

A More Competitive Energiewende: Securing Germany's Global Competitiveness in a New Energy World

Main Report



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Contents

Executive summary: A More Competitive Energiewende	1
Report structure	9
1. New global energy reality challenges Germany's international competitiveness	11
2. German consumer electricity prices have been rising rapidly	15
3. Growing energy price differentials have impaired German competitiveness	19
4. Defining the energy scenarios	29
5. Rebates are crucial to German industrial competitiveness	33
6. The potential for expanded natural gas production in Germany	41
7. Reforming the Energiewende to reduce power system costs	53
8. Economic impact of reducing the cost of the power system and developing Germany's shale gas potential	63
9. Conclusions	73

Appendices

Eight appendices are also available at www.ihs.com/GCSv2. They are as follows:

Appendix 1: The EEG and German energy policy

Appendix 2: Case studies - Supply chains and innovation networks in German manufacturing

Appendix 3: Methodology for shale gas resource assessment and economic impact of gas production in Germany

Appendix 4: Capturing the linkage between energy prices, exports, and investment

Appendix 5: Tailored model system for the industry and macroeconomic scenario analysis

Appendix 6: Energy modeling approach

Appendix 7: Commodity price outlooks

Appendix 8: References

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Executive summary: A More Competitive Energiewende

Germany's prosperity, more than that of any other major industrial nation, depends on its ability to export. But in a highly competitive world, German industry is at increasing disadvantage owing to the growing energy price disadvantage that it faces. Average industrial electricity prices in Germany have risen approximately 60% since 2007, while prices in the United States and in China have increased less than 10%.

This price gap between Germany and its competitors is the result of two factors. First, costs associated with the Energiewende have risen rapidly. Germany is already committed to an additional €185 billion (constant 2013) in renewables support costs over the next two decades. Second, the shale gas revolution in North America has reduced gas prices there, making the United States a much more competitive location for manufacturing and exporting.

This price gap now threatens Germany's economic performance. Diverging international energy prices are a particular risk for Germany, owing to its reliance on a competitive manufacturing sector and exports. Manufacturing accounted for 21% of the German economy in 2013, one of the highest shares among all large developed economies. The difference is even more striking in terms of trade. Total exports represented 51% of German gross domestic product (GDP) in 2013, compared to 26% of GDP for China, 27% for France, 16% for Japan, and 13% for the United States.

The objective of the Energiewende was a competitive transition to a low-carbon economy. One of the key principles of this transition was to maintain "competitive energy prices."¹ Germany has rapidly developed renewables capacity, but it has not generated the expected reduction in CO₂ emissions. Moreover, with some of the highest electricity prices in the industrial world, Germany has failed to achieve its competitive energy price goal.

In the last few months, German policymakers and the wider public have increasingly become aware of the economic urgency of Energiewende reform. Considering the long-term economic consequences highlighted in this study, a successful reform of the Energiewende could be as important for Germany's economic performance in the years ahead as the labor market reforms were a decade ago.

The current high-cost energy path will make Germany less competitive in the world economy, penalize Germany in terms of jobs and industrial investment, and impose a cost on the overall economy and household income. Without reforms to the Energiewende, Germany will lose industrial capacity as investment moves offshore and the international market share of German products shrinks. The consequences for the German economy would be profound, directly affecting Germany's GDP, jobs, income, trade position, and government revenues. In January 2014, German Minister of Economy and Energy Sigmar Gabriel recognized this by warning that, "We have reached the limits of what we can ask of our economy" in terms of energy prices. He added that if Germany remains on the current course, it will face a "dramatic deindustrialization."²

This study describes a path to get the Energiewende back on the course originally intended. It points the way to a "More Competitive Energiewende," pivoting away from a focus solely on renewables development toward a more balanced approach. A more measured pace of renewables growth brings an increase in CO₂ emissions over the path of the current Energiewende. However, using gas-fired generation instead of coal as a complement to renewables reduces this impact in a cost-effective way.

In this study, we compare the effects of remaining on the current course of the Energiewende to a More Competitive Energiewende in which domestically produced natural gas plays a larger role. Compared to the current path, the More Competitive Energiewende—a lower-cost system with gas—has the following economic benefits:

1. BMWi, BMU (2011), *Energiekonzept für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung*.

2. Sigmar Gabriel in a speech at the 21st Handelsblatt Jahrestagung, <http://www.sigmar-gabriel.de/reden/rede-bei-der-handelsblatt-jahrestagung-energiewirtschaft-2014-am-21-januar-2014>.

- **Gross Domestic Product:** GDP would be nearly €28 billion, or 0.9%, larger in 2020, and €85 billion, or 2.5%, larger in 2025. The gain in GDP is even greater in the longer term, reaching €138 billion, or 3.4%, by 2040.
- **Employment:** The economy would support 207,000, or 0.5%, more jobs in 2020, and 559,000, or 1.3%, more jobs in 2025. In the longer term, the economy would support nearly 1 million additional jobs by 2040. These employment increases are net of the slower growth in jobs in “green” energy industries.
- **Disposable Income:** The benefits of Energiewende reform extend to all the citizens of Germany, as the resulting economic growth increases real disposable income. Reform would add an average of €123 in disposable income per person in 2020 and €847 per person in 2040.
- **Government Revenues:** Increases in overall economic activity and royalties from gas production would yield nearly €40 billion in additional annual revenues by 2030, rising to €68 billion by 2040.
- **Manufacturing Exports:** Lower energy prices increase German manufacturing's relative competitiveness. Net exports for the manufacturing sector would be €36 billion larger in 2030 and €63 billion larger by 2040—a gain of 20%.

However, even with a More Competitive Energiewende, German retail electricity prices will remain relatively high by international standards. As a result, maintaining the EEG rebates, which provide large energy intensive industries with some relief from these higher prices, is essential to realizing the economic benefits presented in this study. If the rebates were phased out, by 2020 GDP would be almost 5% lower and real disposable income per capita would decrease by more than €500 per year, by far offsetting direct savings in private consumers' electricity bills.

The Energiewende is an initiative with global significance. Germany is in a unique position to take the lead in demonstrating how a transition towards a low-carbon world can be managed in a sustainable and affordable manner. By linking deployment of mature renewables with natural gas as a bridging technology, Germany could stay on the path toward a low-carbon economy while opening new opportunities in a global energy world. To do otherwise, would make Germany less competitive and would cause loss of industrial investment that would translate into loss of jobs.

Why are German energy prices higher than those of competitors?

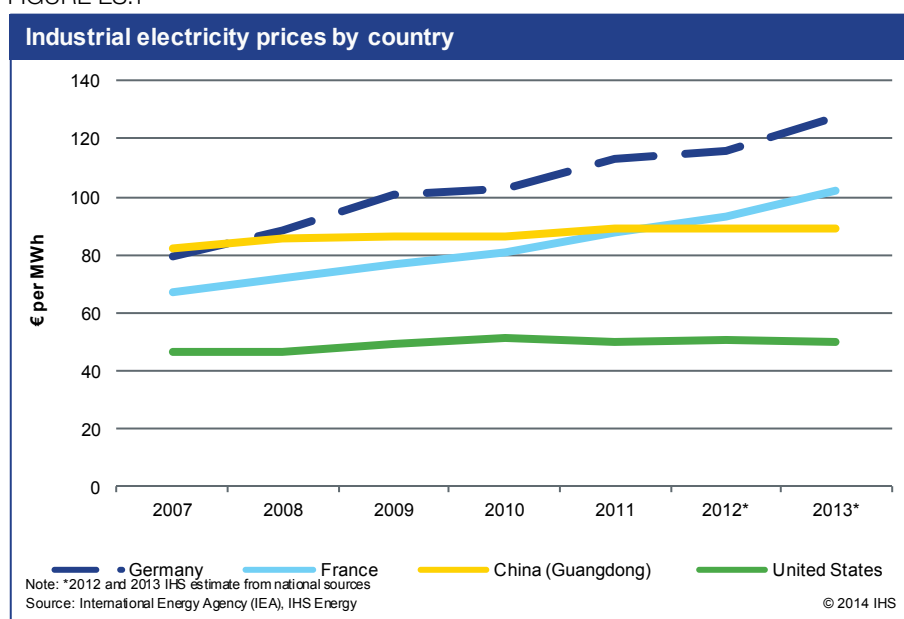
We have identified two factors that are driving the energy price disadvantage that is challenging Germany's industrial competitiveness. Neither was anticipated when the Energiewende was shaped a few years ago.

- **The high cost of the domestic power system.** The Erneuerbare Energien Gesetz (EEG), or Renewable Energy Sources Act, funds renewable power deployment through a surcharge on electricity bills. This surcharge has been the primary driver of electricity price increases for most German consumers. Total costs will exceed €23 billion (€62.4 per megawatt-hour [MWh]) in 2014, up from €13.5 billion (€35.3/MWh) in 2011, and costs will remain high for many years. As a result, German electricity prices will remain high by international standards over the long term. A rebate system provides some relief from the EEG charges for large, energy-intensive industry, helping to support overall GDP growth, but most consumers pay the full cost of renewables support. The rebates do not protect most small and medium-sized enterprises, which are so central to the Germany economy.
- **The unconventional revolution in North America.** The Energiewende was based upon the expectation of high and rising prices for conventional energy. Events have undermined that assumption as abundant, low-cost natural gas supply has emerged in North America. Improving exploration and production techniques have brought about the large-scale development of shale gas and associated gas in North America over the past five years. The resulting much lower level for North American gas prices—less than one-third of those in Europe—has dramatically boosted the competitiveness of American manufacturing industries. Based on its improved competitive energy position, North America is now attracting

approximately €90 billion in new industrial investment, both from US and non-US companies (including European companies).³

As a result, German electricity prices, already high by international standards, have been increasing faster than prices in major competing markets. Between 2007 and 2013, the International Energy Agency (IEA) found that German industrial electricity prices increased almost €50/MWh, or about 60%, as shown in Figure ES.1. Over the same period, prices in the United States rose by less than €4/MWh (8%) while prices in China rose by €7/MWh (9%).

FIGURE ES.1



German industrial electricity prices are also at the upper end of the range of European prices. A recent analysis by the European Commission shows that, among the major European economies, only Italy has higher industrial power prices.⁴

Why are energy prices critical to Germany?

Energy is an important cost component for most industries, although the degree of importance varies across sectors. For energy-intensive sectors like chemicals, energy costs are a primary component of production costs and international differences have significant impacts on competitiveness. However, if energy makes up a small share of a sector's costs, large international differences in energy costs may not be a major concern.

These differences among industries could lead some to argue that industrial policy should focus on the "greener," less energy-intensive industries and accept or even welcome the exit of energy-intensive industries from Germany. Yet this view misses a critical point. Germany's highly integrated supply chains and industry clusters connect energy-intensive and non-energy-intensive businesses. Policy that places energy-intensive industry at a relative disadvantage to global peers will have broad implications across the domestic industrial landscape.

Table ES.1 demonstrates the degree of integration in the German manufacturing sector. Across all manufacturing industries, approximately 69% of inputs (by value) are sourced within Germany. Energy-intensive industries—like

TABLE ES.1

Historic shares in industry inputs € million (constant 2013)			
	Domestic	Total	Share
Machinery and equipment n.e.c.	98,149	130,004	75%
Chemical and Pharmaceuticals	52,948	82,908	64%
Motor vehicles, trailers and semi-trailers	162,937	228,061	71%
Basic metals	35,454	59,303	60%
All Industries	660,984	964,449	69%

Note: Analysis is based on 2009 Input-Output model of the German economy.

Source: IHS Economics

3. IHS (2013), *America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy*; Vol 3: *A Manufacturing Renaissance*, <http://www.ihs.com/info/ecc/a/americas-new-energy-future-report-vol-3.aspx>.

4. European Commission (2014c), *Energy prices and costs in Europe*, http://ec.europa.eu/energy/doc/2030/20140122_communication_energy_prices.pdf.

chemicals and basic metals—source a large share of their inputs from domestic suppliers. In this way, German manufacturers and service providers, large and small, energy-intensive and less energy-intensive are linked to each other through supply chains. Any impact to the health of energy-intensive industry is not isolated, but reverberates throughout these supply chains and throughout the entire economy.

How do energy prices impact competitiveness?

The competitiveness of a company or sector depends on its cost position relative to the rest of the market. However, isolating the influence of energy costs from that of all other competitive factors is difficult. To estimate the impact on competitiveness of Germany's higher electricity prices, we did an econometric analysis to quantify across 16 German manufacturing sectors the historical change in net exports that was attributable to higher electricity prices relative to a peer group of trading partners.

The benchmark industrial electricity price for Germany's key trading partners increased between 2008 and 2013, but less than Germany's prices increased. While Germany's average electricity price level was 21% above the international benchmark in 2008, that difference widened to 40% in 2013. As a result of this growing price differential, Germany's manufacturing sector suffered net export losses that increased from 2008 to 2011 and climbed again in 2013. Net export losses directly attributed to the electricity price differential were €15 billion in 2013—triple 2009's losses—and totaled €52 billion for the six-year period, 2008–13. Most of the losses attributable to the electricity price differential occurred in energy-intensive sectors. Nearly 60%, or €30 billion, occurred in paper, chemicals and pharmaceuticals, non-metallic mineral products, and basic metals. The remainder of the losses is spread across all other sectors.

The net export losses for smaller-scale electricity consumers attributable to the international electricity price differential were much larger than the share of small and medium enterprises (SMEs) in Germany's manufacturing industry. Between 2008 and 2013, smaller-scale consumers experienced 77% of the cumulative net export losses, while SMEs account for only 29% of Germany's total manufacturing output. In other words, the export losses fell disproportionately on smaller companies.

Balancing costs and emission reductions

Given the importance of competitive energy prices to German manufacturing and the broader economy, how does Germany respond? An inherent tension lies at the heart of the Energiewende. Slowing the pace of renewables development to a more measured rate of growth is the only way to reduce power system costs. However, this slows the transition to a lower-carbon economy. The challenge for policy today is to find an appropriate balance between cost containment and emissions reduction.

Natural gas is an important part of the solution. Indeed, natural gas is the cleanest fossil fuel, with just half the CO₂ emissions of coal and much lower contributions to air pollution. Increasing gas production and the resulting low prices have allowed the United States to reduce its CO₂ emissions back to 1994 levels, despite economic growth of 60% since that time. In a new communication released in January 2014, the European Commission included indigenous conventional and unconventional natural gas (shale gas) among “the sustainable indigenous sources”, along with “renewable energy sources”, available to its member countries.⁵

Greater development of local gas resources

Gas currently plays a limited role in Germany's power generation, accounting for only 11% of the total in 2012, compared to 30% in Britain and over 40% in Italy. However, Germany has an opportunity to expand the role of gas, creating a low-carbon power system that partners highly efficient gas generation with renewables.

Development of Germany's domestic shale gas resources would allow gas to play a larger role in the power system without increasing imports. IHS performed a detailed analysis of Germany's shale gas potential to better understand this opportunity. Using an analogue approach that is standard for largely unexplored regions, the geological characteristics of each German shale play—depth, total organic content, thickness,

5. European Commission (2014b), *A Policy Framework for Climate and energy in the Period from 2020 to 2030*, http://ec.europa.eu/energy/doc/2030/com_2014_15_en.pdf.

maturity, and others—were compared to US plays to develop cost and production estimates based on extensive experience in the United States. These estimates were then adjusted to account for the specifics of Germany's regulatory and fiscal structure. Resources in environmentally sensitive areas were excluded from consideration.

IHS estimates that more than 20 billion cubic meters (Bcm) per year of shale gas production is possible in Germany by 2030, the equivalent of 25% of current consumption. Production would continue to rise after that, peaking at more than 25 Bcm in the mid-2030s. Conventional and shale gas production would be almost 30 Bcm through the 2030s, enough to meet more than 35% of current German gas demand. This volume would be similar to Germany's current imports from Norway. Russian exports to Germany were 37 Bcm in 2013.

Favorable geology is only part of the equation. Without the appropriate policy framework, these levels of production will not be reached. IHS has identified five necessary policy conditions for shale development in Germany:

- Acceptance of hydraulic fracturing under a “prudent development” regulatory framework;
- Appropriate contract terms for exploration and development;
- An efficient regulatory system able to process licenses for many wells per year;

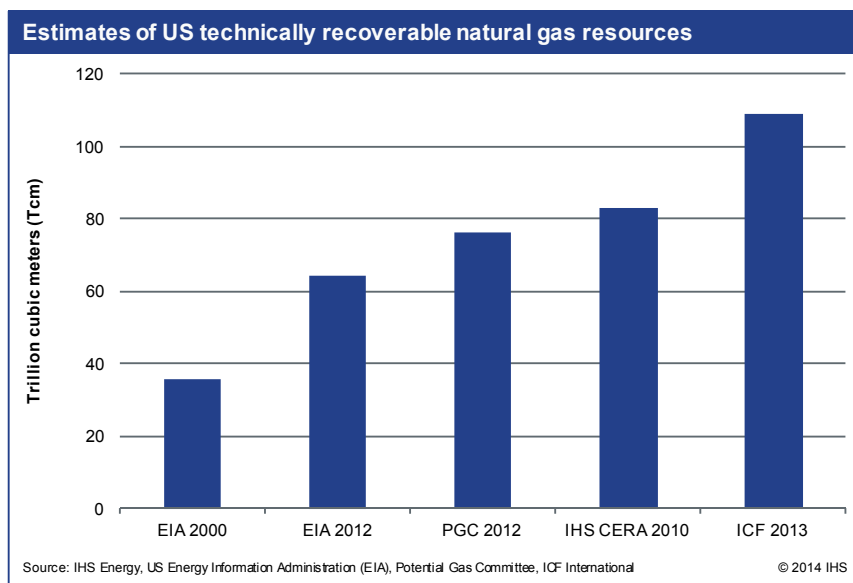
Shale rig site – Poland



North American Natural Gas Production—Not a “Bubble”

Estimates of technically recoverable reserves (excluding associated gas resources in oil reservoirs) in the United States are three times higher today than they were in 2000, enough to provide a 100-year supply of natural gas at current demand levels. These evolving estimates of technically recoverable reserves—combined with actual drilling experience—confirm that this is a long-term supply phenomenon, not a passing “bubble.”

FIGURE ES.2



- A fiscal regime tailored to the needs of shale gas development that appropriately rewards affected land-owners, communities, and states;
- An indigenous supply chain able to support the operation of up to 300 modern drilling rigs located throughout Europe.

The European gas market is highly interconnected, and production in one market has an impact on prices in neighboring markets. For this reason, IHS also undertook an analysis of overall European shale potential. Substantial production is possible in other countries, including Poland and the United Kingdom, if they adopt policies conducive to shale development. Total shale gas production in the EU 28 could exceed 70 Bcm in 2030, increasing to almost 90 Bcm by 2040. This is on the same scale as current Norwegian pipeline exports to the EU of 100 Bcm. Russian exports to the EU in 2013 were 130 Bcm.

Production on this scale would have an impact on gas prices in the European market. Development of local gas supply would put downward pressure on European prices, reducing them by as much as 20% compared with a scenario in which Europe did not develop its shale endowment. At the same time, it would contribute to greater energy security, meeting an objective of both Germany and the European Union.

Economic impacts of a lower-cost power system with shale gas

Abundant and secure supplies of natural gas provide a basis for balancing costs with emissions reductions in the German power system. Reforming the Energiewende to slow the pace of renewables development, particularly expensive offshore wind, and to expand the role of gas would enable Germany to reduce power system costs while minimizing the impact on CO₂ emissions. Lower-priced gas would make gas-fired generation more economic than coal beginning in the mid-2020s, meaning that operators would not invest to prolong the life of existing coal plants. New power plants would be gas-fired because of the lower capital cost of gas plants compared to coal.

These reforms would reduce the cumulative cost of the power system by €125 billion (constant 2013) from 2014–40, primarily due to reduced capital investment. The benefits of reduced capital spending would be partially offset by increased spending on fuel and emissions.

By 2020, German GDP would be 0.9% higher than if the Energiewende stayed on its current high-cost path. The benefits of a More Competitive Energiewende in the form of additional GDP growth would grow over time, with GDP 2.3% and 3.4% higher in 2030 and 2040, respectively. By 2040, this cost savings would result in 1 million net additional jobs and an average of €847 per person additional real disposable income (see Table ES.2).

TABLE ES.2

Impact of lower cost power system with shale gas versus current path			
	2020	2030	2040
Change in GDP (%)	0.9%	2.3%	3.4%
Change in disposable income per capita (€ constant 2013)	123 €	580 €	847 €
Change in employment (thousands)	207	488	944

Source: IHS Economics

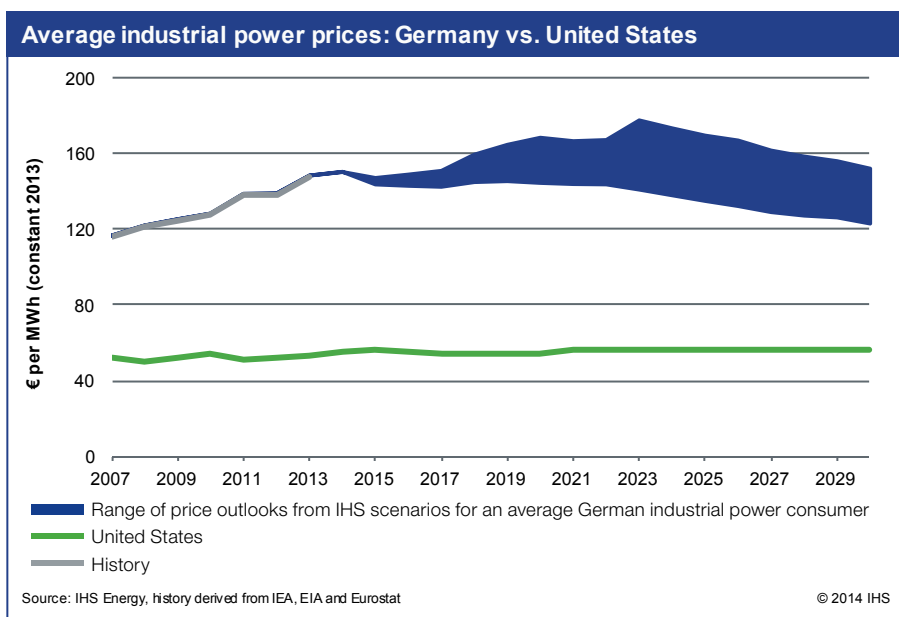
Shale gas development is a key contributor to this economic stimulus, accounting for about 77% of the GDP increase in 2020 and nearly 44% of the GDP increase in 2040. It also has an important fiscal impact, providing a source of additional government revenue.

The role of rebates

However, despite the cost reductions that a reformed Energiewende can bring, German retail electricity prices will remain high by international standards (see Figure ES.3). As a result, maintaining the existing EEG rebates for energy-intensive customers is essential to recognizing the economic benefits presented in this study.

If the rebates were phased out, the impact would be immediate and significant. Customers that benefit from the maximum EEG rebates could see their electricity prices increase by more than 65% if the rebates were removed, while customers partially protected by the EEG rebates today would also see substantial increases in their electricity prices. By 2020—a mere six years from now—GDP would be almost 5% lower (see Table ES.3). A residential consumer would save about €55 per year on his or her electricity bills, but real disposable income—“money in consumers’ pockets”—would decrease by more than €500 per year.

FIGURE ES.3



Conclusion

German energy costs and emissions have risen as the Energiewende has progressed.⁶ Slower deployment of renewables combined with a greater role for natural gas—particularly domestically produced natural gas—can reduce the costs and risks of the Energiewende. However, none of this will happen without prudent policy choices.

TABLE ES.3

Impact of phasing out rebates versus current path			
	2020	2030	2040
Change in GDP (%)	-4.8%	-4.9%	-5.3%
Change in disposable income per capita (€ constant 2013)	-543 €	-812 €	-1,061 €
Change in employment (thousands)	-1,106	-1,103	-1,122

Source: IHS Economics

Continuation on the current track will result in a decreasing role for gas over time, as domestic gas production declines and coal continues to dominate the thermal mix in Germany. (The share of domestic gas production in Germany’s total gas consumption has decreased from 20% in 2000 to 10% today). Increasing the role of indigenously produced gas in the power sector alongside mature renewables provides Germany with an opportunity to secure an affordable and sustainable path for the Energiewende.

However, German consumer electricity prices will remain internationally high in the long-term. As a result, retaining the EEG rebate system is of critical importance to preserve the health of energy-intensive industry in Germany and the supply chain, including small and medium sized companies, that depends upon it. Moreover, this study demonstrates that the average consumer benefits from the rebate system, because the benefit of stronger economic growth greatly outweighs the small decrease in electricity bills that would result from removing the rebates.

Reforming the Energiewende is necessary to maintaining the vitality of the German economy and the economic well-being of the German people. Reform embodied in a More Competitive Energiewende can secure a sustainable path toward a renewable energy future while maintaining a stronger German economy that has greater exports, more manufacturing jobs, and is more competitive in the changing global economy.

6. IHS estimates German CO₂ emissions rose by about 2% in 2013 based on AGEB energy consumption statistics.

Report structure

In this study, IHS performed a first-of-its-kind economic analysis of the impact of gas and power prices on the German economy.⁷

Chapter 1 compares end user prices for gas and power in Germany to prices in a number of other countries, demonstrating Germany's competitive disadvantage in terms of energy costs.

Chapter 2 considers the drivers that have increased end-consumer electricity prices in Germany over the past six years and describes the rebates that have limited price rises for energy-intensive consumers.

Chapter 3 quantifies the impact that high energy prices have had on the German economy in recent years and quantifies the resulting reduction in competitiveness of German industry. The impact of the electricity price difference on supply chains and industry clusters is also analyzed.

Chapter 4 describes the scenarios that form the basis of the analysis presented in the remainder of the report—the *Current Path* of today's Energiewende and the two paths within the More Competitive Energiewende.

Chapter 5 models the impact of changing the allocation of renewable support costs on end consumer prices and the subsequent impact on economic performance. The economic analysis considers the impact on the industries that receive the rebates and the wider impact on their suppliers, customers, and the overall economy.

Chapter 6 analyzes the potential for development of shale gas resources in Germany and in Europe as a whole. It demonstrates the impact on natural gas prices.

Chapter 7 describes the potential to reduce the cost of the Energiewende and the impact of reform on the future path of German CO₂ emissions. It also describes the role of gas in a More Competitive Energiewende.

Chapter 8 models the potential economic benefits of reforming the German power system, with and without the development of German and European shale gas.

Chapter 9 presents the study conclusions and the path forward for a More Competitive Energiewende.

IHS offers consistent data, analysis and forecasts for more than 200 countries, with up to 500 economic indicators per country. Econometric analysis is one of the core competences of IHS Economics, which represents the merger of two of the world's leading economic analysis firms, Wharton Econometrics and DRI. The founder of IHS Economics' practice in this area was Lawrence Klein, who was awarded the Nobel Prize in 1980 "for the creation of econometric models and their application to the analysis of economic fluctuations and economic policies". The Nobel Prize committee added, "Few if any researchers in the empirical field of economic science have had so many successors and such a large impact as Lawrence Klein."

7. This study builds upon IHS' October 2013 study *The Challenge to Germany's Global Competitiveness in a New Energy World*. In this new report, we extend the time frame to 2040 and consider the benefits that development of shale gas in Germany and Europe could bring. In addition, we break down the economic impacts quantified in the original report into their constituent parts by comparing the impact of each policy change to a baseline. The baseline, which is defined in detail in Chapter 4, models current German energy policy and regulation.

1. New global energy reality challenges Germany's international competitiveness

Key findings

- The Energiewende has moved away from its goal of competitive low-carbon energy.
- The energy price differential with the United States in particular is growing as German electricity prices rise and US gas prices fall.

More than 10 years into Germany's transformational Energiewende, the country's future economic competitiveness is at risk. The Energiewende was designed to create a competitive transition to a low carbon economy. The 2010 Energiekonzept, which outlines Germany's energy strategy to 2050, emphasized maintaining competitiveness as one of the main tasks of German energy policy: "Germany shall in the future, alongside competitive energy prices and high levels of welfare, become one of the most energy efficient and most environmentally friendly economies in the world."⁸

However, German electricity prices, already high by international standards, are increasing faster than prices in major competing markets. Between 2007 and 2013, the International Energy Agency (IEA) reports that German industrial electricity prices increased almost €50/MWh, or about 60%, as shown in Figure 1.1. Over the same period, prices in the United States rose by less than €4/MWh (8%) while prices in China rose by €7/MWh (9%).⁹ German industrial electricity prices are also at the upper end of the range of European prices. Recent analysis by the European Commission shows that, of the major European economies, only Italy has higher industrial power prices.¹⁰

At the same time, the global energy landscape has been transformed. A core assumption underpinning the Energiewende was that the cost of oil and gas would continue to rise. Then came the unconventional revolution in shale gas and tight oil in the United States, which drove natural gas prices there down to less than one-third of Europe's prices (see Figure 1.2). As a result, industries are shifting investment to the United States

FIGURE 1.1

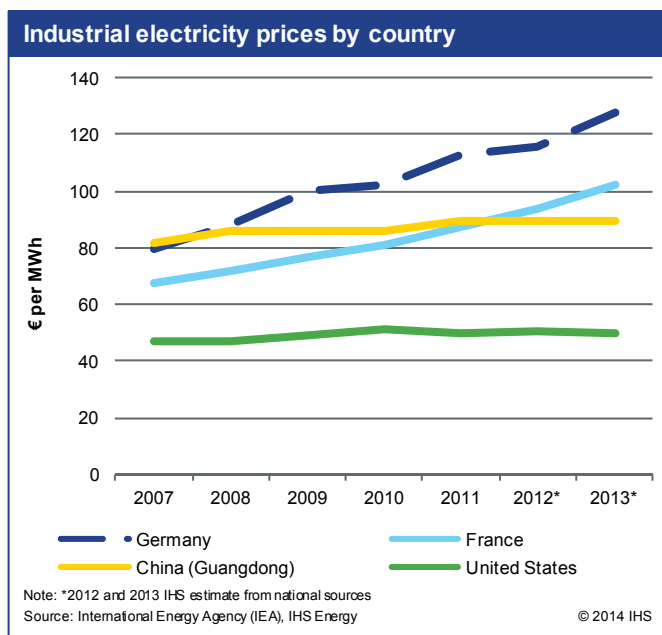
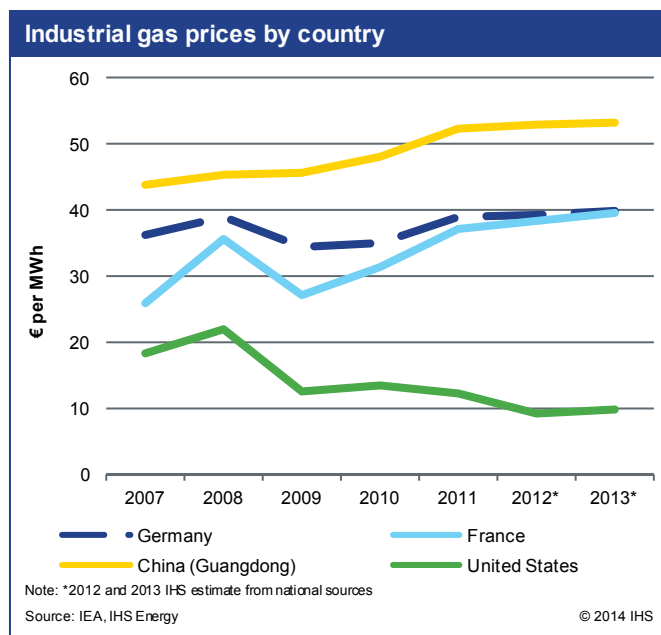


FIGURE 1.2



8. BMWi, BMU (2011), *Energiekonzept für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung*, http://www.bmubund.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/energiekonzept_bundesregierung.pdf.

9. IEA data is used for the international comparison of industrial energy prices, as it is the only source for end-consumer prices across a range of geographies. For 2012 and 2013, IHS estimated industrial prices, based on national sources.

10. European Commission (2014c), *Energy prices and costs in Europe*, http://ec.europa.eu/energy/doc/2030/20140122_communication_energy_prices.pdf.

where inexpensive domestic energy resources have created a tremendous boost for US manufacturing. A massive amount of new investment—approximately €90 billion—by both US and non-US companies (including European companies) is now planned, paving the way to higher economic growth and job creation in the United States over the next several years.¹¹

The new US advantage is causing increasing alarm in Europe and prompting European companies to shift investment away from Europe to the United States. The energy price differential is a particular concern for Germany, because German exports represent half of GDP, far more than in any other large economy (see Table 1.1).

The increases in power system cost are occurring at the same time as German CO₂ emissions are rising. Three factors have driven the growth in emissions:

TABLE 1.1

Exports as share of 10 largest economies, 2013		
Country	GDP (€ billion, constant 2013)	Exports as share of GDP
Germany	2,740	51%
United Kingdom	1,909	31%
Italy	1,559	30%
France	2,064	27%
Russian Federation	1,602	27%
China	6,985	26%
India	1,430	25%
Japan	3,760	16%
United States	12,644	13%
Brazil	1,682	13%

Source: IHS Economics

- 1. Phase-out of nuclear power.** With the start of the phase-out of nuclear power, Germany has lost a significant source of zero-carbon generation.
- 2. Increased use of coal.** Low coal and carbon prices and strong gas prices over the past two years have boosted coal-fired generation.
- 3. Rising electricity demand.** Although electricity demand fell during the recession, it has since recovered. Meeting the 2020 goal of a 10% reduction in demand compared to 2008 levels will require a very significant effort across all sectors of the economy.

German emissions growth is in marked contrast to the United States, where the shale gas revolution has allowed CO₂ emissions to decrease even as electricity prices remained stable and the economy has grown.¹²

1.1 Energiewende: At the top of the political agenda

The Energiewende in its current form is not sustainable. Energy policy, and how to reform the EEG in particular, now tops the political agenda in Germany. The 2010 Energiekonzept made it clear that renewables should be an important contributor to power supply diversification for Germany but that cost-efficiency should also be considered. Following the decision to phase out nuclear, the objective of cost-efficiency faded somewhat, but the EEG reform proposals presented on 21 January 2014 brought costs back into focus.

The January 2014 proposal broadly follows the roadmap for EEG reform laid out in the December 2013 Coalition agreement. The aim is to increase the efficiency of renewables support policies and improve the integration of renewables into the power system. To this end, the proposals seek to increase the exposure of Germany's most mature renewables to market dynamics by mandating that generators sell their output on the power exchange. The proposals also call for progressive replacement of the current feed-in tariff mechanism with a market premium for all generators above 100 kilowatts (kW) by 2017. In addition, various bonuses will be removed and remuneration for onshore wind adjusted. The proposals also seek to improve

11. IHS (2013), *America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy; Vol 3: A Manufacturing Renaissance*, <http://www.ihs.com/info/ecc/a/americas-new-energy-future-report-vol-3.aspx>.

12. EIA (2013), *U.S. Energy-Related Carbon Dioxide Emissions, 2012*, <http://www.eia.gov/environment/emissions/carbon/>.

the efficiency of the price discovery mechanism by instituting competitive tenders to set support levels for each technology.

As part of the EEG reform proposals, the government is reviewing the distribution of EEG costs in an attempt to reduce end-consumer electricity prices. One EEG reform included in the proposal suggests that self-consumption—hitherto fully exempt from the EEG surcharge under paragraph 37 of the EEG—will be expected to contribute to the EEG payment in the future. On 18 December 2013, the European Commission formally opened an investigation into the EEG surcharge and the rebates available for energy-intensive industry on the grounds of EU State Aid rules. However, in early January, Minister for Energy and Economics Sigmar Gabriel emphasized that “We must ensure in Germany that energy-intensive industry remains unburdened by the EEG law (Germany’s renewable energy law).” He added, “Anything else would result in us de-industrializing Germany. This is not an exaggeration. Europe cannot have an interest in damaging German industry.”¹³

The EEG reform proposals coincided closely with the European Commission’s announcement of its 2030 energy and climate policy package. The package focuses on reducing CO₂ emissions through a single, binding, EU-wide target to reduce greenhouse gases by 40% compared with 1990 levels. There is also a 27% renewable energy target, but, in contrast to the 2020 target, this is not broken down into a series of national targets. In their current format, the proposals represent a rebalancing of EU policy from a focus on renewables deployment with strong member state accountability toward a focus on CO₂ reduction across an integrated European market.

13. EurActiv (2014), *Expensive renewable energy is threat to industry: German minister*, <http://www.euractiv.com/energy/expensive-renewable-energy-threat-news-532637>.

2. German consumer electricity prices have been rising rapidly

Key findings

- Renewables support, paid by consumers through the EEG surcharge on their electricity bills, is the main driver of the recent increase in German consumer electricity prices.
- Rebates from the EEG surcharge have provided some relief for large, energy-intensive industries.

As shown in chapter 1, German electricity prices are increasing faster than prices in major competing markets. This chapter examines the factors that have driven this increase.

2.1 Policy costs drive German end consumer electricity prices

End consumer prices are made up of four elements: wholesale prices, customer servicing costs, network costs, and policy costs. Wholesale prices reflect the cost of supplying power to the grid and include the fuel used for power generation, as well as the cost of constructing, operating, and decommissioning non-renewable generating capacity. Customer servicing reflects the costs of selling power to end consumers, including elements such as billing. Network costs reflect the cost of developing, operating, and maintaining the distribution and transmission grids. Policy costs reflect the taxes and levies paid to support Germany's energy policy goals. Charges are also levied for non-energy related items, such as the electricity tax, which includes a contribution towards pension liabilities.

Wholesale power prices have fallen significantly in recent years, driven down primarily by a combination of lower carbon and coal prices. The baseload price of electricity in Germany averaged €38/MWh in 2013, down from €66/MWh in 2008.¹⁴

In contrast, the taxes and surcharges the government levies to support national energy policy have been rising rapidly in recent years. The EEG is the primary mechanism for supporting the deployment of renewable power in Germany, and hence implementing the Energiewende. The costs of supporting renewables

FIGURE 2.1

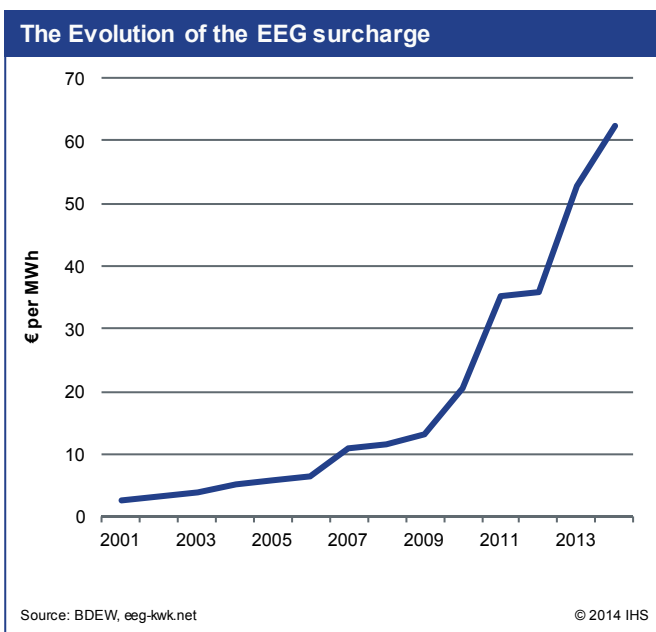
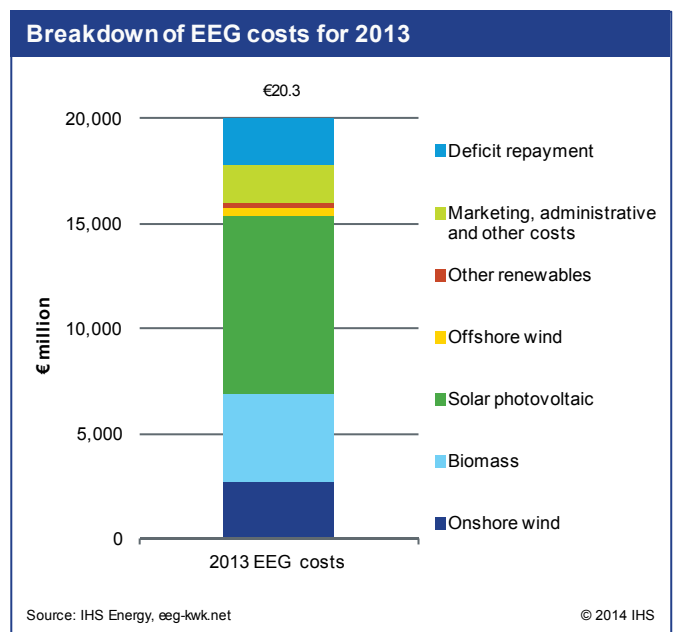


FIGURE 2.2



14. The baseload price reflects the price for electricity delivered at a flat rate of 1 MWh per hour every hour of the day.

are recovered through the EEG surcharge levied on end consumer's electricity bills. As a result increases in renewables support costs feed directly into consumer electricity bills.

Almost a quarter of German power generation (and over 45% of capacity) has been developed with EEG support. Through this process, the market for renewables (and also for thermal generation) has been transformed. However, costs have risen significantly and are now far higher than the original projections (see Figure 2.1). In 2011 the federal government stated that the EEG surcharge would not exceed €35/MWh.¹⁵ In 2014, it will exceed €60/MWh and will remain substantially higher than €35/MWh for at least the next 15 years.

Support for solar photovoltaic (PV) is by far the greatest single driver of the increases in the EEG surcharge, accounting for over €8 billion of the €20 billion cost incurred in 2013, as shown in Figure 2.2. The rapid rise in EEG cost between 2010 and 2013 is largely due to the accelerated deployment of solar PV over that period. Further details on the evolution of EEG costs can be found in Appendix A.

IHS estimates that Germany has committed its consumers to more than €185 billion (constant 2013) of support costs for renewables over the next 20 years.¹⁶ There is more to come—further support will be required to meet the 2020 renewables target and other longer-term targets.

Costs will continue to increase as renewables deployment progresses. The direct net cost of renewables support exceeded €18.5 billion in 2013 and is expected to surpass €21.5 billion annually in 2014.¹⁷ Furthermore—a critical point often overlooked—the full cost of integrating renewables is actually higher than indicated here, as the EEG surcharge does not include the substantial costs of network development associated with rising renewables penetration.

Consumers across Europe pay to support renewables. But the costs borne by German end consumers are higher than elsewhere in Europe because Germany has adopted a more rapid shift to renewable energy than its European peers. The direct net cost of support paid to renewables developers in 2012 was €14 billion in Germany (0.5% of German GDP). This compares to only €2 billion in France (less than 0.1% of France's GDP), about 15% of what Germany paid. Eurostat reports that taxes and other policy costs account for as much as 30% of 2012 industrial electricity prices in Germany.¹⁸

The United States has adopted a very different approach, supporting renewables through tax credits or support for capital investments. In contrast to Germany, these costs are borne by taxpayers, rather than being recovered through the electricity bill.

2.2 Rebates limit impact of rising policy costs for some consumers

Although German energy policy is costly, policymakers are not blind to the burden that it creates for export-oriented industry. They have developed a range of rebates that attempt to mitigate the negative consequences for industrial end consumers, and particularly large, energy-intensive consumers, from the full effect of rising policy costs.

Rebates exist for a range of charges: network charges, the combined heat and power surcharge, the concession charge, EU ETS costs. However, two rebates are of particular importance because of their scale: the electricity tax and the renewables surcharge. Depending on eligibility, industrial consumers pay lower rates for both.

- Only companies with an annual electricity bill exceeding 14% of their gross value added are eligible for reductions in the EEG charge. For companies receiving the maximum rebate, the surcharge falls to

15. Bundesregierung (2011), *Eckpunktepapier*, 6. Juni 2011, <http://www.nachhaltigkeit.info/media/1326187886phpeIPyvC.pdf?sid=1ff9fd008294babebc61c8539f932185>.

16. €185 billion is IHS' estimate of the remaining support under the EEG committed to renewable capacity that has already been developed. Further costs will be incurred as additional capacity is developed. The exact level of future support depends on future tariffs, wholesale power prices, and renewables generation.

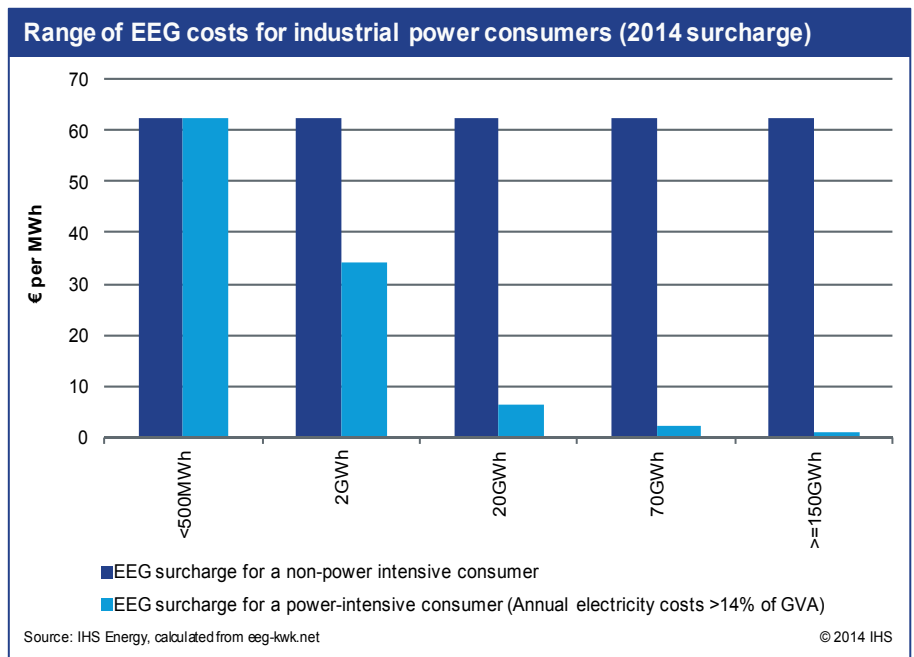
17. Direct net cost refers to the volume of support payments less wholesale market revenue that is allocated to end consumers. It does not account for administrative expenses or other additional costs absorbed in the form of deficits.

18. Where prices have been shown for industrial consumers split by size, the Eurostat classification has been used. Proportion of the final bill relating to taxes and policy costs is for the IF category with consumption volume of 70-150 GWh/year. The tax and policy cost share for other industrial end consumers was between 23% and 31%.

€0.50/MWh. Unless a firm can demonstrate that energy costs play a significant role in its cost base, high volumes of consumption do not translate into rebates.

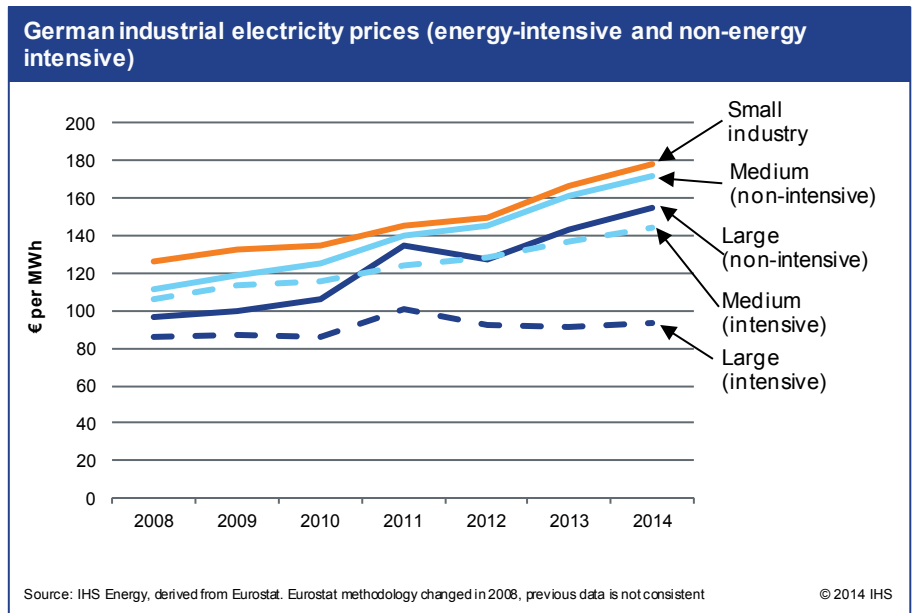
- The electricity tax rate for manufacturing industries is €15.40/MWh, lower than the general electricity tax rate of €20.5/MWh. Further reductions of up to 90% are available for more than half of Germany's manufacturing businesses under the Spitzenausgleich mechanism, depending on a company's consumption levels and pension payments.¹⁹

FIGURE 2.3



The value of the EEG rebates varies with consumption, as shown in Figure 2.3, with the largest consumers seeing the greatest benefit. Based on Eurostat data and the rebate rules for the EEG surcharge, IHS derived historic price series for industrial electricity prices in Germany and split consumers into two groups: energy intensive and non-energy intensive. These price series are depicted in Figure 2.4.²⁰ Using these prices, we calculated the value of the EEG rebate to different consumer groups:

FIGURE 2.4



- **Large Industrial Consumers.**²¹ The EEG rebate is worth over €61/MWh for a large energy intensive consumer in 2014 (up from €52 per MWh in 2013). Without it, the annual electricity bill for such a customer would rise by more than €9.2 million (65%) in 2014.²²

19. The Spitzenausgleich mechanism applies for manufacturing industry if the tax burden exceeds €1,000 per year and the business demonstrates energy efficiency measures.

20. Categorization based on Eurostat. Eurostat sectors are domestic (including commercial) or industrial. Eurostat defines five domestic categories (DA to DE) and seven industrial categories (IA to IG). The Eurostat data series starts in 2008; data prior to that time is not consistent with currently reported prices. Eurostat reports average prices for each size category. For categories IC-IG, IHS derived separate price series for energy-intensive and non-energy-intensive consumers from the Eurostat series.

21. For large industry, IHS used category IF (70–150 GWh/year). Both medium and small industry refers to an IC customer (0.5–2 GWh/year). The 1 GWh/year cut off is important because customers with consumption below this level are not eligible for any rebate from the EEG.

22. The calculation is based on the actual 2014 rebate. If rebates were removed, the annual charge would change since the EEG support cost would be spread over a larger volume. This adjustment has not been made here, as the scale of the adjustment would depend on how the rebate structure was amended. Further details on the impact of altering the volume exposed to the rebate are presented in Chapter 5.

- **Medium Industrial Consumers.** Due to the graduated nature of the rebates, the benefit for smaller energy intensive consumers is somewhat less. For a company with 2 GWh of annual consumption, the EEG rebate is €28 per MWh in 2014. Removing this would increase this customer's annual electricity bill by €56,000 in 2014, or by almost 20%.
- **Small Industrial Consumers.** Energy-intensive consumers with small annual electricity consumption (less than 1 GWh) are not eligible for rebates and pay the full EEG surcharge. For a consumer with annual consumption of 500 MWh, the EEG charge is €31,200 and accounts for over 35% of the total electricity bill. This is a significant burden for many small-and medium-sized enterprises in Germany (see text box 'Energy Costs and Net Exports of Smaller-Scale Electricity Consumers' in chapter 3.1).

The rebates are critical to the companies that receive them, but only a small portion of companies are eligible. Based on a report by Bundesverband der Energie und Wasserwirtschaft (BDEW) and data from transmission system operators, only 4% of Germany's 43,000 industrial businesses—accounting for around one-fifth of total German power consumption—paid a reduced EEG charge in 2013.²³

The remaining 96% of German industry—and all commercial and household consumers—are exposed to the full EEG cost and to the resulting rapid increases in power prices. The majority of Germany's small-and-medium-sized enterprises (SMEs) are fully-exposed to the EEG surcharge. Many of these enterprises belong to the Mittelstand, which forms the backbone of German industry and is integral to its flexibility and innovation base. Electricity costs are a significant burden for these companies' competitive positions. According to Germany's chemical association, the Verband der Chemischen Industrie—the EEG will cost its members €800 million in 2013 after all rebates have been taken into account. This cost is expected to exceed €1 billion in 2014. As discussed in Chapter 3 this cost significantly increases the competitiveness challenge for energy intensive industry.

23. For more information about the BDEW, refer to <http://www.eeg-kwk.net>.

3. Growing energy price differentials have impaired German competitiveness

Key findings

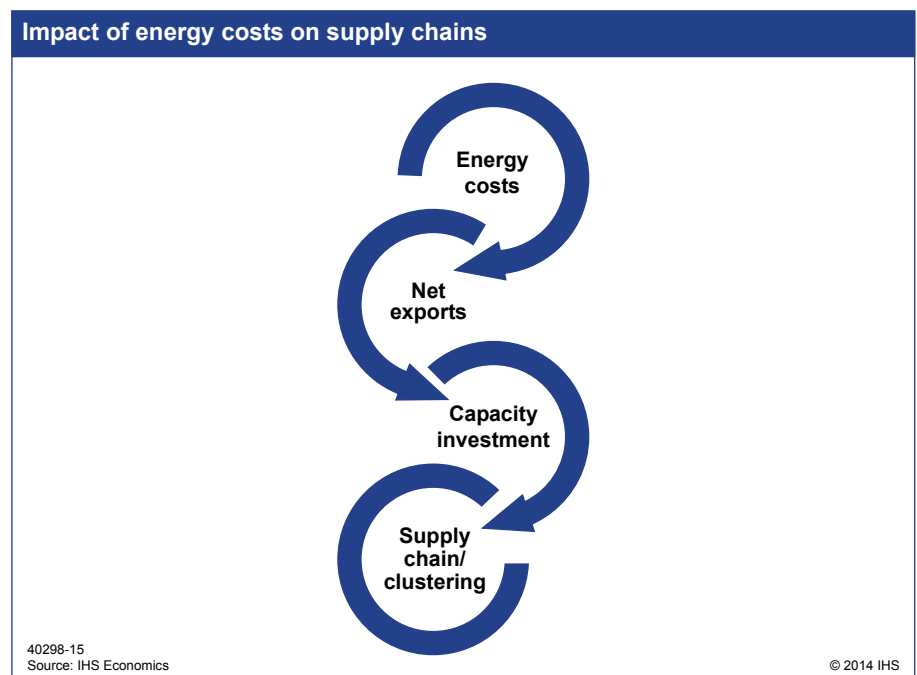
- Despite Germany's recent strong export performance, exports could have been even higher if German industry had not paid an electricity price premium over what its competitors pay.
- High energy costs have caused industrial investment losses—German companies are being forced to invest abroad rather than domestically to stay competitive—with significant impacts on Germany's highly integrated supply chains.

Germany is highly dependent on the success of its manufacturing sector. Manufacturing accounted for 21% of the German economy in 2013. Germany's exports represented 51% of its economy, a larger share than in any other major economy worldwide; by comparison, the export ratio was 26% in China in 2013, 16% in Japan, and 13% in the United States.

Energy is an important cost component for most businesses, although the degree of importance varies from sector to sector. Our analysis demonstrates a direct link between energy costs and the commercial success of Germany's manufacturing sectors. To measure commercial success we examine the following concepts (see Figure 3.1):

- **Net Exports:** The combined national and international market shares of a sector are indicators of commercial success. All things equal, an increase in net exports indicates an improved market share position. Output and capacity utilization reflect changes in market share, and sustained market share changes will trigger adjustments in production capacity over time.
- **Capacity Investment:** Energy costs are an important factor in investment decisions for German manufacturers considering whether to expand or contract their industrial production capacity in Germany or abroad. If a business loses market share, it will reduce capacity or, if more competitive business conditions can be found elsewhere, relocate to reduce its costs and improve its competitive position.
- **Supply Chain:** Company supply chains often span multiple sectors. The commercial success of one business in the supply chain affects the other businesses in that link through product supply, demand, or price changes. Capacity adjustments in one business therefore flow along the supply chain.
- **Clustering:** The term "cluster" refers to a geographically bound concentration of economic activity comprised of firms in the same industry,

FIGURE 3.1



their suppliers, and their supporting institutions and infrastructure.²⁴ High-performing clusters become a source of self-perpetuating competitive advantage for a region and bring innumerable benefits to the individual firms within them, including cost savings, knowledge sharing, and facilitation of innovation. Changes in the competitiveness of some firms within a cluster have the potential to affect all of the cluster's firms.

IHS modeling shows that sectors vary in their sensitivity to energy costs and, as a result, in their sensitivity to international energy cost differences. If energy makes up a small share of a sector's overall costs, large international differences in energy costs may not be a major concern. This could lead to the conclusion that industrial policy should focus on these "greener" and "cleaner" industries and accept, or even welcome, the relocation of energy-intensive industries outside of Germany.

But this view misses a critical point. In Germany's highly integrated supply chains and industry clusters, energy-intensive and non-energy-intensive businesses are intricately connected. Policy that favors non-energy-intensive industry will have broad implications across the industrial landscape. This study demonstrates the wide-ranging effects of growing international energy price differences—how sensitive industry sectors are to energy costs, how industries adjust and relocate production capacity in response to energy cost changes, and how knock-on effects flow through the supply chain and industry clusters to affect the competitiveness of the entire industrial economy.

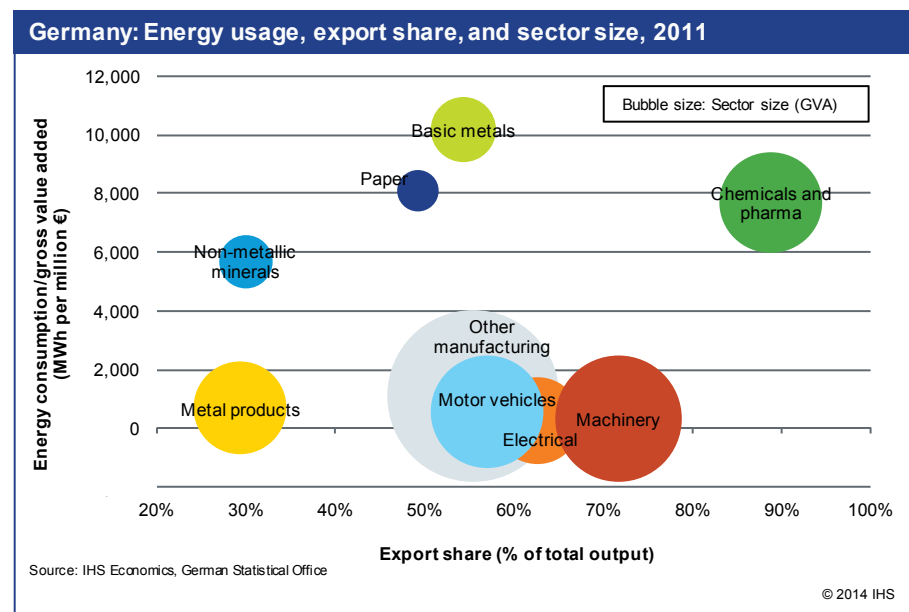
Each of Germany's manufacturing sectors is exposed to energy costs and international competition to varying degrees. Figure 3.2 illustrates various sectors' energy consumption relative to their gross value added (vertical axis) and their level of export dependence, which is the ratio of sectoral exports to sectoral output (horizontal axis). The size of each bubble represents the relative size of each industry, measured in terms of gross value added.

Industries higher on the vertical axis are more energy intensive. These sectors, including metals, chemicals, paper, and non-metallic minerals (such as glass), are more exposed to high energy costs.

The horizontal axis represents the trade intensity of a sector measured as the exports share of total output. Industries further to the right along this axis are more export dependent, meaning that they sell a greater share of their production outside of Germany.

Three sectors account for about half of Germany's manufacturing output: machinery, motor vehicles, and chemicals and pharmaceuticals. Each of these sectors is highly export-dependent, with a ratio of exports to total sales ranging from 57% for motor vehicles to nearly 90% for chemicals and pharmaceuticals. However, among these three manufacturing sectors, only the chemical and pharmaceuticals industry is energy-intensive (located in the upper half of Figure 3.2).²⁵ So the most-export-dependent of the three largest German manufacturing sectors is also the most energy-intensive.

FIGURE 3.2



24. Porter (1998), *On Competition*.

25. The pharmaceuticals industry alone is not energy-intensive. In this report, we use a standard industry classification that aggregates chemical products and pharmaceuticals.

How does energy intensity affect an industry sector's performance under the conditions of an open economy and globalized world market? The next section seeks to answer this question and quantify the effects of changing energy costs on sectoral performance.

3.1 Energy costs influence exports performance

A sector's net exports—the difference between exports and imports of a sector's products—serve as a measure of how competitive local producers are compared to producers abroad. More precisely, a change in the net export position of a sector signals improving competitiveness (increasing net exports) or deteriorating competitiveness (falling net exports). Net exports may fall if:

- Production from other countries replaces exports of German products, or
- Imports replace domestic sales of German products.

Virtually all of Germany's major manufacturing sectors have posted increasing net exports since the global recession in 2008–09. A European Commission study stated that energy prices were not a major issue for European and German manufacturers, largely because energy efficiency measures have kept European manufacturers' energy intensity low by global standards.²⁶

But that study covers only the period from 2000 to 2009 and therefore does not capture the sharp EEG surcharge increase in Germany that has occurred since 2009. Moreover, the European Commission study also does not capture the competitive advantage that has emerged in the United States from the shale gas revolution.

IHS analysis fills this major gap by focusing on recent history, albeit with a different approach. We demonstrate that the improvement of Germany's export position was achieved against headwinds from rising energy costs. In other words, Germany's export performance could have been better if the cost difference between Germany and its major trading partners had not widened.

Additionally, the improvement in Germany's overall net export position since 2009 predominantly occurred in the machinery and motor vehicles sectors, which are not energy-intensive. Net exports from the energy-intensive chemicals and pharmaceuticals sector hardly improved at all. Several different factors may have influenced this outcome, but the results of our modeling signal that energy costs played a role.

The competitiveness of a company or an entire sector clearly hinges on its cost position compared to the rest of the market. However, capturing this linkage for energy costs and isolating this influence from the influences of myriad other competitive factors is difficult. Economists seeking to isolate the impacts of carbon emission policies have developed modeling methodologies that empirically test the economic impacts of these emission policies. For this study, IHS leveraged these modeling techniques to isolate the contribution of rising energy costs to the broader economy.²⁷

IHS built an empirical model that links changes in the net export positions of 16 German manufacturing sectors to changes in their relative energy costs. Other explanatory variables, such as the differences in GDP between OECD countries and Germany and the real effective exchange rate based on consumer price indices, were also tested in order to ensure that the resulting coefficient is not distorted by variations of demand growth or exchange rates and overall price levels.

The econometric results confirm that, all else remaining equal, the net exports of the 16 German manufacturing sectors in our sample are sensitive to changes in energy costs. A sector's energy costs have a statistically highly significant negative impact on the sector's net exports.²⁸ In other words, the net exports of the 16 German manufacturing sectors decrease when German energy costs rise relative to international competitors.

26. European Commission (2014c), *Energy prices and costs in Europe*, http://ec.europa.eu/energy/doc/2030/20140122_communication_energy_prices.pdf.

27. Please refer to Appendix 4 for further literature references, more detailed explanation, and the results of the empirical models that were built for this study.

28. Altogether, the model used in this analysis explains 95% of the cross section and time variation of the industries' net exports.

As indicated above, our model derives relationships between electricity costs and net exports for each of the 16 sectors analyzed. These relationships are then used as coefficients to quantify the impact of electricity price increases on the net exports of German manufacturing sectors from 2008 through 2013.

We begin by estimating what Germany's net exports would have been if German industries paid the same electricity prices as their competitors.

- We compare the average electricity price that German industries paid to an international benchmark price—a trade-weighted average of the industrial electricity prices of Germany's five most important trading partners (France, the United States, the United Kingdom, Italy, and the Netherlands).^{29,30}
- We apply the resulting price differential to the net export model to estimate the incremental change in net exports for each sector resulting from the difference between German end-user electricity prices and the international benchmark price.

Between 2008 and 2013, the benchmark industrial electricity price for Germany's key trading partners increased by less than prices in Germany increased (see Figure 3.3). As a result of this growing price differential, Germany's manufacturing sector suffered net export losses, which rose each year between 2008 and 2011 and climbed again in 2013. Net export losses that can be attributed to the electricity price differential were €15 billion in 2013—triple 2009's losses—and totaled €52 billion for the six-year period from 2008 through 2013.

Most of the losses attributable to the electricity price differential occurred in energy-intensive sectors (see Figure 3.4). Nearly 60%, or €30 billion, occurred in paper, chemicals and pharmaceuticals, non-metallic mineral products, and basic metals. The remainder of the losses is spread across all other sectors.

Energy-intensity is critical, but eligibility for rebates is also

FIGURE 3.3

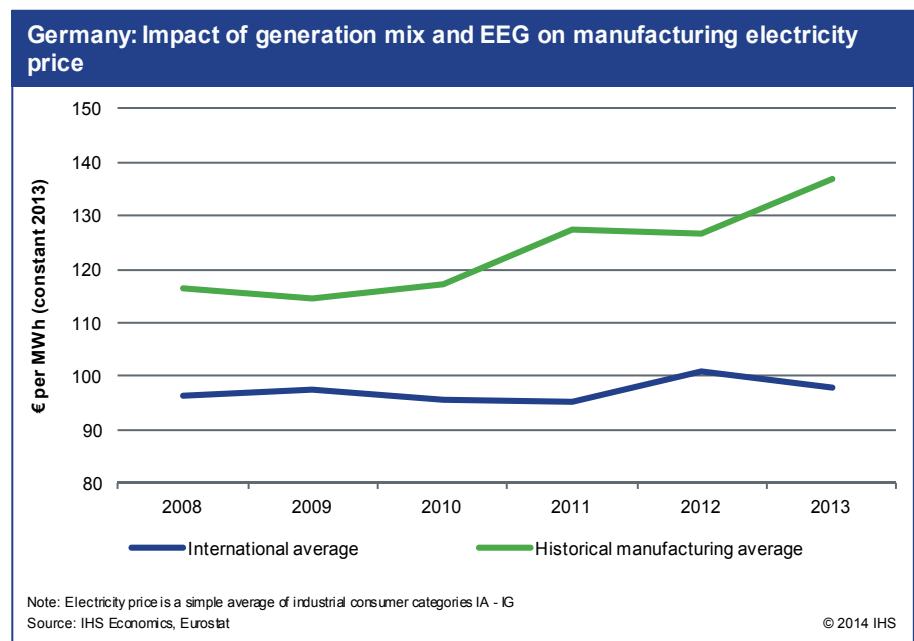
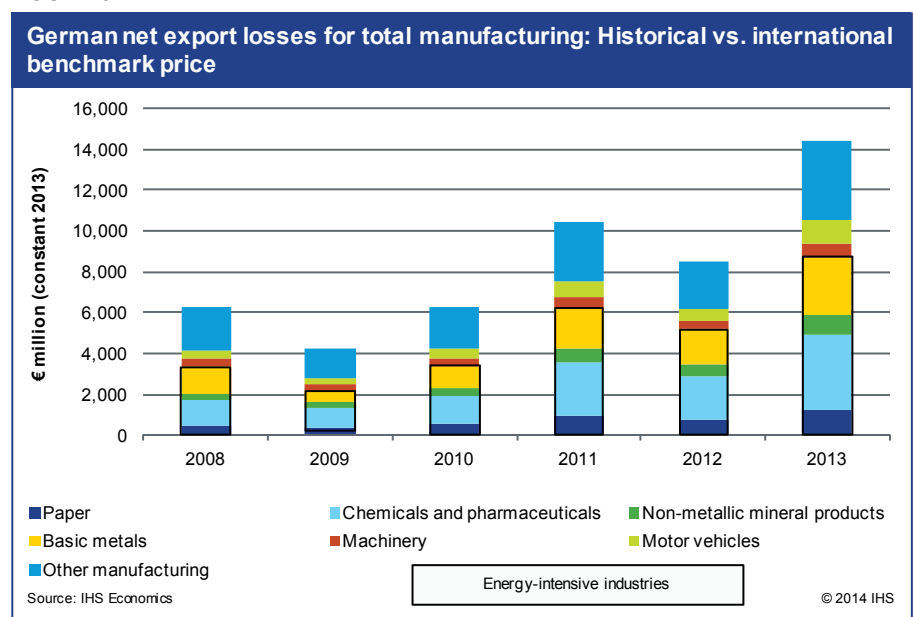


FIGURE 3.4



29. The average electricity price for German industry is the average of prices for end-consumer categories IA, IB, IC, ID, IE, IF, and IG.

30. China is not included in this analysis owing to a lack of data.

important. Smaller-scale consumers that pay the full surcharge confront the same competitive pressures as larger consumers that benefit from the rebates. Our analysis signals that smaller consumers have been disproportionately affected by net export losses.³¹ Between 2008 and 2013, small-scale electricity consumers experienced 77% of the cumulative net export losses attributable to the international electricity price differential, but SMEs accounted for only 29% of Germany's total manufacturing output.³² Not every SME under Eurostat's definition is a small-scale electricity consumer and vice versa, but SMEs and small-scale electricity consumers largely overlap.

All else equal, these forgone sales, if realized, would have stimulated domestic production, stronger economic growth, more jobs and more investment into production capacity.

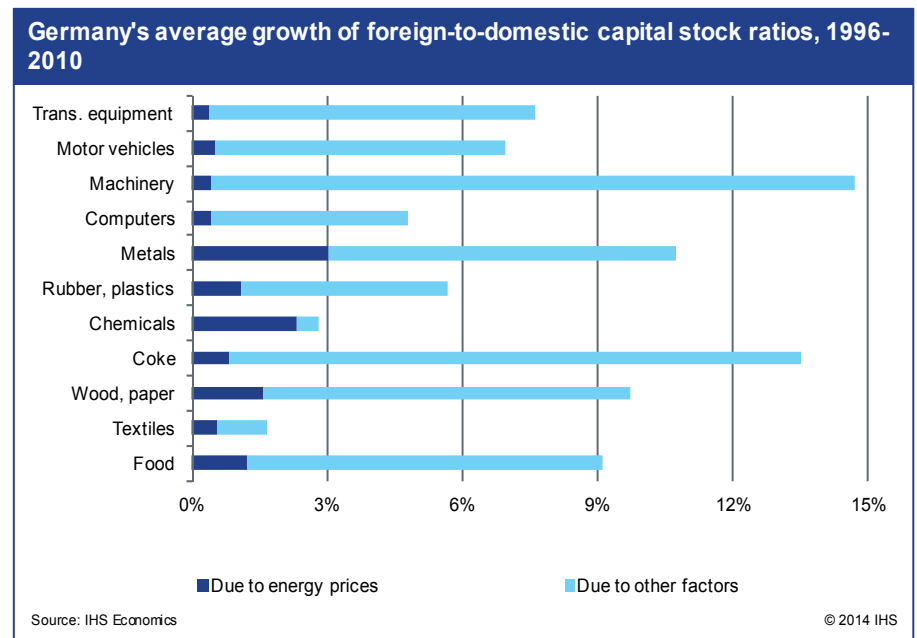
3.2 "Industrial investment losses": Energy costs influence investment decisions

Another way to capture the impact of high electricity prices on competitiveness is to consider the link between prices and industry investment decisions. High energy prices increase overall costs and, all else equal, extend the time it takes for an investment to become profitable. High relative energy prices may result in off-shoring of production and the eventual destruction of domestic production capacity as firms increase foreign investment and reduce domestic investment. We call this off-shoring and shrinking of domestic production capacity "industrial investment loss."

IHS modeling demonstrates that energy price differences play an important role in investment decisions. In the face of high energy prices in Germany, companies tend to increase investments abroad and decrease domestic investments. This effect is particularly strong among energy-intensive industries. Econometric modeling can isolate the energy price effect from other influences on companies' domestic or foreign capital stock, such as market growth, exchange rate changes, and asset prices.³³

Figure 3.5 demonstrates the relationship between energy prices and the geographic dimensions of capital investment. It depicts the degree to which German industries shifted their investments abroad from 1995 through 2010. For each of the 11 industries examined, the stock of foreign capital of German companies increased faster during that time than the stock of domestic capital. The dark blue segment of the bar represents the portion of the shift to investment abroad that is attributable to changes in energy prices. The rest of the bar represents the influence of all other factors on that decision.

FIGURE 3.5



Direct investment abroad accelerated over time at the expense of domestic investment, and energy cost was an important driver. For example, according to Eurostat, Germany's chemical industry had a foreign investment stock of €24.8 billion (2013 prices) in 1995. This figure had risen to €37.1 billion by 2010. Of the €12.3 billion of foreign direct investment during this time, €9.7 billion is attributable to Germany's energy price disadvantage. In

31. See appendix 4 for more detail.

32. In this analysis, small electricity consumers are defined as Eurostat categories IA, IB, and IC. These categories are not protected by rebates and pay the full EEG-surcharge.

33. For more details on the econometric modeling approach and results, please refer to appendix 4.

other words, this €9.7 billion would have been invested in Germany if the energy cost difference between Germany and the international benchmark had not widened.

In addition to chemicals and pharmaceuticals, several other sectors stand out for their sensitivity to energy price increases. The metals, wood, and paper products industries have experienced particularly strong shifts from domestic to foreign investment in response to energy price increases. The same is true for the food products and rubber and plastics industries, although these sectors are not regarded as energy-intensive in our analysis. However, rubber and plastics are tightly connected to energy-intensive chemical suppliers.

3.3 Integrated supply chains and industry clusters facilitate jobs and innovation

The previous sections confirmed the linkages between energy costs and a sector's output and investment decisions. The analysis highlighted the particularly strong effect on energy-intensive industries. However, owing to Germany's highly integrated domestic supply chains, output and investment decisions have implications that extend to other connected industries. To illustrate that point, we now focus on how manufacturing sectors interact within the German economy.

There are multiple interdependent relationships among energy-intensive firms and other firms in the German economy. Energy price challenges that energy-intensive firms face can cascade through supply chains and affect inter-industry relationships, posing a particular challenge to Germany's economic structure.

This interaction and interdependence among companies and industries may occur in two ways:

- Vertically: through customer relationships in the supply chain;
- Industry clustering: this concept stretches beyond supply chain relationships to include the agglomeration of companies with similar businesses, processes, or products within a narrowly defined geographic area.

We first explore the vertical dimension of the supply chain. Table 3.1 indicates that the largest and most energy-intensive sectors in Germany obtain approximately 60% to 75% of their inputs, including 70% of their manufacturing inputs, from domestic sources. In this way, German manufacturers and service providers, large and small, energy-intensive and less energy-intensive, depend on the presence and investment decisions of energy-intensive industry.

As Table 3.2 shows, approximately 20% of the total employment supported by the machinery and equipment industry's supply chain is found in Germany's manufacturing sector. The supply chains of both energy-intensive and non-energy-intensive industries

TABLE 3.1

Historic shares in industry inputs € million (constant 2013)			
	Domestic	Total	Share
Machinery and equipment n.e.c.	98,149	130,004	75%
Chemical and Pharmaceuticals	52,948	82,908	64%
Motor vehicles, trailers and semi-trailers	162,937	228,061	71%
Basic metals	35,454	59,303	60%
All Industries	660,984	964,449	69%

Note: Analysis is based on 2009 Input-Output model of the German economy.

Source: IHS Economics

TABLE 3.2

Historic employment supported by supply chains			
	Manufacturing	Total	Share
Machinery and equipment n.e.c.	246,267	1,201,514	20%
Chemical and Pharmaceuticals	71,357	922,541	8%
Motor vehicles, trailers and semi-trailers	353,016	1,920,994	18%
Basic metals	69,388	87,863	79%
All Industries	1,431,136	9,008,639	16%

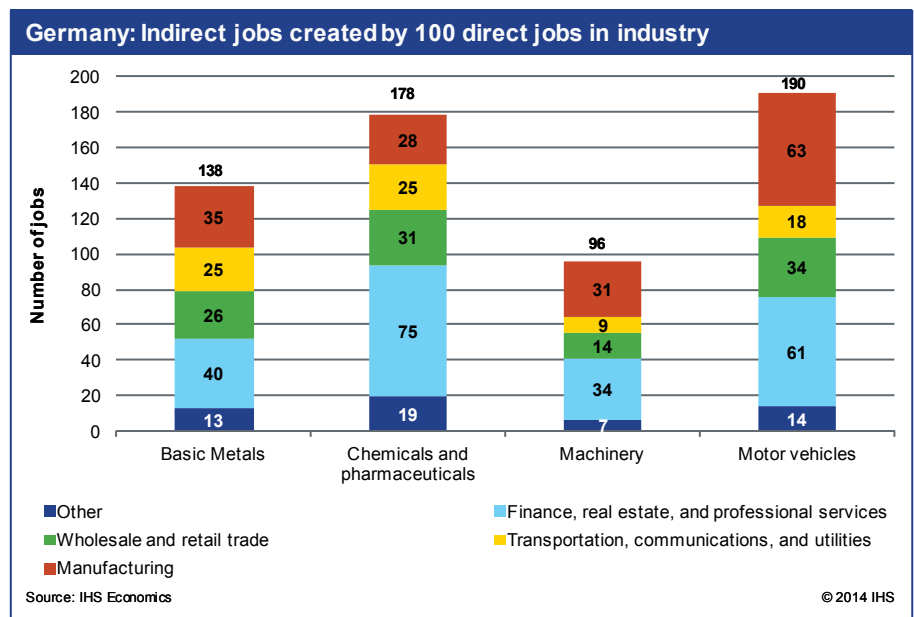
Note: Analysis is based on 2009 Input-Output model of the German economy.

Source: IHS Economics

support employment throughout the German economy, including hundreds of thousands of manufacturing jobs. And the larger an industry is, the greater the supply chain and corresponding employment connections.

Economic modeling can measure the employment influence of each industry by considering the number of indirect jobs (in the supply chain) that 100 direct jobs create (see Figure 3.6). These indirect jobs are present throughout the value chain, from manufacturing and logistics to professional services and finance. The chemical and pharmaceutical industry supports 178 indirect jobs for every 100 industry employees, nearly as high as the 190 indirect jobs for each 100 employees that the motor vehicles industry supports.

FIGURE 3.6



3.3.1 The benefits of economic clusters

The chemical and pharmaceutical sector also provides a good example of the impact of clustering (also known as co-location) among German companies. Decreasing the industry's competitiveness will not only result in workforce reductions throughout the sector and its supply chains, but it will affect the productivity and economic performance of other interrelated German sectors as well. For example, a recent analysis found that many of Germany's leading regions for chemicals production are also hubs for plastics manufacturing and for the oil and gas industry.³⁴

The benefits of co-location occur for a number of reasons. First, clustering increases the productivity of firms by providing them access to shared business best practices; specialized labour and service providers; experienced management talent; and resources for training, product testing, marketing, and improving the local business environment. Second, as cluster participants and their customers interact, both formally and informally, they share knowledge that drives the direction and pace of innovation for their respective firms. Third, as people leave established companies to start new firms, clustering encourages entrepreneurship and increases the frequency of new business formation within the region.

For the chemicals industry, the co-location of firms can provide numerous advantages including:

- Shared infrastructure, which reduces costs through economies of scale in waste treatment, incineration, and the provision of steam and other utilities.
- Logistics integration, which reduces costs, efforts, and risks in the transport, handling, and storage of materials.
- Materials integration in which by-products from one process become the raw materials for other processes, reducing chemical waste and decreasing the additional costs associated with externally purchased raw materials.

34. Ketels (2007), *The role of clusters in the chemical industry*, <http://www.epca.eu/content/Publications/ThinkTankReports/docs/EPCAHarvardclusters.pdf>.

- Greater expertise and more efficient processes in areas such as R&D; process engineering; logistics; and environmental, health and safety monitoring and performance.

The chemicals industry in Germany acts as a customer for knowledge-based companies such as law, accounting, and IT firms and suppliers of hydrocarbon feedstocks, equipment, construction, and services. Energy-intensive and non-energy-intensive businesses—both small and large firms—collaborate and share mutual dependencies in the cluster. Meanwhile, downstream manufacturing companies (such as plastics processors) benefit from their proximity to petrochemical manufacturers.

Through both competition and cooperation, clusters enhance firm productivity, encourage product and process innovation, improve wage rates, and enhance the market success of companies linked together in complementary activities. The case study on the chlor-alkaline industry in this section provides an example for such mutual relationships. Appendix 2 provides further case studies for supply chain linkages spanning several industries.

These arguments indicate that higher energy prices may at first seem to harm only Germany's most energy-intensive industries, but due to cluster effects they actually have widespread effects on employment, productivity, and innovation in many German industries.

3.3.2 Chlorine and chemical clusters

Chlorine is essential to the manufacture of thousands of essential products, including clean drinking water, energy-efficient building materials such as polyvinyl chloride (PVC), electronics, fiber optics, solar energy cells, 93% of pharmaceuticals, 86% of crop protection compounds, and much more.³⁵

Germany is Europe's largest chlorine producer. Total European chlorine production in 2013 was around 9.5 million metric tons. Of this, Germany had more than a 40% share.

According to the industry trade association Euro Chlor, the chlorine industry directly employs about 39,000 people in Europe, and many times this number are employed in related industries. Chlorine's central position in dozens of job-creating value chains is clearly depicted in Figure 3.7.

Chlorine is produced from ordinary table salt (sodium chloride) in an aqueous solution using a process called electrolysis. For every 1 metric ton of chlorine produced, 1.13 metric tons of caustic soda are also produced. Just like chlorine, caustic soda is an extremely important raw material in hundreds of chemical processes and products.

Chlorine production is highly electricity-intensive, regardless of the specific technology employed. On a per kilogram basis, energy consumption for chlorine production is similar to energy-intensive sectors such as iron and steel, cement, and glass. However, very little elemental chlorine is transported between countries or economic regions due to its highly reactive nature and other physical properties. In fact, according to a recent European Commission study, "More than 94% of all chlorine manufactured in Europe is used or converted to other products on the same site."³⁶ On the other hand, products made with chlorine, such as PVC, are heavily traded around the globe, making German PVC producers extremely exposed to international competition.

Almost all chlorine production in Germany takes place in chemical clusters. Clustering (often referred to in German as "Verbund" or "Chemieparcs") is extremely important to the competitiveness of the German chemical industry. Chlorine production is often at the heart of these chemical clusters. There are at least 60 chemical clusters in Germany. Some of the most important ones are located near Ludwigshafen, Cologne, Marl, Munich, and Böhlen/Schkopau. In all of these main chemical clusters, chlorine plays a major role in the manufacture of hundreds of chemicals. If chlorine production were to stop in any one of these clusters, the deleterious effects on the production of polymers, medicines, plant protection products, and hundreds

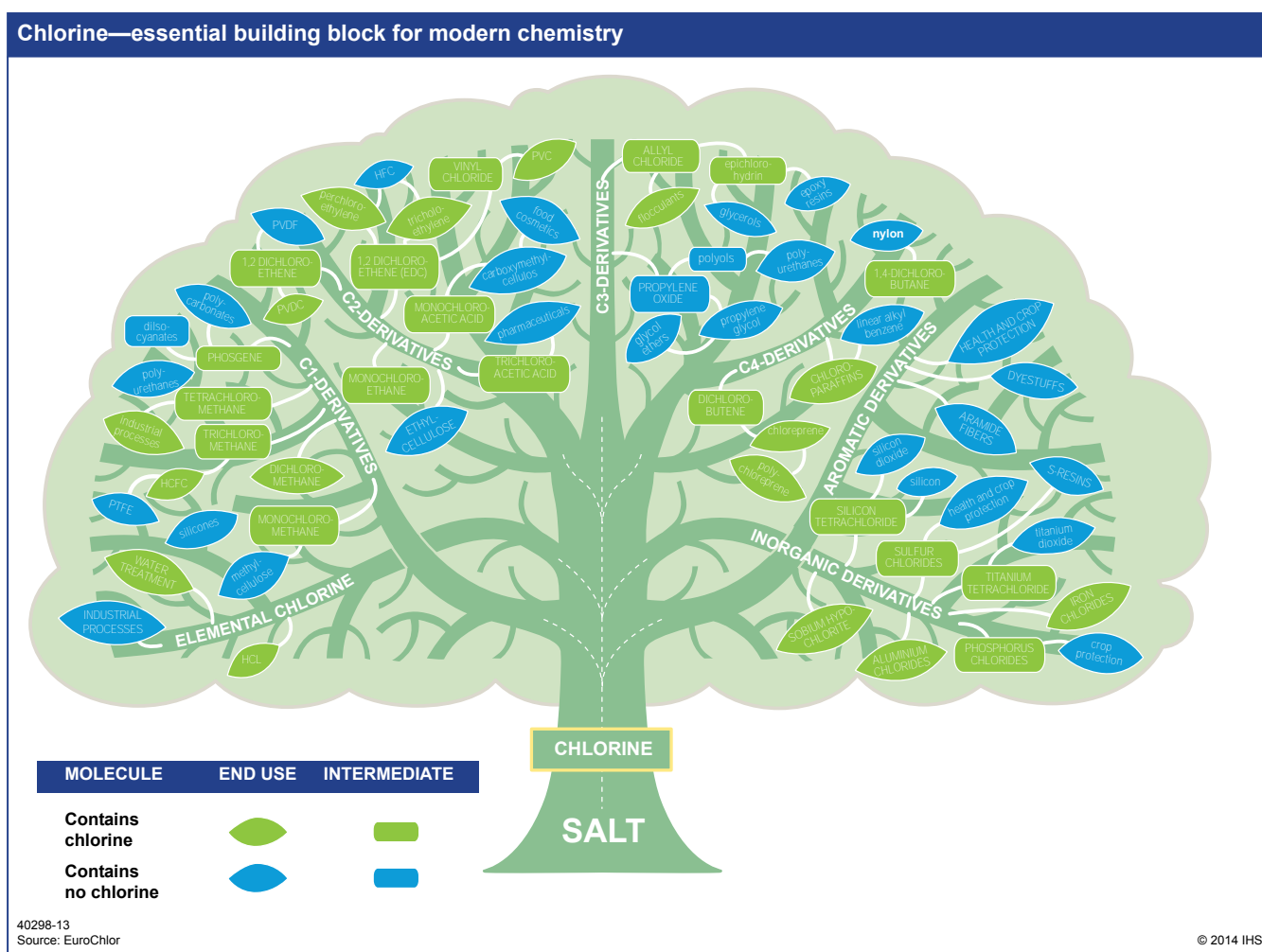
35. American Chemistry Council (2014), <http://www.americanchemistry.com/>.

36. European Commission (2014c), *Energy prices and costs in Europe*, http://ec.europa.eu/energy/doc/2030/20140122_communication_energy_prices.pdf.

of other products would be virtually incalculable. The result would be serious disruption further downstream in such diverse sectors as automobile manufacturing, consumer goods, and agriculture.

PVC is the largest chlorine derivative on a volume basis. PVC is one of the most widely used polymers in the world, and its unique technical properties make it particularly valuable in the construction industry. Roughly 70% of global PVC production is used in construction, often in the form of window profiles or plastic pipe. As in the case of chlorine, Germany is the largest producer of PVC in Europe and home to some of the largest companies, which convert PVC resin to finished goods. Four producers with eight production locations in Germany operated 2 million metric tons of production capacity in 2013, or 31% of Western European capacity. German PVC producers have been able to survive, not the least as a result of clustering, but profit levels have been entirely unsatisfactory and well below reinvestment levels. Production sites in other European countries such as Italy and Romania have already shut down permanently. It would not take much for German production facilities to experience the same fate.

FIGURE 3.7



4. Defining the energy scenarios

Key findings

- The *Current Path* scenario continues the current approach to energy policy in Germany—the Energiewende—with the primary focus on increasing the share of renewables in the power system.
- The More Competitive Energiewende demonstrates how the Energiewende can be reformed to maintain German competitiveness.
 - The *Lower Cost – Conventional* scenario slows the development of renewables, especially offshore wind, to reduce the cost of the Energiewende. Coal-fired generation remains more competitive than gas-fired through 2040.
 - The *Lower Cost – Shale* scenario introduces shale gas development in Germany. The resulting lower gas prices make gas more competitive than coal in power generation, make it a partner for renewables, and help lower emissions.

Chapter 1 demonstrated that electricity prices for German industry have been rising rapidly and are high relative to Germany's competitors. Chapter 3 demonstrated that, despite rebates that reduce the impact of recent price increases for some energy-intensive consumers, manufacturing output has been negatively affected by the high level of electricity prices. Chapter 3 also demonstrates the effect of energy costs on industrial activity. The high share of exports in Germany's economy, high and rising electricity prices in Germany, falling gas prices in the United States, and slower growth in energy prices among other international competitors all create a competitiveness challenge for German industry.

In this report, IHS has analyzed several options to move policy toward a More Competitive Energiewende. We consider both the allocation of the costs of the Energiewende as well as how the total cost could be reduced through a detailed scenario analysis. IHS has defined a baseline scenario—*Current Path*—against which the policy choices analysed in the rest of the report are compared. This chapter describes the core characteristics of each scenario.

4.1 The baseline – *Current Path*

The baseline—*Current Path*—continues the current approach to energy policy in Germany to 2040. The primary policy focus, and the primary measure of success, is the share of renewables in the power generation mix. Although the rebates provide energy-intensive industry with some protection, preserving international competitiveness is not a core concern. Similarly, little consideration is given to the efficiency of CO₂ abatement—that is, whether the lowest-cost abatement (at the German or the European level) is occurring.

This policy focus leads to a growing share of all forms of renewable generation, including offshore wind. The role of thermal generation declines. Owing to the relative economics of coal and gas generation, coal-fired generation is maximized and operators invest to extend the life of existing plants (see Table 4.1 and Appendix 7 for further details of IHS commodity price outlooks).³⁷ When new power plants are required, gas-fired generating capacity, with its lower capital costs, is built. IHS estimates the capital cost for a new combined cycle gas turbine at €1,113 per kilowatt (kW), compared to €2,440/kW for steam coal. Gas-fired generation also provides more flexible backup for intermittent renewables, a key consideration, particularly in the later part of the scenario.

In *Current Path*, large-scale deployment of all renewable technologies means that renewable targets through 2040 are met. Electricity demand continues to increase as the economy grows, although the relationship is weaker than in the past. Owing to the continued competitiveness of coal and slow progress on energy efficiency, the power sector does not reduce its CO₂ emissions in line with the economy-wide target. Coal remains ahead of gas in power dispatch during the outlook period for this analysis, which spans the present through 2040. Shale gas in Germany is not developed and development elsewhere in Europe is limited.

37. Based on IHS projections for fuel and CO₂ prices.

The rebates that energy-intensive industries receive from the electricity tax and the renewables surcharge—the EEG—continue throughout the modelled period. For the EEG rebates, the 2013 eligibility rules continue unchanged.

TABLE 4.1

Wholesale commodity price assumptions: Scenario comparison					
Constant 2013					
		2013	2020	2030	2040
All scenarios					
Oil	\$ per barrel	109	97	98	98
Coal	\$ per metric ton	82	106	109	113
Exchange rate	\$/€	1.33	1.39	1.44	1.49
Oil	€ per barrel	82	70	68	66
Coal	€ per metric ton	62	76	75	76
Current Path					
Gas	€ per MWh	27	24	23	24
Power	€ per MWh	38	43	41	39
Carbon	€ per metric ton	5	13	20	29
Lower Cost—Conventional					
Gas	€ per MWh	27	24	23	24
Power	€ per MWh	38	44	45	46
Carbon	€ per metric ton	5	15	22	33
Lower Cost—Shale					
Gas	€ per MWh	27	22	20	19
Power	€ per MWh	38	43	40	39
Carbon	€ per metric ton	5	14	21	31

Source: IHS Energy

The EEG surcharge is one of the key drivers of Germany's electricity price premium. Rebates from the EEG surcharge have played a critical role in minimizing the competitive disadvantage that high electricity prices impose on German industry. However, the rebates that energy-intensive firms currently receive are the target of an investigation by the European Commission to determine if they are a form of state aid, raising questions about whether they will continue in their current form. Additionally, rising costs inevitably raise the question of how best to share the EEG cost burden across consumer groups. The exemption currently available for production of power for self-consumption is the focus of particular attention.

In **Chapter 5**, we quantify the economic impact of changing the allocation of the costs of the Energiewende. To perform this analysis, we modelled the impact of phasing out all rebates from the EEG—including the self-consumption rebate—between 2015 and 2020 and allowing the electricity tax exemption to expire in 2022.³⁸ The construction, and hence the cost, of the power system is the same as in *Current Path*. Only the allocation of the costs is altered.

4.2 Reducing the cost of Germany's power sector: The lower cost scenarios in a More Competitive Energiewende

In the remainder of this report, we quantify the impact of reducing the cost of the power system. We consider two lower cost fuel mixes—one based on conventional gas and coal and one based on development of Germany's shale gas resources. Details of the key assumptions for each scenario are presented in Table 4.2.

The primary policy objective in both scenarios is the desire to balance emissions reductions with reductions in the cost of the Energiewende compared to *Current Path*. This is achieved by slowing the deployment of renewables, in particular offshore wind, which is capped at 6.5 GW. The lowest-cost conventional generation fills the gap left by slower growth in renewable deployment. The differentiator between the two lower-cost scenarios is the role played by gas—and by domestically produced gas in particular.

38. We have assumed the Spitzenausgleich expires, increasing the electricity tax for impacted companies from €1.5/MWh to €20.5/MWh

- **Lower Cost – Conventional.** As in *Current Path*, German shale is not developed in this scenario. Coal-fired generation remains more competitive than gas-fired generation in the long term. Given the desire to reduce Germany's energy costs, investments are made to keep the existing coal fleet in operation for as long as possible. When new thermal capacity is required, gas-fired generation is built due to its lower capital costs, but it is powered with additional imports of natural gas.
- **Lower Cost – Shale.** In contrast to *Current Path* and *Lower Cost – Conventional*, shale gas is developed in this scenario. The increased gas production leads to reductions in German gas prices and, as a result, gas-fired generation is more economic than coal beginning in the mid-2020s. This leads to lower utilization of the existing coal fleet, meaning that operators do not invest to prolong the life of these plants. Gas generating capacity grows strongly in this scenario.


In both of these scenarios, the current rebate regime is maintained unchanged.

In **Chapter 6** we consider the impact that shale gas could have on imports of natural gas and the level of prices. We first consider the potential for shale gas development in Germany and then the potential across Europe. Based on these production outlooks we have quantified the impact on German gas prices of developing shale gas.

In **Chapter 7** we compare the two lower cost options for the power system with *Current Path*. Results, with and without shale, are presented to allow the impact of shale development to be separately identified. For each scenario we present the full set of power sector results: installed capacity, generation mix, system costs, and CO₂ emissions.

The economic impacts of reducing the cost of the power system are presented in **Chapter 8**.

TABLE 4.2

Defining the power sector scenarios			
	Current Path	Lower Cost— Shale	Lower Cost— Conventional
Primary policy objective	Renewables deployment	Balancing cost and emissions reduction	Balancing cost and emissions reduction
<i>Fuel Mix—2040 Installed Capacity</i>			
Offshore wind	30 GW	6.5 GW	6.5 GW
Onshore wind	66 GW	47 GW	47 GW
Solar PV	71 GW	63 GW	63 GW
Coal generation	Coal in merit to 2040, main source of conventional generation	Remains important component of fuel mix through 2030	Coal in merit to 2040, main source of conventional generation
Gas generation	Role limited to provision of flexible backup	In merit from mid-2020s, role grows strongly from that date	Role of gas increases, overtakes coal by the end of the period
Support assumptions	Solar PV over 52 GW unsupported Fixed cost recovery as required to ensure sufficient dispatchable back up maintained		
<i>Shale gas development</i>			
Shale gas	Not developed	German shale production exceeds 20 Bcm	Not developed
<i>Cost/emissions trade-off</i>			
Cost Emissions	Higher cost Lower emissions	Lower cost Higher emissions	Lower cost Highest emissions
40298-26 Source: IHS Energy		 key differentiation between the scenarios	© 2014 IHS

5. Rebates are crucial to German industrial competitiveness

Key findings

- Removing the EEG rebates for large, energy-intensive customers would increase their electricity prices by more than 60%. Prices for residential customers would decrease by approximately 5%.
- Removing the rebates would be harmful not only to German industry, but to the economy as a whole. By 2020, GDP would be nearly 5% lower and the economy would support 1.1 million fewer jobs.
- A residential consumer would save about €55 per year on his or her electricity bills, but real disposable income per capita would decrease by more than €500 per year by 2020.

The *Current Path* baseline includes maintaining the existing rebates for large, energy-intensive industry from the EEG and electricity tax. However, changes in the rebate mechanism are currently under consideration and a state aid investigation is underway at the European level. Given the ongoing uncertainty about the future of the rebates, in this chapter we consider the potential impact of phasing out the rebates between 2015 and 2020 and allowing the electricity tax rebate to expire in 2022, compared to *Current Path*.

In this analysis, the composition of electricity-generating capacity, fuel mix, and associated costs are the same as in *Current Path*. The focus of the analysis is on quantifying the impact on the German economy of different methods of allocating the EEG costs.

Industrial customers that currently benefit from rebates would experience large electricity price increases if the rebates are phased out. Higher electricity prices for energy-intensive consumers have significant and sustained detrimental effects on the entire economy, reducing GDP nearly 5% between 2020 and 2030 and reducing disposable income by more than €800 per capita in 2030 compared to *Current Path*.

5.1 The impact of removing rebates on end-consumer electricity prices

To quantify the economic impact of removing the rebates, IHS developed end-consumer electricity price forecasts for all Eurostat consumer categories, further broken down into energy-intensive and non-energy-intensive consumers for industrial categories IC-IG. To construct these overall price forecasts, IHS developed forecasts for each major component of end-consumer prices: wholesale price, grid cost, customer servicing costs (including marketing and margin components), and taxes and levies.³⁹ To cover the cost of building new thermal capacity, we also modeled fixed cost recovery. (See Appendix 6 for details about the retail price forecast and the wider energy modelling approach.) Two sets of retail electricity prices have been developed:

- For *Current Path*, the rebates are maintained throughout the outlook period. Eligibility is determined according to the 2013 rules.
- To model the impact of removing the rebates, all EEG rebates—including the self-consumption rebate—are phased out linearly from 2015 to 2020. For the electricity tax rebate, the current eligibility rules are applied through 2022. From 2023 onwards, all industrial companies pay the full rate. All other rebates, for example for the CHP levy, are unchanged.⁴⁰

Figure 5.1 shows the forecasts of electricity prices to 2040 for household and large energy-intensive consumers. The shapes of the price outlooks vary significantly depending on the consumer category.

39. The taxes and levies further break down into an EEG surcharge, Stromnetzentgeltverordnung, Konzessionsabgabenverordnung, Stromsteuergesetz, and CHP surcharge.

40. No changes are assumed in exemptions from CO₂ emissions payments.

5.1.1 Energy-intensive consumers

For energy-intensive consumers, electricity prices in *Current Path* decline slightly in real terms over the outlook period. The wholesale price is the main driver of end consumer prices for this category. We expect a slight decline in wholesale prices in real terms, as the share of zero-marginal cost generation (wind and solar) grows. (See Appendix 7 for further details.)

In contrast, if rebates are phased out, prices for energy-intensive consumers rise through the remainder of this decade, peak in 2023, and then begin to decline. The increase from 2015–20 is due to removal of the EEG rebate, and the increase between 2022 and 2023 is due to expiration of the electricity tax rebate. The gradual decline from 2024 reflects the long-term decline in the EEG charge as feed-in tariffs associated with already developed renewables expire.

The impact of phasing out the rebates on electricity bills depends on annual consumption.

- **A medium-sized energy-intensive industrial consumer** with annual consumption of 2 GWh would experience additional costs of over €55,000 in 2023 if the rebates were phased out—equivalent to a 20% increase in its electricity bill.
- **A large, energy-intensive industrial consumer** would experience a 65% increase in power costs if the rebates were phased out.

5.1.2 Non-energy-intensive consumers

For households and other non-energy-intensive consumers, the EEG surcharge is the primary driver of the price increase. The underlying EEG surcharge—the element associated with direct support for renewable capacity additions—is expected to increase in real terms through most of this decade. It will then stabilize through the mid-2020s. In the latter half of the 2020s, the cost of renewables support is expected to drop rapidly as the existing solar support begins to expire.

The direct cost of renewables support, however, is only part of the EEG charge paid by consumers. Over the past two years in particular, deficits have built up as the EEG surcharge has failed to recover the full support paid to renewables generators each year. In 2014, 9% of the EEG surcharge is due to historic deficits. Assuming the full deficit is recovered in 2014, we expect that the charge will drop toward €50/MWh in 2015. However, recovering the deficit in full has proved challenging in the past, and at least part of the current deficit may be carried into 2015. Furthermore, annual variations on the scale seen between 2013 and 2014 are likely to continue, as the level of the EEG is inherently uncertain owing to its design. Variations due to weather conditions alone could cause the EEG surcharge to fluctuate by as much as plus or minus 14% around our forecast from one year to the next.

If the rebates are phased out, electricity prices for non-energy-intensive consumers would be slightly lower than in *Current Path*, as the costs associated with the EEG would be allocated across the entire volume of power consumed by end-users in Germany. The total amount of EEG support paid to renewable generators does not change between the two cases.⁴¹

The impact of phasing out the rebates on electricity bills depends on the type of consumer, as shown in Figure 5.1.

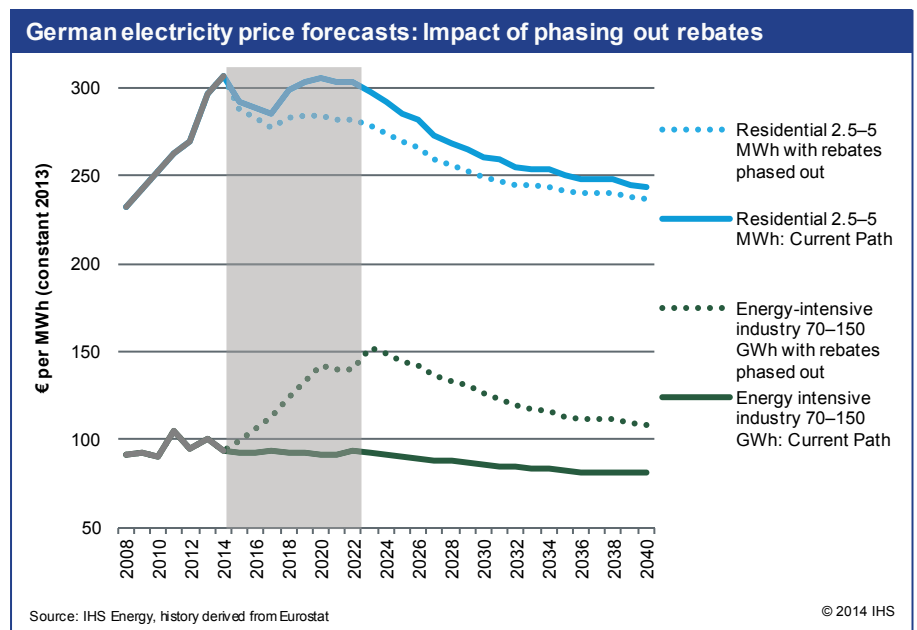
- **A residential consumer** of 2.5 MWh per year would save a maximum of €22/MWh, or about €55 per year on a total electricity bill of almost €765 if the rebates were phased out—a roughly 5% saving.⁴²

41. Power demand relevant for the EEG surcharge assessment is 478 TWh, according to German TSO data applied to calculate the 2013 EEG surcharge. This does not include power demand met by power generated and consumed onsite – this power is freed from the EEG surcharge under Paragraph 37 EEG.

42. Residential consumer of 2.5 MWh, which is the second smallest category of Eurostat price categorization, band DC (2.5 – 5 MWh/year).

- Small industrial consumers** are not eligible for the EEG rebate, but they can benefit from the electricity tax rebate. The maximum savings created by removing the EEG rebates occurs in the early 2020s when prices are €18/MWh less than in *Current Path*. Assuming annual consumption of 20 MWh, this is equivalent to €370 per year in savings on an electricity bill of more than €3,600—a 10% saving.⁴³ However, these customers are negatively impacted when the rebate from the electricity tax expires in 2022. The increase in price from removing the electricity tax rebate is greater than the savings from the phase-out of the EEG rebate. As a result, post-2022 electricity prices for this class of customer are higher if the rebates are phased out than under *Current Path*. The maximum difference is €5.7/MWh for a 20 MWh/year customer, equivalent to an increase of €114 per year.

FIGURE 5.1



5.2 Economic impact of phasing out rebates

Phasing out the EEG and electricity tax rebates would increase electricity prices for many industries. Customers partially protected by the EEG rebates today would see substantial increases in their electricity prices, while customers that benefit from the maximum rebates could see electricity price increases of as much as 65%. The immediate impacts on output, exports, and investment dominate the economic outcome in the short- to medium-term. More structural economic effects—such as the permanent loss of production capacity, productivity effects, and innovation—occur over the longer term.

FIGURE 5.2

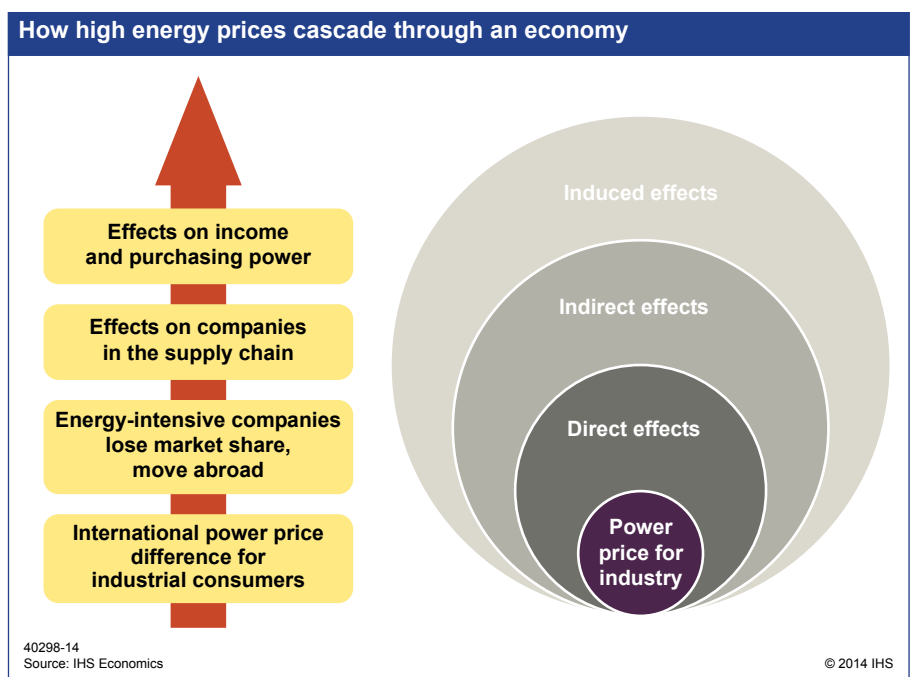


Figure 5.2 provides an overview of how electricity price increases flow throughout the economy. These economic impacts can be divided into three types: direct, indirect, and induced.

- Direct impact.** The direct impact affects the core industry's output, employment, and income. Higher

43. Small industrial or commercial customer in Eurostat band IA (<20 MWh/year).

energy prices that increase the industry's input costs dampen manufacturing activity through net export losses, lower investment, and production.

- **Indirect impact.** Changes in the purchasing patterns of the core industry trigger indirect impacts on that industry's suppliers. This creates corresponding changes in output, employment, and labor income throughout their supply chains and via inter-industry linkages. The affected supplier activities span most industries in the German economy. The linkages across these supplier relationships were demonstrated in Chapter 3.
- **Induced impact.** Finally, income earned by workers in both the direct and indirect industries is spent on food, housing, leisure, autos, household appliances, and other consumer items. The additional output, employment, and labor income generated from the industries that meet this increased consumption are categorized as induced economic impacts.

These direct and indirect economic effects cascade through Germany's industrial base. Supply chain impacts also impact employees in the supplier industries, including non-manufacturing industries such as agriculture, construction, and services. The largest impacts on employment in the supply chain occur in industries that are most strongly linked to the directly impacted industry.

To quantify the impacts of removing the rebates on the German economy, IHS modeled the effects of phasing out the rebates compared to the *Current Path* scenario. IHS incorporated the relative change in capital investment, the new path for electricity prices, and the shock to incomes from phasing out the rebates into our macroeconomic models.

The findings confirm that there would be substantial and sustained macroeconomic disadvantages to the German economy if the current rebates are removed.

Removing the rebates causes the German economy to underperform relative to *Current Path*. Although total power system costs remain the same, the much higher electricity prices for large energy-intensive companies resulting from removing the rebates severely dampen industrial activity. The German economy, although not contracting, would experience slower GDP growth if the rebates are removed, since many energy-intensive businesses relocate, reduce capacity, or put investment plans on hold owing to higher electricity prices.

Table 5.1 depicts the differences between *Current Path* and a future in which the rebates are phased out. The difference in GDP between the two cases widens quickly until 2020, with the percentage difference stabilizing somewhat after that time. With the rebates gone, gross domestic product in 2040 is €215 billion, or nearly 5.3%, below the forecasted level in *Current Path*.

The impact on GDP of phasing out the rebates cascades through Germany's economy.

The reduction in economic activity will reduce employment in energy-intensive industries and affect adjacent businesses in the supply chain and industry clusters. The absolute job loss if rebates are phased out compared to *Current Path* increases to 1.1 million by 2020 and remains nearly steady beyond that year.

TABLE 5.1

Summary of main metrics: Rebates phased out vs. Current Path			
€ billion (constant 2013)			
	2020	2030	2040
GDP	-149.3	-173.8	-214.7
GDP (percentage difference)	-4.8%	-4.9%	-5.3%
Government revenue	-64.6	-77.0	-108.9
Manufacturing exports	-49.8	-175.3	-182.3
Private non-residential fixed investment	-57.2	-63.7	-129.4
Per-capita disposable income (€, 2013)	-543.0	-812.5	-1,060.6
Employment (millions)	-1.1	-1.1	-1.1

Note: All quantities in € billion (constant 2013) unless otherwise specified.

Source: IHS Economics

Reduced household income will reverberate through the entire economy.⁴⁴ The difference in disposable income between the two cases steadily grows throughout the forecast period. Average disposable income per capita is €543 lower in 2020 and more than €1,000 lower in 2040 if the rebates are phased out. The associated employment and income losses will lead to a permanently weaker economic development path for the entire economy.

For private sector households, the income losses dwarf the savings on electricity bills that would result from reallocation of the EEG-surcharge. As the rebates are phased out, energy-intensive companies assume a greater share of the EEG surcharge, meaning that the burden for private households decreases. However, household electricity bills decrease by approximately €40 per year, far short of the losses in annual disposable income that removing the rebates brings.

The weaker economic activity that results from removing the rebates will also reduce government revenue during the forecast period. As Table 5.1 illustrates, the lower taxes that consumers and producers pay would reduce government revenues by €65 billion compared to *Current Path*, a 4.9% decrease. The fiscal losses stabilize through the following decade, before increasing beyond 2030. The expiration of the electricity tax rebate in 2022 will provide some relief for government revenue, but not enough to offset the shortfall from weaker economic activity.

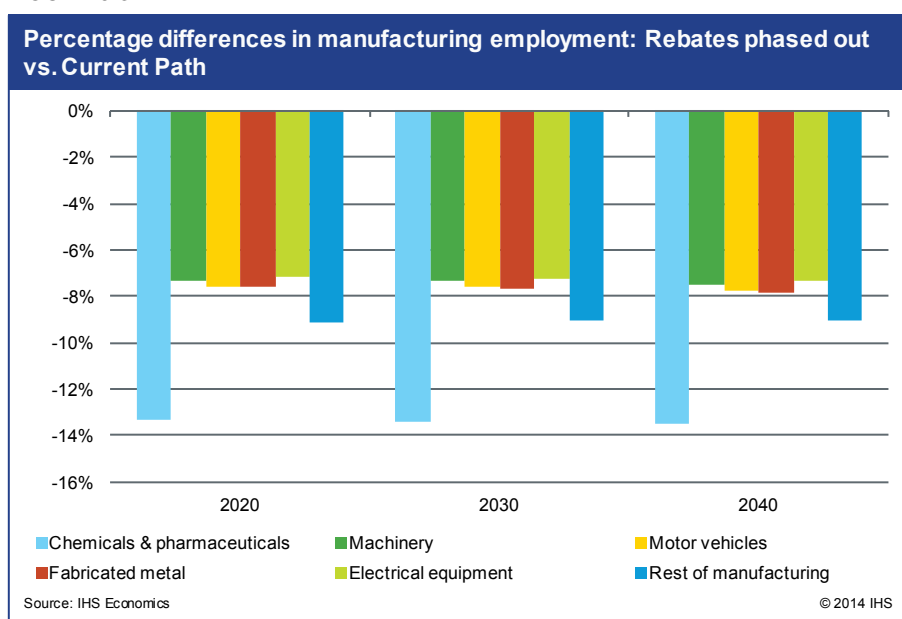
Manufacturing employment is disproportionately impacted in the near term if the rebates are phased out. As the rebates are phased out after 2015, manufacturing jobs account for the bulk of employment loss. However, by 2020 the indirect effects on the supply chains of energy-intensive industries cascade through the economy, accelerating employment losses in non-manufacturing sectors. Between 2020 and 2040, approximately 500,000 of the lost jobs, or around half of the total employment loss, are in non-manufacturing sectors.

While the number of job losses is almost identical in the manufacturing and non-manufacturing industries if the rebates are phased out, the relative importance of the employment losses varies markedly. By 2040, manufacturing's total employment losses equal 8.7% of all manufacturing employment. In non-manufacturing sectors, this number of jobs represents 1.75% of 2040 employment. This demonstrates the disparate impact of removing the rebates on Germany's manufacturing sectors relative to its impact on the rest of the economy.

Broken down by manufacturing sub-sector, Figure 5.3 shows that machinery, motor vehicles, and chemicals and pharmaceuticals bear the largest employment losses in terms of the absolute number of jobs. In relative terms, the impact is greatest in the chemicals and pharmaceuticals sector, where employment losses range between 12% and 13.5% of employment under *Current Path* for the forecast period.

Removing the rebates also substantially weakens the competitiveness of Germany's export sector. Without rebates, large, energy-intensive

FIGURE 5.3



44. For a description of indirect effects via supplier industries refer to Section 2.

companies pay markedly higher electricity prices. As demonstrated in Chapter 3, higher energy costs negatively impact their competitiveness, sending supply chain impacts throughout the broader industrial base. As a result, Germany's exports decline. Figure 5.4 shows that phasing out the rebates reduces manufacturing exports by nearly €50 billion, or 3.3%, by 2020. By 2040, the reduction in total manufacturing exports reaches €182 billion or 7.9% of manufacturing exports in *Current Path*.

Removing the rebates also leads to longer-term structural changes in Germany's economy. The increase in electricity prices for companies that currently qualify for EEG rebates would dampen investment in adjacent sectors and force many companies in the most energy-intensive industries to allocate or even relocate production capacity abroad. By the middle of the next decade, energy-intensive sectors will comprise a significantly smaller share of German industry than they do today. Energy-intensive research and production, including related skill-sets, will follow these companies off-shore, resulting in the permanent loss of these critical assets.

From 2025 through 2040, the IHS modeling approach takes these structural changes in German manufacturing into account. Although price shocks and their cascading effects dominate in the short- to medium-term, the diverging patterns of German domestic investment between a world with and without rebates become more and more important in the long term. This is particularly true since investment decisions have compounding effects, building upon prior years' investments over a given period.

If the rebates are removed, rising electricity prices and the relocation of energy-intensive industries would drive the first phase of industrial investment losses, which would reach nearly €60 billion by 2020 compared to *Current Path*. By 2025, when the electricity price shock has passed and the economy is able to achieve a modest recovery, the investment difference moderates slightly. Nevertheless by 2030, the persistently higher electricity prices in Germany and the accumulated losses to Germany's industrial capital base continue to erode investment levels, and the industrial investment loss owing to removing the rebates peaks at

FIGURE 5.4

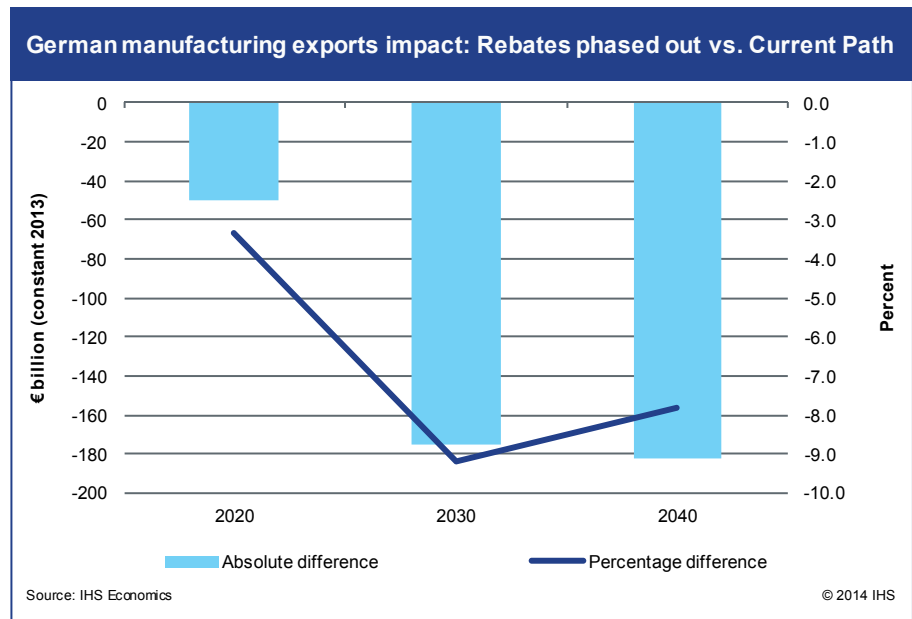
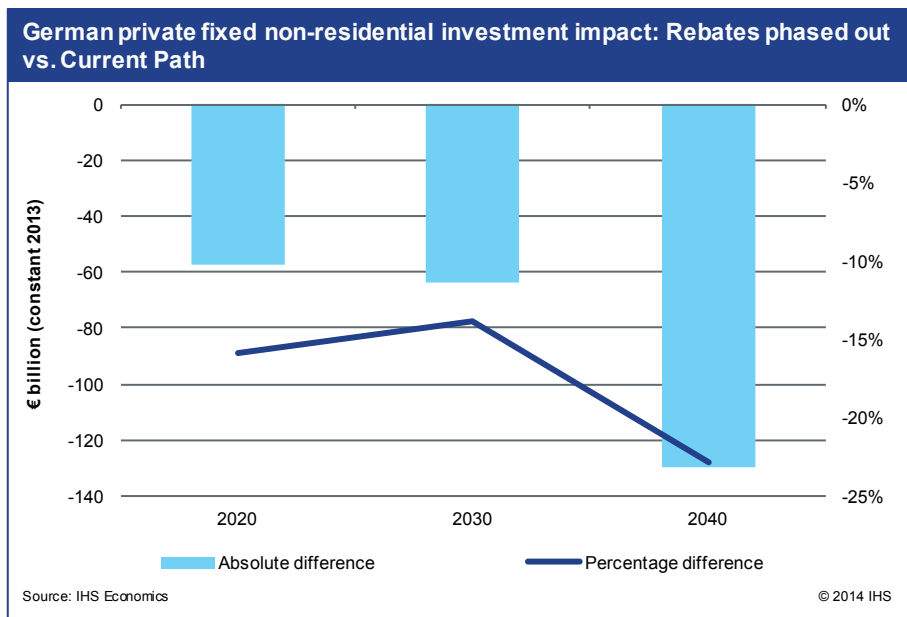


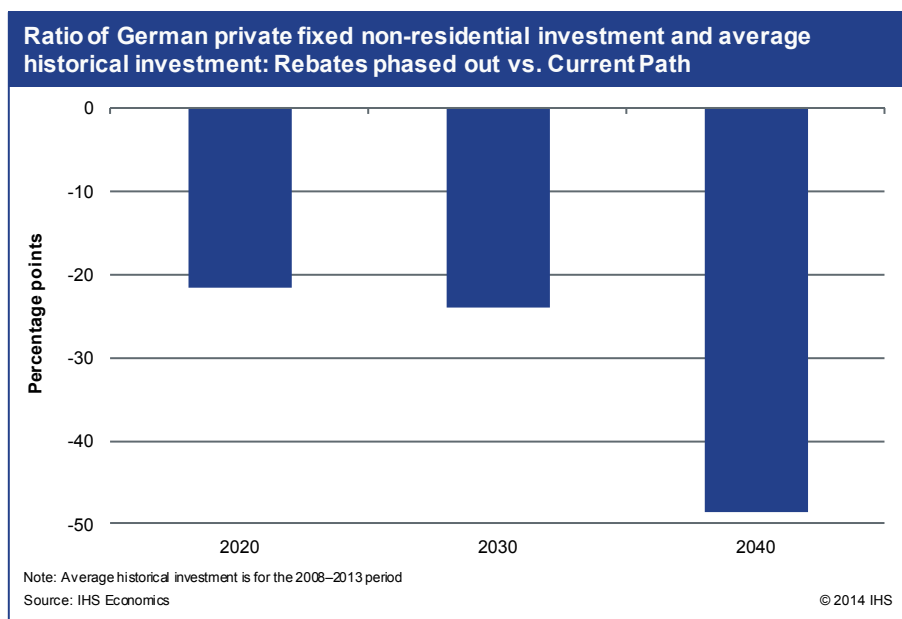
FIGURE 5.5



almost €130 billion in 2040, as shown in Figure 5.5. If the rebates are phased out, domestic fixed investment is 23% lower than in *Current Path*.

To provide context around the scale of the forgone investment, Figure 5.6 compares the investment reduction if the rebates are phased out to the historically observed average annual investment level—approximately €275 billion—between 2008 and 2013. By 2040, the annual difference in investment between phasing out the rebates and *Current Path* will be nearly half as much as the historic average total investment observed between 2008 and 2013.

FIGURE 5.6



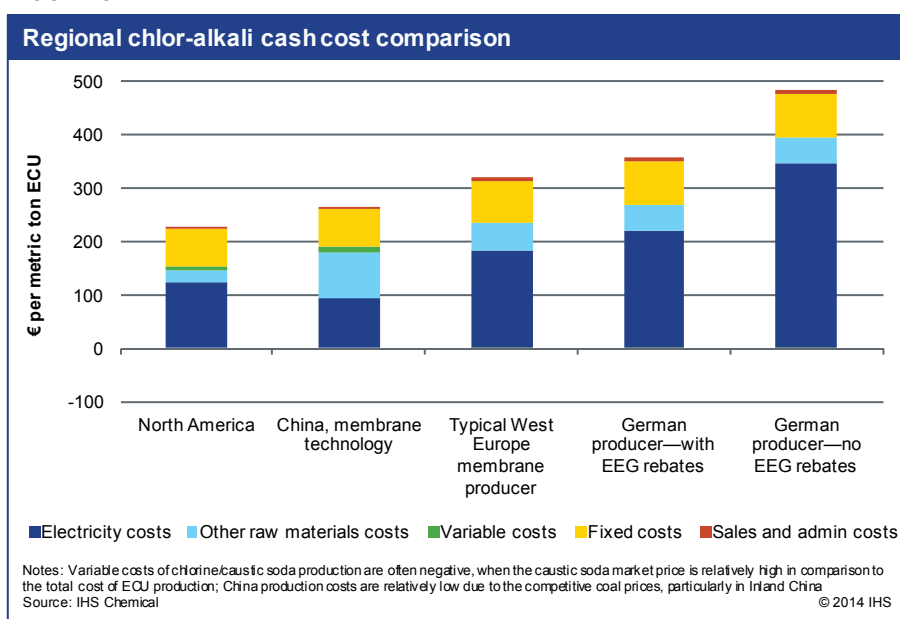
The impact of phasing out the rebates on the chlorine-PVC supply chain

Polyvinyl chloride (PVC) is 57% chlorine and 43% carbon—predominantly derived from oil or gas via ethylene. Electricity is the third key raw material that goes into PVC production. Even relatively small differences in chlorine production costs can mean the difference between making a profit, breaking even, or losing money in the PVC business. As discussed earlier, electrolysis is used to release chlorine from salt, requiring large amounts of electricity. Electricity makes up more than 55% of the cost of producing chlorine (and its co-product caustic soda). Owing to North America’s vast reserves of natural gas and coal, electricity is more than 50% cheaper in North America than in Europe. North America also has a cost advantage in ethylene production, giving it a significant advantage over other PVC producing regions.

Figure 5.7 depicts a German chlorine producer’s cost structure compared to regional and global competitors. Even under the *Current Path* scenario, with the current rebate mechanisms maintained, German chlorine producers have significantly higher costs than other major producing regions, such as Asia and particularly North America.

Elimination of the EEG rebates would have significant negative impact on chlorine production costs. If the EEG rebates were to be

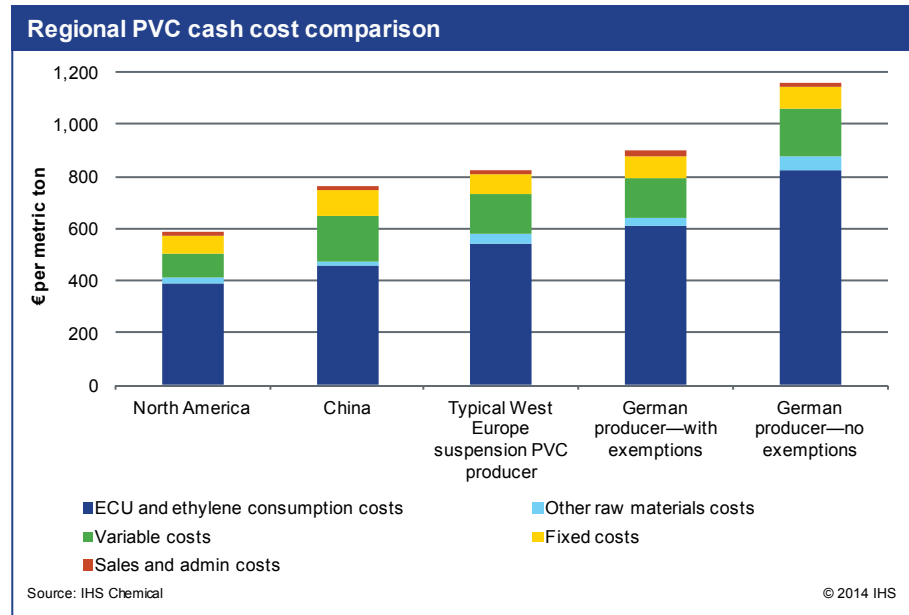
FIGURE 5.7



eliminated, the electricity price for chlorine producers would eventually increase by almost 60% and the total cost of producing an electrochemical unit would jump 36%, from €352 per metric ton to €479 per metric ton.⁴⁵ All major chlorine producers belong to the group of large energy consumers and benefit from EEG rebates.

With the increased chlorine cost, the cost of producing a metric ton of PVC in Germany would increase dramatically, as shown in Figure 5.8, seriously compromising German producers' already marginal competitive position. Even in comparison with neighboring European countries, Germany's position would be seriously weakened. Given current poor profitability, a large increase in electricity costs above an already high base case would inevitably lead to the demise of Germany's PVC industry.

FIGURE 5.8



45. An electrochemical unit is 1 metric ton of chlorine and 1.33 metric tons of caustic soda.

6. The potential for expanded natural gas production in Germany

Key findings

- With a supportive policy framework, domestic shale gas production could reach 20 billion cubic meters per year by 2030, or 25% of current German gas consumption.
- Shale gas production could significantly alter Germany's import position, increasing total domestic gas production to over 35% of today's consumption level through the 2030s, up from around 10% today.
- European shale gas production in excess of 50 Bcm could reduce German gas prices by 20%.

Germany has significant shale gas resources. Despite Europe's dependence on imported fossil fuels, exploitation of the continent's shale endowment remains far from certain. The need for an import dependent continent to maximize domestic production was recognized in the European Union's recently released Policy Framework for Climate and Energy in the Period 2020 to 2030, which highlights the role that unconventional gas and oil can play in improving Europe's security of supply:

“Declining EU oil and gas production makes further exploitation of sustainable indigenous energy sources a necessity. Contributions may come from renewable energy sources, domestic reserves of conventional and **unconventional fossil fuels (primarily natural gas)** and nuclear according to Member State preferences over their energy mix and within the framework of an integrated market with undistorted competition. Where indigenous sources are exploited, this should respect the framework of existing Union legislation and international commitments such as that adopted by the G20 for the phase out of fossil fuel subsidies.”⁴⁶

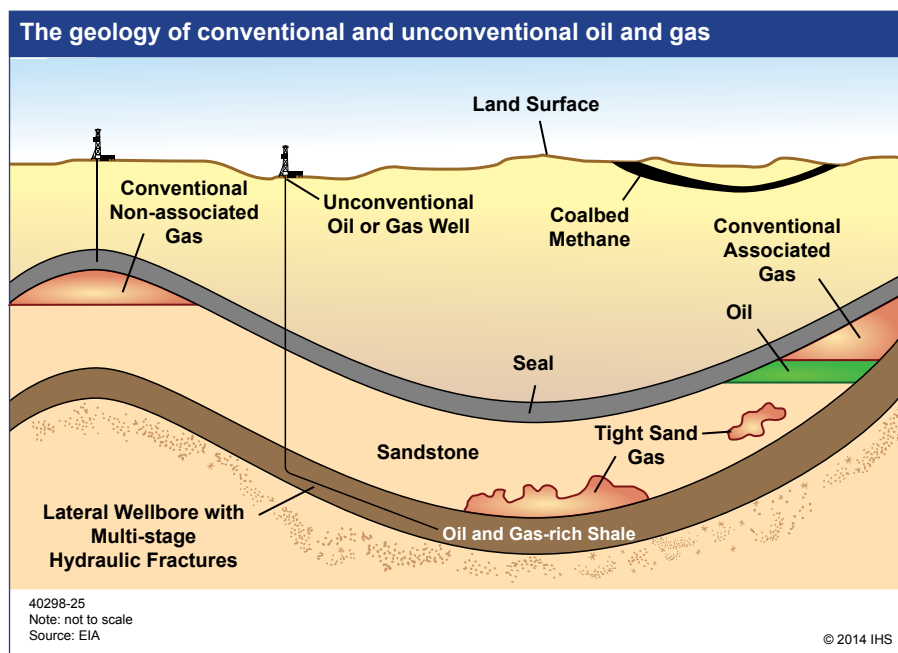
In this chapter of the report we examine Germany's potential to develop shale gas and the scope of potential development across the European Union. We then discuss the impact that shale gas could have on the price of gas in Germany. In Chapter 8 we analyze the benefits of increased domestic gas production on Germany's competitive position.

6.1 What is shale gas?

Shale gas is natural gas. It differs from “conventional” gas not in its chemical composition, but in the types of reservoirs where it is found. In a conventional reservoir, natural gas has migrated from a source rock into a “trap” that is capped by an impermeable layer of rock, as shown in Figure 6.1. A well is drilled into the reservoir to allow the natural gas to flow into the wellbore and up to the surface.

Shale formations are often the source rock for conventional gas reservoirs, and geologists have known for decades that these shale formations contain gas.

FIGURE 6.1



46. European Commission (2014c), *Energy prices and costs in Europe*, http://ec.europa.eu/energy/doc/2030/20140122_communication_energy_prices.pdf

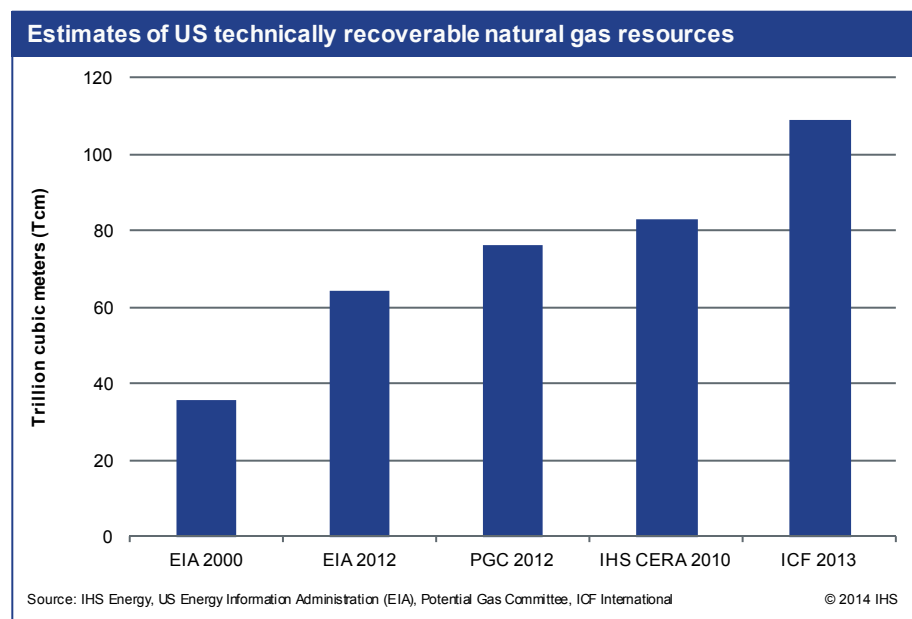
However, shale has low permeability, meaning that it is difficult for the gas to flow from the dense rock of the formation into a production well.

Two technologies—hydraulic fracturing and horizontal drilling—are critical to producing gas from shale formations. Each of these technologies has been safely in use for decades—hydraulic fracturing has been practiced in the United States since the late 1940s and in Germany since the early 1960s—but combining the two is the key to economically producing gas from shale resources.

- Hydraulic fracturing involves pumping a fluid at high pressure into the wellbore. This creates new fractures or expands existing fractures in the shale rock, allowing gas to flow into the well. Small particles such as sand or ceramic beads, known as proppants, are added to the fluid to fill the fractures and keep them open. Fracturing fluids used today are typically 98-99% water and proppants, with additional chemicals added in very small quantities to aid in the fracturing process.
- Horizontal drilling (also known as directional drilling) involves drilling vertically to the depth of the shale formation, then drilling horizontally within the shale, accessing a much larger portion of the reservoir than is possible with a vertical well. Horizontal drilling, with its lateral reach, greatly reduces the surface impact of resource development.

Combining these technologies has transformed natural gas (and oil) production in North America. Operational learnings by operators and service companies, such as “walking” rig technology, have enabled drilling as many as 12 wells per drill pad and reduced the environmental footprint of shale gas. These advances have allowed shale gas to constitute 44% of total US natural gas production today, compared to 2% a decade ago. The United States has overtaken Russia as the world's largest natural gas producer. Figure 6.2 depicts various estimates of technically recoverable US natural gas reserves over time, which have roughly tripled since 2000. The same technologies applied to oil have raised US oil output by more than 60% since 2008—an increase of 3.1 million barrels per day. This increase is greater than the total oil production of nine out of the 13 OPEC countries.

FIGURE 6.2



The environmental impacts of shale gas production are not substantially different from those of conventional onshore oil and gas production. Proper well construction and management of fluids at the surface are the most important environmental protection measures for conventional oil and gas and for shale gas production. Nonetheless, the public is understandably concerned about the impacts that may result from shale gas production, particularly in areas that have not previously seen oil and gas development. Developing the capacity for best practice regulation is a crucial step in this process.

Technology exists to minimize the environmental and safety impact of shale gas production, and this technology is already in wide use. Appropriate regulations and good operating practices, combined with technology, can minimize the environmental impact of increased European gas production. Experience gained in the United States and Canada can be applied to European development. For example, recycling water used in the hydraulic fracturing process can significantly reduce the water use impact for shale

production. Likewise, a number of advancements, including using new fracturing additives and process improvements at the well site, have reduced the likelihood and impact of spills at the well site.

Several initiatives in the United States have explored the framework of regulation, community involvement, and best practices needed to ensure responsible shale gas development. These efforts can provide knowledge for Germany to follow as its shale industry develops.

Notably in 2011, then-US Energy Secretary Steven Chu appointed a group of environmental, industry, and state regulatory experts to form a subcommittee of the Secretary's Advisory Board to address natural gas issues.⁴⁷ The study this group produced has become the foundation for the shale gas policy of the Obama Administration, and

many of its recommendations about prudent shale gas development are also applicable in the German context.⁴⁸ The study concluded that the risk of chemicals used in the hydraulic fracturing process affecting water supply is very slight and that attention needs to focus on best practices for managing flowback and produced water and for air emissions, and community impacts. The recommendations of this group and others for sustainable shale gas development are included in Appendix 2.

Shale rig site – Poland



6.2 Germany has substantial shale gas resources

This section provides an estimate of Europe's shale gas resource potential, particularly the 10 shale gas plays in Germany.⁴⁹ IHS determined play boundaries based on geological characteristics and operator reports. We then calculated the area open to development by accounting for geological risk and excluding all conservation areas, water protection areas, and bird protection areas included in the Natura 2000 Network. The environmental review process eliminated 7% to 47% of individual play areas in Germany.

Because of a lack of drilling data in Europe, our resource estimates used geological analogues. We compared each European play's geological characteristics to established US shale plays in order to develop production profiles for each well. Only fuller exploration of the geology will provide a more accurate assessment of the resources available. For this reason, policy that enables exploratory drilling is critical to better understand Europe's resources.

6.2.1 Gas in place estimate

Estimating the amount of gas in place (GIP) is the first step in assessing the shale gas resource potential. Our analysis is based on source rock analysis, including an evaluation of the richness of organic matter and the maturity of European shale, using geological data of varying quality available for the shale gas play areas being assessed.

47. The membership of this subcommittee included Daniel Yergin, Vice Chairman of IHS.

48. US Department of Energy (2011), *Shale Gas Production Subcommittee Second Ninety Day Report*, http://www.shalegas.energy.gov/resources/111011_90_day_report.pdf

49. This analysis does not consider coal bed methane and other types of unconventional gas development.

A shale gas play is defined as the lateral and vertical extent of shale rock with the potential characteristics in rock properties, thickness, and gas content to generate and produce natural gas. After mapping and analyzing shale intervals believed to have potential, we defined the final prospective play areas and calculated the GIP resources. Detailed geologic information, such as depth contour maps, thickness maps of specific shale intervals, and detailed maturity maps, was not available for each potential geological horizon. Few, and in some cases no, horizontal wells have been drilled in the high-potential shale plays, so limited data are available for analysis. Notwithstanding these limitations, the geological interpretation allows comparisons of each play to a North American analog and the modeling of its productive capacity. This evaluation is not designed to support the detailed exploration of individual plays or to identify specific “sweet spots” of future high potential but rather to provide an estimate of the scale of potential future production.

Shale gas potential in Germany is estimated at 436 trillion cubic feet (Tcf) or 12.35 trillion cubic meters (Tcm) of dry GIP and 14 Tcf or 0.4 Tcm of GIP associated with oil and wet gas shale plays. Our 12.35 Tcm GIP estimate compares to 13 Tcm (459 Tcf) published by the Bundesamt für Geowissenschaften und Rohstoffe in 2012.⁵⁰ Taking into account the large variation and uncertainty in geological parameters, these two estimates are strikingly similar. Appendix 2 contains further details on the methodology IHS used to estimate gas in place volumes.

The volume of gas that can be technically and commercially recovered is typically in the range of 5% of the GIP volume. Estimates of producible volumes are discussed in the following sections.

6.2.2 From gas in place to potential production

IHS performed a detailed analysis to develop an outlook for production capacity. Many variables influence the economic model's output, but energy policy is the key driver that will determine the pace of shale gas development in Europe.

Our cost estimates are based on US costs adjusted to European rates, and they include the cost of best practice environmental protection measures. IHS performed an analysis of environmental costs unique to the European market. For instance, IHS included costs for paving the entire well pad as required by German regulation. IHS also reviewed requirements in each country for environmental safeguards, water supply costs and disposal, casing design and testing, as well as well site requirements, such as spill barriers and road construction regulation.

A broad array of favorable above-ground factors enabled the vast and rapid expansion of US shale gas production. Private leasing and state regulations allowed for flexibility and growth. Regulatory capacity was sufficient to keep up with growing production. Smaller independent companies helped speed learning and development.

The regulatory framework that evolves in Germany and more widely in Europe will be a key determinant of the speed and scale of shale gas development. In this analysis, we assume that European policy regarding shale gas will broadly emulate the US experience. The recently adopted EU recommendation is a positive sign that generally follows the recommendations of the 2011 US Department of Energy report described above.⁵¹ Describing the recommendation, EU Environment Commissioner Janez Potočnik said, “Shale gas is raising hopes in some parts of Europe, but is also a source of public concern. The Commission is responding to calls for action with minimum principles that Member States are invited to follow in order to address environmental and health concerns and give operators and investors the predictability they need.”⁵² Both recommendations cover macro-level impact analysis, risk analysis, reduction of air emissions, disclosure of hydraulic fracturing fluid components, pre-drill testing of air and water conditions to establish baseline environmental conditions, and ensuring best practices in well design and construction.

50. BGR (2012), *Abschätzung des Erdgaspotenzials aus dichten Tongesteinen (Schiefergas) in Deutschland*, http://www.bgr.bund.de/DE/Themen/Energie/Downloads/BGR_Schiefergaspotenzial_in_Deutschland_2012.pdf.

51. European Commission (2014a), *IP/14/55*, http://europa.eu/rapid/press-release_IP-14-55_de.pdf.

52. *Ibid.*

In November 2013, EU Energy Commissioner for Energy Gunther Oettinger commented on the need to apply the highest environment standards to shale gas development in Germany, saying “Protection of areas where drinking and groundwater occurs, like in the case of Lake Constance, is absolutely right.” He also made it clear that exploration should continue. “Germany should at the same time see the potential that shale gas has and provide the necessary legal basis for demonstration projects and exploration. If we allow test drilling, we will be a lot smarter in a few years and know more about the costs. This is highly advisable to an engineering country like Germany.”⁵³ The proposed legislation in Germany would prevent development in water production areas and existing legislation requires that all wellpads are fully paved and sealed.

Key upstream assumptions are:

- **Acceptance of hydraulic fracturing under a reasonable regulatory framework.** The technology needs to be permitted under a stable and clearly defined system of law and regulation. Without this, drilling programs required for exploration and production cannot proceed.
- **Contract periods long enough for operators to find the “sweet spots.”** Contract periods and relinquishment terms must allow operators to build effective acreage positions and scale up operations. Operators need to be able to easily secure acreage and hold it for sufficient time to identify the “sweet spots.” In shale gas plays, sweet spots are relatively small areas—typically 15%–30% of the play—that have much higher-than-average productivity and resources. Identifying these sweet spots requires drilling numerous wells per play and can take many years. Current contract terms and relinquishment requirements in the European Union member states do not allow sufficient time for this development model. In the supportive scenario, we assume that contract terms in the European Union member states are adjusted to allow an operator to drill for 10 years with no relinquishment requirement.
- **Efficiency of regulatory processes.** Regulatory capacity and ease of access are crucial, given the number of wells required to reach impactful production levels. A “one-stop-shop” for permitting by a well-staffed regulator is best practice. European countries generally rely on operators to coordinate their activities among a variety of regulators, including those for land use planning, oil and gas permitting, and water resource management. In North America, comprehensive regulations, primarily created and enforced at the state or provincial level, govern the development of mineral rights. Current EU regulation focuses on individual components such as species protection and water protection. Implementation in Member States follows this pattern. Most US states have a specific government agency that is responsible for working with operators and landowners to manage shale resource extraction.
- **Fiscal regimes that benefit impacted landowners and state/local governments.** The community impact will be more manageable if there is direct benefit to landowners and other impacted parties, such as towns near drilling sites. In the United States, this is automatic because the surface rights owner generally also owns the mineral rights. Additionally, local authorities benefit from ad valorem property taxes on mineral values.
- **Fiscal terms that are adjusted to the cost structure of shale gas development.** The supportive scenario includes a five-year royalty holiday in Germany to reduce operators’ initial costs and allow the industry to reach a critical scale of production.
- **Supply chain development.** A sophisticated supply chain lowers the barrier to entry for operators since service companies maintain technological knowledge. The supply chain for inputs such as tubing, sand, completion crews, and drilling rigs must expand to enable the operation of up to 300 rigs over 25 years.

If these supportive policies are in place, IHS identified 611 Bcm of commercially recoverable gas, plus 326 million barrels (bbl) of oil and condensate that can be produced by 2040. The 1,200 drilling pad locations with nine wells per pad on average (10,800 total wells) suggest average ultimate recoverable volumes of 56

53. Oettinger, Die Zeit, 20 May 2013, <http://www.welt.de/politik/ausland/article116347546/Das-Umfeld-fuer-tief-greifende-Reformen-ist-ideal.html>

million cubic meters of gas per well and 30 thousand bbl of liquids per well. Drilling activity is expected to occur for six months to nine months on each pad, with up to a total of only 50 drilling rigs active during any single year. After the well is drilled and completed, the drilling rig and other equipment is removed, leaving behind only minimal wellhead equipment.

As shown in Figure 6.3, the Namurian NW and Wealden plays contain the vast majority of the resource in Germany. The majority of the resource (87%) is located in the traditional petroleum producing federal state of

FIGURE 6.3

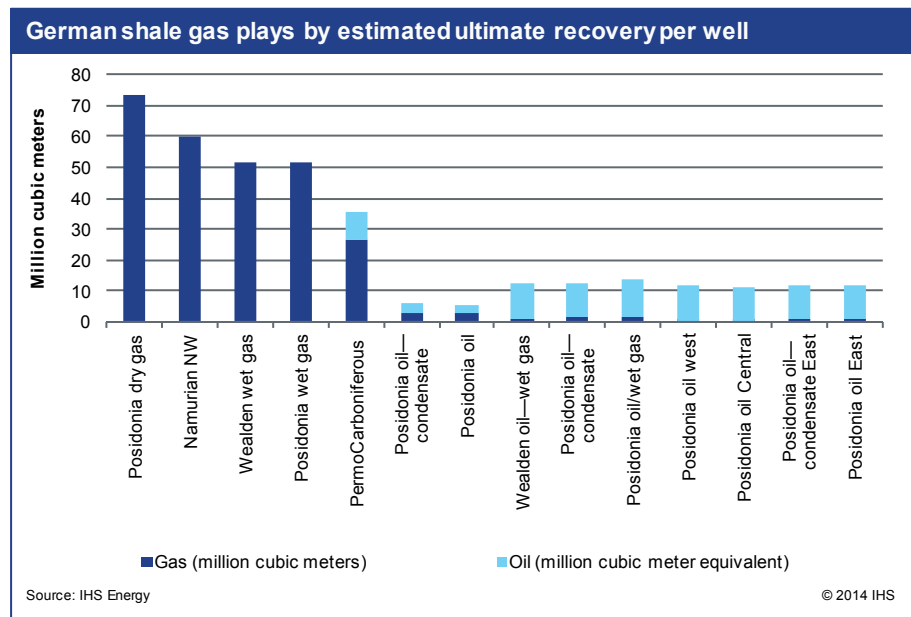
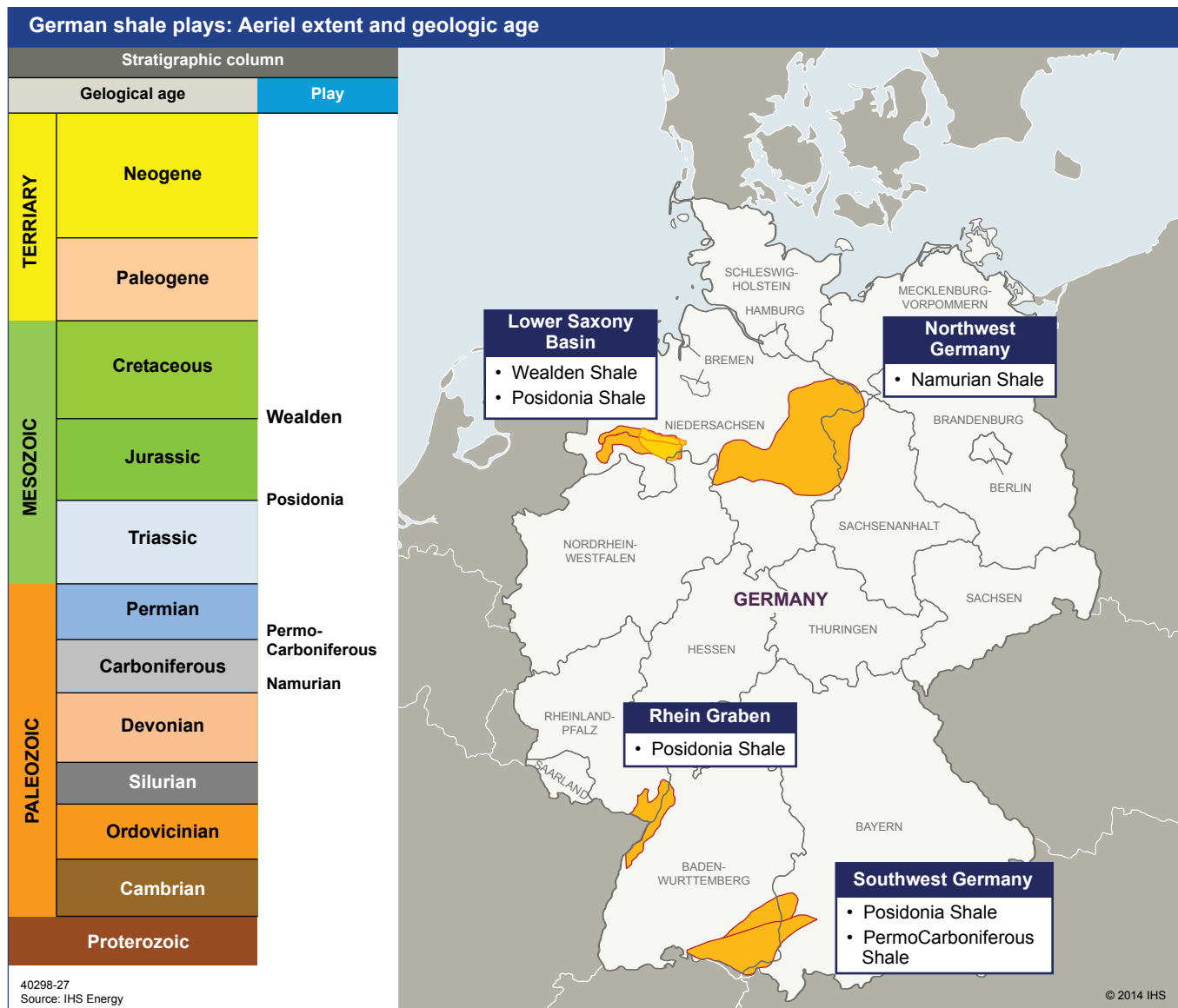


FIGURE 6.4



Lower Saxony. The Lower Saxony gas plays account for 860 of the 1,200 total well pads in the IHS analysis of shale gas development. Figure 6.4 shows the location and geologic age of Germany's shale plays.

We anticipate that it would take time to ramp-up production. Policy enablers, such as drilling location availability, regulatory capacity, public support, and fiscal terms drive the forecast.

After a brief pilot period from 2018 to 2021, IHS assumes a ramp-up to full scale development beginning in 2021 and lasting for 15 years. Reaching these production levels will require 50 fully operational drilling rigs at the peak, which we expect to be within the capacity of the industry supply chain.

As shown in Figure 6.5, IHS estimates that German production from shale gas, at its peak, could exceed 20 Bcm per year, representing 25% of Germany's current gas consumption. Nearly all of the resource potential identified in Germany is commercial at the €21/MWh price level. This price is critical, as it allows German shale to compete with imported gas supply. The average price of gas at Germany's Net Connect Germany (NCG) hub was €27/MWh in 2013. The production schedule that IHS developed includes only the 10 plays considered above. If the industry were to expand, other shale plays may become viable and would boost shale gas production in later years, retaining total production near the 25 Bcm per year level past 2050.

The European gas market is highly interconnected, and production in one market has an impact on prices in neighbouring markets. For this reason, IHS conducted an analysis of the potential for shale gas development across all of Europe. This analysis includes a resource estimate at the play-level and an aggregate view of the overall shale gas resource in high potential countries in Europe, including Germany, France, Poland, the United Kingdom, Austria, the Netherlands, and Denmark. IHS performed the same US analogue analysis on all of the plays included in this study to develop resource estimates.

Figure 6.6 shows our estimates of dry shale gas recoverable at various price levels in each country. Our estimates identify 2,086 Bcm of dry shale gas resource recoverable in the countries studied, assuming prices remain above €21/MWh. At €26/MWh,

FIGURE 6.5

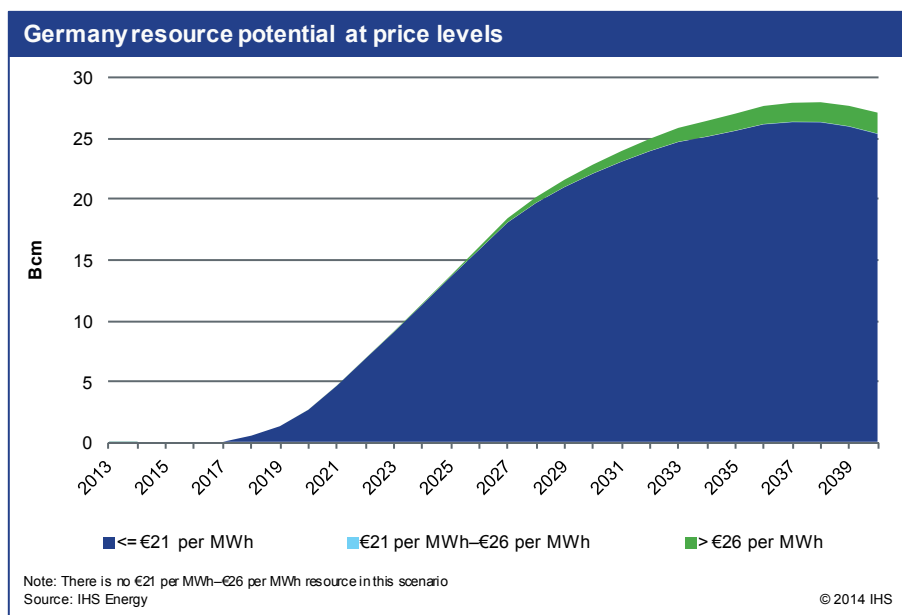
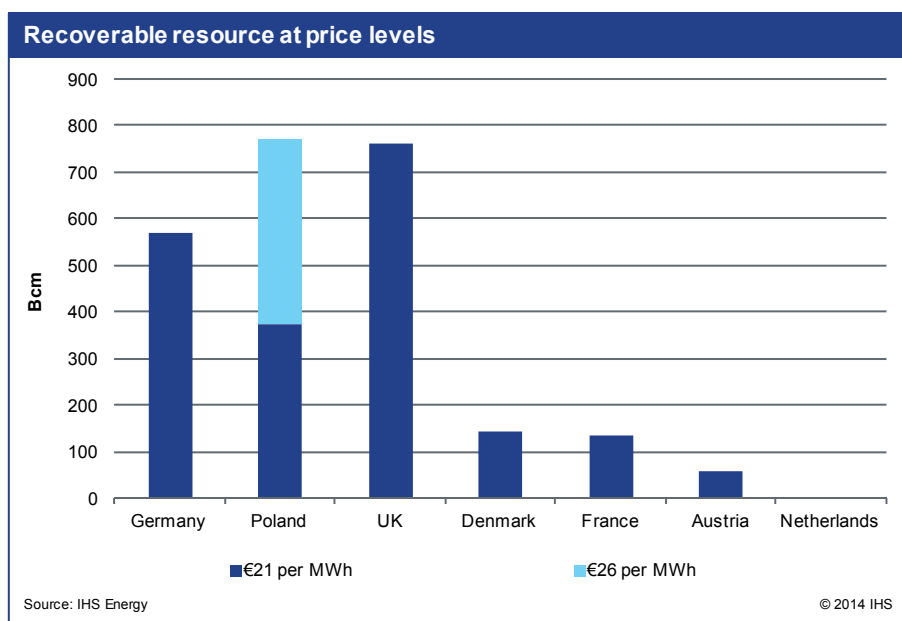


FIGURE 6.6



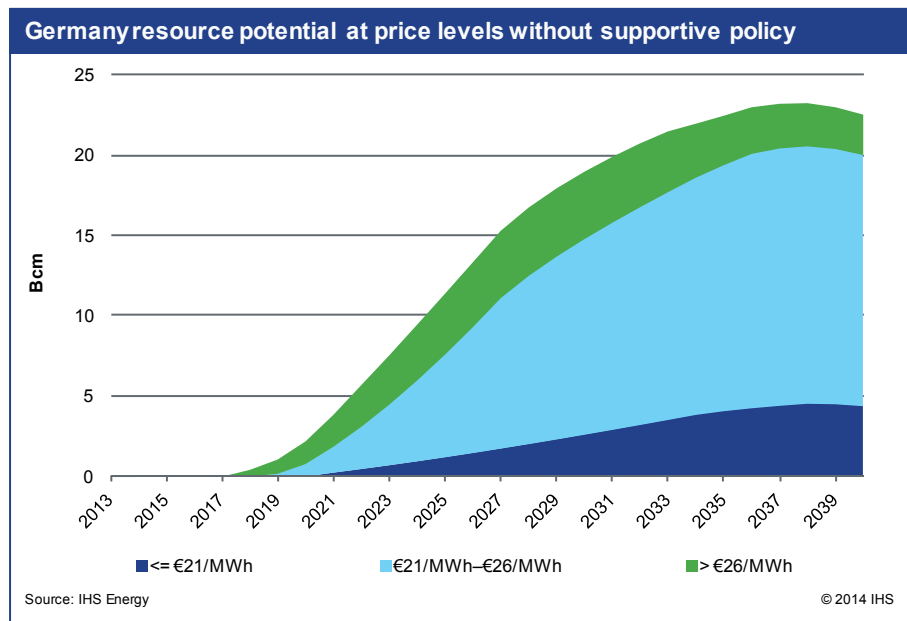
2,494 Bcm of dry gas is recoverable. Polish resources are the most price-sensitive, nearly doubling if prices rise to €26/MWh.⁵⁴ IHS estimates that resources on this scale have the potential to support European shale gas production at the €21/MWh price level of over 70 Bcm per year in 2030, rising to almost 90 Bcm by 2040. Production on this scale is comparable to pipeline exports from Norway to the European Union, which are around 100 Bcm per year.

Shale gas development will be limited without a supportive policy framework

The scale of future shale gas production in Europe is uncertain because the industry is at a very early stage. The drilling needed to determine the true geological potential will occur only with the development of a legal and regulatory framework that supports shale gas development.

Many regulatory factors could slow or stop shale gas development in Europe, including reluctance to accept hydraulic fracturing under reasonable terms, contract terms that do not allow sufficient time to assess sweet spots and complete pilot drilling programs, and long permitting periods that extend drilling investment timelines. A less supportive policy framework would increase costs and limit available drilling locations. Our modeling shows that without a supportive policy framework, rising production costs will push many plays over the threshold and render development no longer economic. With less supportive policy, the vast majority of Germany's gas resources would only be produced at prices greater than the €21/MWh, as shown in Figure 6.7. The volume of gas recoverable in Europe at or below today's prices peaks at 106 Bcm per year if a supportive policy framework is in place, and falls to 63 Bcm per year without it.

FIGURE 6.7



6.3 Shale gas could reduce European gas prices by 20%

In this section we consider the long-term outlook for natural gas pricing in Germany and the impact that large-scale development of the unconventional resource base could have on gas prices.

6.3.1 The German gas market

Germany is the largest gas market in Europe, with annual consumption of 80 Bcm. Domestic production currently supplies around 10% of demand, down from over 20% in 2000, (see Figure 6.8). Conventional supplies will continue to decline and production is expected to be below 5 Bcm per year, beginning in the early 2020s. The remainder is imported from the Netherlands, Norway and Russia. As domestic production and Dutch supplies decline, imports from Russia, which fell significantly following the economic crisis of 2008, are expected to grow. Shale gas production could significantly alter Germany's import position, increasing

54. €26/MWh is the IHS long-term European gas price projection in the absence of shale development. Prices could drop to €21/MWh with large-scale European shale development. See section 6.3 for further explanation of these price levels.

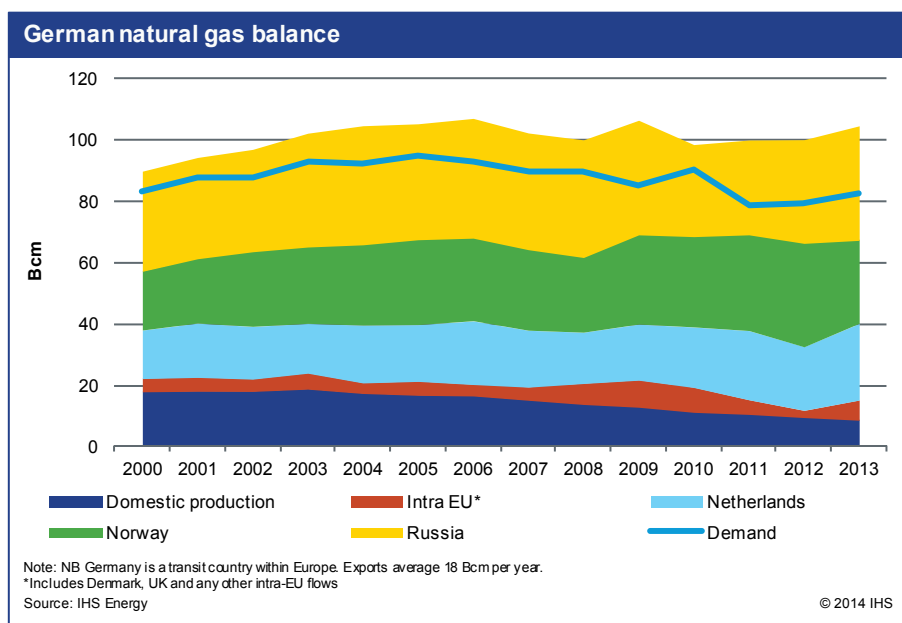
total domestic gas production to over 30 Bcm per year, which represents over 35% of today's consumption level, up from less than 10 Bcm today.

However, Germany cannot be considered in isolation. It is an important transit country, transporting Russian gas west and Dutch and Norwegian gas east and, as such, it has pipeline connections with many European markets. Furthermore, following the liberalization of the European gas market, prices across the interconnected markets of Northwest Europe are now highly correlated. Prices at Germany's two gas hubs—

Gaspool and NCG—are closely linked to prices in the Netherlands and in the United Kingdom. A shortage or an excess of gas in any national market affects prices in neighboring markets, and gas will flow from the lower-priced market to the higher-priced market to bring the region back into balance.

Germany sits at the heart of this single market that stretches from Ireland to Italy and, as a result, any discussion of gas pricing in Germany is in reality a discussion of European gas pricing.

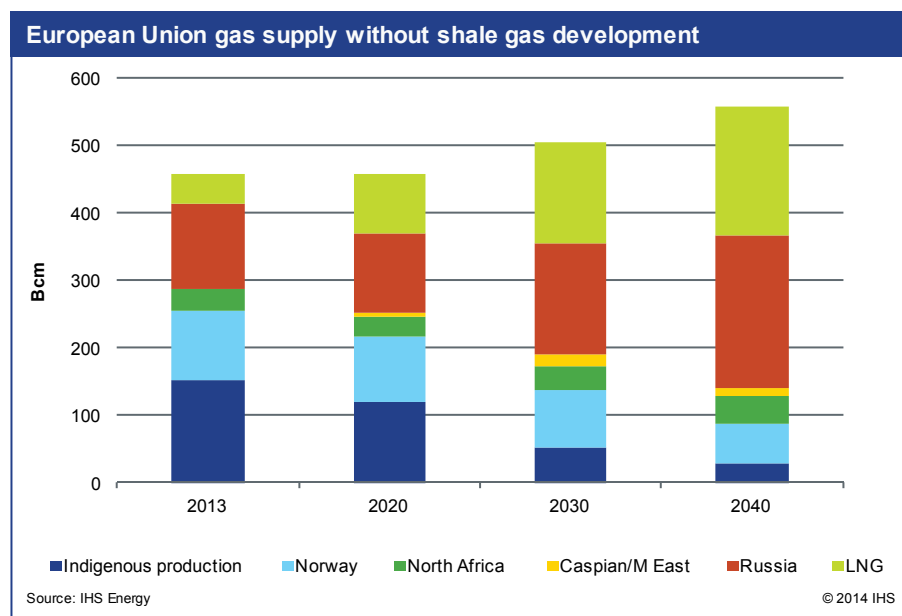
FIGURE 6.8



6.3.2 Gas price outlook without European shale production

The European Union currently has a variety of sources of natural gas, as shown in Figure 6.9. Gas produced in the European Union meets around one-third of demand, with the remainder imported from four major external suppliers: North Africa (predominantly Algeria), Norway, the global liquefied natural gas market (LNG), and Russia. A fifth, Azerbaijan, is due to be added by the end of the decade. Although all of these sources will remain significant suppliers to Europe in the absence of large scale domestic unconventional production, only LNG and Russia have the potential to provide the incremental volumes of gas required to fill Europe's growing import gap.

FIGURE 6.9



European gas production has declined rapidly in recent years, and this decline is expected to continue. By 2030, IHS expects conventional domestic production to account for just 10% of European demand, compared to today's 34%. As a result, the price at which new supplies are available to fill the emerging supply gap will set European gas prices in the long term.

Russia, which supplies around 25% of European gas consumption, has traditionally formed one of the backbones of European supply. Russia has proven conventional gas reserves of 33 Tcm and has been investing heavily to expand its gas production and export capacity. New fields, such as Gazprom's giant Bovanenkovo field, which came on stream in 2012 and will produce over 100 Bcm per year at peak production, and growing production by independent players, ensure that Russian gas production can continue to grow. In addition, Russia has the potential to substantially increase deliveries to Europe. Current pipeline capacity can deliver more than 250 Bcm per year to Europe, and Russia plans to develop as much as 118 Bcm of additional export capacity. In 2013, Russia exported 130 Bcm of gas to the European Union.

International oil prices remain an important determinant of the price of Russian gas delivered to Europe. The details of individual contracts vary widely, but on average IHS estimates that a Brent oil price of \$97.5/bbl—our long term outlook for oil prices—corresponds to price for gas delivered to Germany of around €25/MWh at current exchange rates, €2/MWh below the average price of gas in 2013 at NCG.⁵⁵

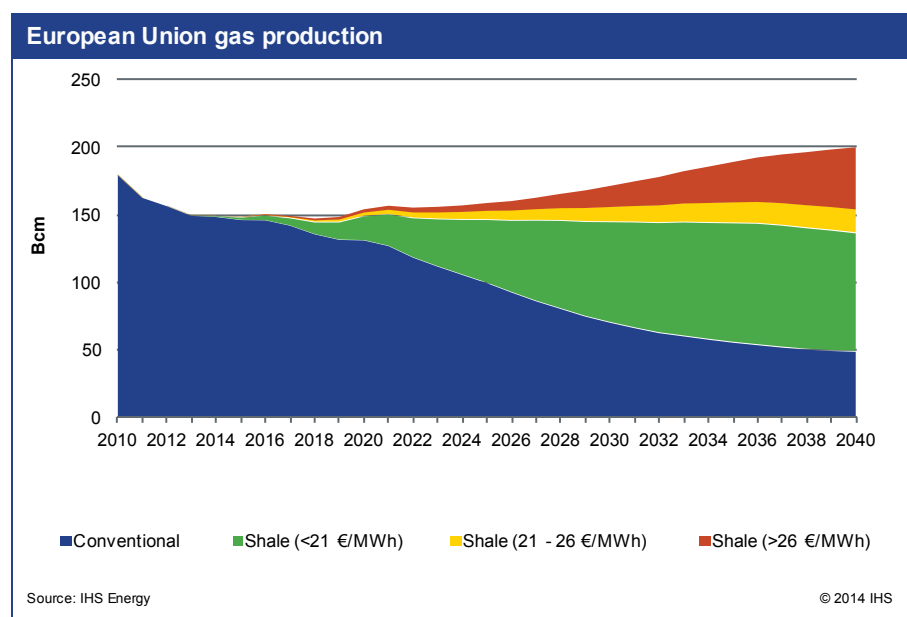
IHS analysis indicates that the full cycle cost of LNG from North America delivered to Europe will be in the range of €22 to €30/MWh (constant 2013) at a constant exchange rate, assuming an underlying Henry Hub price of €10 to 14/MWh. Our outlook for North American gas prices is stable—we estimate that in excess of 25 years of supply is available at prices of €10/MWh or less (although volatility can temporarily raise prices in response to such factors as weather and pipeline bottlenecks). As a result, even with large-scale LNG exports, the price of gas in North America is likely to remain around today's levels in the long-term. Gas from the eastern Mediterranean and East Africa is also expected to be priced within this range.

Assuming long-term average prices of €10 to 14/MWh for Henry Hub gas and \$95 to \$100/bbl for Brent crude oil, the cost of LNG from North America would be very similar to that delivered under a long-term contract with "traditional" indexation. As a result, IHS expects the price of gas in Europe—traded and long-term contract—to remain within the range set by these two benchmarks, with our central case estimate set at €26/MWh at today's exchange rate. Seasonal spreads will remain and prices will exhibit day-to-day and longer-term volatility, but on average we expect prices to trade within this range. Unlike today, the driver of the price outlook is the cost of new gas supply, so we expect prices to remain stable within this range across a wide range of oil price assumptions.

6.3.3 Gas price outlook with large scale European shale gas production

The pricing outlook described above is based on an assumption of ongoing rapid decline in European gas production. However, shale gas development in Europe has the potential to reverse the decline at competitive prices (see Figure 6.10 and Figure 6.11). As discussed in the preceding sections, IHS estimates that the development cost for most of this additional volume is below our long-term price outlook. With the appropriate support from policy makers, pricing incentive exists for industry to develop European unconventional gas. European production on this scale would have profound implications for suppliers seeking to increase deliveries to Europe.

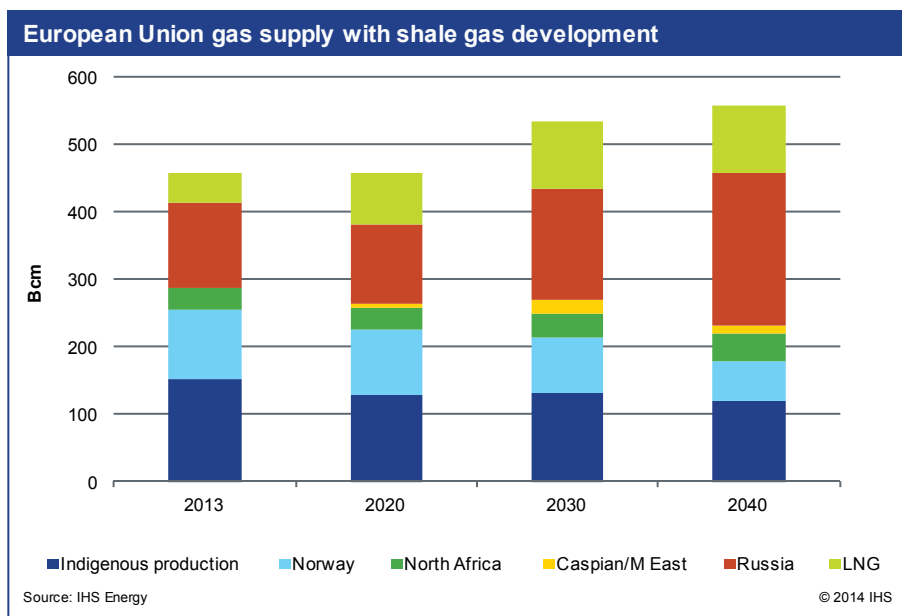
FIGURE 6.10



55. As many of the drivers of European gas prices are US dollar denominated, the European price forecast is subject to exchange rate variation. IHS expects that the Euro will appreciate against the US dollar over the outlook period, increasing from 1.32 in 2013 to 1.45 from 2030 onwards. At current exchange rates \$1/MMBtu = €2.6/MWh. By 2030, \$1/MMBtu would be equivalent to €2.3/MWh.

As discussed above, our expectation of future prices for Russian pipeline gas and new LNG supplies from the United States and East Africa are very similar throughout the outlook period. However, this similarity hides a very different risk profile. At €26/MWh, LNG suppliers, on average, are covering their costs (including a margin to the owner of the liquefaction)—and no more. In contrast, the weighted average cost of Russian supply delivered to Europe is substantially less than €26/MWh even in the long term. As a result, Russia has the potential to adjust pricing to maintain market share. But does the incentive exist for this to happen?

FIGURE 6.11



With unconventional development on the scale described above, a major supplier with low production costs has a clear incentive to reduce its price to maintain sales volume and maximize revenue. At €21/MWh, new LNG would be unable to compete in the European marketplace. Over time, existing production would be diverted to higher-paying markets in Asia and Latin America and new supply would not be developed with Europe as a target market.

The €21/MWh price has two further benefits for a low-cost supplier such as Russia:

- **Gas competitive in power generation.** As shown in Figure 6.12, with gas priced at €21/MWh and coal and carbon priced according to IHS outlooks, gas fired generation would be cheaper than coal fired generation for power generation in Europe. This could boost European Union gas consumption by around 30 Bcm from the mid-2020s onwards. Furthermore, with a greater share of indigenous production, the role of gas in power generation could expand more rapidly than anticipated, boosting demand still further.
- **High cost shale not developed.** By reducing the price to €21/MWh, over 20 Bcm of unconventional gas that would be economic at €26/MWh would not be produced.

Figure 6.12 demonstrates that it is economically rational for a low-cost supplier such as Russia to reduce prices if the competitive threat is large enough. Assuming 53 Bcm of additional European production, Russian gas revenue would be the same if the European gas price is €26/MWh and Russia and LNG equally share the loss of market share as if Russia reduced its price to €21/MWh and LNG suffered all the loss of revenue.

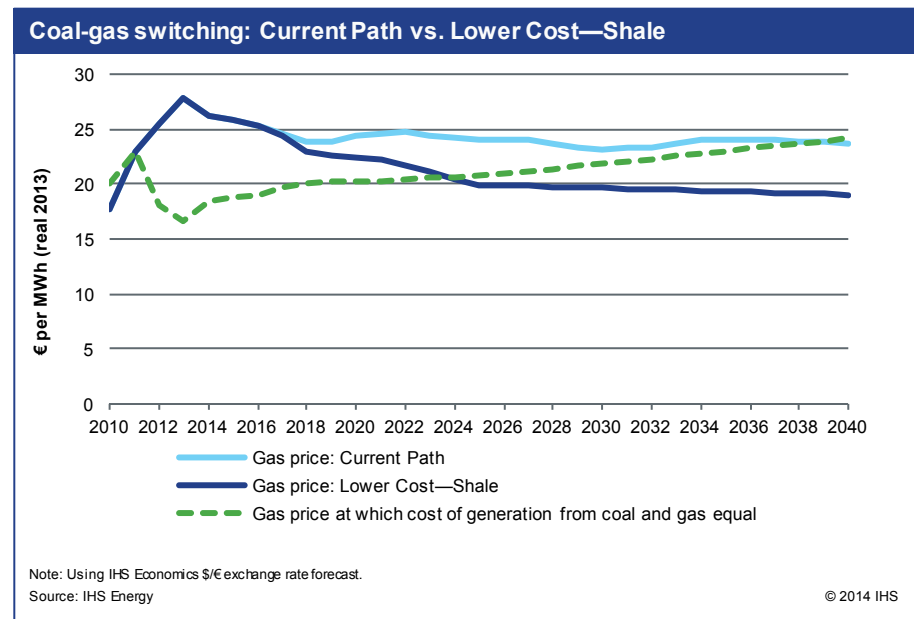
As a result, in a scenario in which large-scale development of shale occurs, IHS expects the price for gas in Germany—and across all the integrated markets of Northern and Western Europe—to drop from a long-term average of €26/MWh to €21/MWh, (assuming a constant exchange rate), a 20% reduction in the wholesale price of gas.

Through the outlook period, IHS forecasts the euro to appreciate slowly against the dollar. As US LNG and international coal are priced in dollars and Russian gas pricing is linked to oil, which is priced in dollars, any change in the dollar-to-euro exchange rate does not influence the relationship between commodity prices: coal, gas, and oil. The exchange rate is expected to go from 1.32 euros per dollar in 2013 to 1.45 euros per

dollar from 2030 onwards. This has an impact on prices in euro term, most clearly seen in the gas price outlooks.

Support for shale development throughout Europe is required to achieve a material reduction in the future European gas price. Whether this lower-cost future can be realized depends primarily on the policies of three member states: Germany, Poland, and the United Kingdom.⁵⁶ These three markets together have the potential to develop enough unconventional gas over the next 20 years to significantly reduce the price of gas in Europe. Individually, they have the potential to materially change the supply-demand balance in their individual markets and raise the level of economic activity.

FIGURE 6.12



56. France also has significant unconventional potential, but the current policy does not facilitate development.

7. Reforming the Energiewende to reduce power system costs

Key findings

- Focusing on the development of mature renewable technologies, combined with a greater role for natural gas, could reduce cumulative power system costs in Germany by up to €125 billion between 2014 and 2040.
- Cumulative CO₂ emissions from the power sector between 2014 and 2040 are almost 500 million metric tons higher in a system with coal-fired generation as the primary form of back up (*Lower Cost – Conventional*) than in a system that uses more gas (*Lower Cost – Shale*).

As shown in Chapter 1, electricity prices for German end consumers are internationally high. In this chapter we explore the options available to reduce prices by reducing the cost of power generation. We quantify the potential savings by comparing alternative fuel mixes to the baseline.

7.1 The fuel mix scenarios

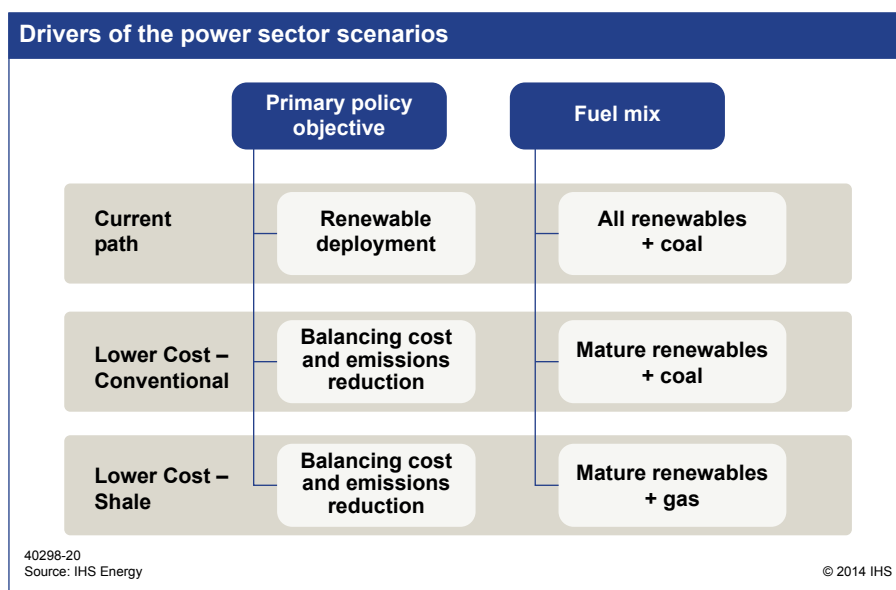
We first define and then consider the impact of two alternative options for Germany's fuel mix under a More Competitive Energiewende, compared to *Current Path*. The scenarios are differentiated by their primary policy objectives, as shown in Figure 7.1. The policy objective drives generation capacity additions in each scenario, which in turn lead to different generation patterns, system costs, and CO₂ emissions.

7.1.1 Renewable capacity additions

Substantial growth in new renewable capacity occurs in all the fuel mix scenarios considered in this report. As Figure 7.2 shows, the main differentiator is the scale of offshore wind additions. For reference, at the end of 2013, installed renewable capacity in Germany was 35.7 GW of solar PV and 33.7GW of onshore wind.^{57,58}

The outlook for offshore wind is more uncertain than that for solar PV or on-shore wind. The advantages of offshore wind are clear—it is larger in scale and has a higher load factor than other renewable technologies. However, offshore wind is costly and as yet unproved in challenging locations over the long term. It also requires construction of on- and off-shore transmission facilities.

FIGURE 7.1



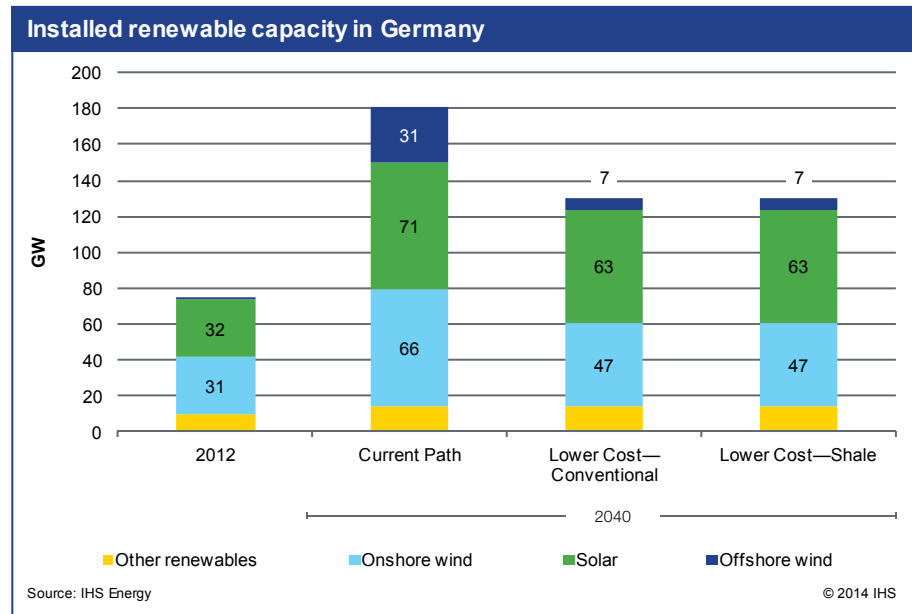
57. BWE (2014), *Windenergie an Land wächst 2013 wie prognostiziert – Ungewissheit für 2014 und 2015 bleibt groß*, <http://www.wind-energie.de/presse/pressemitteilungen/2014/windenergie-land-waechst-2013-wie-prognostiziert-ungewissheit-fuer>.

58. Bundesnetzagentur (2014), *Photovoltaikanlagen: Datenmeldungen sowie EEG-Vergütungssätze*, http://www.bundesnetzagentur.de/cln_1912/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/Photovoltaik/DatenMeldgn_EEG-VergSaetze/DatenMeldgn_EEG-VergSaetze_node.html.

FIGURE 7.2

Although support for solar PV is capped at 52 GW, IHS expects that capacity will continue to be added above this point due to the high level of end consumer electricity prices in Germany. Following the reduction in the costs of panels that has occurred since 2010 and the increases in electricity prices for small consumers in Germany, installing solar PV can be economic for some consumers even without support.

- Current Path.** Additions of solar PV average 3.5 GW per year through 2020, taking installed capacity over the 52 GW cap. However, as discussed above we expect small consumers to continue to add capacity even without support, albeit at a much slower rate than in the 2010s. Installed capacity reaches 70 GW in 2040.



We expect substantial additions of onshore wind—the most mature and lowest-cost renewable technology—over the outlook period. Much of the increase in installed capacity will come from repowering—installing larger, more efficient turbines at existing sites—rather than greenfield developments. Annual additions average 1.2 GW per year between 2014 and 2040. Installed capacity in 2040 reaches 65 GW.

Through 2030, offshore wind is added in line with the deployment rates proposed in the 2013 coalition agreement. Post-2030 the deployment rate increases to 1.6 GW per year. Installed capacity reaches 30 GW in 2040.

- Lower Cost – Conventional.** The 52 GW support cap for solar PV is reached in 2022. As in the *Current Path*, capacity continues to be added once the cap has been reached, although the additions are slower. Installed capacity reaches 63 GW in 2040, compared to 70 GW in *Current Path*.

Although onshore wind is the lowest-cost form of renewable power, it is more expensive than thermal generation. Therefore, in a scenario designed to reduce the cost of the power system, additions are lower than in *Current Path*. Onshore wind additions average 0.5 GW per year, compared to 1.2 GW in *Current Path*. Installed capacity in 2040 reaches 47 GW. Such a slowdown in additions could result from either a reduction in support levels that makes only the best resource sites economical or a cap on the volume of capacity that is supported in any year.

As the least mature and highest capital cost renewable technology, offshore wind sees the greatest variation in capacity additions among the scenarios. In *Lower Cost - Conventional*, capacity is added in line with the deployment rates proposed in the 2013 coalition agreement through 2020. No further capacity is added beyond this point. Installed capacity is 6.5 GW from 2020 to 2040.

- Lower Cost - Shale.** The renewable capacity addition assumptions in this scenario are the same as in the *Lower Cost-Conventional*.

7.1.2 Thermal capacity

The volume of thermal generating capacity is similar in all cases, at around 100 GW. This level of dispatchable capacity is required to ensure the stability and reliability of Germany's power system. The composition of the capacity, however, differs by scenario, as shown in Figure 7.3.

Dispatchable plants, such as coal and gas, have two roles in the power system:

- Meeting power demand not met by renewables;
- Acting as back-up power for occasions when the wind does not blow and the sun does not shine.

As the share of renewable supply grows, the need to meet demand declines while the need for back-up grows.

To guarantee electricity supply, there must be enough generating capacity available to meet peak demand. This capacity must also be dispatchable, meaning that it must respond immediately when called upon by the system operator. Solar and wind capacity are not dispatchable and provide very little in the way of peak coverage. Peak demand in Germany occurs early on winter evenings when there is no output from solar.

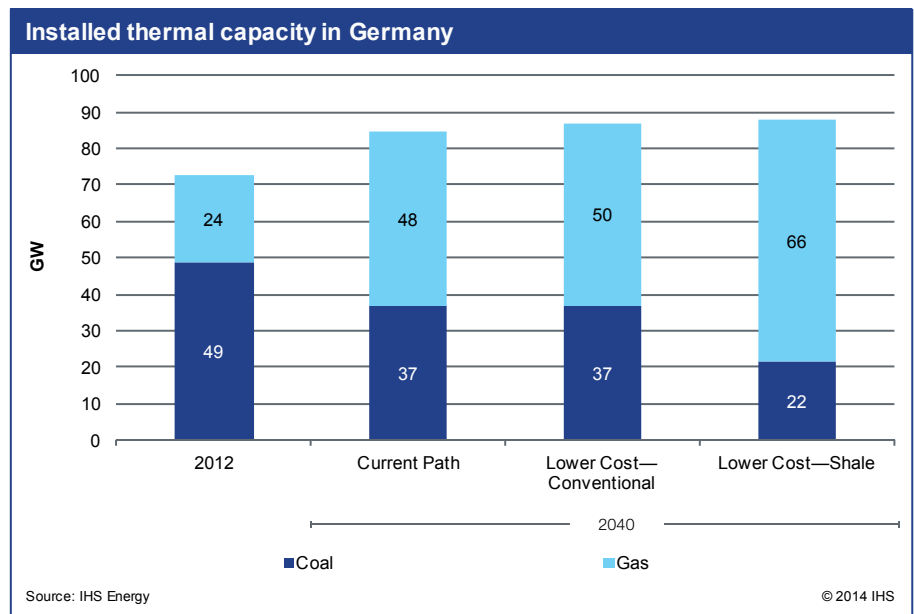
In the absence of affordable storage technology, thermal capacity is required to back-up non-dispatchable capacity. 0.9–1 GW of thermal capacity is required to back-up every 1 GW of wind or solar. As a result, the amount of thermal capacity that must be maintained barely changes as more renewable generation is added.

- **Current Path.** Coal capacity increases in the remainder of this decade as capacity currently under construction comes on-line. In the longer term, utilization falls as renewables capacity increases, and installed capacity declines. Capacity decreases by 7 GW in the 2020s and by another 10 GW in the 2030s. By 2040, installed coal capacity in Germany stands at 37 GW.

Installed gas capacity is expected remain stable during the remainder of this decade. Capacity additions are expected to accelerate early in the 2020s as the final nuclear plants close and the oldest coal plants retire. By 2040, installed gas capacity stands at 48 GW, up from 25 GW today.

- **Lower Cost – Conventional.** Installed coal and gas capacity is the same as in *Current Path*.
- **Lower Cost – Shale.** Coal plants retire more quickly in this scenario than in the *Current Path* or *Lower Cost – Conventional* scenarios. By 2040, installed coal capacity in Germany is 22 GW. To secure a power supply, the lower level of coal capacity is offset by a larger gas fleet. By 2040, 66 GW of gas generating capacity is installed in Germany. The higher level of coal retirements in this scenario result from gas being a more economic source of generation than coal from the mid-2020s.

FIGURE 7.3

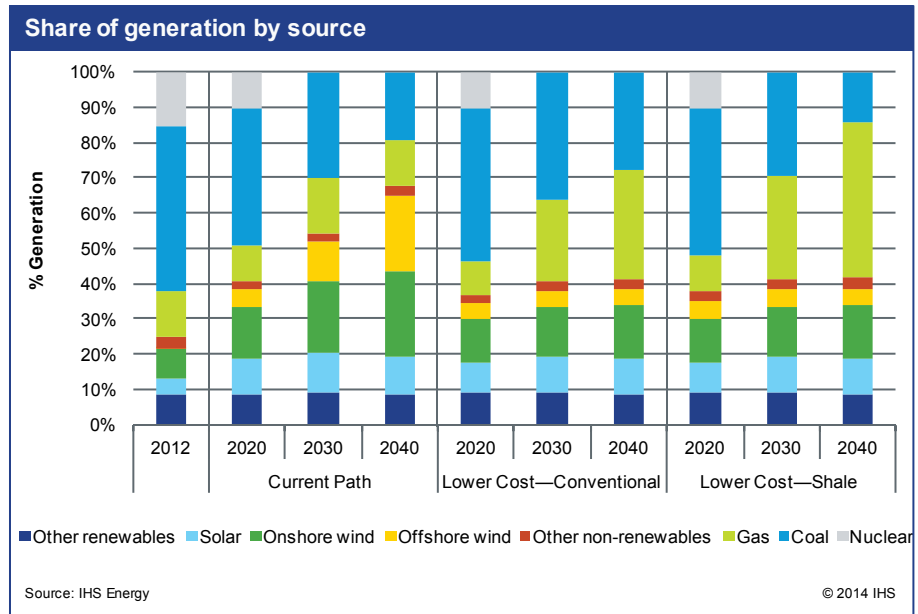


7.2 The power generation mix

Combining the capacity outlooks described above with IHS commodity price outlooks, we developed projections for the power generation mix under each of the scenarios. Figure 7.4 shows the fuel mix in each scenario based on IHS projections for wholesale prices for coal, CO₂, gas, and oil.

- Current Path.** Germany's renewable targets through 2040 are met, with renewables accounting for 65% of Germany's total electricity generation by 2040. Coal continues to play a role throughout period, accounting for almost 20% of total generation by 2040. The contribution of gas-fired power grows by only 2%, to 13%.

FIGURE 7.4



- Lower Cost – Conventional.** The 2020 renewable target is met. Although generation from renewables continues to grow through the outlook period, the share of renewables falls short of targets: reaching 38% of generation in 2030 and 39% in 2040.

With gas prices unchanged from Current Path, coal is dispatched ahead of gas throughout the outlook period. As a result, coal accounts for 34% of generation in 2030 and 28% by 2040. However, the role of gas grows strongly, filling much of the gap created by the slower development of renewables. Gas generation accounts for over 30% of generation by the end of the period.

- Lower Cost—Shale.** The 2020 renewable target is met. Although generation from renewables continues to grow through the outlook period, the share of renewables falls short of target: reaching 38% of generation in 2030 and 39% in 2040.

Due to the lower gas price in this scenario, gas-fired generation plays a much larger role in this scenario than in the others. The growth in gas-fired generation in Germany accelerates in the mid-2020s and by 2040 gas accounts for almost 45% of generation. As natural gas use grows, coal generation plays a smaller role in this scenario than in *Current Path*, accounting for less than 15% of generation by 2040. However, the transition away from coal is gradual—coal continues to account for 30% of German generation in 2030, compared to almost 50% today.

7.3 Impact of altering the fuel mix on the cost of the power system

Based on the scenarios described above, the cumulative cost of the power system between 2014 and 2040 can be reduced by as much as €125 billion (constant 2013) compared to *Current Path*. Figure 7.5 compares the cost of the main components of the power system under *Lower Cost - Shale* with the cost under *Current Path*. The system cost is broken down into five categories: capital investment, network costs, other, fuel, and emissions.

FIGURE 7.5

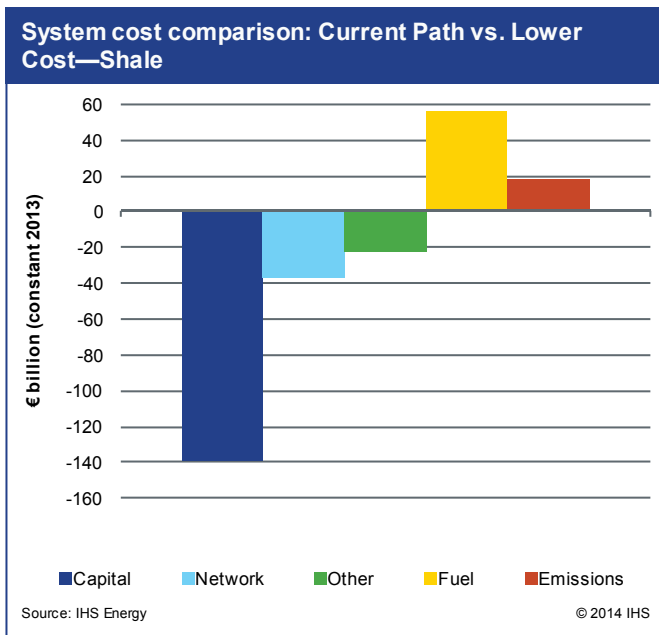
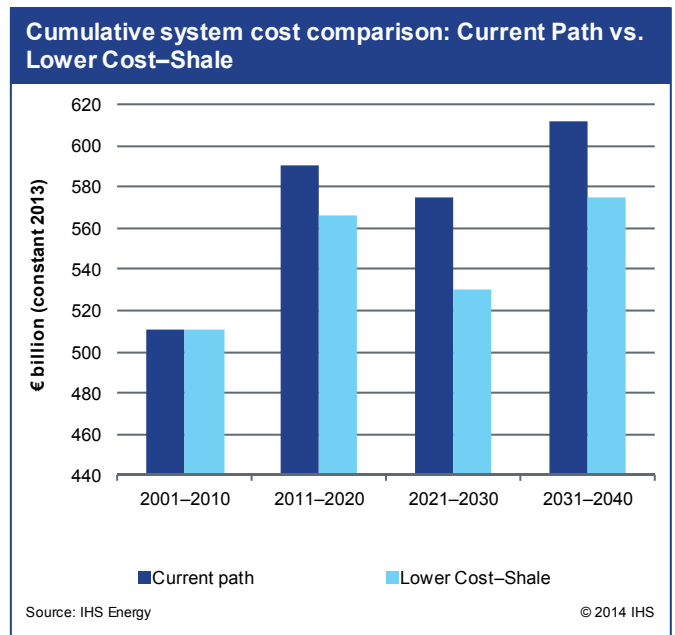


FIGURE 7.6

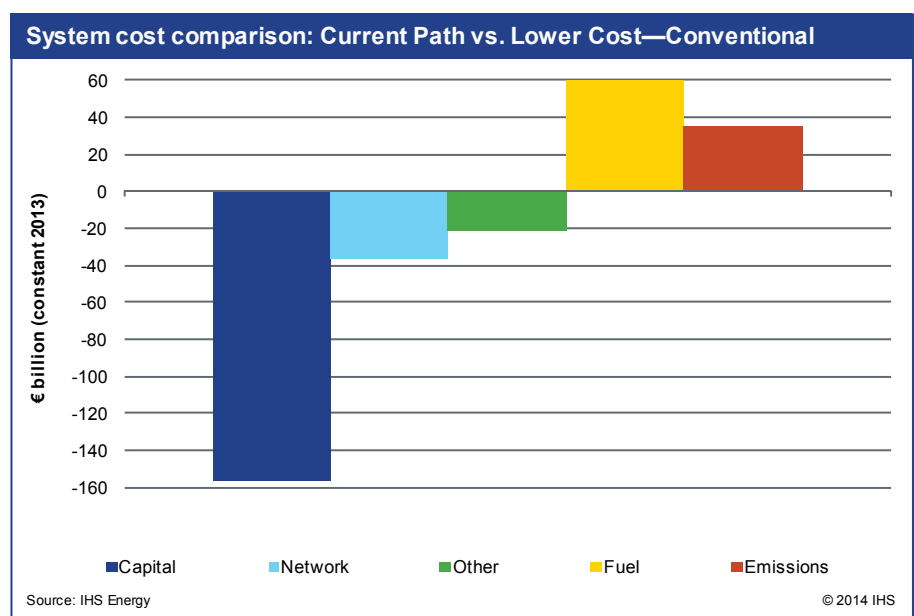


The change in each cost is considered in turn:

- Capital Investment.** Cumulative capital investments between 2014 and 2040 are €140 billion (constant 2013) less in *Lower Cost – Shale* compared to *Current Path*. This reduction is due to the lower investment in renewables, in particular offshore wind.
- Network costs.** Network costs are €37 billion lower in *Lower Cost – Shale* than in *Current Path*, since offshore transmission is not required and the need for onshore transmission is reduced.
- Other costs.** Other costs are predominantly operation and maintenance costs. These are €23 billion less in *Lower Cost – Shale* compared to *Current Path*, as maintenance costs for renewables are generally higher than for thermal plants
- Fuel and Emissions.** The savings described above are offset by increased spending on fuel and emissions in *Lower Cost – Shale* than in *Current Path*, spending on coal and gas increases by €56 billion and on emissions allowances by €18 billion.

The scale of the savings varies through time, as shown in Figure 7.6. Net cost reductions are greatest from 2021 through 2030. Increased spending on fuel and emissions offsets more of the reduction in capital costs from 2031 through 2040.

FIGURE 7.7



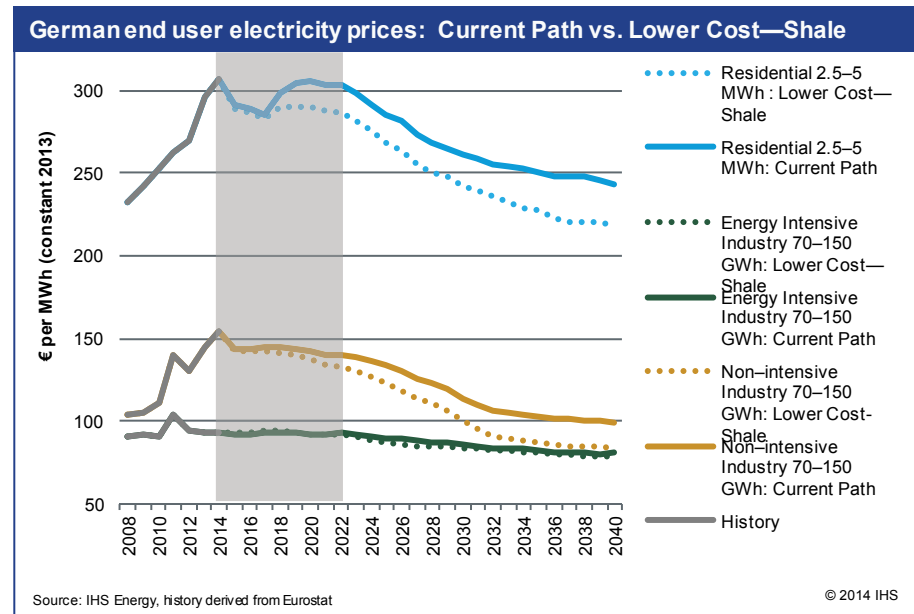
The total cost of the power system in *Lower Cost – Conventional* is €5 billion more than in *Lower Cost – Shale*, and the breakdown of costs is similar. The reduction in capital investment compared to *Current Path* is €155 billion, €15 billion more than in *Lower Cost – Shale* (see Figure 7.7). Capital spending is greater in *Lower Cost – Shale* than in *Lower Cost – Conventional*, as more gas generating capacity is built in the former scenario. However, increased spending on fuel and emissions in *Lower Cost – Conventional* offsets the decreased capital costs. Spending on emissions allowances alone is €15 billion more in *Lower Cost – Conventional* than in *Lower Cost – Shale*.

7.4 Impact on retail prices of reducing the cost of the power system

In this section, we compare retail price outlooks for *Current Path* with those for *Lower Cost – Shale*. As discussed above, the results for *Lower Cost – Conventional* are not presented separately, since the cost of the power system and, therefore, retail prices are similar to the *Lower Cost – Shale*.

Reducing the cost of the German power system has different impacts for different consumer segments. The impact is smallest for large industry sectors that receive rebates from the EEG surcharge and is greatest for consumers that do not, as shown in Figure 7.8

FIGURE 7.8



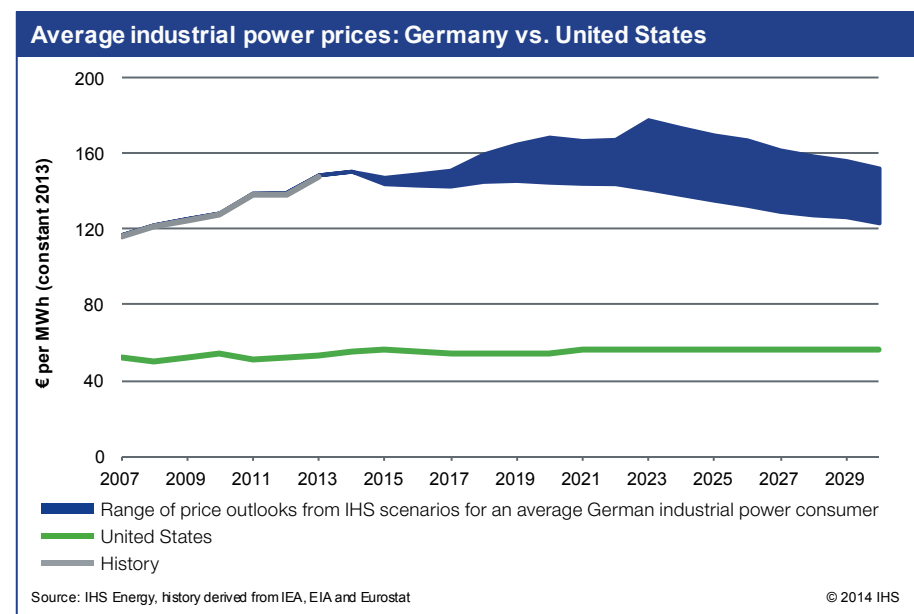
- Industrial consumers that benefit from rebates.**

Wholesale power prices are the main driver of electricity prices for large industrial consumers that benefit from the full rebates. Wholesale power prices are very similar in *Lower Cost – Shale* and in *Current Path*. As a result, end user prices are also very close.

- Other consumers.** The picture for consumers that do not benefit from the rebates is clear: the lower the cost of the power system, the lower the retail price for electricity.

Prices for small industrial consumers are around €7/MWh lower in the *Lower Cost—Shale* than in *Current Path* through the 2020s. This increases to €10/MWh by the end of the period.

FIGURE 7.9



The saving is slightly higher—€17/MWh through the 2020s—for household consumers. The difference grows throughout the period, increasing to €26/MWh by 2040. For a typical household, this equates to an annual saving of €40 (constant 2013) in 2020, rising to €65 by 2040.

Figure 7.9, shows the range of average industrial power prices calculated for the scenarios in this report. The upper bound represents prices where rebates have been phased out (discussed in Chapter 5) and the lower bound represents *Lower Cost – Shale* (discussed earlier in this chapter).⁵⁹ This range is compared to the IHS forecast for average industrial electricity prices in the United States. As discussed in chapter 1, the price differential with the United States has grown strongly since 2007, as German prices have risen. Although the potential exists for the differential to decline slightly in the future from current levels, it will remain substantial throughout the outlook period.

7.5 Cost reduction versus emissions reduction

An inherent tension lies at the heart of the Energiewende. Power system costs can be materially reduced only by reducing the build out of additional renewables capacity. However, this slows down the transition to a cleaner, low-carbon economy. The challenge facing policy makers today is to find an appropriate balance between cost containment and emissions reduction. Figure 7.10 depicts the tradeoffs inherent in each of the scenarios considered in this report.

FIGURE 7.10

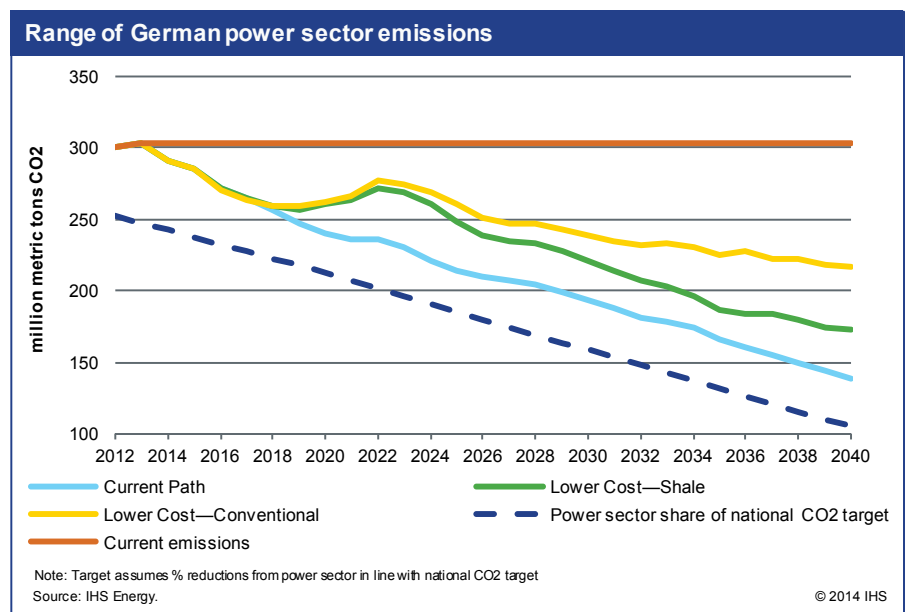
Cost-emissions trade-off					
		Fuel Mix	Cumulative (2014-2040)		Abatement cost (€/metric ton)
			Cost (€ billion, constant 2013)	Emissions (million metric tons)	
Power sector fuel mix	Current path	All renewables with coal	1,595	5,640	340
	Lower Cost – Conventional	Mature renewables with coal	1,475	6,725	515
	Lower Cost – Shale	Mature renewables with gas	1,470	6,255	390

40298-19
Source: IHS Energy
© 2014 IHS

7.5.1 The Impact of a lower cost power system on CO₂ emissions

So far the focus of the discussion has been on cost reduction, but emissions abatement is an important part of any analysis of the potential costs and benefits of Germany's electricity generation mix. Figure 7.11 shows the range of power sector CO₂ emissions among our three scenarios. Cumulative emissions from the power sector between 2014 and 2040 are over 1 billion metric tons higher in *Lower Cost – Conventional* than in *Current Path* and are 0.6 billion metric tons higher in *Lower Cost - Shale* than in *Current Path*.

FIGURE 7.11



7.5.2 The cost of abatement

Although emissions from the power sector drop significantly over the outlook period in all scenarios, the key differentiating factor

59. Price series for Germany is a weighted average of IA to IG consumers.

among the scenarios is how much it costs to reduce or abate a metric ton of CO₂ emissions by changing the fuel mix. Calculating the cost of each ton of CO₂ reduction is known as the abatement cost.

We calculated the cumulative reduction in CO₂ emissions between 2014 and 2040 by comparing them to 2013 levels. The total carbon abatement is demonstrated by comparing the current (2013) CO₂ emissions (the horizontal red line in the previous chart) with the CO₂ emissions trajectory of each scenario. For example, in *Lower Cost – Conventional*, the total CO₂ emissions difference is the area between the horizontal red line “current CO₂ emissions” and the yellow line “*Lower Cost – Conventional*”.

These cumulative emissions reductions are then divided by the change in power system costs for each scenario. We calculate the change in costs by comparing the cost of the 2013 fuel mix to the cost of the fuel mix in each year of each scenario. The abatement costs are given in Figure 7.10 (cost emissions trade-off).

The abatement costs highlight clearly the trade-off that Germany must make, as well as how gas can reduce CO₂ emissions in a cost effective manner. The scenarios can be divided into two categories:

- The *Current Path* scenario has high system costs but lower CO₂ emissions.
- *Lower Cost – Conventional* and *Lower Cost – Shale* have higher CO₂ emissions but lower system costs.

Current Path has the lowest abatement cost, then *Lower Cost – Shale*. Abatement costs are highest in *Lower Cost – Conventional*, as the emissions reductions achieved by adding renewable capacity are offset, in part, by emissions from coal generation.

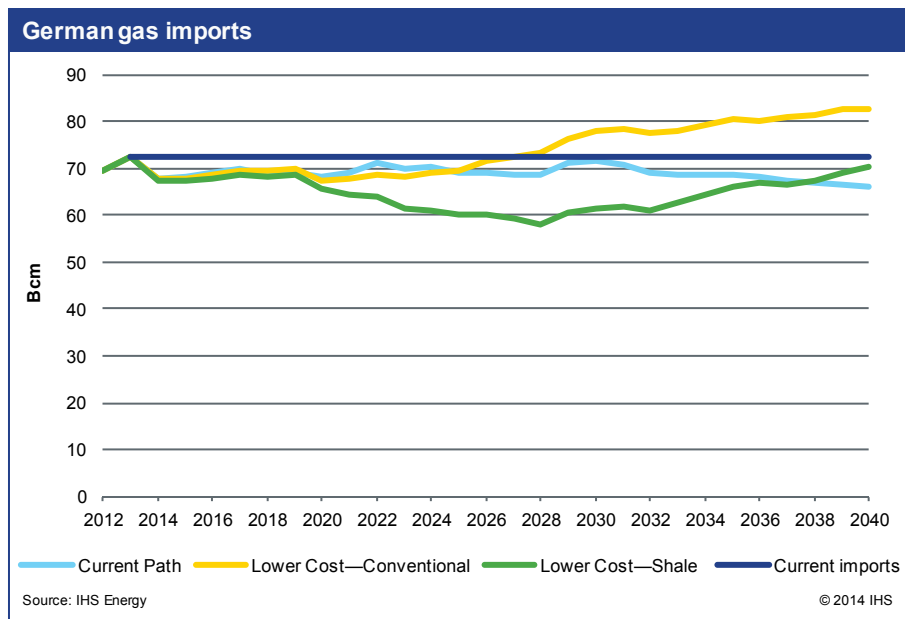
These abatement costs highlight the key benefit that gas can bring to the German power system: a greater role for gas in partnership with renewables reduces abatement costs by €125 per metric ton compared to scenarios where coal acts as the primary back up for renewables.

7.6 Gas import requirements

One aim of the Energiewende is to reduce Germany's energy imports. Clearly, greater use of gas-fired generation without the development of additional local resources would require increasing gas imports. Although greater diversity of global supplies goes some way toward addressing security of supply concerns, German gas imports will remain around current levels in *Current Path*. In *Lower Cost – Conventional* imports will exceed 80 Bcm through the 2030s as domestic production declines and the role of gas in the power sector grows.

However, if Germany were to develop a supportive policy framework for the domestic development of shale gas, imports could decrease, even if gas were to play a much larger role in the power system (see Figure 7.12). This reduction in imports—by more than 15% through most of the 2020s, despite rising demand—would improve Germany's security of supply and also have positive economic consequences.

FIGURE 7.12



A greater role for gas can help Germany meet its CO₂ target

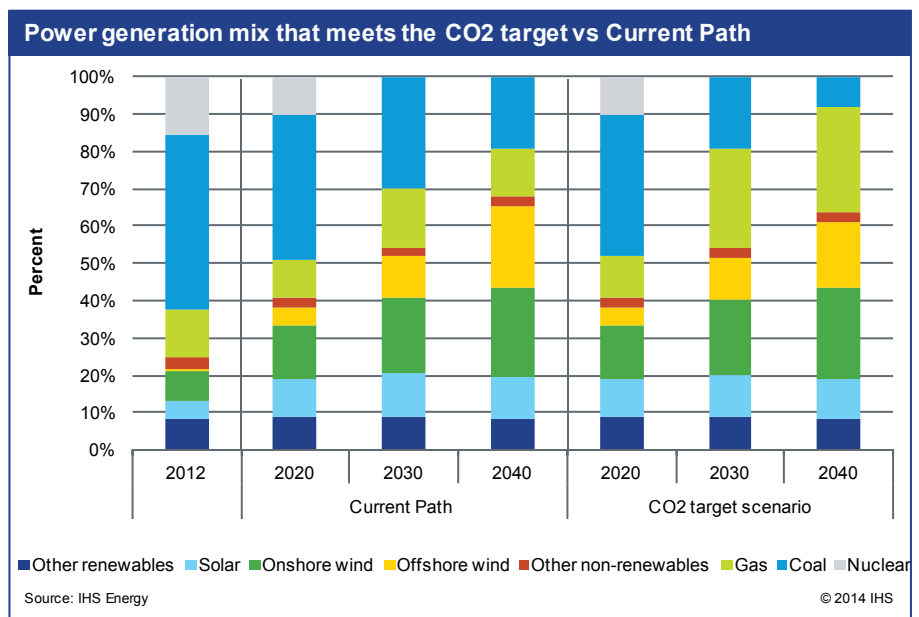
Germany's power sector does not reduce emissions in line with the economy-wide target in all three of the scenarios described above. This is a consequence of:

- The phase out of nuclear, which will remove Germany's zero carbon bridging technology;
- Slow progress on energy efficiency, which means Germany is unlikely to meet its electricity demand reduction targets;
- The competitiveness of coal-fired generation versus gas.

Development of shale gas can make gas-fired generation more competitive than coal by the middle of the next decade, but the phase out of nuclear will lead to a sustained increase in CO₂ emissions versus the target, and meeting the electricity demand reduction goals will be very challenging. This means that even if German renewables targets are met, CO₂ emissions from the power sector are unlikely to decrease in line with the economy-wide target. No specific CO₂ target has been established for the power sector, which accounts for approximately one-third of Germany's total emissions. However, an insufficient reduction in emissions by the power sector greatly increases the burden on the remaining sectors of the economy to lower their emissions. A greater role for gas could allow Germany to meet its CO₂ targets without increasing costs above *Current Path*.

Figure 7.13 shows just such a generation mix. This generation mix—which has been designed to meet the power sector's share of the CO₂ target beginning in 2030—is achieved by large-scale deployment of all renewable technologies, in conjunction with a growing role for gas. Installed capacity for solar PV and on-shore wind are the same as in *Current Path*. Offshore wind deployment is limited to 25 GW, as opposed to 31 in *Current Path*. Shale gas is developed, making gas more competitive than coal from the mid-2020s. The impact of this can be seen

FIGURE 7.13



beginning in 2030, when the role of gas grows, displacing coal generation. The role of gas is much greater in the scenario that meets the CO₂ target than in *Current Path*. This increased role for gas reduces cumulative CO₂ emissions by 0.5 billion metric tons compared to *Current Path*, and the CO₂ abatement cost is €215/metric ton, down from €340 per metric ton in *Current Path*.

Less dependence on gas imports, in volume terms, would also be reflected in Germany's trade balance. As a result, the value of annual net gas imports would be approximately €10–€15 billion lower each year beyond 2025 in the scenarios that includes shale development as compared to the scenarios without shale. In 2040, the difference in net gas imports would be the equivalent of almost half a percentage point of Germany's total imports and 7% its total trade balance.

7.7 Making the right trade-off

Oil and gas prices will be partly or completely determined by international pricing dynamics. German policy makers have little influence over them. However, policy makers do have direct and significant influence over the costs of the power supply. The embedded competitive disadvantage of Germany as an energy importer, compared to self-sufficient countries, requires the government to take special care when setting electricity policy. Decisions in one direction or another can have profound implications, for good or ill, for the economic health of German industry and the wider economy. As a result, policy makers now face important choices about how to balance costs and emissions and how to spread costs among consumers to minimize Germany's international competitiveness disadvantage. Whatever decisions are arrived at on the cost/emission spectrum, the efficiency of the energy transformation clearly can be improved by increasing role of natural gas—particularly locally produced natural gas—in the energy mix.

8. Economic impact of reducing the cost of the power system and developing Germany's shale gas potential

Key findings

- By combining a lower-cost power system with the development of shale gas, Germany can realize significant increases in economic activity much earlier than in the scenario without shale gas, beginning as early as 2020.
- Combining a lower cost power system with shale development would turn the German federal budget positive and lift government revenues, with the incremental increase of total revenues reaching €68 billion by 2040.

Reducing the cost of the power system and developing domestic shale gas resources could improve Germany's economic performance. To separate the effects of a less expensive power system and the effects of developing domestic shale gas, we present results from two comparisons. The first comparison is between *Current Path* and *Lower Cost – Conventional*. The second comparison is between *Lower Cost – Conventional* scenario and *Lower Cost – Shale*. This comparison demonstrates the incremental boost that shale gas development could bring to the German economy.

IHS modeled a number of factors to understand the economic implications inherent in transitioning to a lower-cost power system. In *Lower Cost – Conventional*, these factors include:

- **Electricity prices:** A lower average electricity price path due to a lower-cost power system. Small and medium end-consumers benefit as electricity prices are lower compared to *Current Path*, while electricity prices for the largest consumer categories are slightly higher.
- **Investment in renewables capacity:** Less capital spending is required since less renewables capacity—in particular offshore wind—is developed compared to *Current Path*.

In *Lower Cost – Shale*, the following factors complement and amplify the factors described above:

- **Gas prices for end-consumers:** Households and industrial end consumers directly benefit from a lower gas price path.
- **Electricity prices:** All end consumers benefit indirectly as less expensive gas trims electricity prices.
- **Shale gas development:** Capital and operating expenditures associated with developing and producing gas in Germany provide an economic boost.
- **Royalties** from shale gas production increase government revenue and improve the budget balance.

8.1 Gross domestic product

Lower electricity prices for small and medium consumers in *Lower Cost – Conventional* improve the competitiveness of the manufacturing sector, spur industrial activity, and enhance economic growth over the forecast period. As shown in Figure 8.1, improving the competitiveness of German firms and reductions in household electricity bills contribute to improved GDP growth over *Current Path*.

Average annual GDP growth in *Lower Cost – Conventional* is 1.7% from 2013 through 2030 and 1.5% from 2013 through 2040—0.1 percentage points higher than in *Current Path* in each time frame. Although this increase in growth rates may at first look small, the compounding effect leads to significant gains over the next 27

years. The economic boost of reducing the cost of the power system adds €60 billion to 2030 GDP and €77 billion to 2040 GDP, compared to *Current Path*. This is an increase of 1.7% and 1.9% of GDP over *Current Path* in 2030 and 2040, respectively.

Small and medium electricity consumers directly benefit from a lower EEG surcharge, and thus lower electricity prices, in both lower-cost scenarios, because they are not protected by rebates. As shown in Chapter 3, small and medium electricity consumers have suffered a disproportionate share of the net export losses from Germany's manufacturing sector attributable to high electricity costs. The benefit to energy cost competitiveness for small and medium consumers far outweighs the negative effect to large industrial consumers, whose electricity prices increase slightly in *Lower Cost - Conventional* compared to *Current Path*.

Developing shale gas as part of a lower-cost power system brings an additional €20 billion increase in GDP in 2030 and €60 billion in 2040, compared to a low-cost system without shale. Lower electricity prices for all end-consumer categories across the board, savings for firms and households from lower gas prices, and shale gas production activity add another 0.6% in 2030 and 1.5% in 2040 to GDP, as shown in Figure 8.2.

FIGURE 8.1

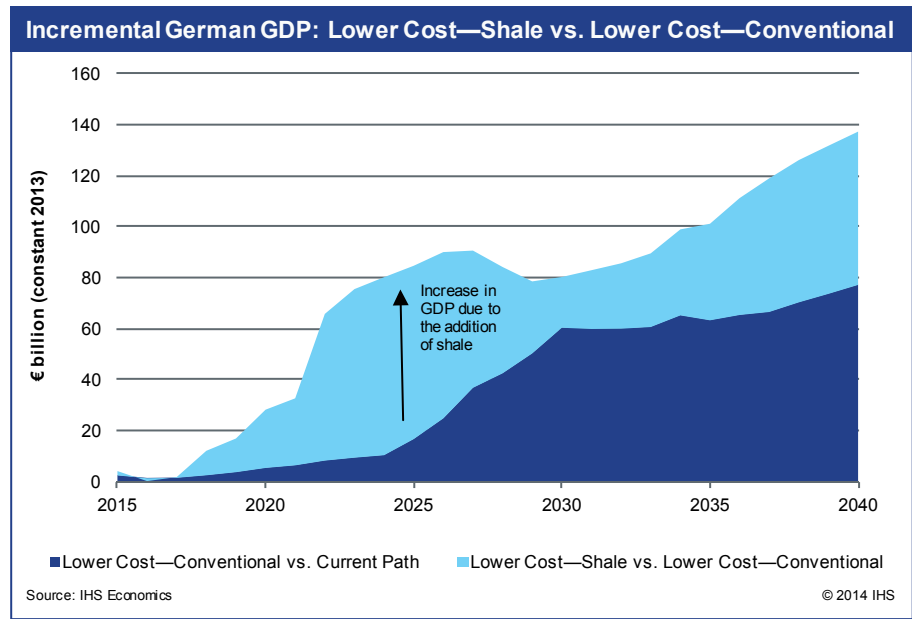
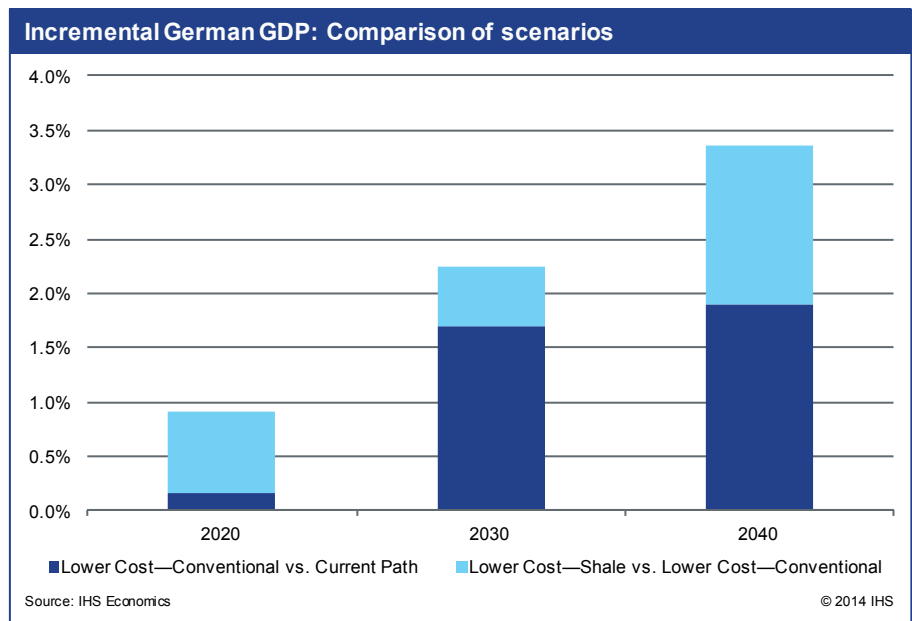


FIGURE 8.2



In *Lower Cost - Shale*, electricity prices are lower for all consumer groups compared to *Current Path*. In this case, all consumer groups benefit from improving cost competitiveness, enhanced industrial activity, and stronger growth.

By developing a lower-cost power system that includes shale gas, Germany can realize significant increases in economic activity much earlier than in the scenario without shale gas. Although the gains in *Lower Cost - Conventional* are somewhat limited until 2025, the development of shale gas will support GDP growth as early as 2020. Direct and indirect jobs associated with drilling activity will stimulate growth, but the bigger impact comes from lower gas prices for households and the corporate sector. Shale gas production in Germany decreases end-consumer gas prices between 2020 and 2025 in particular, spurring economic growth. Even though the gap between *Lower Cost - Conventional* and *Lower Cost - Shale* shrinks between 2025 and 2030, the benefits of an earlier boost to the German economy are important.

Summary of GDP impact:

Adopting the *Lower Cost – Conventional* path will add €5 billion to German GDP by 2020 as compared to *Current Path* (see Table 8.1). The impact will increase to €60 billion and €77 billion by 2030 and 2040, respectively. The incremental gain in GDP in *Lower Cost – Shale*, compared with *Lower Cost – Conventional*, will add another €23 billion in 2020, €20 billion in 2030, and €60 billion in 2040. The total difference between *Current Path* and *Lower Cost – Shale* amounts to €28 billion in 2020, which will widen to €80 billion and €138 billion by 2030 and 2040.

TABLE 8.1

GDP impact of a lower cost power system			
	2020	2030	2040
Change in GDP (%)			
Impact of Lower Cost—Conventional vs. Current Path	0.2%	1.7%	1.9%
Incremental impact of Lower Cost—Shale vs. Conventional	0.7%	0.6%	1.5%
Impact of Lower Cost—Shale vs. Current Path	0.9%	2.3%	3.4%
Change in GDP (€ billion constant 2013)			
Impact of Lower Cost—Conventional vs. Current Path	5.3	60.4	77.2
Incremental impact of Lower Cost—Shale vs. Conventional	22.9	19.9	60.3
Impact of Lower Cost—Shale vs. Current Path	28.2	80.4	137.6

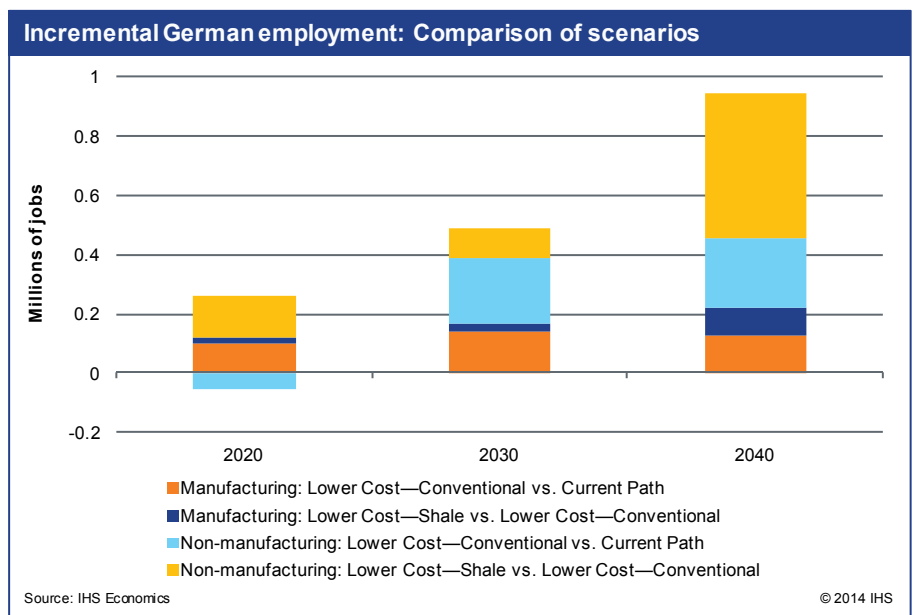
Source: IHS Economics

8.2 Jobs, income, and consumer spending

The increase in economic activity associated with a lower-cost power system also impacts employment. Employment rises at the beginning of the forecast period in all scenarios, but then declines, partly as a result of demographic factors. In *Current Path* and *Lower Cost – Conventional*, this decline begins in 2017. In *Lower Cost – Shale*, employment continues to rise until 2023, as a higher labor force participation rate due to the more dynamically growing economy temporarily offsets the impact of the demographic change.

Figure 8.3 shows the additional employment in both lower-cost scenarios compared to the *Current Path* scenario. *Lower Cost – Conventional* has 368,000 jobs—or almost 1% more jobs—in 2040 than *Current Path*. Adding shale development would result in 576,000 additional jobs—for a total of 944,000 more jobs in *Lower Cost– Shale* compared to *Current Path*.

FIGURE 8.3



Source: IHS Economics

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In *Lower Cost – Conventional*, the manufacturing sector would support 130,000 more jobs, a 2% increase over *Current Path*. Shale gas development would add another 87,000 jobs, or 1.5%, to manufacturing employment. The manufacturing sector in particular would benefit from a less expensive power system and shale gas development. Industry employment effects are discussed in detail in Section 8.5.

Under the lower-cost power system scenarios, investment in renewables, especially in offshore wind, would be more modest than in the *Current Path* scenario. This change in investment must be taken into account when estimating employment effects. Employment in the “green” energy industry would continue to grow

in the lower-cost scenarios, but at a slower pace. Higher employment in other sectors of the economy more than compensate for this change.⁶⁰

Summary of employment impact:

Adopting the *Lower Cost - Conventional* path will add 42,000 jobs to employment in Germany by 2020 as compared to *Current Path* (see Table 8.2). The impact will increase to 363,000 and 368,000 jobs by 2030 and 2040, respectively. The incremental difference between *Lower Cost - Conventional* and *Lower Cost - Shale* will add another 165,000 in 2020, 125,000 jobs in 2030, and 576,000 jobs in 2040. The total difference between *Current Path* and *Lower Cost - Shale* amounts to 207,000 jobs in 2020, which will widen to 488,000 jobs by 2030 and to 944,000 jobs by 2040.

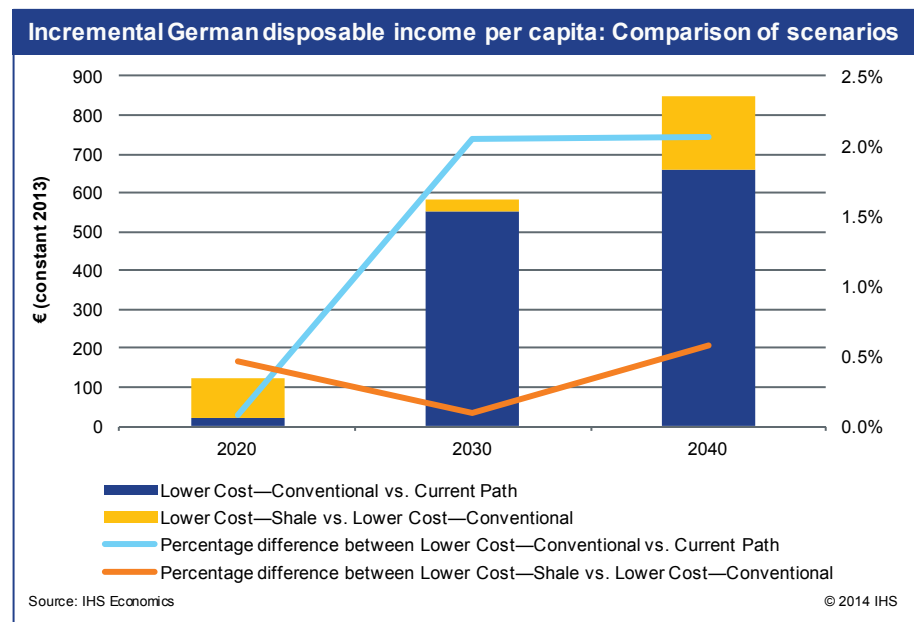
TABLE 8.2

Employment impact of a lower cost power system			
	2020	2030	2040
Change in employment (%)			
Impact of Lower Cost—Conventional vs. Current Path	0.1%	0.9%	0.9%
Incremental impact of Lower Cost—Shale vs. Conventional	0.4%	0.3%	1.4%
Impact of Lower Cost—Shale vs. Current Path	0.5%	1.2%	2.3%
Change in employment (thousand)			
Impact of Lower Cost—Conventional vs. Current Path	41.9	363.3	368.4
Incremental impact of Lower Cost—Shale vs. Conventional	165.1	125.1	575.5
Impact of Lower Cost—Shale vs. Current Path	207.0	488.4	944.0

Source: IHS Economics

The benefits of a lower-cost power system extend beyond industry and government to the German people, as shown in Figure 8.4. As a result of lower electricity prices, per capita disposable income in *Lower Cost - Conventional* is greater than in *Current Path*. A further boost in disposable income would occur with the development of domestic shale gas resources in *Lower Cost - Shale*.

FIGURE 8.4



The implications for German consumers are most tangible when presented on a per capita basis. Additional annual real disposable income in *Lower Cost - Conventional*, compared to *Current Path*, would rise steadily from €18 per capita in 2020 to over €660 per capita, or more than 2% relative to *Current Path*, in 2040. Adding shale development results in an additional €187 in per capita disposable income by 2040, or a total of €847 above *Current Path*.

60. IHS accounted for job losses in the green energy industry by deducting investment in renewable energy generation facilities in the industry and macroeconomic modeling framework. Lower employment (of approximately 100,000 jobs) in the operation and maintenance of green power facilities has also been taken into account. A more detailed discussion on green energy jobs can be found in the Appendix.

Lower retail gas prices for households provide part of the economic stimulus in *Lower Cost – Shale*. Based on the number of German households connected to the gas grid in 2012, according to the German Statistical Office, savings on the annual average gas bill per household will amount to €18 by 2020 (see Figure 8.5). Savings steadily increase to nearly €60 and €80 by 2030 and 2040, respectively (constant 2013) as the gas price difference between *Lower Cost – Shale* and *Lower Cost – Conventional* continues to increase.

Summary of impact on real disposable income per capita: Adopting the *Lower Cost – Conventional* path will add €18 to disposable income per capita in Germany by 2020 as compared to *Current Path* (see Table 8.3). The impact will increase to €554 by 2030 and to €660 by 2040. The difference between *Lower Cost – Conventional* and *Lower Cost – Shale* will add another €105 in 2020, €27 in 2030, and €187 in 2040. The total difference between *Current Path* and *Lower Cost – Shale* amounts to €123 in 2020 and widens to €581 billion by 2030 and €847 billion by 2040.

8.3 Government revenue

Government revenues would increase in both lower-cost scenarios. The additional economic activity these scenarios generate means that tax revenues from households and industry are higher than in *Current Path*.

Figure 8.6 shows the increase in annual government revenues in the lower-cost scenarios compared to *Current Path*. IHS estimates that the difference in annual government revenues in

FIGURE 8.5

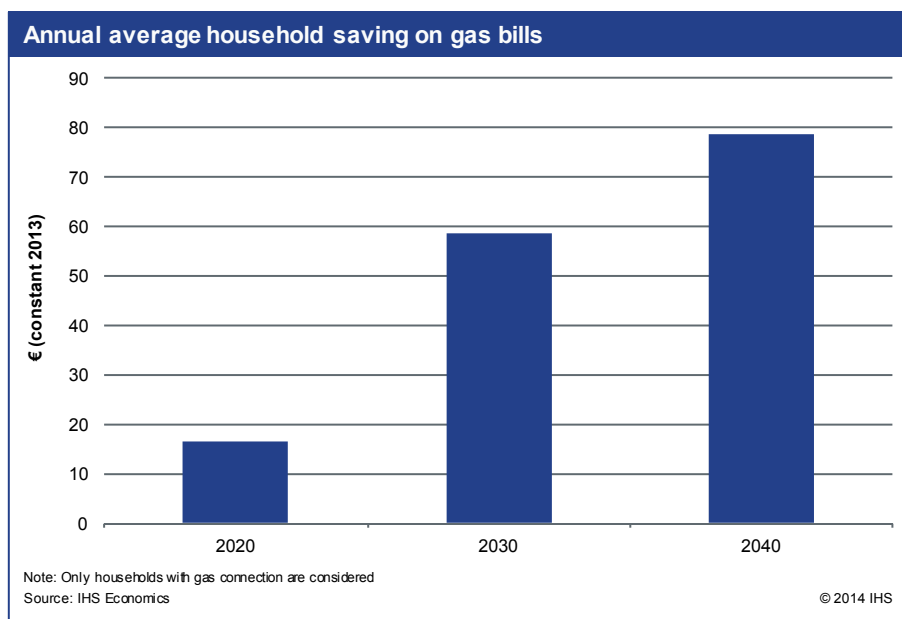
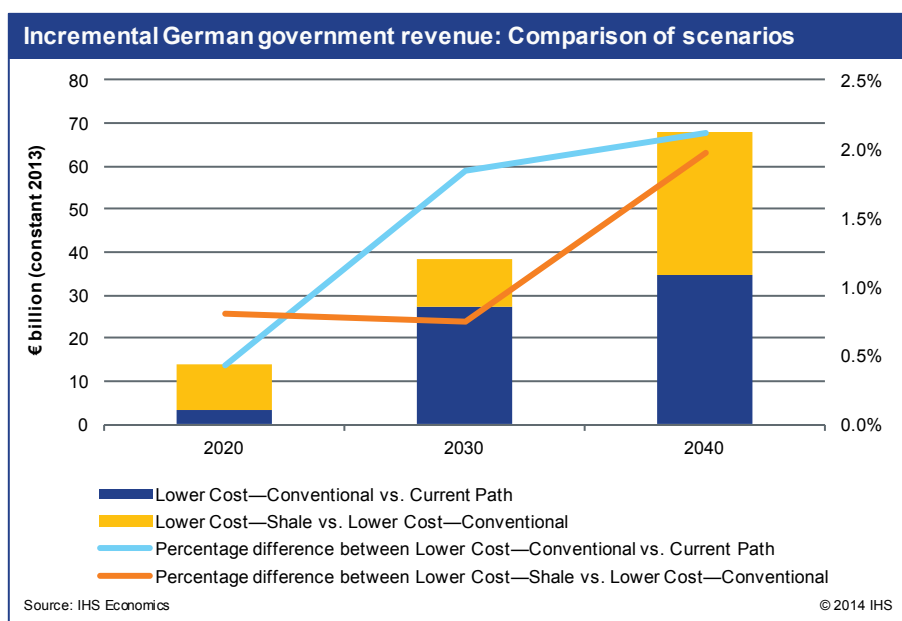


TABLE 8.3

Disposable income per capita impact of a lower cost power system				
	2020	2030	2040	
Change in disposable income per capita (%)				
Impact of Lower Cost—Conventional vs. Current Path	0.1%	2.1%	2.1%	
Incremental impact of Lower Cost—Shale vs. Conventional	0.5%	0.1%	0.6%	
Impact of Lower Cost—Shale vs. Current Path	0.5%	2.2%	2.7%	
Change in disposable income per capita (€, constant 2013)				
Impact of Lower Cost—Conventional vs. Current Path	18.2	553.7	660.3	
Incremental impact of Lower Cost—Shale vs. Conventional	104.8	27.2	186.8	
Impact of Lower Cost—Shale vs. Current Path	123.0	580.9	847.1	

Source: IHS Economics

FIGURE 8.6



Lower Cost – Conventional compared to *Current Path* would grow over the forecast period, from around €3 billion in 2020 to more than €27 billion in 2030 and nearly €35 billion in 2040. In *Lower Cost – Shale*, government revenues grow by an additional €11 billion by 2030 and €33 billion by 2040. Approximately €1 billion of this increase is royalty payments from gas production.

Reducing power system costs will also put the German government budget on an improved path for the entire forecast period. IHS forecasts a government deficit exceeding €16 billion by 2040 for *Current Path*. In *Lower Cost – Conventional*, the deficit shrinks to €7 billion in 2040, owing to higher revenues and lower welfare expenditures. In *Lower Cost – Shale*, the German federal budget would turn positive throughout the study time horizon, with a surplus of €9 billion by 2040.

Summary of impact on government total revenues:

Adopting the *Lower Cost – Conventional* scenario will add €3 billion to German government revenues by 2020 compared to *Current Path* (see Table 8.4). The additions to revenue will increase to €27 billion by 2030 and €35 billion by 2040. The incremental difference between *Lower Cost – Conventional* and *Lower Cost – Shale* will add another €11 billion in 2020, €11 billion in 2030, and €33 billion in 2040. The total difference between *Current Path* and *Lower Cost – Shale* amounts to €14 billion in 2020, which will widen to €39 billion by 2030 and €68 billion by 2040.

TABLE 8.4

Government revenue impact of a lower cost power system				
	2020	2030	2040	
Change in government revenue (%)				
Impact of Lower Cost—Conventional vs. Current Path	0.3%	1.9%	2.1%	
Incremental impact of Lower Cost—Shale vs. Conventional	0.8%	0.8%	2.0%	
Impact of Lower Cost—Shale vs. Current Path	1.1%	2.6%	4.1%	
Change in government revenue (€ billion, constant 2013)				
Impact of Lower Cost—Conventional vs. Current Path	3.4	27.3	34.9	
Incremental impact of Lower Cost—Shale vs. Conventional	10.6	11.2	33.2	
Impact of Lower Cost—Shale vs. Current Path	14.0	38.5	68.0	

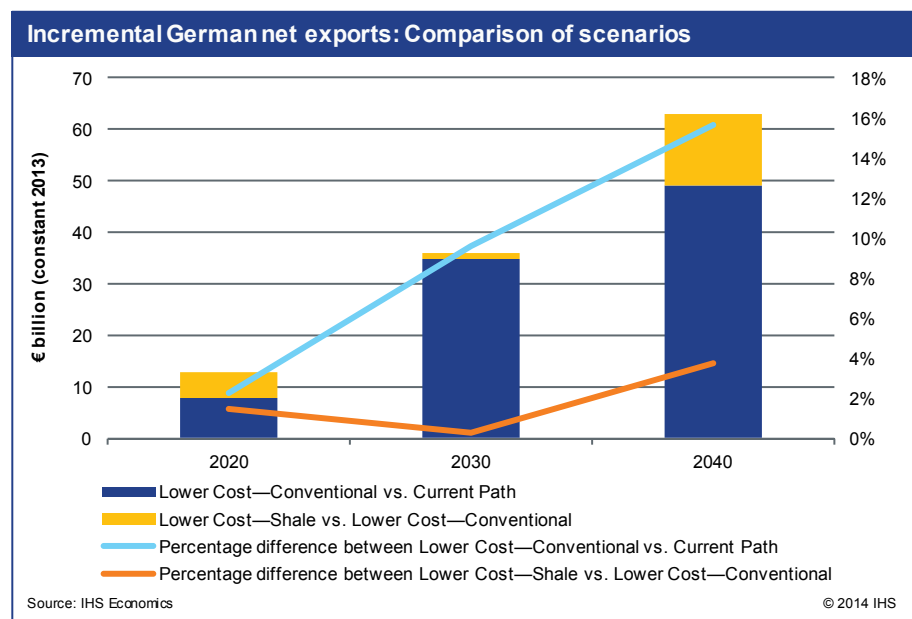
Source: IHS Economics

8.4 Manufacturing exports

A lower-cost power system moderates the electricity price premium in Germany, compared with its key trading partners, thus reducing Germany's competitive power price disadvantage and supporting its export sector. In *Lower Cost – Conventional*, lower electricity prices for small and medium end-consumers, combined with the retention of rebates for large consumers, will enable energy-intensive industries to continue to operate at high utilization rates, maintain employment, and increase their contributions to GDP and government revenues.

The lower-cost power system puts Germany in a position to increase its manufacturing exports over *Current Path* throughout the forecast period, as shown in Figure 8.7. German manufacturing's sales losses to overseas competitors will be mitigated, though not completely reversed.

FIGURE 8.7



Source: IHS Economics

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In *Lower Cost – Conventional*, Germany could increase its manufacturing net exports in 2030 by €35 billion compared with *Current Path*. By 2040, the difference is €49 billion, an increase of almost 16% over *Current Path* in that year.

The inclusion of shale gas development would further improve the competitive position of all companies with respect to electricity prices and further spur Germany's manufacturing exports. In *Lower Cost – Shale*, the manufacturing net exports rise by an additional €14 billion in 2040 to €63 billion, a 4% increase over *Lower Cost – Conventional*.

In terms of total manufacturing exports, the gap between *Lower Cost – Conventional* and *Current Path* would peak in 2040 at €14.8 billion, or 6% of the exports in the lower-cost scenario. In *Lower Cost – Shale*, exports are an additional €31 billion higher in 2040, rising to a total of €179 billion.

Summary of impact on net manufacturing exports:

Adopting the *Lower Cost – Conventional* path will add €8 billion to German net manufacturing exports by 2020 as compared to *Current Path* (see Table 8.5). The impact will increase to €35 billion by 2030 and €49 billion by 2040. The incremental gain between *Lower Cost – Conventional* and *Lower Cost – Shale* will add another €5 billion in 2020, and €1 billion and €14 billion in 2030

and 2040. The total difference between *Current Path* and *Lower Cost – Shale* amounts to €13 billion in 2020, which will widen to €36 billion by 2030 and €63 billion by 2040.

TABLE 8.5

Net manufacturing exports impact of a lower cost power system				
	2020	2030	2040	
Change in net manufacturing exports (%)				
Impact of Lower Cost—Conventional vs. Current Path	2.2%	9.7%	15.6%	
Incremental impact of Lower Cost—Shale vs. Conventional	1.5%	0.3%	3.8%	
Impact of Lower Cost—Shale vs. Current Path	3.7%	10.0%	20.0%	
Change in net manufacturing exports (€ billion, constant 2013)				
Impact of Lower Cost—Conventional vs. Current Path	7.7	34.7	49.2	
Incremental impact of Lower Cost—Shale vs. Conventional	5.1	1.2	13.8	
Impact of Lower Cost—Shale vs. Current Path	12.8	35.9	63.0	

Source: IHS Economics

8.5 Industry impacts

We now examine how changes in power system costs and the development of German shale gas resources impact three key manufacturing industries: machinery, motor vehicles, and chemicals and pharmaceuticals. We present figures on employment and output in each sector in Table 8.6 and Table 8.7.

Output in these industries grows throughout the forecast period in all three scenarios, but growth is faster in the lower-cost scenarios than in *Current Path*. In particular, the energy-intensive chemical and pharmaceutical industry prospers in the lower-cost scenarios. From 2015 to 2040, the industry's output grows at an annual

TABLE 8.6

Output in selected industries				
€ billion (constant 2013)				
	2020	2030	2040	CAGR
Current Path				
Chemicals and pharmaceuticals	185.8	212.5	228.1	1.1%
Machinery	243.5	272.7	290.4	1.1%
Motor vehicles	506.3	618.4	689.4	1.6%
Total manufacturing	2,155.7	2,542.3	2,789.1	1.5%
Lower Cost—Conventional				
Chemicals and pharmaceuticals	199.6	231.8	259.6	1.4%
Machinery	243.9	277.4	301.1	1.2%
Motor vehicles	507.6	629.5	703.1	1.7%
Total manufacturing	2,202.1	2,632.6	2,996.1	1.8%
Lower Cost—Shale				
Chemicals and pharmaceuticals	201.1	233.3	263.4	1.4%
Machinery	246.0	280.3	306.5	1.3%
Motor vehicles	511.3	632.4	712.6	1.8%
Total manufacturing	2,219.0	2,650.1	3,039.9	1.8%

Source: IHS Economics

rate of 1.4% in *Lower Cost – Conventional* compared to a rate of 1.1% in *Current Path*.

Other industries benefit as well, and Germany's total manufacturing output in 2040 is €207 billion, or 7.4%, higher in the *Lower Cost – Conventional Scenario* than in *Current Path*. When shale development is included, total manufacturing output rises an additional €44 billion compared to *Lower Cost – Conventional*.

Employment for the three major industries is forecast to decline or to exhibit weak growth in all of the scenarios, but more jobs will be preserved in the lower-cost scenarios. Employment in motor vehicles will grow, albeit slowly, in the lower-cost scenarios, while employment in machinery and in chemicals and pharmaceuticals will decline slightly.

Differences in employment among the scenarios grow larger throughout the forecast period. Comparing *Lower Cost – Conventional* with *Current Path*, chemicals and pharmaceuticals will have about 34,000 more jobs in 2040 in *Lower Cost – Conventional*, machinery will have 8,000 more jobs, and motor vehicles 11,000 jobs. In all manufacturing, 129,000 more jobs would be generated in *Lower Cost – Conventional* than in *Current Path*.

Lower Cost – Shale would maintain 88,000 more jobs in 2040 compared to *Lower Cost – Conventional*. The chemical and pharmaceutical sector would gain 7,000 jobs, while machinery and motor vehicles would increase their employment by 18,000 and 13,000, respectively.

8.6 Investment impact

The boost to Germany's economy from lower energy prices will also flow to private investment. As the long-run prospects for German industry improve with the lower energy price outlook, Germany will remain an attractive place for manufacturing.

Lower Cost – Conventional would result in private fixed non-residential investment in 2030 of €469 billion, €8 billion more than in *Current Path*. By 2040, this gap would widen to €26 billion, amounting to an increase of almost 5% over *Current Path*.

Developing domestic shale gas would bring a two-fold boost in investment—through direct investment in extraction facilities and accompanying industries, and through lower gas prices and higher activity throughout the economy. Private, fixed non-residential investment in *Lower Cost – Shale* would exceed investment in *Lower Cost – Conventional* by €22 billion in 2030 and €21 billion in 2040. Shale gas development would thereby add around 4% annually to *Current Path* investment level in both 2030 and 2040.

The overall improvement to Germany's economy in both lower-cost scenarios would not only result in higher tax revenues, but lower unemployment would also reduce the burden on the government from social expenditures, freeing funds for reinvestment in the economy. In the *Lower Cost – Conventional Scenario*,

TABLE 8.7

Employment in selected industries				
Thousands				
	2020	2030	2040	CAGR
Current Path				
Chemicals and pharmaceuticals	477.2	465.9	443.3	-0.3%
Machinery	1,105.7	1,055.8	980.5	-0.4%
Motor vehicles	942.0	981.1	997.0	0.5%
Total manufacturing	6,434.2	6,193.7	5,805.6	-0.4%
Lower Cost—Conventional				
Chemicals and pharmaceuticals	510.5	502.3	478.1	-0.3%
Machinery	1,105.7	1,064.0	988.6	-0.4%
Motor vehicles	944.5	991.5	1,007.9	0.5%
Total manufacturing	6,530.4	6,332.4	5,935.0	-0.3%
Lower Cost—Shale				
Chemicals and pharmaceuticals	512.5	504.0	484.9	-0.2%
Machinery	1,110.8	1,072.4	1,006.1	-0.3%
Motor vehicles	948.1	993.6	1,021.3	0.6%
Total manufacturing	6,557.0	6,358.1	6,022.6	-0.3%

Source: IHS Economics

government fixed investment would be €4 billion by 2040, 6% higher than in the *Current Path* Scenario. In *Lower Cost – Shale*, that gap would widen to a €12 billion advantage over *Current Path* by 2040.

Summary of impact on private fixed non-residential investment: Adopting the *Lower Cost – Conventional* scenario will leave private, fixed non-residential investment in Germany nearly unchanged by 2020 as compared to *Current Path* (see Table 8.8). The impact will become stronger, however, increasing by €8 billion by 2030 and €26 billion by 2040. The incremental difference between *Lower Cost – Conventional* and *Lower Cost – Shale* will add another €10 billion in 2020, €22 billion in 2030, and €21 billion in 2040. The total difference between *Current Path* and *Lower Cost – Shale* amounts to €9 billion in 2020, which will widen to €29 billion by 2030 and €47 billion by 2040.

FIGURE 8.8

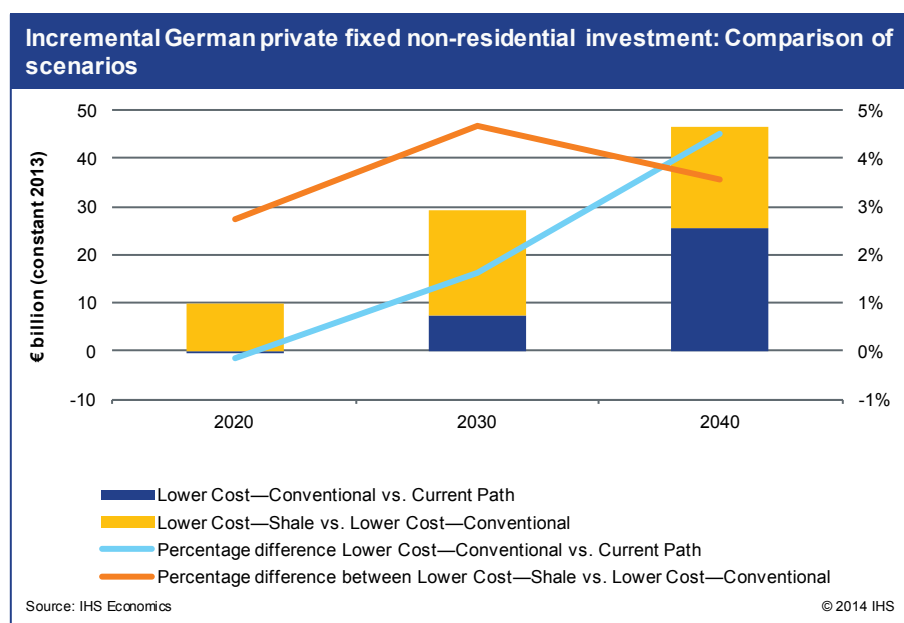


TABLE 8.8

Private fixed non-residential investment impact of a lower cost power system				
	2020	2030	2040	
Change in private fixed non-residential investment (%)				
Impact of Lower Cost—Conventional vs. Current Path	-0.2%	1.6%	4.5%	
Incremental impact of Lower Cost—Shale vs. Conventional	2.7%	4.7%	3.6%	
Impact of Lower Cost—Shale vs. Current Path	2.6%	6.4%	8.2%	
Change in private fixed non-residential investment (€ billion, constant 2013)				
Impact of Lower Cost—Conventional vs. Current Path	-0.6	7.5	25.6	
Incremental impact of Lower Cost—Shale vs. Conventional	9.8	22.0	21.1	
Impact of Lower Cost—Shale vs. Current Path	9.2	29.4	46.6	

Source: IHS Economics

9. Conclusions

The Energiewende in its current form is not meeting its objective of providing a competitive transition to a low-carbon economy. The current route is neither competitive nor low-carbon. For this reason, the German economy is increasingly at a disadvantage compared to its key global competitors, owing to German industry's growing energy price burden compared to its international competitors. And—in the great paradox—CO₂ emissions in Germany have risen despite the rising costs associated with renewable deployment under the Energiewende.

Without reform of the Energiewende, industrial capacity will be lost as investment moves offshore and the international market share for German products shrinks. This will directly impact Germany's GDP, jobs, income, trade position, and government revenues. Moving towards a More Competitive Energiewende—combining the retention of rebates with moderation in the growth of renewables and shale gas development—presents an opportunity to secure a sustainable path toward a renewable energy future. This path would maintain a strong German economy that has greater exports, more manufacturing jobs, and is more competitive in the changing global economy.

In this study, we compare the effects of remaining on the current course of the Energiewende to a More Competitive Energiewende in which domestically produced natural gas plays a larger role. Compared to the current path, a lower-cost system with gas has the following economic benefits:

- **Gross domestic product:** GDP would be nearly €28 billion, or 0.9%, larger in 2020, and €85 billion, or 2.5%, larger in 2025. The gain in GDP is even greater in the longer term, reaching €138 billion, or 3.4%, by 2040.
- **Employment:** The economy would support 207,000, or 0.5%, more jobs in 2020, and 559,000, or 1.3%, more jobs in 2025. In the longer term, the economy would support nearly 1 million additional jobs by 2040. These employment increases take into account a slowing of growth of jobs in “green” energy industries.
- **Disposable income:** The benefits of Energiewende reform extend to all the citizens of Germany, as the resulting economic growth increases real disposable income. Reform would add an average of €123 in disposable income per person in 2020 and €847 per person in 2040.
- **Government revenues:** Increases in overall economic activity and royalties from gas production would yield nearly €40 billion in additional annual revenues by 2030, rising to €68 billion by 2040.
- **Manufacturing exports:** Lower energy prices increase German manufacturing's relative competitiveness. Net exports for the manufacturing sector would be €36 billion larger in 2030 and €63 billion larger by 2040—a gain of 20%.

However, despite the cost reductions that a reformed Energiewende could bring, German retail electricity prices will remain high by international standards. As a result, maintaining the existing EEG rebates for energy-intensive customers is essential to recognizing the economic benefits presented in this study. Without the rebates, GDP would be almost 5% lower in 2020—a mere six years from now—as damage to energy-intensive industry would flow through supply chains and affect economic growth. A residential consumer would save about €55 per year on his or her electricity bills, but real disposable income—“money in consumers' pockets”—would decrease by more than €500 per year.

The Energiewende is an initiative with global significance. Germany is in a unique position to take the lead in demonstrating how a transition towards a low-carbon world can be managed in a sustainable and affordable manner. By linking deployment of mature renewables with natural gas as a bridging technology, Germany could stay on the path toward a low-carbon economy while opening new opportunities in a global energy world.