gebunden.

10. the advancement of loans and the assumption of guaranties and similar commitments;

11. the hiring of staff if positions are not provided for in the staffing schedule for the fiscal year.

(3) The Supervisory Board can give its opinion on the proposals to the Shareholders' Meeting.

§ 11 Development Advisory Committee

(1) The Development Advisory Committee has 12 members. The Mayor of the City of Essen is automatically a member. 5 members are delegated by the Essen City Council. The Projekt Ruhr GmbH delegates 6 members.

(2) The term of office of the members of the Development Advisory Committee delegated by the Essen City Council ends with the expiration of the electoral period of the Essen City Council which follows the beginning of the term of office. They remain in office until the new members are delegated.

(3) Each member of the Development Advisory Committee can lay down his or her office by written declaration to the Chairman of the Development Advisory Committee or to the Management, observing a period of one month's notice. By agreement with the retiring member the Company can dispense with this notice period.

(4) If a Committee member has been proposed by the Essen City Council because he or she is a member of the Council or the Essen City Administration, then his or her term of office ends prior to the term of office stipulated in § 11 Par. 2 as soon as the municipal mandate or office terminates. If a member proposed by the Essen City Council retires prematurely from the Development Advisory Committee, then the Council designates a successor proposed by that parliamentary party or group which proposed the retiring member.

(5) If a Committee member has been delegated by Projekt Ruhr GmbH, his or her membership ends with the termination of the office on which delegation is based.

(6) The representatives of the City of Essen on the Development Advisory Committee are bound by the decisions of the Essen City Council and its committees pursuant to § 113 Par. 1 GO NW.

§ 12
Vorsitz, Einberufung und Beschlussfassung des Entwicklungsbeirates

(1) Vorsitzende des Entwicklungsbeirates ist der jeweilige Oberbürgermeister der Stadt Essen. Der Entwicklungsbeirat wählt auf Vorschlag der Projekt Ruhr GmbH aus seiner Mitte einen Stellvertreter für die in § 11 Abs. 2 festgelegte Amtszeit. Im Falle der Verhinderung werden die Aufgaben des Vorsitzenden durch seinen Stellvertreter wahrgenommen. Scheidet der Stellvertreter während der Amtszeit aus, so wählt der Beirat auf Vorschlag der Projekt Ruhr GmbH einen Stellvertreter für den Rest der Amtszeit.

(2) Der Entwicklungsbeirat wird von dem Vorsitzenden oder im Verhinderungsfall von seinem Stellvertreter, so oft es die Geschäfte erfordern, mindestens jedoch einmal vierteljährlich einberufen. Die Einladung erfolgt durch einfachen Brief unter Mitteilung der Tagesordnung, des Tages, der Tageszeit und des Ortes mit einer Frist von mindestens zwei Wochen. Der Tag der Aufgabe der Einladung zur Post und der Tag der Beiratssitzung sind nicht mitzurechnen. Die Beschlussanträge und Beratungsunterlagen sind der Einladung beizufügen. In dringenden Fällen kann die Einladung auch schriftlich per Telefax mit einer Frist von 3 Tagen erfolgen.

(3) Der ordnungsgemäß einberufene Entwicklungsbeirat ist beschlussfähig, wenn mehr als die Hälfte seiner Mitglieder an der Sitzung teilnehmen.

(4) Der Entwicklungsbeirat fasst seine Beschlüsse mit einfacher Mehrheit der abgegebenen Stimmen, soweit sich nicht aus dem Gesetz oder diesem Gesellschaftsvertrag etwas anderes ergibt. Bei Stimmengleichheit entscheidet die Stimme des Vorsitzenden.

(5) In eiligen und unaufschiebbaren Angelegenheiten können Beschlüsse durch Einholung von schriftlichen oder fernmündlichen Erklärungen gefasst werden, wenn kein Mitglied des Beirates diesem Verfahren unverzüglich widerspricht.

(6) Über die Sitzung des Entwicklungsbeirates und über die im Umlaufverfahren gefassten Beschlüsse ist eine Niederschrift zu fertigen, die von dem Vorsitzenden und dem Protokollführer zu unterzeichnen ist. Die Niederschrift ist den Gesellschaftern innerhalb von 6 Wochen zuzustellen.

§ 12
Chair, Convocation and Adoption of Resolutions by the Development Advisory Committee

(1) The Chairman of the Development Advisory Committee is always the Mayor of the City of Essen. At the proposal of Projekt Ruhr GmbH, the Development Advisory Committee elects a Deputy Chairman from its midst for the term of office designated in § 11 Par. 2. If the Chairman is prevented, his duties will be performed by his Deputy. If the Deputy Chairman retires from office during his term of office, the Committee, at the proposal of Projekt Ruhr GmbH, shall elect a Deputy Chairman for the remaining term of office.

(2) The Development Advisory Committee will be convened by the Chairman, or if he is prevented, by his Deputy, as often as business requires, but at least once each quarter year. Invitations are extended by simple letter, stating agenda, day, time of day and venue, a period of at least two weeks prior to the meeting. The day of posting the invitations and the day of the Committee meeting shall not be included in this period. The draft resolutions and the materials for discussion shall be enclosed with the invitation. In urgent cases, invitations can be made in writing, by fax, a period of 3 days prior to the meeting.

(3) The duly convened Development Advisory Committee has a quorum if more than half of its members take part in the meeting.

(4) The Development Advisory Committee adopts decisions by simple majority of the votes cast, unless the law or this Memorandum and Articles of Association stipulate otherwise. In a tie vote, the vote of the Chairman decides.

(5) In urgent and unpostponable matters, decisions can be made by obtaining written or telephonic declarations, unless a member of the Committee promptly objects to such a procedure.

(6) A record shall be made of the meeting of the Development Advisory Committee and the decisions taken by circularizing, which record shall be signed by the Chairman and the keeper of the minutes. The record is to be delivered to the Shareholders within 6 weeks.

(7) Die Geschäftsführung und die Vorsitzenden des Aufsichtsrates nehmen an den Sitzungen des Entwicklungsbeirates teil, soweit der Beirat nichts anderes bestimmt.

(7) The Management and the chairmen of the Supervisory Board participate in the meetings of the Development Advisory Committee, unless the Committee the stipulates otherwise.

§ 13
Aufgaben des Entwicklungsbeirates

(1) Der Entwicklungsbeirat berät und fördert die Geschäftsführung bei der Entwicklung und Ausgestaltung der Gesamtkonzeption zur Entwicklung des Zollvereinareals zu einem Wirtschafts- und Kulturstandort der Zukunft von nationaler und internationaler Bedeutung.

(2) Der Entwicklungsbeirat befasst sich insbesondere mit:

1. den Leitlinien zur Entwicklung des Zollvereinareals,
2. der Gesamtkonzeption Zollverein
3. der Ausrichtung der einzelnen Bausteine der Gesamtkonzeption
4. den Grundsätze für die Veräußerung von Grundstücken,
5. den Grundzügen der Bürgerbeteiligung und der Öffentlichkeitsarbeit.

(3) Der Entwicklungsbeirat bereitet wesentliche Beschlüsse der Gesellschaftsversammlung vor und fasst Empfehlungsbeschlüsse insbesondere über:

1. die Feststellung des Jahresbeschlusses,
2. die Verwendung des Jahresergebnisses,
3. die Feststellung des Wirtschaftsplanes (Erfolgs-, Finanz- und Investitionsplan),
4. den Abschluss und die Änderung von Unternehmensverträgen im Sinne der §§ 291 und 292 Abs. 1 AktG,
5. die Gründung, den Erwerb und die Veräußerung von Unternehmen und

§ 13
Duties of the Development Advisory Committee

(1) The Development Advisory Committee advises and assists the Management in developing and giving concrete shape to the overall concept for the development of the Zollverein premises into a nationally and internationally significant location for the future for business and culture.

(2) The Development Advisory Committee in particular concerns itself with:

1. the guidelines for the development of the Zollverein premises;
2. the overall concept Zollverein;
3. the orientation of the individual elements of the overall concept;
4. the principles for the sale of properties;
5. the fundamentals of the participation of local citizens in decision-making and of publicrelations.

(3) The Development Advisory Committee prepares important resolutions of the Shareholders' Meeting and passes resolutions serving as recommendations especially in regard to:

1. the adoption of the Annual Financial Statements;
2. the appropriation of the net annual profit;
3. the adoption of the economic plan (profit plan, budget and investment plan);
4. the conclusion and amendment of affiliation agreements within the meaning of §§ 291 and 292 Par. 1 AktG;
5. the formation, acquisition and sale of enterprises and equity shares therein.

Unternehmen und Beteiligungen.

shares therein.

§ 14
Vorsitz, Einberufung der Gesellschaftsversammlung

(1) Die Gesellschaftsversammlung wird durch die Geschäftsführung in Abstimmung mit dem Vorsitzenden des Aufsichtsrates einberufen. Die Geschäftsführung hat die Gesellschafterversammlung einzuberufen, wenn ein Gesellschafter oder ein Geschäftsführer dies verlang.

(2) Der Vorsitz in der Gesellschaftsversammlung führt der Vorsitzende des Aufsichtsrates oder im Falle seiner Verhinderung sein Stellvertreter.

(3) Die ordentliche Gesellschaftsversammlung wird von dem Vorsitzenden mindestens einmal jährlich – und zwar spätestens acht Monate nach Ablauf des Geschäftsjahres – zur Feststellung des Jahresabschlusses einberufen. Die Einladung erfolgt schriftlich unter Mitteilung der Tagesordnung, des Tages, der Tageszeit und des Ortes mit einer Frist von mindestens zwei Wochen. Der Tag der Aufgabe der Einladung zur Post und der Tag der Sitzung sind nicht mitzurechnen. Die Beschluss- und Beratungsunterlagen sind der Einladung beizufügen. In dringenden Fällen kann die Einladung auch schriftlich per Telefax mit einer Frist von einer Woche erfolgen.

(4) Die Geschäftsführung nimmt an der Gesellschaftsversammlung teil, soweit die Gesellschaftsversammlung nichts anderes bestimmt.

§ 14
Chair, Convocation of the Shareholders' Meeting

(1) The Shareholders' Meeting is convened by the Management in coordination with the Chairman of the Supervisory Board. The Management shall convene the Shareholders' Meeting if a Shareholder or Managing Director so demands.

(2) The Shareholders' Meeting will be chaired by the Chairman of the Supervisory Board or, if he is prevented, by his Deputy

(3) The Ordinary Shareholders' Meeting will be convened by the Chairman at least once annually – namely, at the latest, eight months after the fiscal year expires – to adopt the Annual Financial Statements. Invitations are extended in writing, stating agenda, day, time of day and venue, a period of at least two weeks prior to the meeting. The day of posting the invitations and the day of the meeting shall not be included in this period. The draft resolutions and the materials for discussion shall be enclosed with the invitation. In urgent cases, invitations can be made in writing, by fax, a period of one week prior to the meeting.

(4) The Management participates in the Shareholders' Meeting unless the Shareholders' Meeting stipulates otherwise.

§ 15
Beschlussfassung der Gesellschaftsversammlung

(1) Die Gesellschaftsversammlung ist beschlussfähig, wenn mindestens ¾ des Stammkapitals vertreten ist. Ist keine Beschlussfähigkeit vorhanden, so ist unverzüglich unter Beachtung von § 14 Abs. 3 und unter Hinweis darauf, dass diese Versammlung ohne Rücksicht auf die Höhe des vertretenen Stammkapitals beschlussfähig ist, eine weitere Gesellschaftsversammlung einzuberufen.

§ 15
Adoption of Resolutions by the Shareholders' Meeting

(1) The Shareholders' Meeting has a quorum if at least three-quarters of the share capital is represented. If a quorum is not present, a further Shareholders' Meeting shall be convened without delay, observing § 14 Par. 3, and pointing out that this meeting will have a quorum regardless of the amount of share capital represented.

(2) Gesellschaftsversammlung fasst ihre Beschlüsse mit einfacher Mehrheit der abgegebenen Stimmen, soweit das Gesetz und dieser Gesellschaftsvertrag nicht anderes bestimmen.

(2) The Shareholders' Meeting adopts decisions by simple majority of the votes cast, unless the law or this Memorandum and Articles of Association stipulate otherwise.

(3) Auf je 50 € eines Geschäftsanteils entfällt eine Stimme. Jeder Gesellschafter kann seine Stimmen nur einheitlich abgeben.

(3) One vote is granted for each € 50 of a share. Each Shareholder can cast his votes only in a unitary manner.

(4) Über den wesentlichen Verlauf der Gesellschafterversammlung und die gefassten Beschlüsse ist unverzüglich eine Niederschrift anzufertigen, die von dem Vorsitzenden und dem Protokollführer zu unterzeichnen und den Gesellschaftern innerhalb von 6 Wochen zu übersenden ist.

(4) Without delay, a record shall be made of the principal events of the Shareholders' Meeting and the decisions adopted there, which record shall be signed by the Chairman and the keeper of the minutes. The record is to be sent to the Shareholders within 6 weeks.

(5) In eiligen und unaufschiebbaren Angelegenheiten können Beschlüsse auch außerhalb einer Gesellschafterversammlung mündlich, fernmündlich, schriftlich oder mit Telefax gefasst werden, sofern kein Gesellschafter diesem Verfahren unverzüglich widerspricht. Der Vorsitzende stellt das Zustandekommen der im Eilverfahren gefassten Beschlüsse in einer Niederschrift fest; die Niederschrift wird den Gesellschaftern unverzüglich zur Kenntnis gebracht.

(5) In urgent and unpostponable matters, decisions also can be made outside a Shareholders' Meeting orally, by telephone, in writing or by fax, unless a Shareholder promptly objects to such a procedure. The Chairman establishes the adoption of the resolutions by these summary proceedings, making a record thereof; the record will be brought to the attention of the Shareholders without delay.

§ 16
Aufgaben der Gesellschafterversammlung

§ 16
Duties of the Shareholders' Meeting

(1) Die Gesellschafterversammlung beschließt in den ihr nach dem Gesetz und dem Gesellschaftsvertrag zugewiesenen Fällen. Sie beschließt insbesondere über:

1. grundsätzliche Feststellungen zu den einzelnen Bausteinen des Gesamtkonzeptes Zollverein 2010
2. die Bestellung, die Abberufung und die Anstellungsverhältnisse der Geschäftsführer,
3. Versorgungszusagen
4. die Feststellung des Jahresbeschlusses, die Verwendung des Jahresergebnisses und den Vortrag oder die Abdeckung eines Verlustes,

(1) The Shareholders' Meeting makes decisions on the matters entrusted to it under the law and the Memorandum and Articles of Association. In particular, it resolves on:

1. fundamental conclusions regard the individual elements of the overall concept Zollverein;
2. the appointment, the dismissal and the terms of employment of the Managing Directors;
3. pension commitments;
4. the adoption of the Annual Financial Statements, the appropriation of the net annual profit,and the carryforward of or provisions for a loss;

5. die Entlastung des Aufsichtsrates und des Entwicklungsbeirates,

6. die Feststellung des Wirtschaftsplanes (Erfolgs-, Finanz- und Investitionsplan) und seiner Nachträge,

7. die Bestellung des Abschlussprüfers,

8. die Stimmabgabe in Gesellschafter- und Hauptversammlungen von Tochter- und Beteiligungsgesellschaften,

9. den Abschluss und die Änderungen von Unternehmensverträgen im Sinne der §§ 291 und 292 Abs. 1 des Aktiengesetzes

10. den Erwerb und die Veräußerung von Unternehmen und Beteiligungen,

11. die Verfügung über Geschäftsanteile sowie Verpfändung und Einziehung von Gesellschaftsanteilen,

12. die Aufnahme weiterer Gesellschafter,

13. die Änderung des Gesellschaftervertrages,

14. die Auflösung der Gesellschaft.

(2) Die Gesellschafterversammlung kann weitere Arten von Geschäften bestimmen, die ihrer Zustimmung bedürfen. Sie kann dabei auch festlegen, mit welcher Mehrheit die Zustimmung zu erteilen ist.

5. the ratification of the acts of the Supervisory Board and the Development Advisory Committee;

6. the adoption of the economic plan (profit plan, budget and investment plan) and supplements thereto;

7. the appointment of the Auditors;

8. voting in shareholders' meetings and annual general meetings of subsidiaries and affiliates;

9. the conclusion and amendment of affiliation agreements within the meaning of §§ 291 and 292 Par. 1 AktG;

10. the acquisition and sale of enterprises and equity shares therein;

11. the disposal of capital shares and the pledging or call-in of capital shares;

12. the inclusion of further shareholders;

13. the amendment of the Memorandum and Articles of Association;

14. the dissolution of the Company.

(2) The Shareholders' Meeting can determine further types of transactions requiring its consent. It can also stipulate the majority required for approval.

§ 17
Wirtschaftsplan und mittelfristige Finanzplanung

(1) Die Geschäftsführung stellt für jedes Geschäftsjahr einen Wirtschaftsplan (Erfolgs-, Finanz- und Investitionsplan) auf. Die Gesellschafterversammlung hat den Wirtschaftsplan bis zum 31.10. des Vorjahres festzustellen. Eventuelle Nachträge sind rechtzeitig zur Beschlussfassung vorzulegen.

§ 17
Economic Plan and Medium-Term Financial Planning

(1) The Management draws up an economic plan (profit plan, budget and investment plan) for each fiscal year. The Shareholders' Meeting shall adopt the economic plan by October 31 of the year before. Any supplements shall be submitted for voting in good time.

Beschlussfassung vorzulegen.

(2) Dem Wirtschaftsplan sind ein Stellenplan sowie eine fünfjährige Finanzplanung beizufügen. Diese ist, zusammen mit dem Wirtschaftsplan den Gesellschaftern zur Kenntnis zu bringen.

(2) A staffing schedule and a five-year financial plan shall be attached to the economic plan. The financial plan together with the economic plan shall be brought to the attention of the Shareholders.

§ 18
Jahresabschluss, Lagebericht, Publikationspflicht

(1) Die Geschäftsführung hat innerhalb von drei Monaten nach Ablauf des Geschäftsjahres den Jahresabschluss (Jahresbilanz, Gewinn- und Verlustrechnung, Anhang) und den Lagebericht in entsprechender Anwendung der für große Kapitalgesellschaften geltenden Vorschriften des Dritten Buches des Handelsgesetzbuches aufzustellen und dem Abschlussprüfer zur Prüfung vorzulegen. In dem Lagebericht ist zur Einhaltung der öffentlichen Zwecksetzung und zur Zweckerreichung Stellung zu nehmen sowie auch auf die Risiken der zukünftigen Entwicklung einzugehen.

(2) Nach erfolgter Prüfung ist der Jahresabschluss zusammen mit dem Lagebericht und dem Prüfungsbericht unverzüglich dem Aufsichtsrat, dem Entwicklungsbeirat sowie den Gesellschaftern vorzulegen.

(3) Die Gesellschafterversammlung hat innerhalb von acht Monaten nach Ablauf des Geschäftsjahres über die Feststellung des Jahresabschlusses und die Ergebnisverwendung zu beschließen.

(4) Die Geschäftsführung hat die Feststellung des Jahresabschlusses, die Verwendung des Ergebnisses sowie das Ergebnis der Prüfung des Jahresabschlusses, die Verwendung des Ergebnisses sowie das Ergebnis der Prüfung des Jahresabschlusses und des Lageberichtes ortsüblich bekann zu machen, den Jahresabschluss und den Lagebericht unverzüglich auszulegen und in der Bekanntmachung auf die Auslegung hinzuweisen.

§ 18
Annual Financial Statements, Management Report, Compulsory Disclosure

(1) Within three months of the end of the fiscal year, the Management shall draw up the Annual Financial Statements (Annual Balance Sheet and Income Statement, Notes) and the Management Report, appropriately applying the provisions of the Third Volume of the German Commercial Code which are binding upon large incorporated companies, and shall submit them to the Auditors for examination. The Management Report shall comment on the adherence to public-policy aims and on the attainment of the objectives and shall discuss the risks of the future as well.

(2) On completion of the audit, the Annual Financial Statements together with the Management Report and the Audit Report shall promptly be submitted to the Supervisory Board, the Development Advisory Committee and the Shareholders.

(3) The Shareholders' Meeting shall pass resolution on the adoption of the Annual Financial Statements and the appropriation of profits within eight months of the conclusion of the fiscal year.

(4) The Management shall announce the adoption of the Annual Financial Statements, the appropriation of profits, and the results of the audit of the Annual Financial Statements and the Management Report in the locally customary manner, shall promptly lay open to public inspection the Annual Financial Statements and the Management Report, and shall make reference to the possibility of public inspection in its announcement.

§ 19
Rechnungsprüfung

(1) Der Jahresabschluss sowie der Lagebericht sind in entsprechender Anwendung der Vorschriften des Dritten Buches des Handelsgesetzbuches für

§ 19
Auditing

(1) The Annual Financial Statements and the Management Report shall be examined by an Auditor in keeping with the provisions of the Third Volume of the German Commercial

Buches des Handelsgesetzbuches für große Kapitalgesellschaften durch einen Abschlussprüfer zu prüfen. Bei der Erstellung des Prüfungsberichtes sind die nach § 53 Haushaltsgrundsätzegesetz vorgesehenen Prüfungsfeststellungen zu treffen.

(2) Dem Landesrechnungshof und der Stadt Essen werden die sich aus § 54 Haushaltsgrundsätzegesetz ergebenden Rechte eingeräumt.

(3) Dem Rechnungsprüfungsamt der Stadt Essen wird das Recht eingeräumt, eine Kassen-, Buch- und Betriebsprüfung vorzunehmen. Dieser Prüfungsbericht ist der/dem Vorsitzenden des Aufsichtsrates zur Kenntnis zu bringen.

Third Volume of the German Commercial Code which are binding upon large incorporated companies. In drawing up the Audit Report, the findings shall be stated which are requested by § 53 of the Law on Basic Budgetary Rules.

(2) The rights deriving from § 54 of the Law on Basic Budgetary Rules are granted to the State Board of Audit and the City of Essen.

(3) The Audit Office of the City of Essen is granted the right to perform a cash audit, an audit of the financial records, and a tax-related audit. This audit report shall be brought to the attention of the Chairman of the Supervisory Board.

§ 20
Auflösung der Gesellschaft

Im Falle der Auflösung der Gesellschaft erfolgt die Liquidation durch die Geschäftsführung, sofern nicht die Gesellschaftsversammlung etwas anderes beschließt.

§ 20
Dissolution of the Company

In the event of the dissolution of the Company, liquidation is performed by the Management unless the Shareholders' Meeting stipulates otherwise.

§ 21
Bekanntmachungen der Gesellschaft

Die Bekanntmachungen der Gesellschaft erfolgen im Amtsblatt der Stadt Essen und – soweit gesetzlich vorgeschrieben – im Bundesanzeiger.

§ 21
Announcements by the Company

Company announcements are published in the Official Gazette of the City of Essen and – if required by the law – in the Federal Gazette.

§ 22
Salvatorische Klausel

Falls einzelne Bestimmungen dieses Vertrages unwirksam sein sollten oder dieser Vertrag Lücken enthält, wird dadurch die Wirksamkeit der übrigen Bestimmungen nicht berührt. In diesem Fall sind sich die Gesellschafter darüber einig, dass solche rechtsunwirksamen Bestimmungen bald möglichst durch rechtsgültige zu ersetzen sind, die dem beabsichtigten rechtlichen oder wirtschaftlichen Erfolg nahe kommen.

§ 22
Saving Clause

Should single provisions of this Memorandum and Articles of Association be invalid or should this Memorandum and Articles of Association be incomplete, this shall not affect the validity of the other provisions. In this case, the Shareholders agree that such legally ineffective provisions are to be replaced as soon as possible with legally effective ones which approximate the intended legal or economic effect of those replaced.

§ 23
Gründungskosten

Die Kosten der Beurkundung des Gesellschaftsvertrages, der Bekanntmachung, der Anmeldung der Gesellschaft und ihrer Eintragung in das Handelsregister, sowie die Kosten der Gründungsberatung trägt die Gesellschaft.

§ 23
Formation Expenses

The cost of the notarial recording of the Memorandum and Articles of Association, the official announcement, the registration of the Company and its entry in the Commercial Register, as well as the cost of consultancy services in connection with the formation, are borne by the Company.

Zollverein (Germany)

No 975

Identification

Nomination	The Cultural Industrial Landscape of the Zollverein Mine
Location	Land Nord-Rhein-Westfalen
State Party	Federal Republic of Germany
Date	4 November 1999 (revised text)

Justification by State Party

When the Zollverein Mine XII was completed in 1932, it was considered to be the most modern and beautiful coal mine in the world, the daily output of which, 12,000 tonnes of hard coal, was four times higher than the normal figure. The same year saw the end of the Bauhaus, the most noble objective of which had been to work towards the "new building of the future" by fusing craft and art. In the opinion of the founder of the Bauhaus, Walter Gropius, the goal of architecture was to create objects and spaces for the purpose of which a new development of form had to proceed, in particular, from the works of engineering and industry. At the Zollverein mine the Bauhaus maxim that form must be oriented towards function is perfectly translated into reality.

Zollverein XII was created at the end of a phase of political and economic upheaval and change in Germany, which was represented aesthetically in the transition from Expressionism to Cubism and Functionalism. At the same time, Zollverein XII embodies this short economic boom between the two World Wars, which has gone down in history as the "Roaring Twenties." However, Zollverein is also, and by no means least, a monument of industrial history reflecting an area in which, for the first time, globalization and the worldwide interdependence of economic factors played a vital part.

The architects Fritz Schupp and Martin Kemmer developed Zollverein XII in the graphic language of the Bauhaus as a group of buildings which combined form and function in a masterly way. **Criterion i**

The cultural landscape of the Zollverein Mine bears unique witness to the complex interrelationships of living and working, dominated by large-scale industry, in the midst of one of the largest cultural landscapes in the world. **Criterion ii**

Zollverein XII is an individual monument of outstanding significance in the landscape. During the phase, never to be repeated, of concentration of groups of heavy industries, it was built as an investment provided with all the visionary ambitions of industrial rationalism. Thus it embodies one of the most fundamental ideas of industrial activity in a globally unique manner. **Criterion iii**

With a daily output of 12,000 tonnes of usable coal, Zollverein XII was the most efficient mine in the world. Under the difficult geological conditions of the region, the achievement of this level of output was an outstanding technological feat. **Criterion vi**

Category of property

In terms of the categories of cultural property set out in Article 1 of the 1972 World Heritage Convention, this is a *site*. It is also a *cultural landscape*, as defined in paragraph 39 of the *Operational Guidelines for the Implementation of the World Heritage Convention*.

History and Description

History

Consolidation of the mining claim area was completed in December 1847: the area concerned covered 13.2km^2. At that time it was the northernmost mine in the region. It belongs to the Gelsenkirchen anticline, in which the coal seams, averaging 1.17m thick, are deeply stratified. Mining began in the mid 19th century at a depth of *c* 120m and finished at the fourteenth level (1200m). By the end of mining the underground roadways extended over 120km; they were accessed by twelve shafts, opened up progressively between 1847 and 1932. When Zollverein XII was opened, the earlier shafts were used solely for the movement of men and supplies; all the extracted coal was handled by the new shaft until the mine closed in 1986. The methods of mining evolved as technology developed from hand picks to mechanized coal cutting.

The coals being extracted at Zollverein were especially suitable for coking. Consequently, the first stack-type coke-ovens were built there in 1857. The coking plant expanded considerably over the decades that followed. However, when the Zollverein mine was taken over by the steel company, Vereinigte Stahlwerke AG, in 1926, a new coking plant (the Nordstern plant) was built to process all the coal from its pits in the region. Coke production returned to Zollverein in the late 1950s, when the then holding company for the mines in the region, Gelsenkirchen Bergwerks AG, decided to build a new coking plant to supplement the Nordstern plant. It began production in 1961 from eight batteries, each of 24 ovens, producing 8600t per day; there were also facilities for processing by-products such as tar, sulphuric acid, benzene, ammonium compounds, and gas. This plant closed down in 1993 because of the fall in the demand for coke.

The construction of the stretch of the Cologne-Minden railway between Oberhausen and Hamm in 1847 was decisive for the location of the early Zollverein shafts, which were sunk 500m from the new line so as to facilitate transport of the coal and coke produced. The first passenger station did not open until forty years later. There were also links with the Emscher Valley line, also opened in 1847, which cut the north-western corner of the Zollverein concession. There followed a series of internal link lines during the next eighty years. It was connected with that of the neighbouring Bonifacius mine after Zollverein was taken over by Vereinigte Stahlwerke in 1926.

Coal mining produces enormous quantities of waste material, which is deposited in the characteristic pit heaps. The earliest of these, to the east of shaft 1/2, was planted with trees in 1895 and used as a recreational area for the mine officials. A second grew to the west of shaft 1/2 from that time, and in 1932 was used for pond management, to dry out the boiler-ash and coal slurries from Zollverein XII. A heap begun in 1880 was partially cleared in 1958 to provide land for miners' housing. Other heaps were used for filling areas where coal had been removed from a steeply dipping seam and on an abandoned airfield.

Intensive mining resulted in a number of subsidences, in some places as deep as 25m. This necessitated clearance of irretrievably damaged housing and other facilities. Subsidence exacerbated the water problems in the so-called Emscher Zone, where mining adversely affected the gravitational flow and created large areas of swamp. Local industries and municipalities created the Emscher Association, which carried out a number of projects using pumping stations and creating polders.

The workforce steadily increased to *c* 5000 by the end of the 19th century. During the 20th century it fluctuated between 5000 and 8000. Because there were no alternative property developers when work began in 1847, Zollverein began to construct housing for its workers. Building projects were integrated with the mine operating programmes.

Large building sites were purchased and by 1860 146 flats were ready for occupancy; at that time the mine employed 710 workers. This "Hegemannshof Colony" expanded steadily (by the turn of the century it covered around 90ha), and subsequently two more colonies, "Ottekampshof" and "Beisen," were added. By World War I the property owned by the mine had grown to over 720ha. However, this was by no means adequate for a workforce that numbered some 5000 at that time. Between the two World Wars new workers' housing developed, notably the housing estate built by the Trust Agency for Miners' Housing. In the late 1920s the mine could provide each of its salaried employees and officials with an apartment, but only some 3000 were available for the 8000 workers. After World War II new estates consisting of apartment blocks were built by the housing association established by Vereinigte Stahlwerke AG, such as the Kaldekirche, Westerbruch, and Kapitlacker estates from the 1950s. The Glückauf estate was built by the miners themselves working in collaboration. The houses were owned by private individuals. Two Pestalozzi villages were also built for apprentices. In 1958 there were 7061 dwellings available for a workforce of 8000.

From the start the mine provided consumer services for its employees, selling food and manufactured goods at low prices. They began on a "cooperative" basis, profits being returned to consumers in the form of an annual dividend. This scheme, with its six outlets, was taken over as a company enterprise by Vereinigte Stahlwerke. The system gradually declined after World War II because of competition from commercial stores, and the remaining outlets were bought out in the 1970s.

From the mid 1920s the mine provided welfare services for its employees. The first welfare centre was set up in 1928 (it was rehoused in 1938) and the second in 1934. A large modern welfare centre designed by Fritz Schupp was built in 1953. However, Zollverein closed its welfare facilities in the early 1960s, in line with the current trend in the Ruhr.

Description

- The pits

Only the foundations of the Malakow towers of the original pit survive; they are built over by the present headgear (Pit 1, 1956-58; Pit 2, constructed at the Friedlicher Nachbar mine 1950, transferred to Zollverein 1965), both designed by Fritz Schupp. The brick winding-engine building dates from 1903, with an extension by Schupp of 1958. The 1922 main store has a reinforced concrete frame. The pithead baths are in the form of a brick hall, capable of providing facilities for 3000 miners. The ensemble is completed by the imposing administrative building (1906), the director's villa (1898), and the mine officials' residence (1878). Less survives of the buildings of Pits 3/7/10, 4/11, and 6/9, apart from the 33m high headgear of Pit 10 (1913).

At Pit XII the central hoisting unit (Schupp, 1932) is preserved almost in its entirety. The building axis, which runs parallel to the tracks of the mine railway station, is defined by the central energy-supply plants. These comprise the compressed-air plant (boiler house and upstream compressor houses) in the north and the control station in the south. The stack on the axis of symmetry behind the boiler house, the main feature of the ensemble, was demolished in 1979 for safety reasons.

At right-angles to this group are the buildings of the tub turntable, raised so as to permit passage for wagons. The buildings of the screening plant, the electrostatic precipitator, and the refuse hopper are annexed to this group. The belt-conveyor bridge establishes a functional connection between the refuse hopper, the picking-belt hall, and the coal-washing plant.

With the change from tub to skip extraction at the pit large parts of the tub turntable became redundant, but it was necessary to build an additional conveyor-belt bridge and a connecting building. The facade on the right of the pithead building was closed because of appearance of the "court of honour" was impaired by the new structures.

This entire ensemble was the work of Fritz Schupp, apart from the roof superstructure, which had to be raised in 1982 to accommodate large new dust-extraction plant.

- The coking plants

The coking plants at the individual Zollverein pits have all been demolished, but the central plant has been conserved since it closed down in 1993. The ovens extend over a distance of nearly 1km, parallel to the former Cologne-Minden railway line. Their equipment – pushers, quenching station, screening plant, and loading stations – are all intact, as are the gas-treatment and by-products installations, and ancillary buildings. The result is a unique example of a large-scale industrial complex, which is open to the public and had more than 200,000 visitors in 1999.

- The railway lines

The original main railway lines (Cologne–Minden and the Bergische–Märkische line) are still in use, as part of the Bahn AG network. The railway connection between the Cologne-Minden line via the mine to the Rhein–Herne Canal is also preserved. The route from Zollverein to Bonifacius no longer has its tracks; it is now used as a bicycle path.

- The pit heaps

Most of the mine-refuse heaps are still visible, several having been planted with trees and used as local recreational areas. Subsidences have created small valleys which would be waterlogged had corrective measures not been taken. The pumping stations built in the 1960s and 1970s to relieve problems associated with gravitational water flow are standard functional structures.

- Miners' housing

In the former Hegemannshof and Ottekampshof colonies a considerable number of houses survive almost in their original state, but in a bad state of repair. These are for the most part four-dwelling buildings on a cross-shaped ground plan. They are built in brick, with large gardens attached. Large sections of both estates were, however, demolished in the 1960s as part of large-scale redevelopment projects and replaced by multi-storey apartment blocks.

The early private development in the centre of Katernberg and around the Roman Catholic church is virtually untouched. The facades of the upper floors retain their elaborate decorative details. The buildings around the market place such as the post office and the former town hall, built on land donated to the community by the mine, have preserved their original appearance to a considerable degree.

The Glückauf houses still survive, as do the Pestalozzi villages, with their characteristic single-storey houses with pitched gabled roofs in quiet winding streets. The multi-storey apartments blocks built by the housing associations are undistinguished in style; they are set apart from the earlier housing by the fact that they do not have individual gardens but are sited with extensive green areas around them. The Kapitalecker estate has survived essentially in its original form, though it is greatly in need of repair. Of greater interest are the Westernbruch and Kaldekirche estates with their decorative clinker brick facades.

The successive groups of houses constitute a remarkable sequence of approaches to workers' housing over a period of 140 years, during which profound social and economic changes took place.

- Consumer and welfare facilities

Two of the consumer facilities survive, although one had to be undergo extensive rebuilding after wartime damage. One is a three-storey brick-built structure and the other is two-storey with a decorated plaster facade. Both are now in use as retail shops.

The former welfare centre 1 in Viktoriastrasse still fills a similar function, as offices for medical and law practices. Modifications to the brick building designed by Fritz Schupp in 1938 to adapt it for its present use respected the original design and detailing. His 1953 centre, now in use as accommodation for asylum seekers, has been conserved but is not in a good state of repair.

Management and Protection

Legal status

When coal extraction ceased at Zollverein, the boundaries of the legally defined mining concession covering 13km^2 were no longer of relevance. The larger part, situated within the town of Essen, is within the Düsseldorf administrative district of the Province of North-Rhine Westphalia (*Land Nordrhein-Westfalen*). The north-eastern corner is in the town of Gelsenkirchen.

The area nominated for inscription on the World Heritage List is protected under the Law Governing the Protection and Conservation in the Federal State of North-Rhine Westphalia of 11 March 1980.

Management

Different parts of the nominated area are owned by both public and private bodies: Landsentwicklungsgesellschaft Nordrhein-Westfalen, Ruhrkohle AG, Kommunalverband Ruhrgebiet KVR, and VEBA Immobilien.

Application of the legislation is supervised by the provincial Ministry of Employment, Social and Urban Development, Culture and Sport, working with the municipal authorities of Düsseldorf and Essen. Direct management is the responsibility of two non-profit-making foundations, Stiftung Industriedenkmalpflege und Geschichtskultur and Stiftung Zollverein.

A "Craftsmen's Guild," analogous to those at the great cathedrals, has been set up by the town of Essen and the Regional Development Company to carry out regular maintenance and provide training in conservation practices and techniques.

A National Park of Industrial Culture is being established, which will operate in accordance with a management plan covering the entire area of industrial sites making up the Zollverein. New uses have been devised for most of the main industrial features – a theatrical rehearsal stage, the municipal meeting centre, the North-Rhine Westphalia design office, a private art gallery, workshops for retraining the long-term unemployed, etc.

Conservation and Authenticity

Conservation history

A large-scale rehabilitation programme to preserve the external appearance of the mine complex was carried out in 1990–98. The steel frames of the buildings have been secured and conserved.

The interrelationship of the different industrial components has been secured by retaining at least one major item of plant in each building. In the case of the main boiler house, the vast items of equipment are still *in situ*, but the interior has been adapted for use as an exhibition centre in accordance with plans drawn up by the UK architectural office of Sir Norman Foster and Partners.

Maintenance is assured with the willing help of former workers of the Zollverein mine. There are also training programmes connected with maintenance and presentation of the complex.

Future projects include a major restoration project for the coke-oven plant and further conservation work on the pit heaps.

There is, however, no overall management plan for the historic industrial plant, with a clear management philosophy and objectives. Especially serious is the lack of any conservation programme for the many large items of equipment, the coking plant, or the "white side" of the coke ovens, the chemical processing plant. This is essential, and should begin with a complete inventory of every item of plant on the site.

Authenticity

As an industrial landscape, the Zollverein mine has a high level of authenticity. It comprises all the components of intensive 19th and 20th century industrial exploitation – the complete complex of buildings and equipment necessary for the extraction and treatment of coal and the production of coke, the requisite transportation network (in this case of railways), and the dwellings and communal buildings of the large community of workers, as well as the vast heaps of pit waste.

The individual industrial components have of necessity lost their functional authenticity. However, a policy of sensitive and imaginative adaptive reuse has ensured that their forms survive intact, with significant items of industrial plant preserved, and that their interrelationships remain clearly and logically visible. In particular, the authenticity of the important group of industrial buildings designed for Zollverein XII by Fritz Schupp has been carefully conserved

Social and economic changes have meant that the authenticity of the surviving workers' houses is somewhat variable. However, efforts have been made to ensure that part at least of their group value and authenticity has been retained, so that the corpus illustrates the development of attitudes to workers' housing over an economically and socially significant period of 150 years.

Evaluation

Action by ICOMOS

An ICOMOS-TICCIH expert mission visited the property in February 2000.

Qualities

Coal was essential to the rapid development of industry worldwide in the 19th and 20th centuries. The Zollverein mine constitutes outstanding material evidence of the evolution and decline of this key industry over the past 150 years. The picture that it presents is a comprehensive one, covering the industrial, economic, and social aspects in a remarkably comprehensive manner. The buildings of Pit XII are exceptional examples of the successful application and adaptation of the principles of the Modern Movement to the requirements of heavy industry.

Comparative analysis

The number of coal-mining complexes that operated from the 19th century through to the latter part of the 20th century has never been large, since mines closed down once their coal deposits were exhausted and mining moved elsewhere. The use of alternative sources of energy has seen the role of coal diminish greatly in the past half-century, and in consequence mines have closed down at an accelerating rate. In most cases, this has been accompanied by the demolition of the coal and coke treatment and handling installations. The Zollverein is a rare survival and no comparable site can be identified.

ICOMOS comments

The original nomination was of an area based on the previous extent of underground coal-mining concessions at the Zollverein mine. This bears no relationship to surface features, frequently intersecting streets or districts, and does not include all the historic settlements, of which there are at least nine on the map provided with the original nomination. ICOMOS proposed that the nominated area be confined to the Zollverein XII and Zollverein I and II mines, with the adjoining coking plant. This would provide a clear site boundary, bordered by suitable roads and for the most part enclosed by a high wall.

It was accepted that the surrounding area is a cultural landscape with many important workers' housing complexes, villas, public buildings, churches, etc, but these would be better treated as the buffer zone to the main industrial complex. The zone should be extended to include the suburbs of Katernberg, Schonnebeck, and Stoppenberg. Consideration should also be given to the inclusion of other important mining sites in the area as part of the nominated area.

ICOMOS was very impressed by the meticulous and sensitive conservation and adaptive reuse of the 1930s buildings. It was, however, concerned about the interventions in the coking plant, now managed by an arts organization, and also by a proposal to build a five-storey glass block on top of the washing plant, to house a postgraduate institute of art and design.

At its 24th session in Paris in June 2000 the Bureau of the World Heritage Committee deferred further consideration of this nomination, requesting the State Party to reconsider the boundaries of the nominated area and the buffer zone, to abandon the plans to build a new structure on top of the washing plant, and to prepare a comprehensive management plan for the industrial site, with a conservation plan based on the preparation of a detailed inventory.

The State Party subsequently provided a new plan which took into account the revised boundaries proposed by ICOMOS and gave assurances about the future management of the coking plant and washing plant. In November 2000 a document was submitted to ICOMOS entitled *Regulatory regime for the conservation of "The Cultural Industrial Landscape of the Zollverein Mine*. This document was studied by ICOMOS and TICCIH, who were of the opinion that it did not fully comply with the requirements of the Committee.

The State Party provided a management plan to ICOMOS two days before the 25th Session of the Bureau. Supplementary information was also supplied by the State Party regarding the structure and responsibilities of the Zollverein Development Company (*Entwicklungsgesellschaft Zollverein mbH*). This documentation has been studied by ICOMOS and TICCIH, who consider that it complies with the Committee's requirements regarding management.

The State Party had indicated that it wished to change the name of the nominated property to "The Zollverein Coal Mine Industrial Complex," a proposal with which ICOMOS is in agreement.

Brief description

The Zollverein industrial landscape consists of the complete installations of an historical coal-mining site, with some 20th century buildings of outstanding architectural merit.

Statement of significance

The Zollverein XII Coal Mine Industrial Complex is an important example of a European primary industry of great economic significance in the 19th and 20th centuries. The mine is especially noteworthy for the high architectural quality of its buildings of the Modern Movement.

ICOMOS Recommendation

That this property be inscribed on the World Heritage List on the basis of ***criteria ii and iii***:

> ***Criterion ii*** The Zollverein XII Coal Mine Industrial Complex is an exceptional industrial monument by virtue of the fact that its buildings are outstanding examples of the application of the design concepts of the Modern Movement in architecture in a wholly industrial context.
>
> ***Criterion iii*** The technological and other structures of Zollverein XII is representative of a crucial period in the development of traditional heavy industries in Europe, when sympathetic and positive use was made of architectural designs of outstanding quality.

Bureau Recommendation

That this nomination be *referred back*, to allow ICOMOS time to review the requested management plan received only recently from the State Party.

ICOMOS, September 2001

Zollverein (Allemagne)

No 975

Identification

Bien proposé	Le paysage industriel et culturel de la mine de Zollverein
Lieu	Land de Rhénanie-du-Nord-Westphalie
État partie	République Fédérale d'Allemagne
Date	4 novembre 1999 (texte révisé)

Justification émanant de l'État partie

Quand la Mine XII de Zollverein fut achevée, en 1932, elle était réputée être la plus moderne et la plus belle des mines de charbon dans le monde, avec une production qui, à 12.000 tonnes de charbon maigre par jour, était quatre fois supérieure à la normale. Cette même année marqua la fin du Bauhaus, dont le plus noble objectif avait été de travailler à la réalisation du « nouveau bâtiment du futur » en mariant métier et art. De l'avis du fondateur du Bauhaus, Walter Gropius, l'architecture avait pour but de créer des objets et des espaces pour lesquels un nouveau développement des formes devait naître, tout particulièrement des ouvrages d'ingénierie et de l'industrie. La mine de Zollverein applique parfaitement, dans la réalité, la maxime favorite du Bauhaus : la forme doit procéder de la fonction.

Zollverein XII fut créée à la fin d'une phase de bouleversements et de changements, tant politiques qu'économiques, en Allemagne, qui trouve sa traduction esthétique dans la transition de l'expressionnisme au cubisme et au fonctionnalisme. Par ailleurs, Zollverein XII est la vivante illustration de cette courte période de prospérité économique de l'entre-deux guerres, entrée dans l'histoire sous le nom d' « Années Folles ». Cependant, Zollverein est aussi, voire même peut-être surtout, un monument historique industriel, reflet d'un secteur dans lequel la mondialisation et l'interdépendance mondiale des facteurs économiques ont pour la première fois joué un rôle capital.

Les architectes Fritz Schupp et Martin Kemmer ont conçu Zollverein XII, dans le langage graphique du Bauhaus, comme un groupe d'édifices qui combinent magistralement forme et fonction.

Critère i

Le paysage culturel de la Mine de Zollverein est un témoignage exceptionnel des relations complexes entre la vie et le travail, sous l'égide d'une industrie titanesque, en plein cœur d'un des plus vastes paysages culturels au monde.

Critère ii

Zollverein XII est un monument individuel d'une importance exceptionnelle au sein du paysage. Durant la phase unique de concentration des groupes d'industrie lourde, il fut construit dans l'esprit de toutes les ambitions visionnaires du rationalisme industriel. Il incarne ainsi l'un des concepts les plus fondamentaux de l'activité industrielle, et ce d'une manière unique au monde.

Critère iii

Avec sa production quotidienne de 12 000 tonnes de charbon utilisable, Zollverein XII était la mine avec le plus gros rendement au monde. Au vu des difficiles conditions géologiques de la région, une production d'une telle ampleur était un exploit technologique exceptionnel.

Critère vi

Catégorie de bien

En termes de catégories de biens culturels, telles qu'elles sont définies à l'article premier de la Convention du Patrimoine mondial de 1972, il s'agit d'un *site*. Le bien est également un *paysage culturel*, tel que défini au paragraphe 39 des *Orientations devant guider la mise en œuvre de la Convention du patrimoine mondial*.

Histoire et description

Histoire

La consolidation de la concession minière fut achevée en décembre 1847 : la zone concernée couvrait 13,2 km². À cette époque, c'était la mine la plus au nord de la région. Elle appartient à l'anticlinal de Gelsenkirchen dans lequel les couches de charbon, d'une épaisseur moyenne de 1,17 m, sont profondément stratifiées. Les opérations minières ont commencé au milieu du XIXe siècle, à une profondeur de 120 m environ, et se sont achevées au quatorzième niveau (1200 m). À la fin des opérations minières, les voies souterraines s'étendaient sur plus de 120 km ; on y accédait via douze puits, progressivement ouverts entre 1847 et 1932. À l'époque où Zollverein XII fut ouverte, les premiers puits ne servaient qu'aux mouvements des hommes et des fournitures, tout le charbon extrait étant évacué par le nouveau puits jusqu'à la fermeture de la mine, en 1986. Les méthodes d'exploitation minière évoluèrent parallèlement à la technologie, de l'extraction manuelle à la pioche jusqu'aux haveuses mécaniques à charbon.

Les charbons extraits à Zollverein étaient particulièrement adaptés à la cokéfaction. Par conséquent, c'est là que furent construits les premiers fours de grillage à coke, en 1857. La cokerie s'étendit considérablement au fil des décennies qui suivirent. Toutefois, quand la mine de Zollverein fut reprise par l'aciérie Vereinigte Stahlwerke AG, en 1926, une nouvelle cokerie (le site de Nordstern) fut construite pour traiter tout le charbon extrait de ses mines dans la région. La production de coke retourna à Zollverein à la fin des années 50, quand la compagnie de holding de l'époque pour les mines de la région, Gelsenkirchen Bergwerks AG, décida de construire une nouvelle cokerie pour compléter le site de Nordstern. La production commença en 1961 avec huit batteries, de 24 fours chacune, produisant 8600 tonnes par jour. Des installations permettaient également le traitement des produits dérivés tels le goudron, l'acide sulfurique, le benzène, les composés ammoniacaux et le gaz. Le site ferma en 1993 du fait de l'effondrement de la demande de coke.

La construction du tronçon de chemin de fer Cologne-Minden entre Oberhausen et Hamm, en 1847, fut décisive pour l'implantation des premiers puits de Zollverein, qui furent creusés à 500 mètres de la nouvelle ligne afin de faciliter le transport du charbon et de la coke. La première gare de passagers n'ouvrit que quarante ans plus tard. Il existait également des liaisons avec la ligne de la vallée d'Emscher, elle aussi inaugurée en 1847, qui coupaient l'angle nord-ouest de la concession Zollverein. Au fil des quatre-vingt années qui suivirent, une série de lignes de liaison intérieure s'ajoutèrent. Elles furent reliées à celles de la mine voisine de Bonifacius quand Zollverein fut repris par la Vereinigte Stahlwerke en 1926.

L'exploitation minière du charbon produisait d'énormes quantités de déchets, déposés dans les caractéristiques terrils. Le plus ancien, à l'est du puits 1/2, fut planté d'arbres en 1895 et devint une aire de loisirs destinée au personnel dirigeant de la mine. Un second se développa à partir de cette époque à l'ouest du puits 1/2. Après 1932, il fut utilisé pour assécher les dépôts boueux de chaudière et le charbon limoneux issus de Zollverein XII. Un terril commencé en 1880 fut partiellement déblayé en 1958 pour accueillir des logements de mineurs. D'autres terrils furent utilisés pour le remplissage de zones où du charbon avait été extrait d'une couche en forte déclivité et sur un aérodrome désaffecté.

L'exploitation minière intensive entraîna l'apparition d'un certain nombre d'affaissements, atteignant parfois 25 mètres de profondeur. Ceci imposa la démolition des maisons et autres installations endommagées au point d'être irréparables. Ces affaissements n'ont fait qu'exacerber les problèmes d'eau dans la zone dite d'Emscher, où l'exploitation minière a eu un impact néfaste sur le courant gravitationnel, créant de vastes marécages. Les industries et municipalités locales mirent sur pied l'association Emscher, qui mena à bien plusieurs projets en faisant appel à des stations de pompage et en créant des polders.

Les effectifs connurent une progression régulière, jusqu'à atteindre 5000, approximativement, à la fin du XIXe siècle. Au XXe siècle, ce chiffre fluctua entre 5000 et 8000. Étant donné l'absence d'autres promoteurs immobiliers quand le travail commença, en 1847, Zollverein commença à construire des logements pour ses ouvriers. Les projets de construction furent intégrés aux programmes d'exploitation de la mine.

D'importants sites de construction furent achetés et, en 1860, 146 appartements étaient prêts à accueillir leurs locataires ; à cette époque, la mine employait 710 travailleurs. Cette « colonie Hegemannshof » s'accrut régulièrement (à la fin du siècle, elle couvrait environ 90 hectares) et, par la suite, deux autres, « Ottekampshof » et « Beisen », lui furent adjointes. Quand la première guerre mondiale éclata, les biens immobiliers appartenant à la mine couvraient plus de 720 hectares. Toutefois, cela était loin d'être suffisant pour une force de travail qui comptait à l'époque quelques 5000 hommes. À l'entre-deux guerres, de nouveaux logements furent construits, notamment le lotissement construit par le Trust pour le Logement des Mineurs. À la fin des années 20, la mine pouvait fournir à chacun de ses employés et dirigeants salariés un appartement, mais il n'y en avait que 3000, environ, disponibles pour les 8000 ouvriers. Après la seconde guerre mondiale, de nouveaux lotissements composés d'immeubles furent construits par l'association de logement fondée par la Vereinigte Stahlwerke AG, tels que les complexes Kaldekirche, Westerbruch et Kapitlacker, à partir des années 50. Le lotissement Glückauf est l'œuvre des mineurs eux-mêmes. Les maisons appartenaient à des particuliers. Deux villes Pestalozzi furent également bâties pour les apprentis. En 1958, 7061 logements étaient mis à la disposition d'une force de travail comptant 8000 hommes.

Dès le départ, la mine fournit des produits de consommation à ses employés, vendant de la nourriture et des produits finis à bas prix. Ces services prirent au début la forme d'une coopérative, les bénéfices étant restitués aux consommateurs sous forme de dividendes annuels. Vereinigte Stahlwerke reprit ce programme, avec ses six points de vente, en tant qu'entreprise. Le système connut un déclin progressif à partir de la deuxième guerre mondiale, du fait de la concurrence des magasins commerciaux, et les points de vente restants furent rachetés dans les années 70.

À partir du milieu des années 20, la mine fournit des services d'aide sociale à ses employés. Le premier centre d'aide sociale fut établi en 1928 (et relogé en 1938), le deuxième en 1934. Un centre d'aide social grand et moderne, conçu par Fritz Schupp, vit le jour en 1953. Cependant, Zollverein ferma ses établissements d'aide sociale au début des années 60, suivant la tendance de l'époque dans la Ruhr.

Description

- Les puits

Seules demeurent les fondations des tours Malakow de la mine d'origine ; elles ont été recouvertes par l'actuel chevalement des molettes (Puits 1, 1956-1958 ; Puits 2, construit à la mine Friedlicher Nachbar en 1950, transféré à Zollverein en 1965 ; tous deux construits par Fritz Schupp). Le bâtiment de briques abritant le moteur d'extraction date de 1903, avec une extension conçue par Schupp en 1958. L'entrepôt principal de 1922 possède une structure de béton armé. Les douches du carreau de mine, un édifice en brique, sont capables d'accueillir 3000 mineurs. L'ensemble est complété par un imposant bâtiment administratif (1906), la villa du directeur (1898) et la résidence des officiels de la mine (1878). Plus rares sont les vestiges des structures des puits 3/7/10, 4/11 et 6/9, exception faite du chevalement des molettes du puits 10 (1913), haut de 33 m.

Au puits XII, l'unité centrale de levage (Schupp, 1932), subsiste dans sa quasi totalité. L'axe de construction, parallèle aux voies de chemin de fer de la mine, est défini par les principales installations d'alimentation en énergie. Il s'agit de l'installation à air comprimé (salle des chaudières et salles des compresseurs), au nord, et du poste de contrôle, au sud. La cheminée suivant l'axe de symétrie derrière la salle des chaudières, trait principal de l'ensemble, fut démolie en 1979 pour des raisons de sécurité.

Perpendiculairement à ce groupe se trouvent les édifices de la plaque tournante, surélevée de façon à permettre le passage des wagons. Les bâtiments de l'usine de séparation, le filtre électrostatique et la trémie à déchets, sont annexés à ce groupe. Le pont à courroie transporteuse assure la liaison fonctionnelle entre la trémie à déchets, la halle de la bande de triage et l'usine de débourbage.

Avec l'abandon des wagonnets au profit de l'extraction par skips, plusieurs parties de la plaque tournante devinrent obsolètes, mais il s'avéra nécessaire de construire un pont à courroie transporteuse supplémentaire, ainsi qu'un bâtiment de liaison. La façade à droite du bâtiment du carreau de mine fut fermée, car les nouvelles structures nuisaient à l'aspect de la « cour d'honneur ».

L'ensemble tout entier est l'œuvre de Fritz Schupp, hormis la superstructure du toit, qui dut être surélevée en 1982 pour faire de la place pour une grande installation de dépoussiérage.

- Les cokeries

Les cokeries des puits de Zollverein ont toutes été démolies, mais l'usine centrale a été conservée depuis sa fermeture, en 1993. Les fours s'étendent sur presque un kilomètre, parallèlement à l'ancienne ligne de chemin de fer Cologne-Minden. Les équipements - accrocheurs au puits, station de trempe, atelier de tamisage et stations de chargement - sont tous intacts, à l'instar des installations de traitement des gaz et des sous-produits et des édifices annexes. Le résultat est un exemple unique de complexe industriel à grande échelle, ouvert au public, qui a reçu plus de 200.000 visiteurs en 1999.

- Les lignes de chemin de fer

Les lignes de chemin de fer originales (Cologne-Minden et Bergische-Märkische) sont toujours utilisées, dans le cadre du réseau Bahn AG. La liaison ferroviaire entre la ligne Cologne-Minden et le canal Rhin-Herne, via la mine, est également intacte. La voie menant de Zollverein à Bonifacius n'a plus de rails ; elle sert aujourd'hui de piste cyclable.

- Les terrils

La plupart des terrils de la mine demeurent intacts ; plusieurs ont été reboisés et servent d'aires de loisirs. Les affaissements ont donné naissance à de petites vallées qui seraient inondées n'eussent été les mesures correctives prises. Les stations de pompage construites dans les années 1960 et 1970 pour résoudre les problèmes liés aux courants gravitationnels sont des structures fonctionnelles standard.

- Logements des mineurs

Dans les anciens lotissements de Hegemannshof et Ottekampshof, un nombre considérable de maisons sont quasiment intactes, mais sont néanmoins en mauvais état. Il s'agit pour la plupart de bâtiments réunissant quatre logements, de plan cruciforme. En briques, ils disposent de grands jardins. Néanmoins, d'importantes sections de ces lotissements ont été démolies dans les années 60, dans le cadre de vastes projets de redéveloppement, et ont été remplacées par des immeubles.

Les premiers logements privés, au centre de Katernberg et autour de l'église catholique romaine, n'ont quasiment pas changé. Les façades des étages conservent leurs ornements élaborés. Les édifices entourant la place du marché, tels la poste et l'ancien hôtel de ville, construits sur des terrains que la mine offrit à la communauté, ont préservé dans l'ensemble leur aspect original.

Les maisons de Glückauf subsistent, tout comme les villages Pestalozzi, avec leurs caractéristiques : de plain-pied, avec des toits à pignons en pente, dans de calmes rues sinueuses. Les immeubles construits par les associations de logement ne présentent pas de style distinct ; ils se différentient des logements antérieurs en ce qu'ils ne possèdent pas de jardins individuels, mais s'inscrivent dans de vastes espaces verts. Le lotissement Kapitalecker a subsisté sous sa forme d'origine, quoiqu'il ait un besoin urgent de réparation. Plus intéressants, les lotissements Westernbruch et Kaldekirche s'enorgueillissent de façades en briques vitrifiées.

Les groupes successifs de maisons constituent une remarquable séquence de l'approche des logements de travailleurs sur 140 ans, période au cours de laquelle de profonds changements sociaux et économiques se produisirent.

- Infrastructures de consommation et service d'aide sociale

Deux des infrastructures de consommation subsistent, même si l'une d'entre elles a dû être en grande partie reconstruite après la guerre. L'une est une structure de briques de trois étages ; l'autre s'élève sur deux étages, avec une façade de plâtre ornée. Toutes deux sont aujourd'hui des magasins de vente au détail.

L'ancien centre d'aide sociale 1, sur Viktoriastrasse, remplit toujours une fonction similaire, abritant des cabinets de médecins et d'avocats. Les modifications apportées au bâtiment de brique imaginé par Fritz Schupp en 1938 pour l'adapter à son usage actuel ont respecté la conception et les détails d'origine. Son centre de 1953, aujourd'hui structure d'accueil pour les demandeurs d'asile, a été conservé mais il est en piteux état.

Gestion et protection

Statut juridique

Quand l'extraction de charbon a cessé à Zollverein, les limites de la concession minière légalement définie, couvrant 13 km², ont perdu leur pertinence. La plus grande partie, située dans la ville d'Essen, se trouve dans le district administratif de Düsseldorf, Land de Rhénanie-du-Nord-Wesphalie *(Land Nordrhein-Westfalen)*. L'angle nord-est appartient à la ville de Gelsenkirchen.

La zone proposée pour inscription sur la Liste du patrimoine mondial est protégée par la loi régissant la protection et la conservation dans l'État Fédéral de Rhénanie-du-Nord-Westphalie du 11 mars 1980.

Gestion

La zone proposée pour inscription appartient à diverses entités publiques et privées : Landsentwicklungsgesellschaft Nordrhein-Westfalen, Ruhrkohle AG, Kommunalverband Ruhrgebiet KVR et VEBA Immobilien.

Le ministère provincial de l'Emploi, du Développement social et urbain, de la Culture et des Sports, en collaboration avec les autorités municipales de Düsseldorf et d'Essen, supervise l'application de la législation. La gestion directe a été confiée à deux fondations à but non lucratif, Stiftung Industriedenkmalpflege und Geschichtskultur et Stiftung Zollverein.

Une « Guilde des Ouvriers de Métier », semblable à celles des grandes cathédrales, a été fondée par la ville d'Essen et la Société de Développement Régional pour assurer une maintenance régulière et la formation aux pratiques et techniques de conservation.

Un parc national de la Culture industrielle est également en voie d'établissement ; il fonctionnera conformément à un plan de gestion couvrant toute la zone des sites industriels qui composent Zollverein. La plupart des grandes installations industrielles se sont vues affecter de nouveaux usages : centre de répétitions théâtrales, centre de réunion du conseil municipal, bureau de design de Rhénanie-du-Nord-Westphalie, galerie d'art privé, ateliers de formation des chômeurs longue durée, etc.

Conservation et authenticité

Historique de la conservation

Un programme de réhabilitation à grande échelle, visant à préserver l'aspect externe du complexe minier, a été mis en œuvre de 1990 à 1998. Les structures d'acier des bâtiments ont été renforcées et conservées.

Les relations entre les différents composants industriels ont été préservées, grâce à la conservation d'au moins un élément industriel majeur dans chaque bâtiment. Dans le cas de la grande halle des chaudières, les énormes équipements sont toujours en place, mais l'intérieur a été adapté de manière à pouvoir maintenant servir de centre d'exposition, conformément aux plans élaborés par le cabinet d'architectes britannique Sir Norman Foster and Partners.

La maintenance est assurée avec l'aide bénévole des anciens ouvriers de la mine de Zollverein. Des programmes de formation liés à la maintenance et à la présentation du complexe ont également été mis sur pied.

Parmi les futurs projets figurent un programme majeur de restauration de la cokerie et des travaux de conservation des terrils.

Il n'existe toutefois pour le site industriel historique aucun plan directeur de gestion énonçant des principes et objectifs clairs en la matière. L'absence de programme de conservation pour les grandes installations, la cokerie ou la « partie propre » des fours à coke, ainsi que pour l'usine de traitement chimique, est tout particulièrement préoccupante. Ce point est essentiel, et impose en premier lieu un inventaire complet de tous les équipements du site.

Authenticité

En tant que paysage industriel, la mine de Zollverein présente un degré élevé d'authenticité. Elle comprend tous les composants d'une exploitation industrielle intensive du XIXe et du XXe siècle - le complexe complet de bâtiments et d'équipements nécessaires à l'extraction et au traitement du charbon, à la production de coke, le réseau de transport adéquat (dans ce cas, il s'agit de transport ferroviaire), sans oublier les logements et les édifices publics de cette importante communauté ouvrière, ainsi que les énormes terrils.

Les composants industriels individuels ont bien entendu perdu leur authenticité fonctionnelle. Toutefois, une politique de recyclage sensible et imaginative a assuré la subsistance de leur forme, intacte, parallèlement à la préservation d'importants éléments des installations industrielles, et au maintien d'une visibilité claire et logique de leurs interrelations. L'authenticité du grand groupe de bâtiments industriels construit par Fritz Schupp pour Zollverein XII, en particulier, a soigneusement été préservée.

De par l'évolution économique et sociale, l'authenticité des logements ouvriers demeurant est quelque peu variable. Toutefois, tous les efforts ont été faits pour assurer que leur valeur d'ensemble et leur authenticité soient, au moins partiellement, conservées, afin qu'ils illustrent le développement des attitudes envers les logements ouvriers sur une période économiquement et socialement significative de 150 ans.

Évaluation

Action de l'ICOMOS

Une mission d'expertise de l'ICOMOS-TICCIH a visité le bien en février 2000.

Caractéristiques

Le charbon fut essentiel au rapide développement de l'industrie mondiale au XIXe et au XXe siècle. La mine de Zollverein constitue une preuve matérielle exceptionnelle de l'essor et du déclin de cette industrie prépondérante sur les 150 dernières années. L'image qu'elle présente est un aperçu d'ensemble, couvrant les aspects industriels, économiques et sociaux de façon remarquablement complète. Les bâtiments du puits XII sont des exemples exceptionnels de l'application réussie et de l'adaptation des principes du mouvement moderne aux exigences de l'industrie lourde.

Analyse comparative

Le nombre de mines de charbon en exploitation du XIXe siècle à la fin du XXe n'a jamais été important, les mines ayant fermé une fois les gisements de charbon épuisés, et l'exploitation se déplaçant alors ailleurs. L'usage d'autres sources d'énergie a vu le rôle du charbon grandement diminuer sur la dernière moitié du siècle et les mines ont par conséquent rapidement fermé. Dans la plupart des cas, ce fait s'est accompagné de la démolition des installations de traitement et de manutention du charbon et de la coke. La mine de Zollverein est l'une des rares survivantes, et aucun autre site ne peut lui être comparé.

Observations de l'ICOMOS

La zone proposée pour inscription à l'origine reposait sur les anciennes limites des concessions minières souterraines de la mine de Zollverein. Elle n'a aucun rapport avec les caractéristiques de surface, tronçonne fréquemment rues et quartiers, et ne comprend pas tous les peuplements historiques, qui sont neuf, au bas mot, sur le plan accompagnant la proposition d'inscription d'origine. L'ICOMOS a suggéré que la zone proposée pour inscription soit limitée à Zollverein XII et aux mines de Zollverein I et II, en y ajoutant la cokerie adjacente. Cette approche aurait le mérite de clairement délimiter le site, bordé par des routes appropriées et dans sa majeure partie enfermé dans l'enceinte d'un mur de haute taille.

S'il était entendu que la zone environnante est un paysage culturel présentant de nombreux et importants complexes de logements ouvriers, villas, bâtiments publics, églises, etc., il pouvait toutefois être plus approprié de faire de celle-ci la zone tampon protégeant le complexe industriel principal. Cette zone devrait être étendue aux banlieues de Katernberg, Schonnebeck et Stoppenberg. Il conviendrait également d'envisager l'inclusion des autres grands sites miniers de la région dans la zone proposée pour inscription.

L'ICOMOS était très impressionné par la conservation et la reconversion des bâtiments des années 30, méticuleuses et pleines d'intelligence. Il était cependant soucieux des interventions réalisées dans la cokerie, aujourd'hui confiée à la gestion d'une organisation artistique. Il était également préoccupé par la proposition d'édifier un bloc de verre de cinq étages au-dessus de l'atelier de lavage, pour installer un institut d'enseignement supérieur d'art et de design.

À sa vingt-quatrième session à Paris en juin 2000, le Bureau du Comité du patrimoine mondial a différé l'examen de ce bien en demandant à l'État partie de reconsidérer les limites de la zone proposée pour inscription et de la zone tampon, d'abandonner les plans de construction d'une nouvelle structure au-dessus de l'atelier de lavage, et de préparer un plan de gestion complet pour ce site industriel, avec un plan de conservation reposant sur la conduite d'un inventaire détaillé.

Par la suite, l'État partie a fourni un nouveau plan qui prend en compte les limites révisées proposées par l'ICOMOS et a donné des assurances sur la gestion à venir de la cokerie et l'atelier de lavage. En novembre 2000, un document intitulé *Régime réglementaire pour la conservation du « Paysage industriel et culturel de la mine de Zollverein »* a été soumis à l'ICOMOS. Ce document avait été étudié par l'ICOMOS et le TICCIH qui considérèrent qu'il ne répondait pas complètement aux exigences du Comité.

L'État partie avait fourni un plan de gestion à l'ICOMOS deux jours avant la 25ème session du Bureau. Des informations complémentaires étaient également fournies par l'État partie pour ce qui concerne la structure et les responsabilités de la Société de développement de Zollverein (*Entwicklungsgesellschaft Zollverein mbH*). L'ICOMOS et le TICCIH ont étudié cette documentation et ils considèrent qu'elle répond aux attentes du Comité en matière de gestion.

L'État partie avait également indiqué qu'il souhaitait changer le nom du bien proposé pour inscription en « Le complexe industriel de la mine de charbon de Zollverein », suggestion avec laquelle l'ICOMOS est d'accord.

Brève description

Le paysage industriel de Zollverein se compose des installations complètes d'un site historique d'extraction de charbon, avec plusieurs édifices du XXe siècle d'une valeur architecturale exceptionnelle.

Déclaration de valeur

Le complexe industriel de la mine de charbon de Zollverein XII est un exemple important d'une industrie du secteur primaire d'Europe d'une grande signification économique aux XIXe et XXe siècles. La mine est particulièrement remarquable en raison de la grande qualité architecturale de ses bâtiments du mouvement moderne.

Recommandation de l'ICOMOS

Que ce bien soit inscrit sur la Liste du patrimoine mondial sur la base des ***critères ii et iii*** :

> ***Critère ii*** Le complexe industriel de la mine de charbon de Zollverein XII est un monument industriel remarquable car ses bâtiments sont des exemples exceptionnels de la mise en application des concepts de design du mouvement moderne en architecture dans un contexte purement industriel.
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> ***Critère iii*** Les structures technologiques et associées de Zollverein XII sont représentatives d'une période cruciale dans le développement des industries lourdes traditionnelles en Europe où l'on utilisait à bon escient et de manière harmonieuse des conceptions architecturales d'une qualité exceptionnelle.

Recommandation du Bureau

Que cette proposition d'inscription soit ***renvoyée***, pour permettre à l'ICOMOS d'étudier le plan de gestion demandé et reçu de l'État partie seulement récemment.

ICOMOS, septembre 2001