The German *Energiewende*

Challenges and opportunities

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Structure

- Introduction
- Economic aspects of the *Energiewende*
  - Cost and benefits
  - Job effects
  - Local energy production
  - Grids and security of supply
- Energy Efficiency as second pillar of the *Energiewende*

An introduction to the *Energiewende*

Anti-nuclear protests in Germany in the 1970s...

E3G

...and again in 2011

So Mrs Merkel launched the *Energiewende* after Fukushima in March 2011

Nuclear Phase-Out

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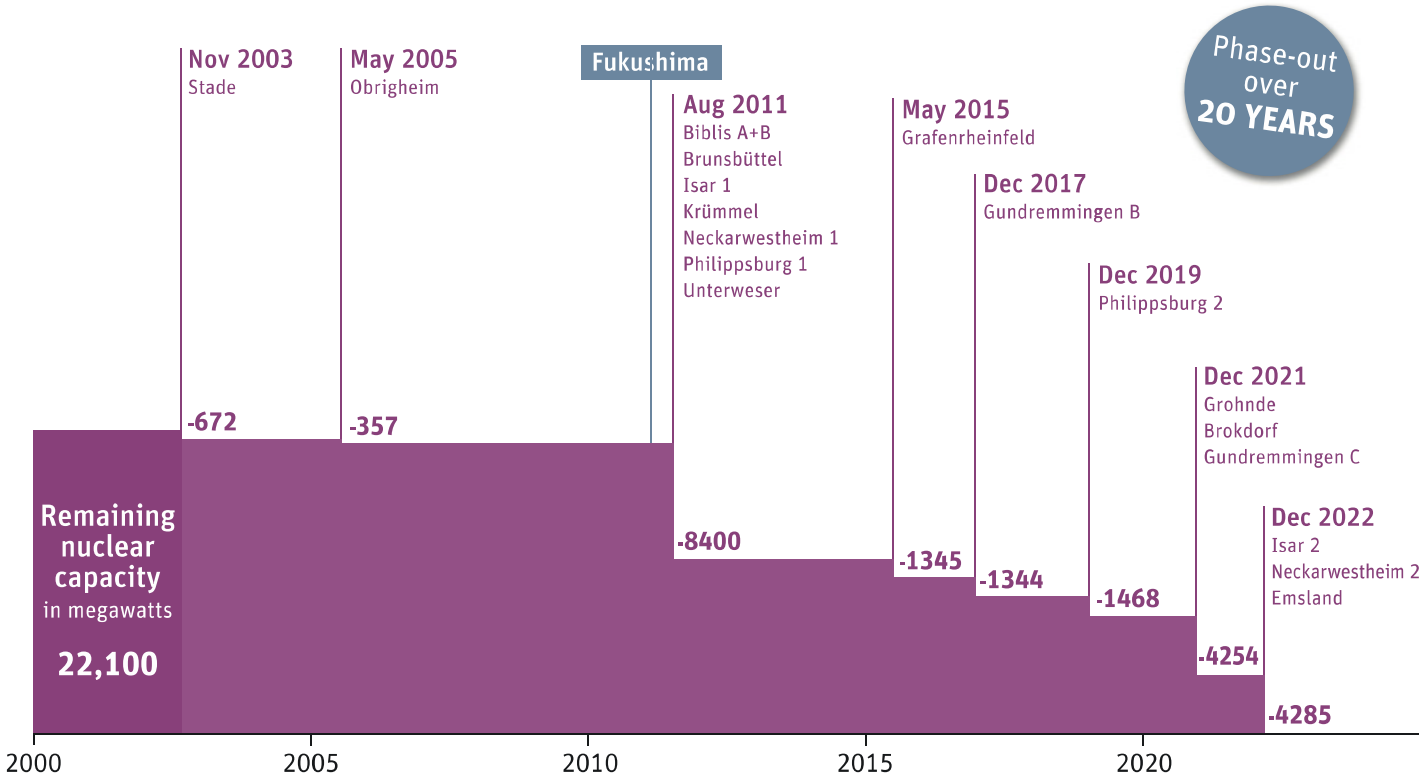
Germany is gradually shutting down all nuclear power plants

Declining nuclear energy installed capacity in Germany, 2000–2022

Source: Institute of Applied Ecology, BMJ, own calculations



Energiewende = energy transition

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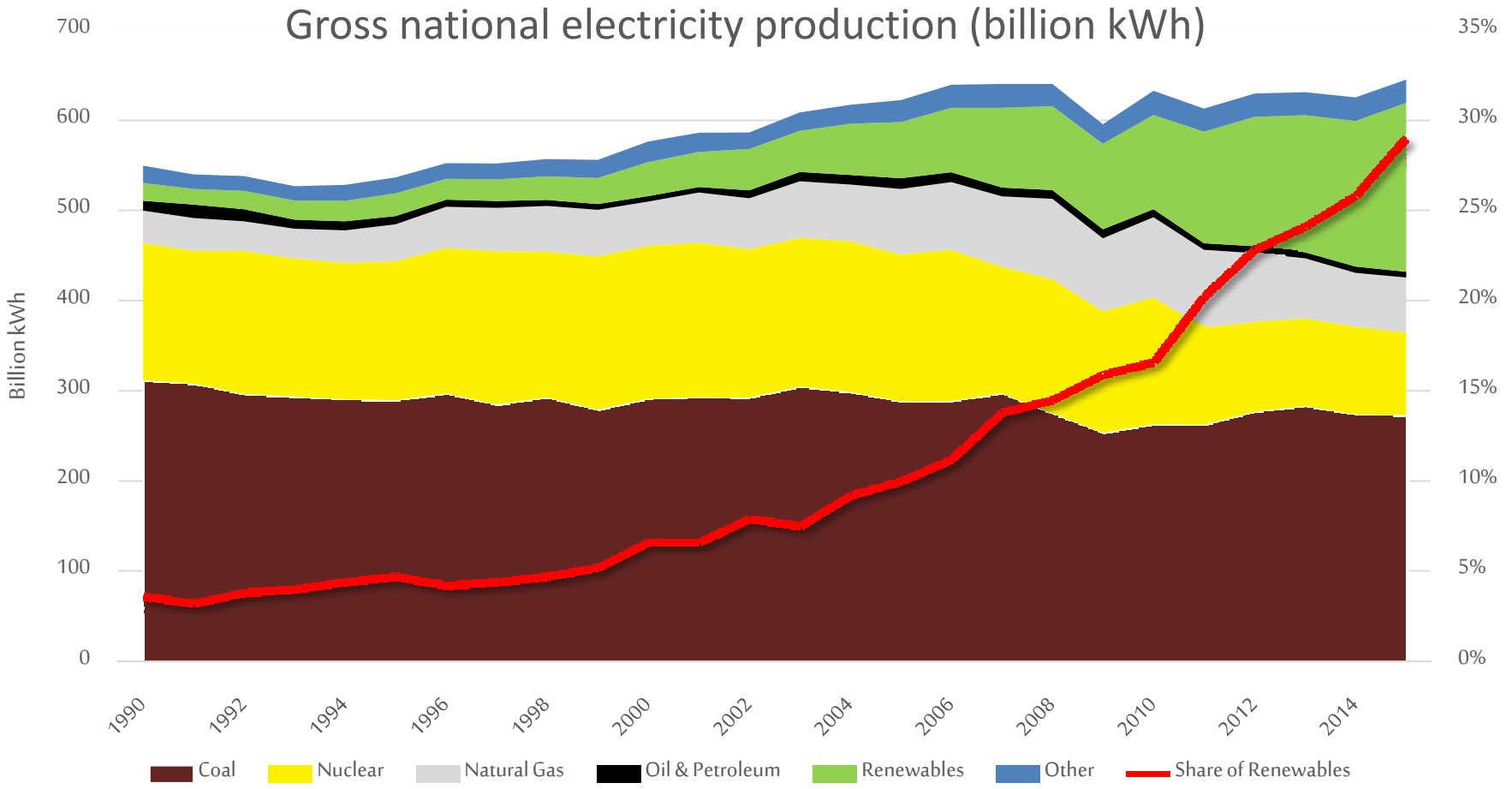
- 1980s: “How can we have economic growth without nuclear energy and fossil fuels?”

➔ Term *Energiewende* coined by a “green Avant-garde”

- 1991 Germany’s First Feed-In Tariff Law
- 2000 First nuclear phase-out by Red-Green government coalition
- 2000 Renewables Act (EEG)
- 2010 Phase out of the Phase Out by Merkel’s government coalition
- 2010 “Energy Concept”
- 2011 Nuclear Phase Out AND *Energiewende* after Fukushima
- 2014 and 2016 EEG reforms

Renewables expansion



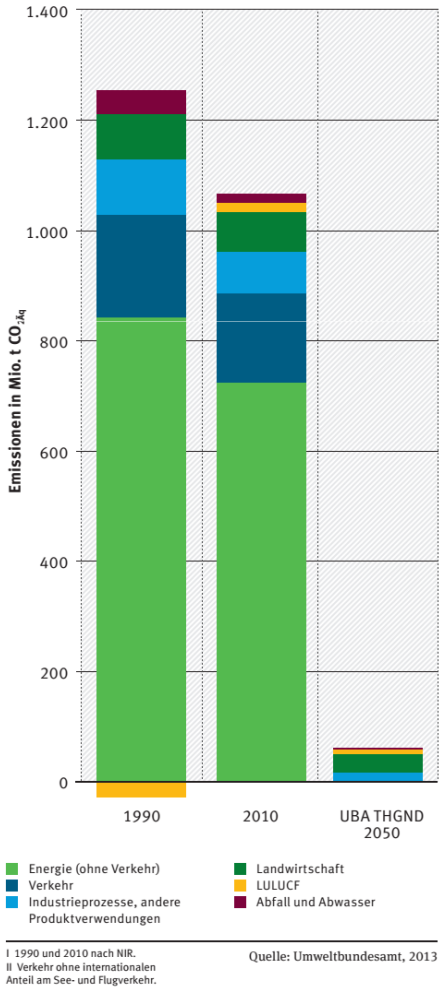
Headline targets

Targets of the *Energiewende* — Table 7

	2020	2025	2030	2035	2040	2050
Reduction in GHG emissions (compared with 1990)	40%		55%		70%	80-95%
Increase in share of RES in gross electricity consumption		40-45%		55-60%		At least 80%
Reduction of primary energy consumption (compared to 2008)	20%					50%
Reduction in gross electricity consumption	10%					25%
Share of electricity generation from CHP plants	25%					
Reduction of energy use in transport sector (against 2005)	10%					40%

BMWi, 2014a, p. 4.

Abbildung 1:
Treibhausgasemissionen[I,II]



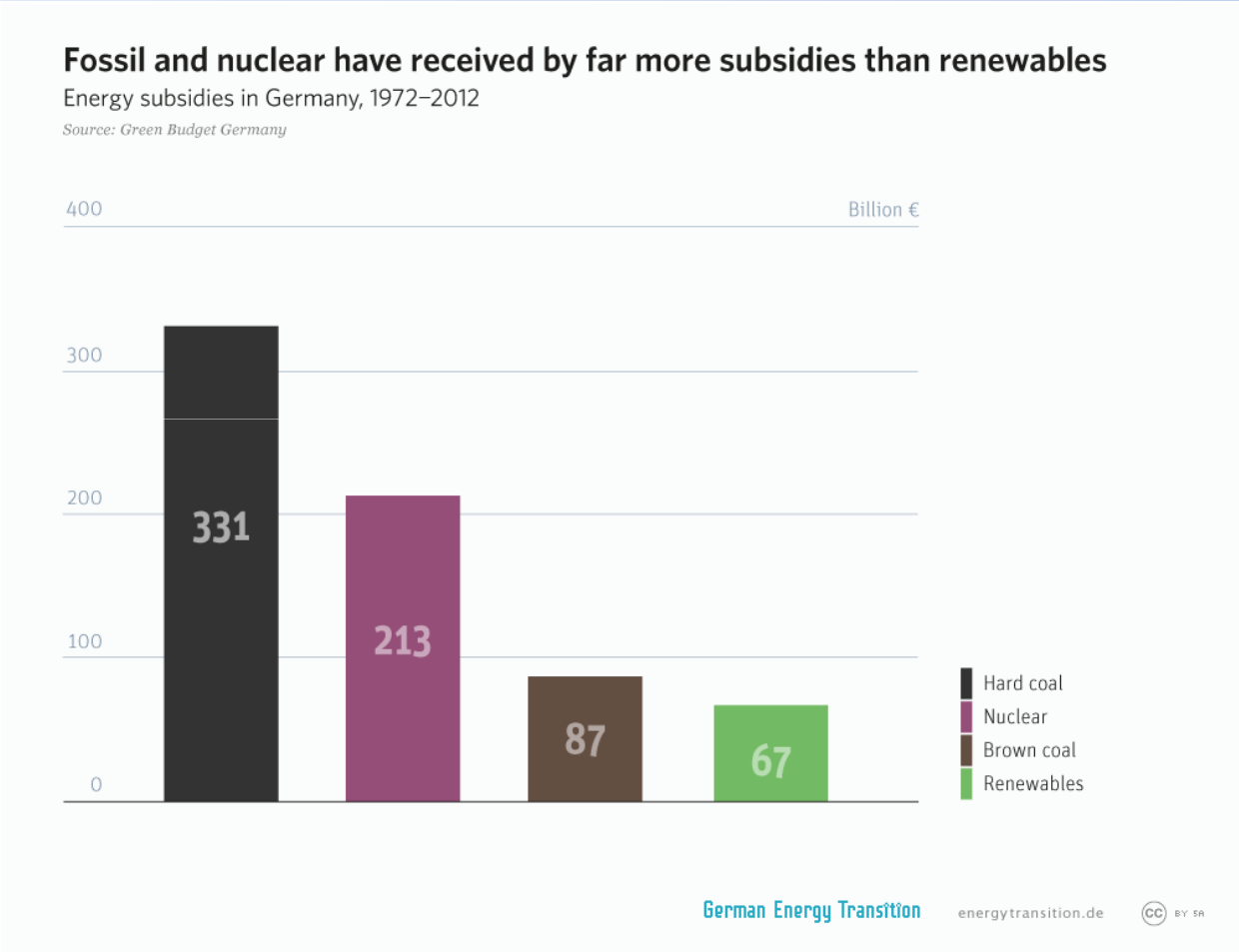
I 1990 und 2010 nach NIR.
II Verkehr ohne internationalen Anteil am See- und Flugverkehr.

Quelle: Umweltbundesamt, 2013

EEG 2016 revision: End of Feed-in Tariff

- Main features of reformed Renewable Energy Law (EEG) (May 2016):
  - RES growth corridor: 40-45% of electricity mix by 2025
  - Quantity-based tendering model to replace feed-in tariff
  - “Direct marketing” of RES power instead of FIT
- This is to limit the costs of the energy transition, integrate RES in to the market, and prevent RES growth beyond what the grid can currently handle
- The unofficial motivation is to help the “Big 4” utilities catch up with RES as they have an advantage over small-scale produces in tenders.

Renewable energy subsidies in context



It Works: Development of GHG Emissions vs. GDP Growth

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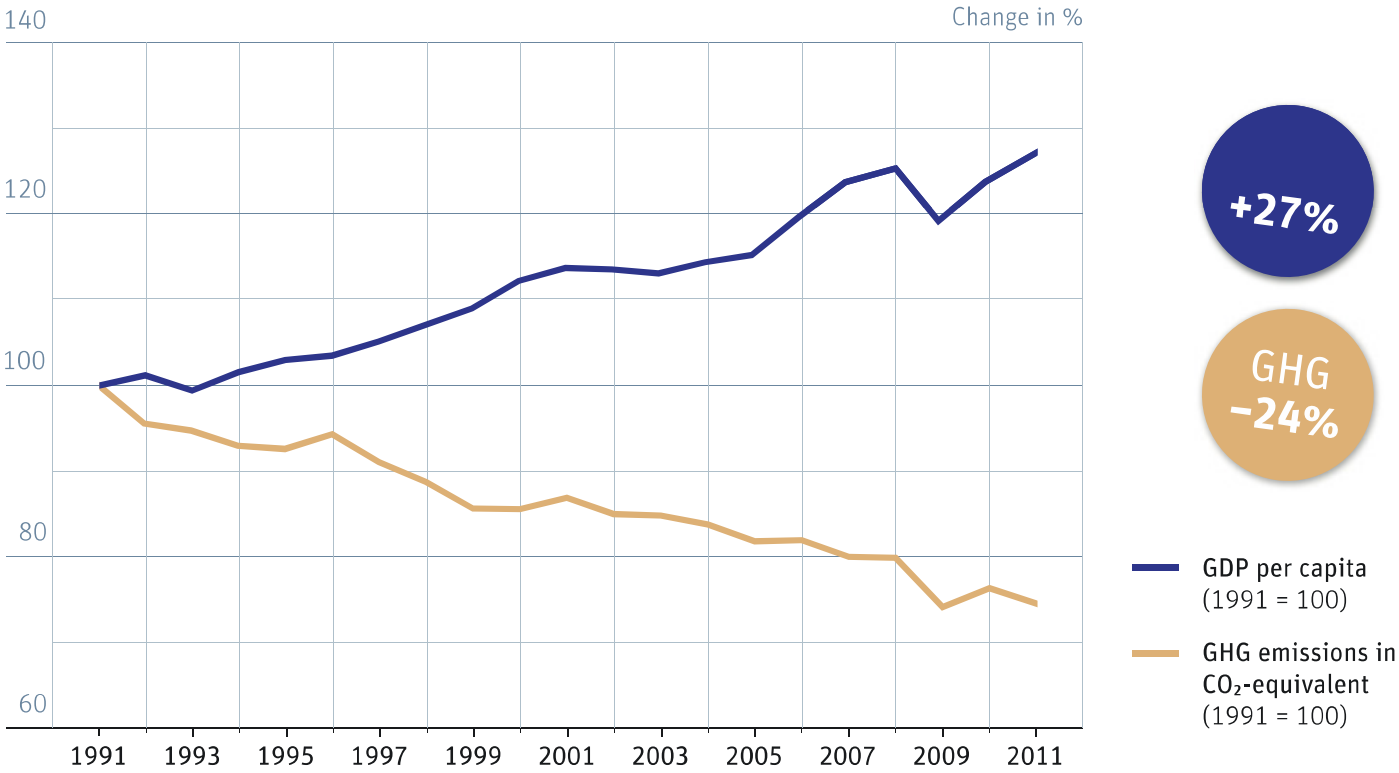
Germany: growing economy, declining emissions

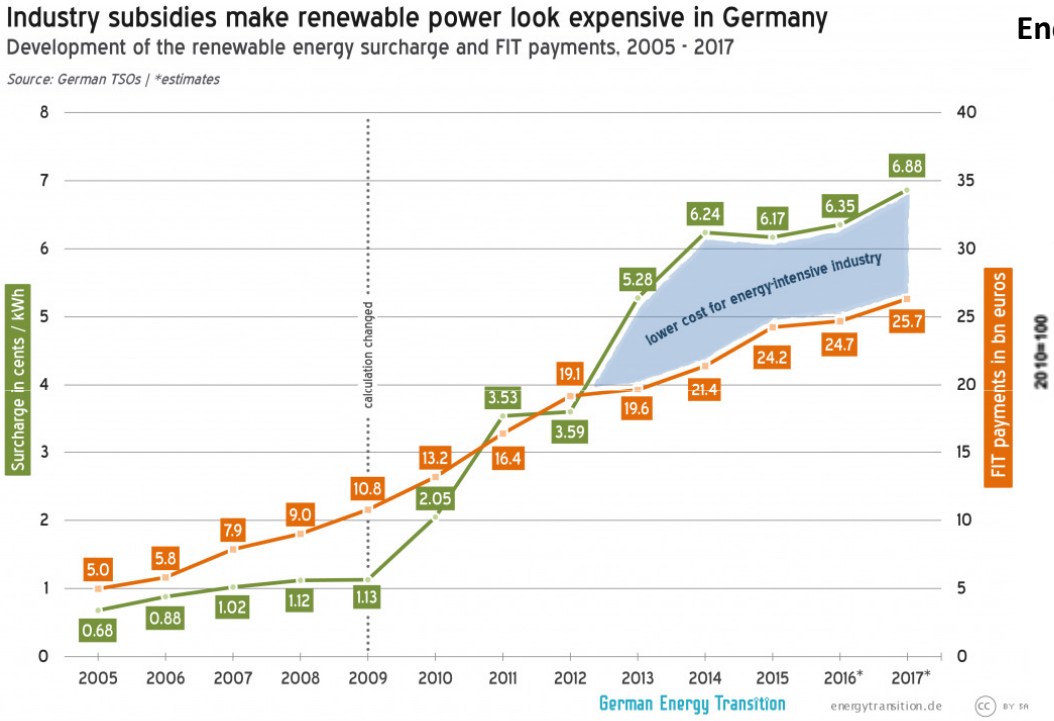
Change of GDP and GHG emissions in Germany, 1991–2011

Source: BMU, BMWi, Destatis

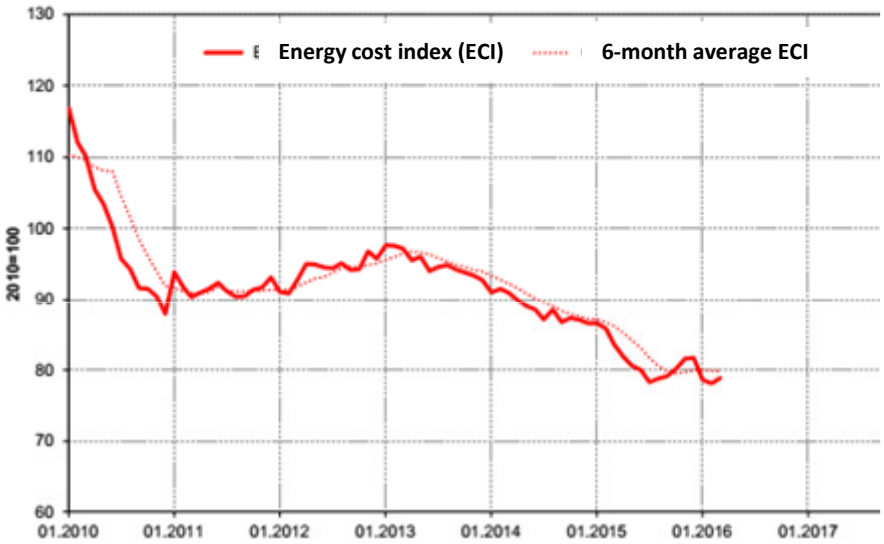


Costs and benefits

Who pays for the *Energiewende*?

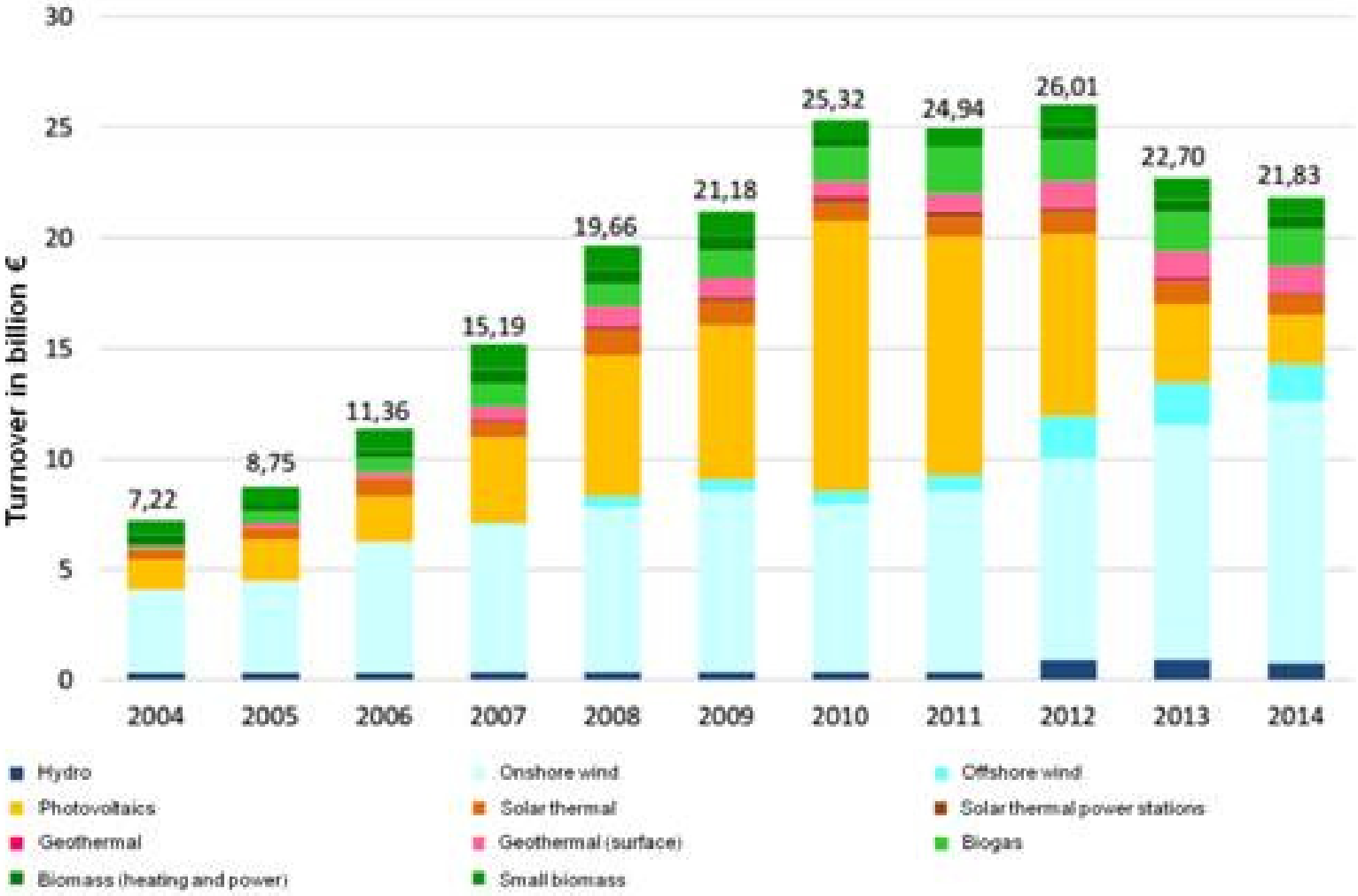


Energy cost index for German industry



Even though consumers have to pay for it, the *Energiewende* is supported by 90% of the population (2015 poll)

Total revenue from renewables



Renewable energy investment

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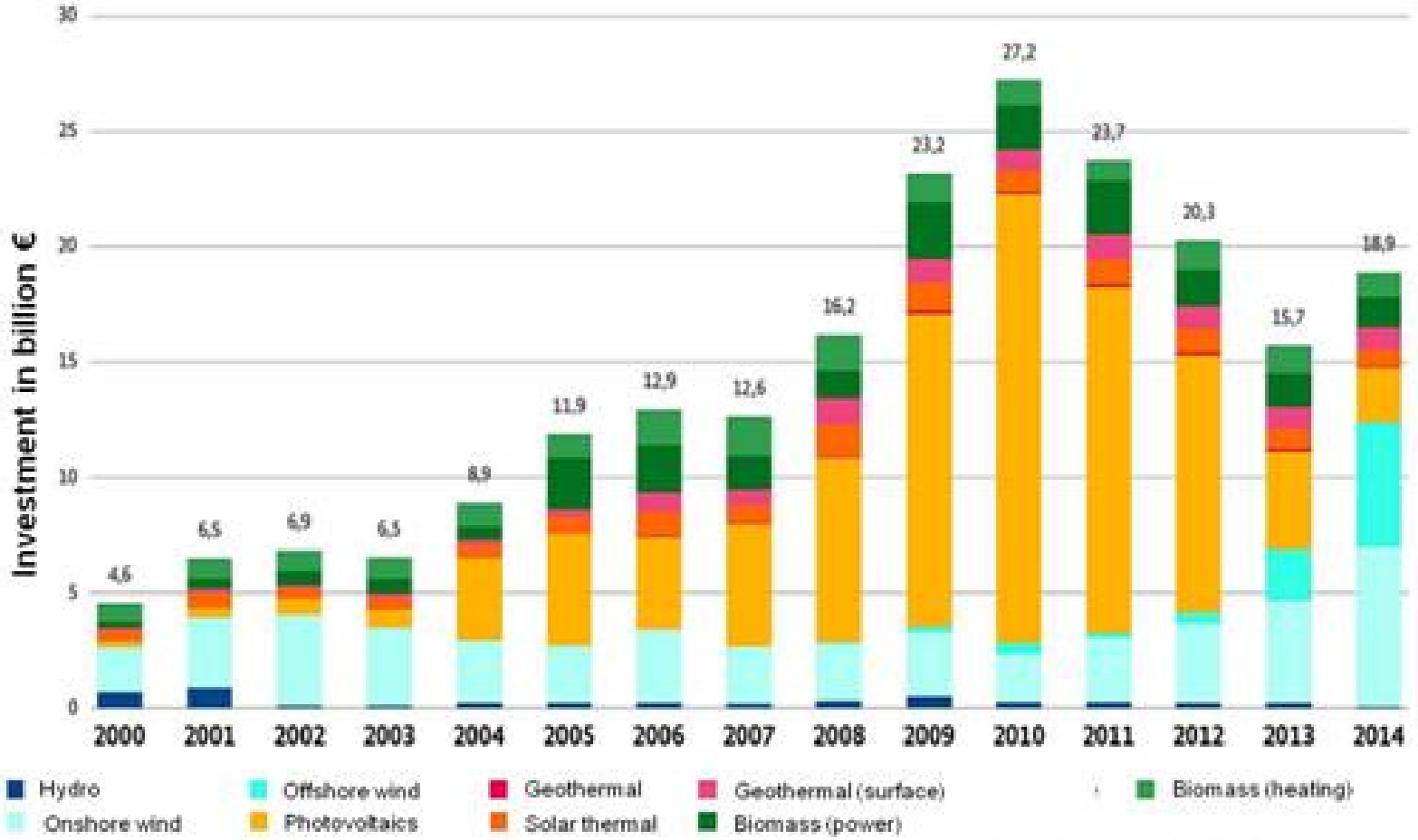

RES costs fell much faster than expected

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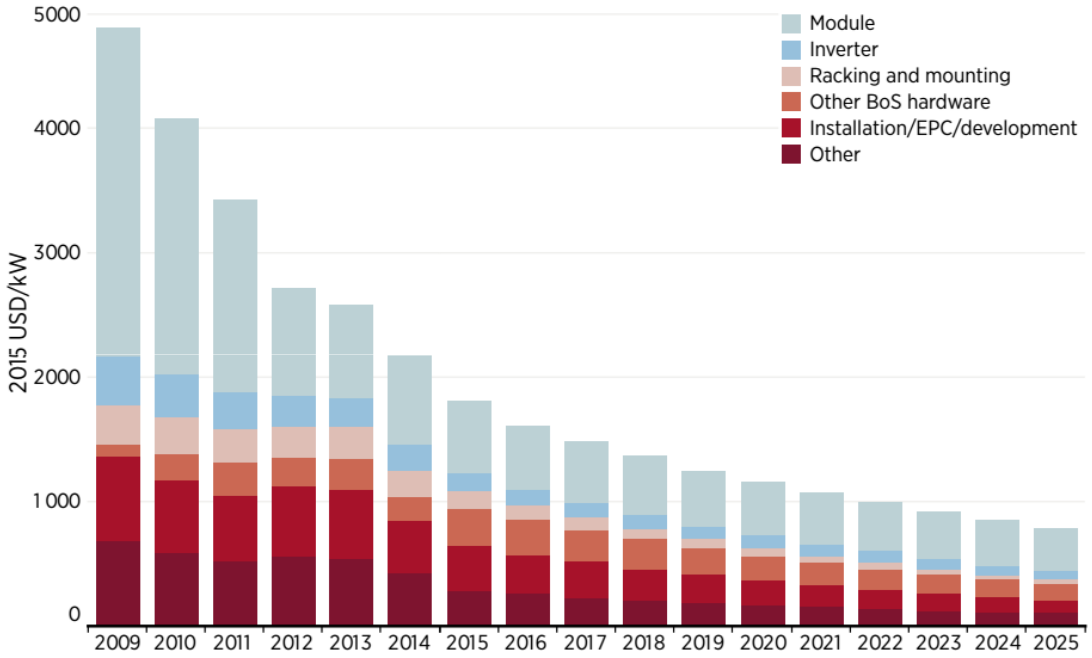
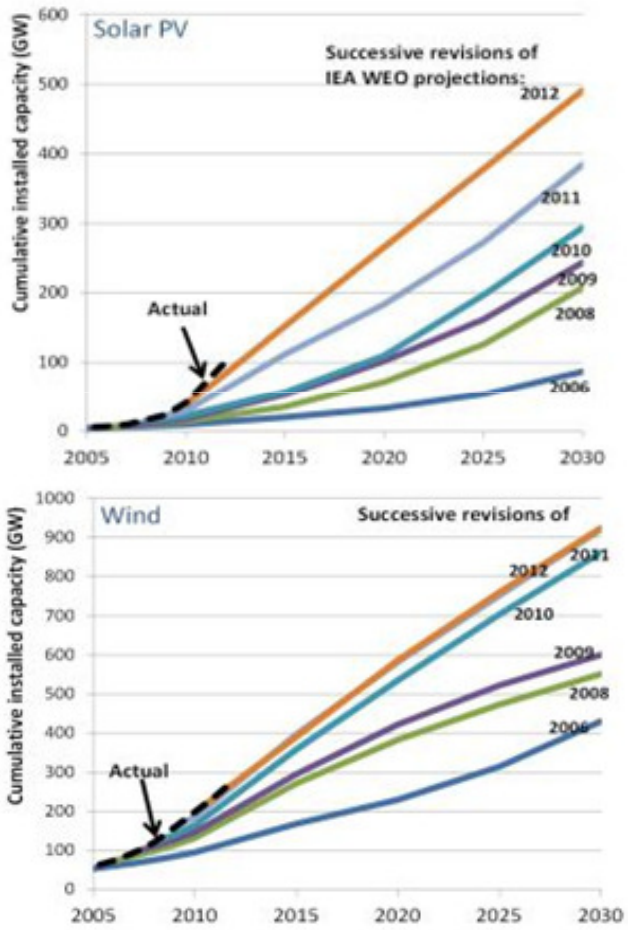
FIGURE ES 1: GLOBAL WEIGHTED AVERAGE UTILITY-SCALE SOLAR PV TOTAL INSTALLED COSTS, 2009-2025





Falling power prices

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German baseload power prices (EEX Phelix 1-year futures)

German utilities are in crisis

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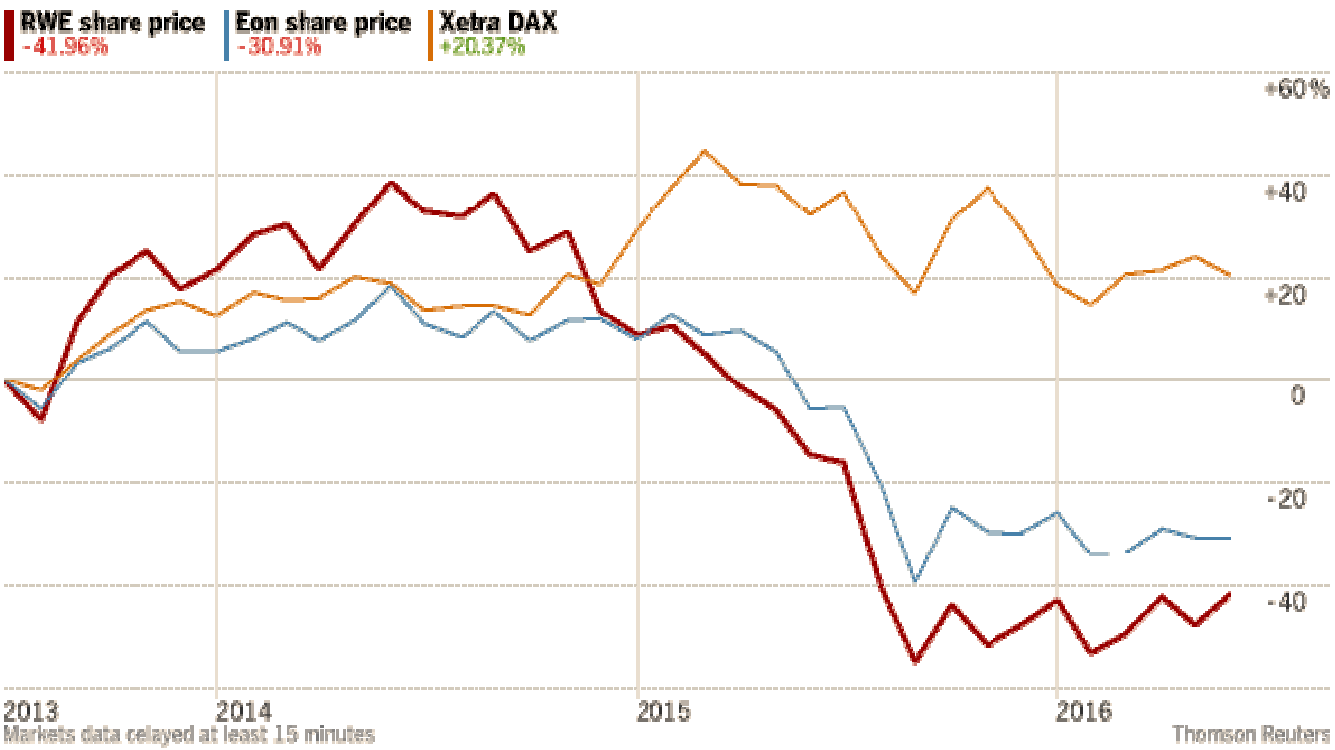
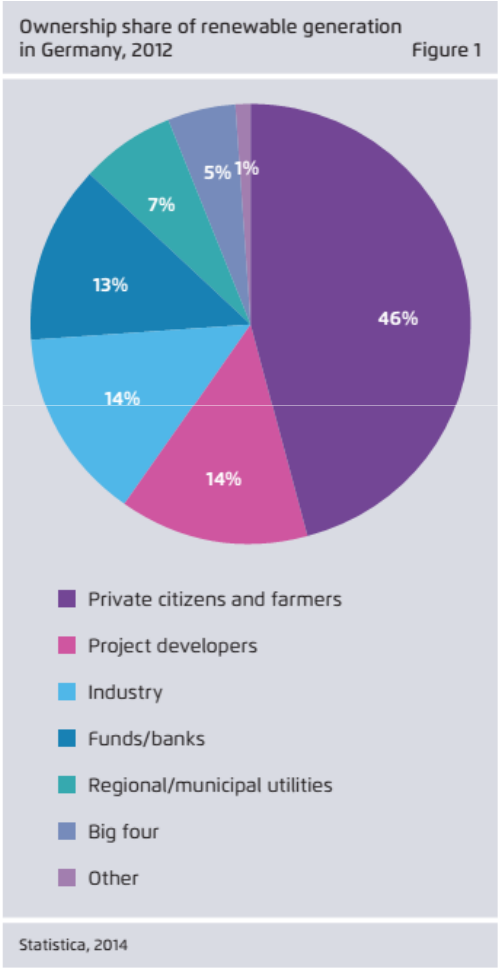
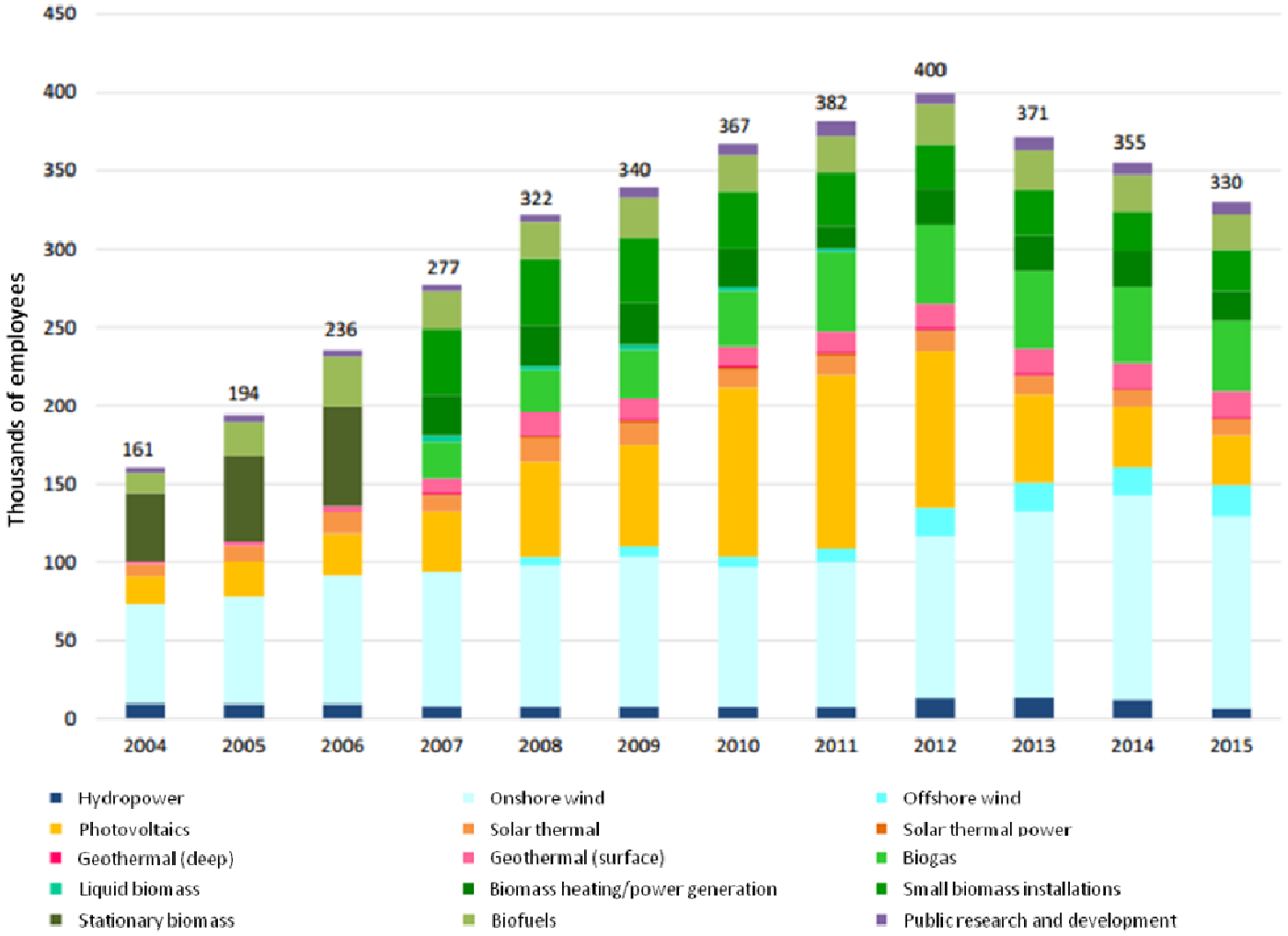




Job effects

Job creation through renewables



Effects on employment in other sectors

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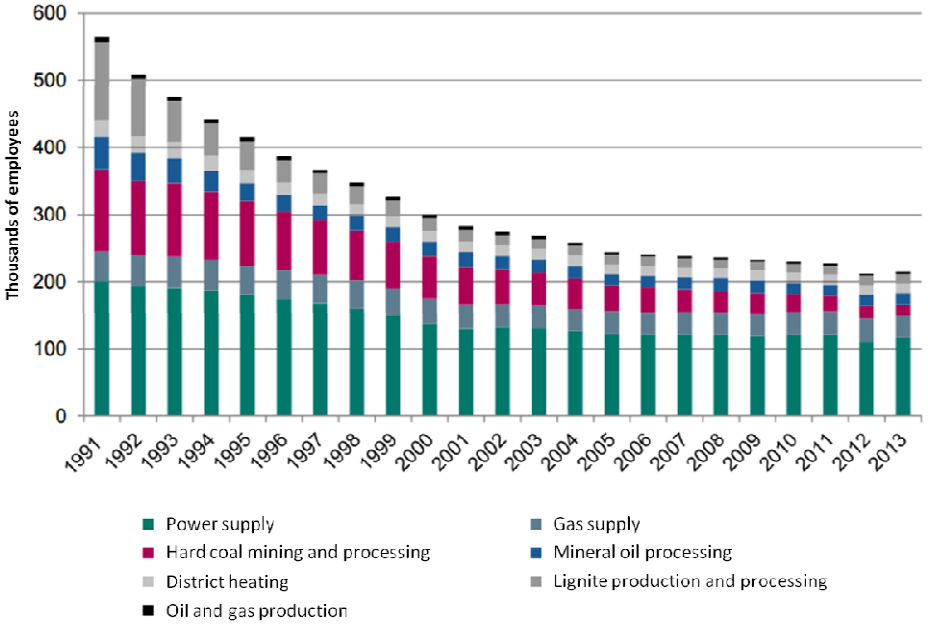
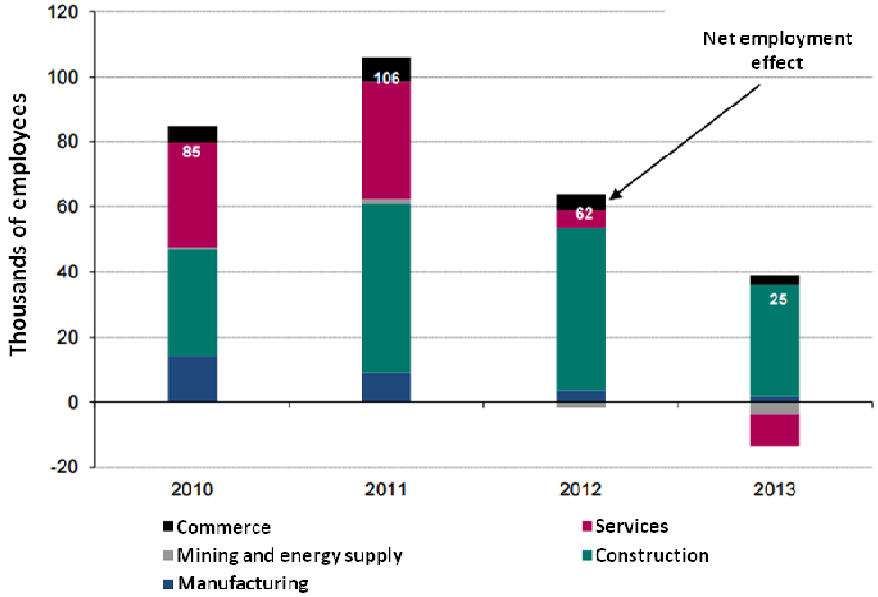
Employment trends in the conventional energy industry



Net employment effects of the *Energiewende*



Different kinds of RES employment

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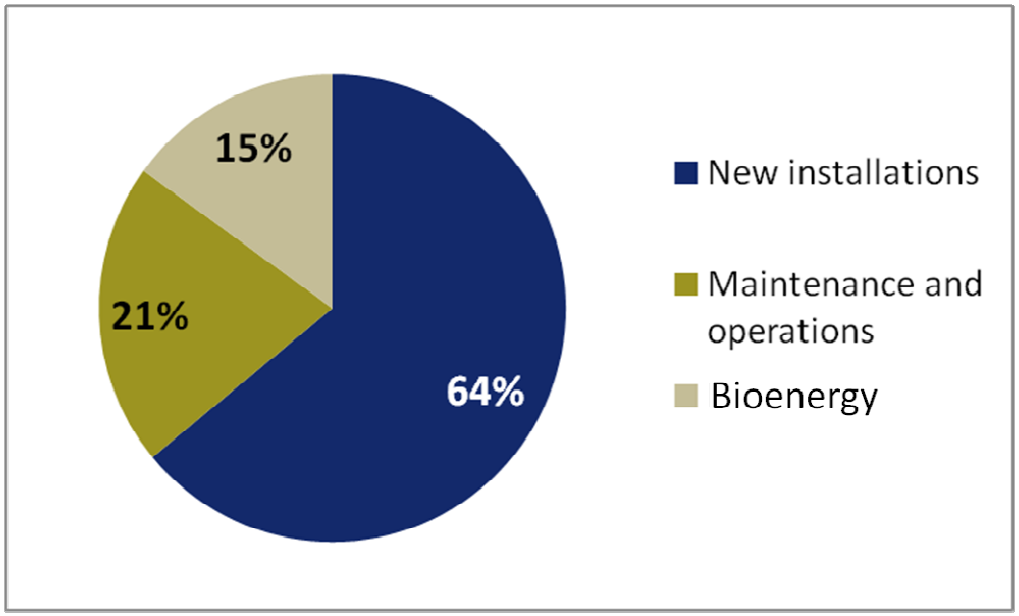
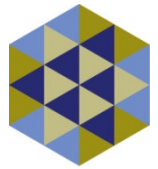
Renewable energy employment by activity (2014)



Future job creation potential of the *Energiewende*

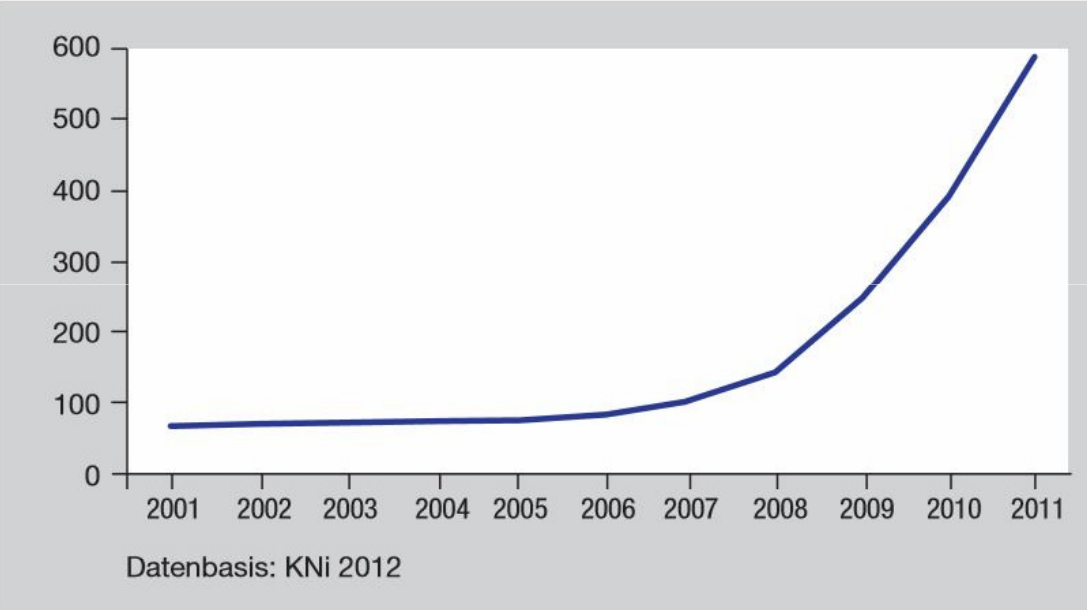


- 2015: 330,000 RES jobs; similar in energy efficiency
- New PwC study: climate policy measures under Climate Action Plan 2020 will
  - create a total of 430,000 new jobs,
  - increase GDP by 1 per cent in 2020
  - result in a net economic gain of €149 bn initial investments of (€125 bn initial investments vs long-term savings of €274 bn)
  - Energy sector faces net burden of €10 bn;
    industry, transport, agriculture and trade & services will receive net gain of €84 bn

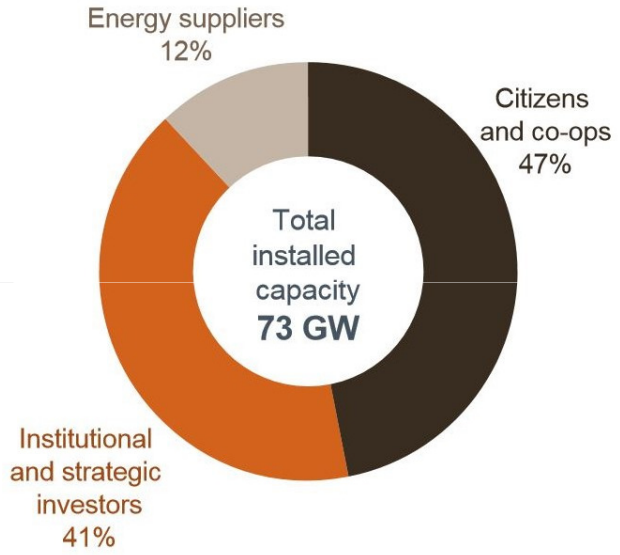
Local energy production

Citizens and communities were involved from the start

Development of energy co-operatives in Germany



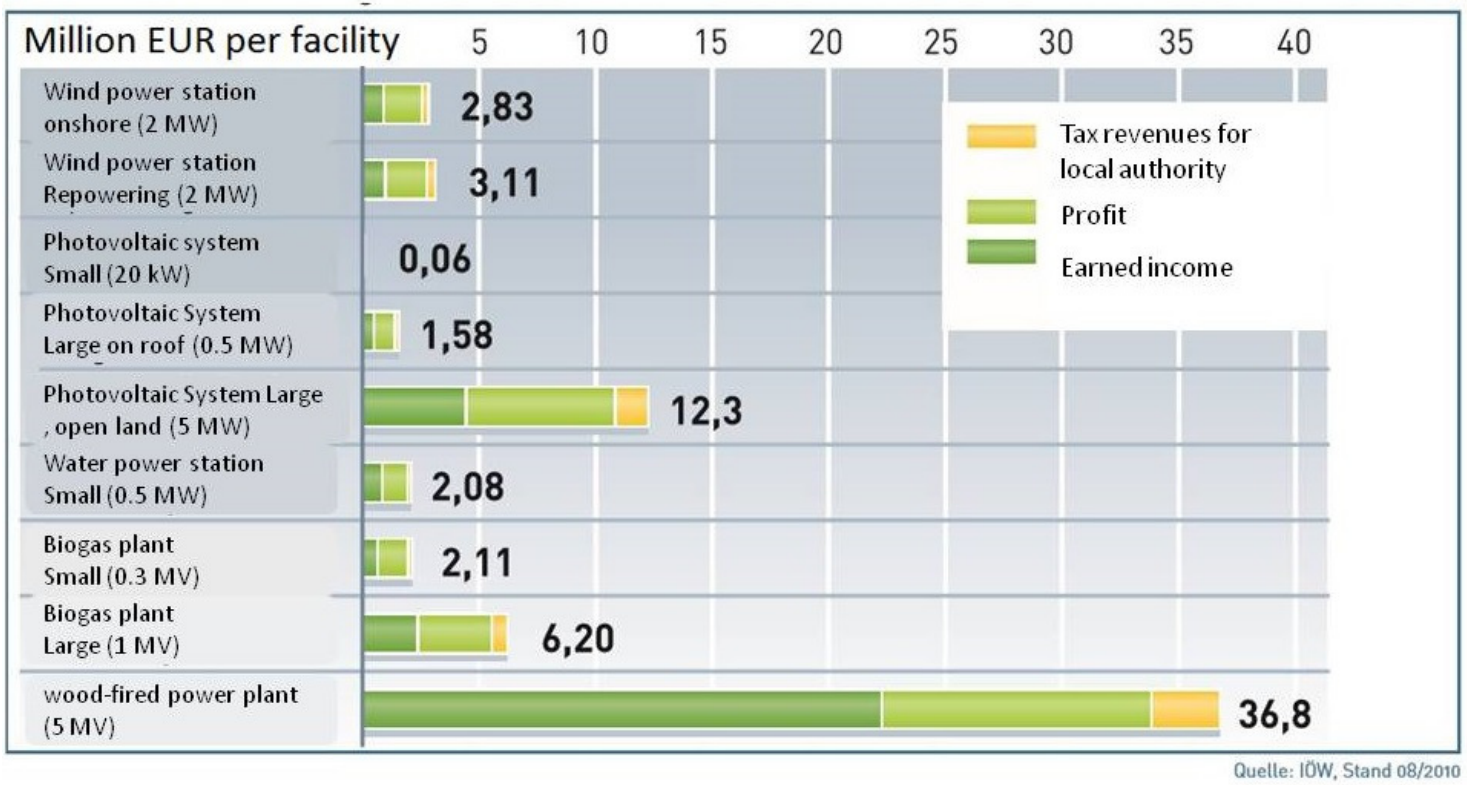
Ownership in renewables in Germany (2012)



Source: AEE, www.unendlich-viel-energie.de

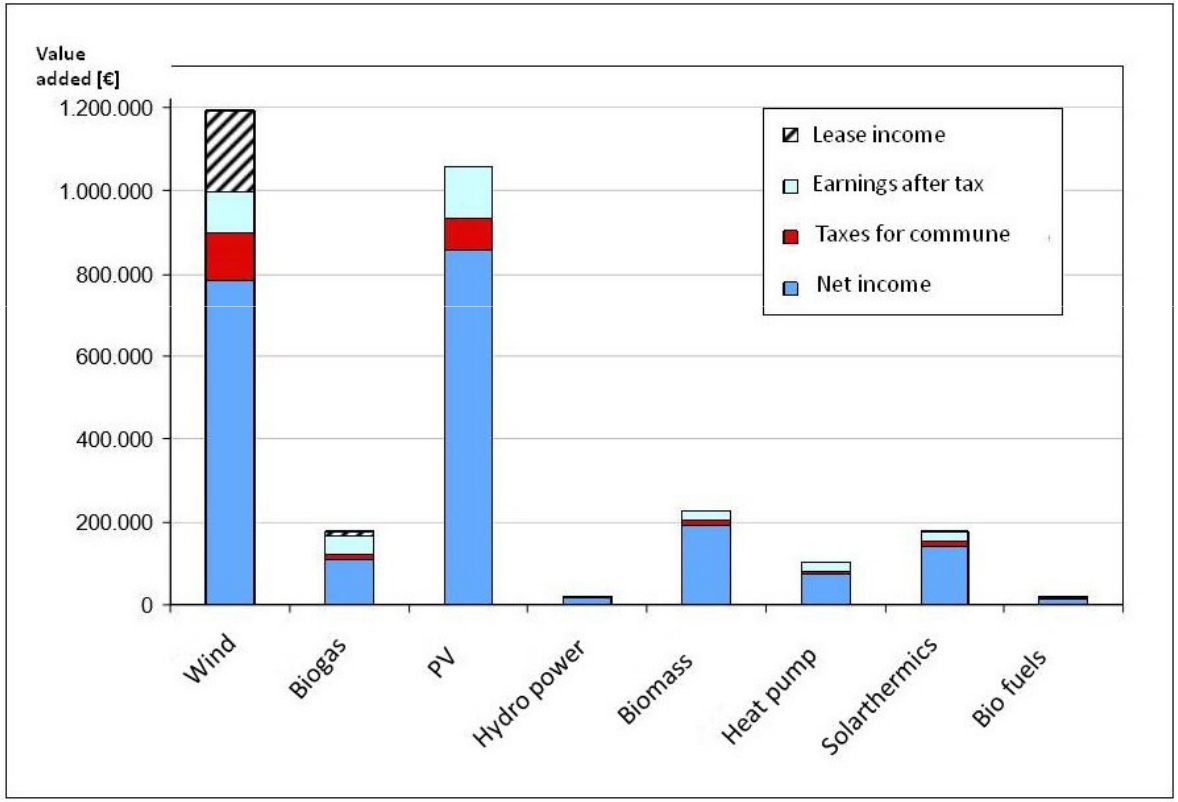
Local benefits in detail (1)

Value-added effects of typical renewable energy electricity generation plants through 20 years operation time

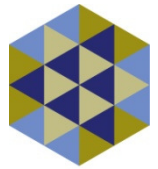


Local benefits in detail (2)

Value-added of eight renewable energy facilities in a modelled sample municipality (2009)



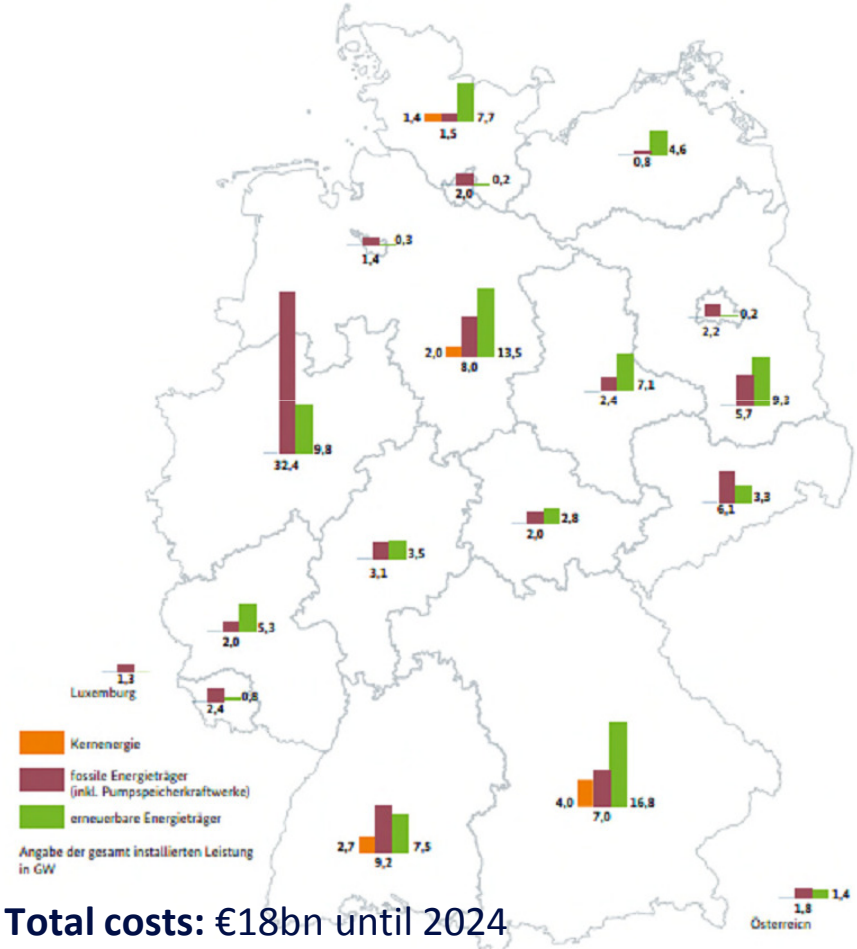
Renewables value chain: wind turbines

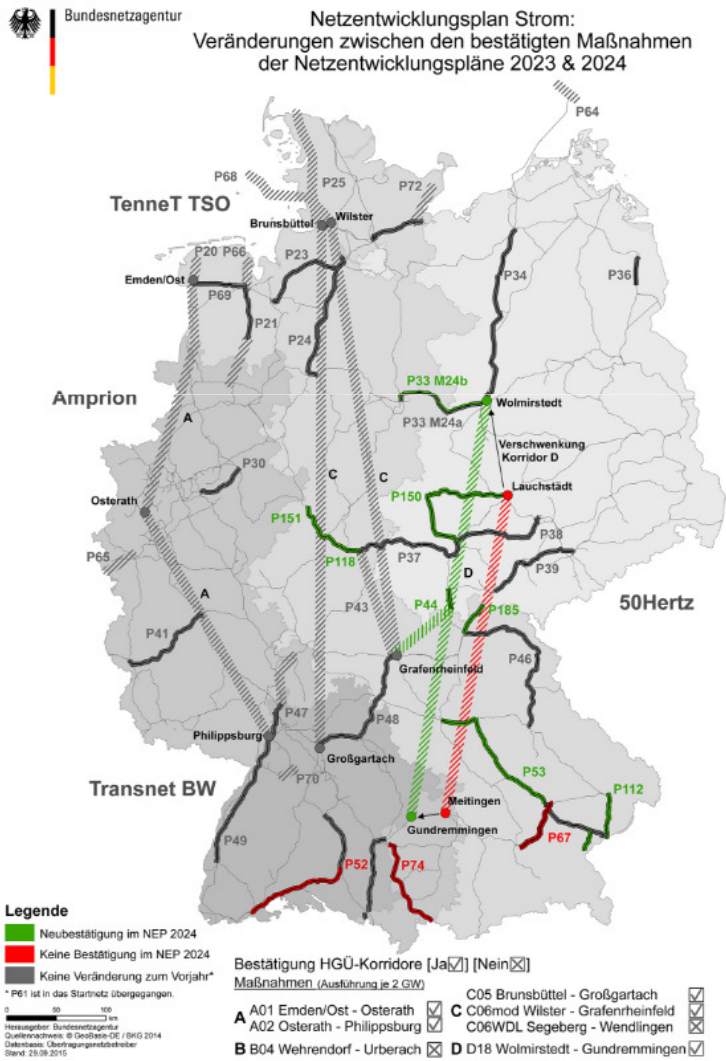


- **Manufacturing:** Wind turbines consist of various parts (e.g. rotor blades, generator, tower etc.) which need to be manufactured in a first step.
- **Planning and Installation:** In order to operate the wind turbines they have to be planned and installed (e.g. connecting it to the grid).
- **Operation and Maintenance:** The facilities need to be operated and maintained (e.g. by training, and hiring additional personnel).
- **Operator:** The energy co-operative or the community which operate the wind farm generates profit from the energy being produced and sold, lease income for the community, taxes etc.).

Grids and security of supply

Grid expansion

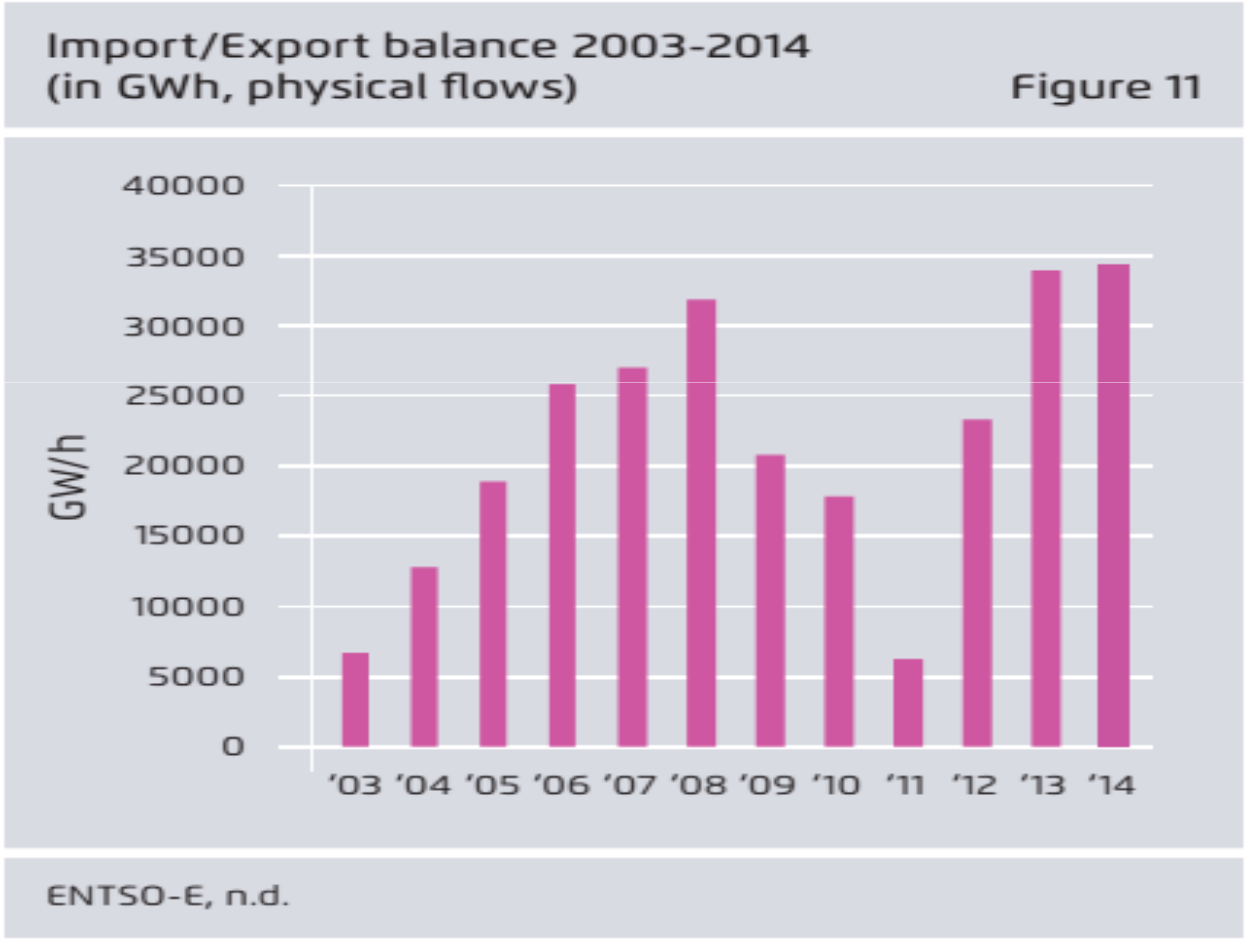




Total costs: €18bn until 2024

Underground power lines will costs additional €3-8bn and lead to delay of 2-3 years

Cross-border electricity trading



Power supply among the most stable in Europe

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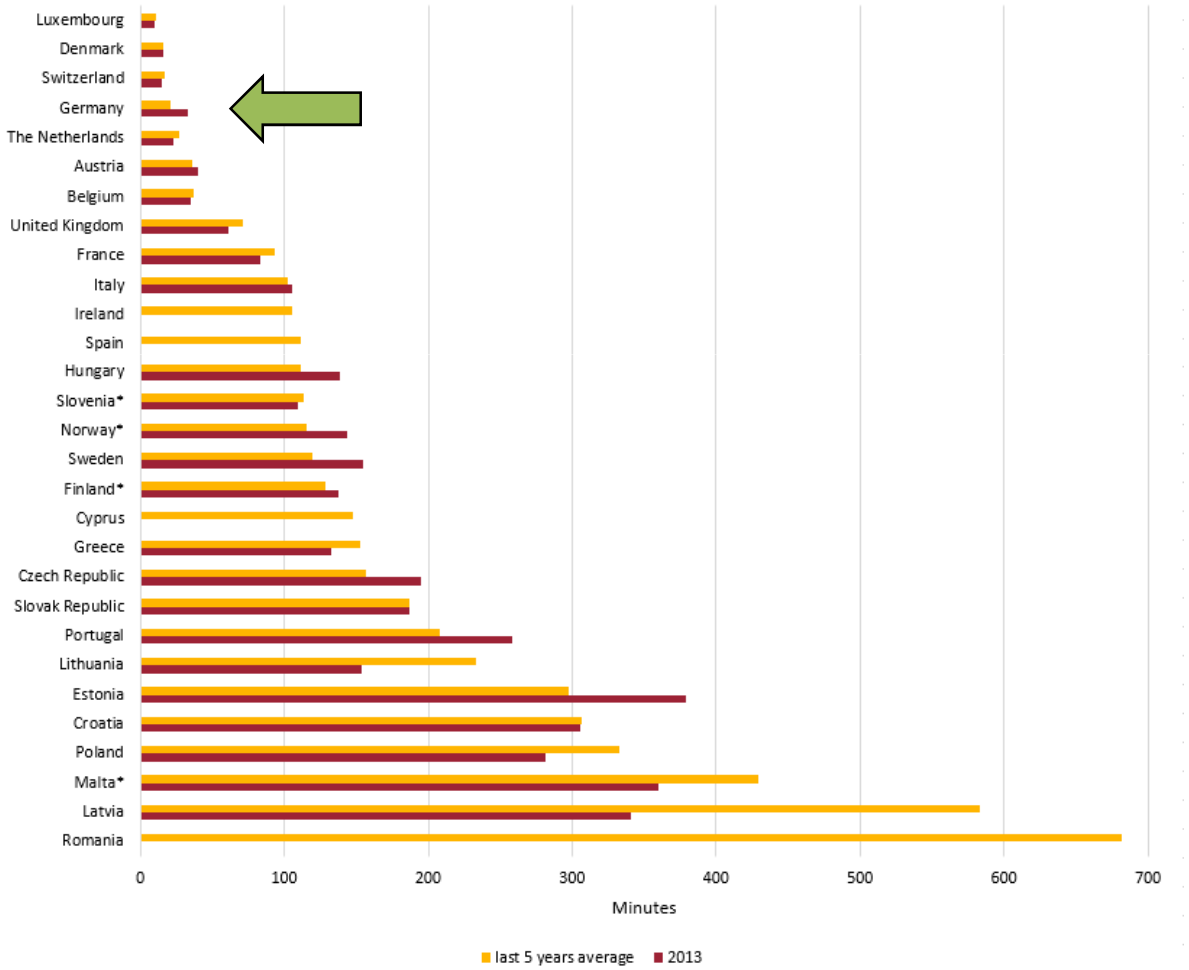
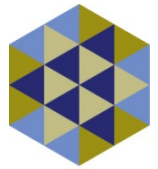
Electricity-grid (in)stability in the European Union – minutes of blackouts



Energy Efficiency

Energy efficiency as second pillar of the Energiewende



- Significant demand reduction & flexibility improvements necessary to deal with peak demand
- Additional benefits:
  - avoided supply-side investment in conventional generation and distribution networks
  - reduced energy costs for industry & consumers
  - substantial & diverse job creation potential
  - innovation & new business models
  - additional tax revenue due to increased economic activity in retrofitting and energy services contracting

Energy efficiency: Progress so far

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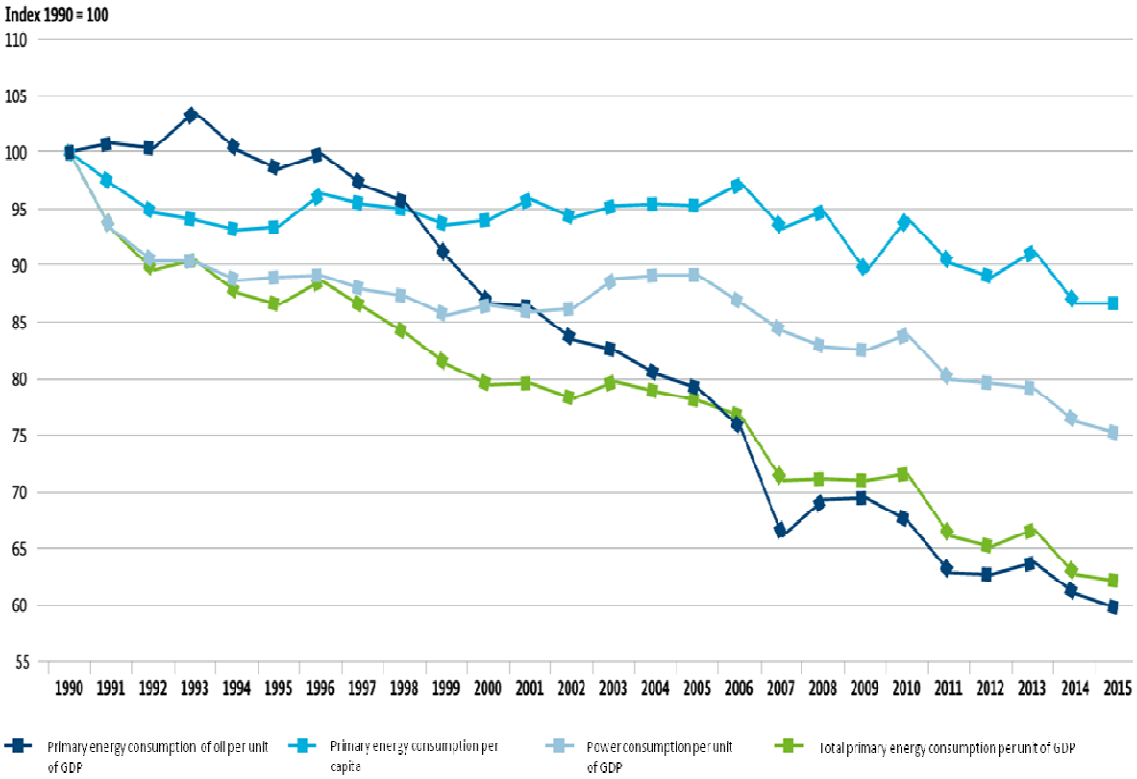
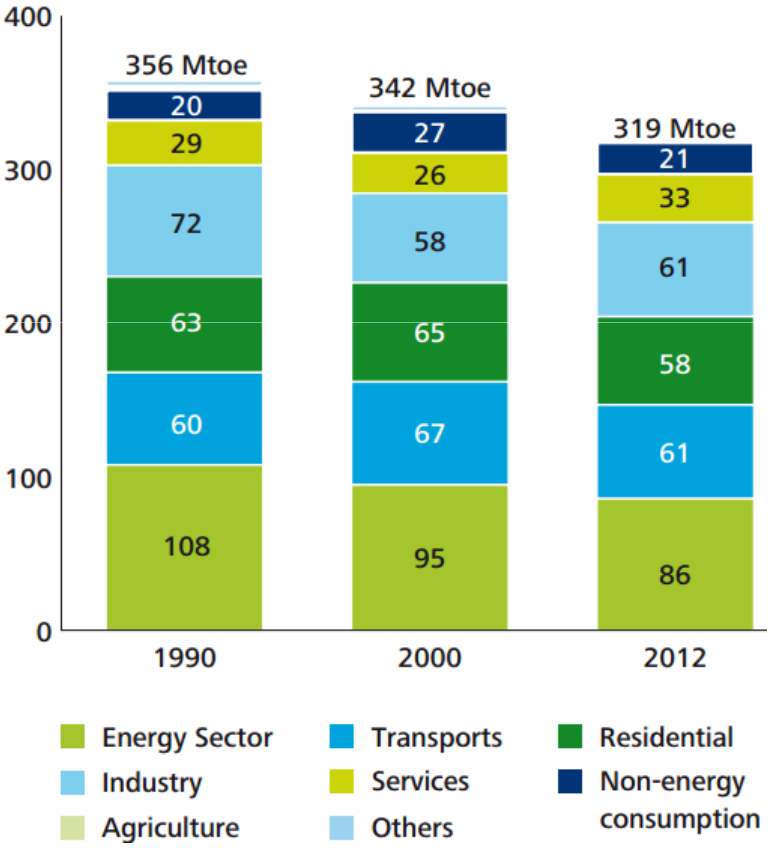
Energy intensity trends



Gross energy consumption by sector (Mtoe)



Bottlenecks in delivery of energy efficiency policies

E3G

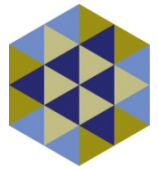
- Buildings sector
  - 40% of energy consumption, 1/3rd of GHG emissions
  - envisaged retrofitting rate of 2% far from reached, decreasing investment

  → lack of convincing incentives and appropriate financial instruments

Bottlenecks in delivery of energy efficiency policies

- Industrial sector:
  - 45% of electricity used by industry
  - Main driver for EE measures: traditional focus on quality, innovation and excellence
  - Industrial energy efficiency potential far from reached, so government developed new incentives
  - 2014 National Action Plan on Energy Efficiency (NAPE)

Key German energy efficiency policies
(Art. 7 EED)



Sector	Key policy measures of the NAPE and the Climate Action Programme 2020	Impact		
		Final energy [PJ]	Primary energy [PJ]	CO_2 emissions [Mt $CO_{2eq.}$]
Cross-sectoral	Introduction of a competitive tendering scheme for energy efficiency	10.7-21.5	25.7-51.6	1.5-3.1
	Support of Energy Performance Contracting	3.2	5.4	0.3
Industry & Tertiary	Energy Efficiency Networks Initiative	50.0	75.0	5.0
	Upgrading the KfW efficiency programme	10.9	29.4	2.0
	Obligation to perform energy audits for non-SMEs (implementation of Art. 8 EED)	33.3	50.5	3.4
Buildings	Upgrading and increased funding of the CO_2 Building Renovation Programme	9.6	12.4	0.7
	Energy saving legislation	11.6	13.5	0.7
Appliances & Products	National Top Runner Initiative	15.8	37.9	2.3
	National Energy-efficiency Label for Old Heating Installations	8.4	10.0	0.7
Transport	Extension of HGV toll to all vehicles >7.5 t	4.2-9.8	4.6-10.8	0.3-0.7
	Differentiation of HGV tolls based on vehicles energy consumption	21.0-32.2	23.1-35.4	1.5-2.3
	Strengthening of public transport	9.8-14.0	10.8-15.4	0.7-1.0

Energy efficiency targets and achievement

E3G

Energy efficiency	2014	2020
Primary energy consumption (comp. to 2008)		-20%
not temperature-corrected	-8.7%	
temperature-corrected	-7.0%	
Gross electricity consumption (comp. to 2008)	-4.6%	-10%
Share of (net) electricity production from CHP	17.3%	25%
Energy productivity		2.1%/a
Final energy productivity (not temp.-corr.)	1.6%/a	
Primary energy productivity (not temp.-corr.)	2.2%/a	
Primary energy productivity (temp.-corr.)	1.8%/a	
Buildings	**2014**	**2020**
Heat demand (comp. to 2008)	-12.4%	-20%
Transport	**2014**	**2020**
Final energy consumption (comp. to 2005)	+1.7%	-10%
Number of electric cars	28,264	1 Million

Thank you for your attention.

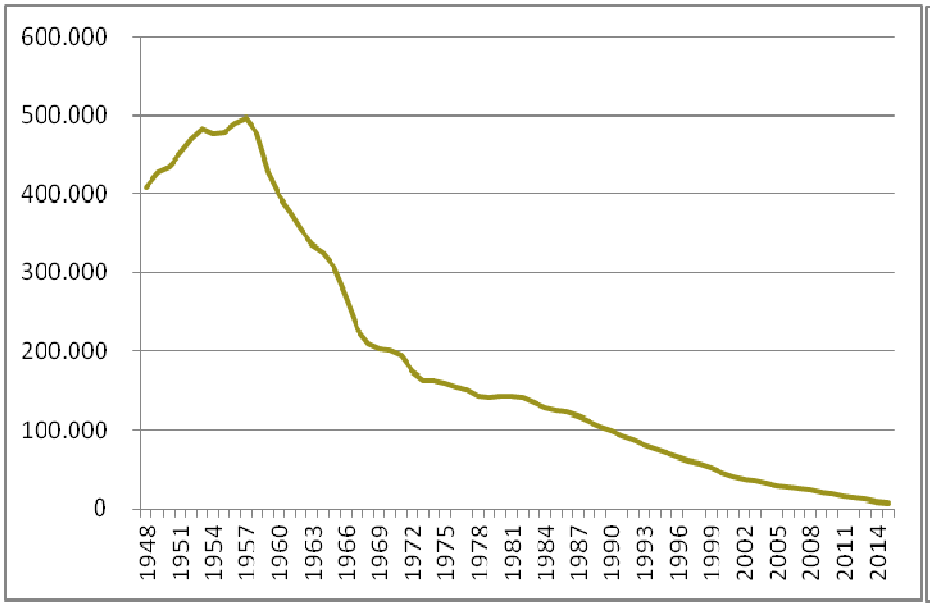
Any questions?

Just Transition and Structural Change

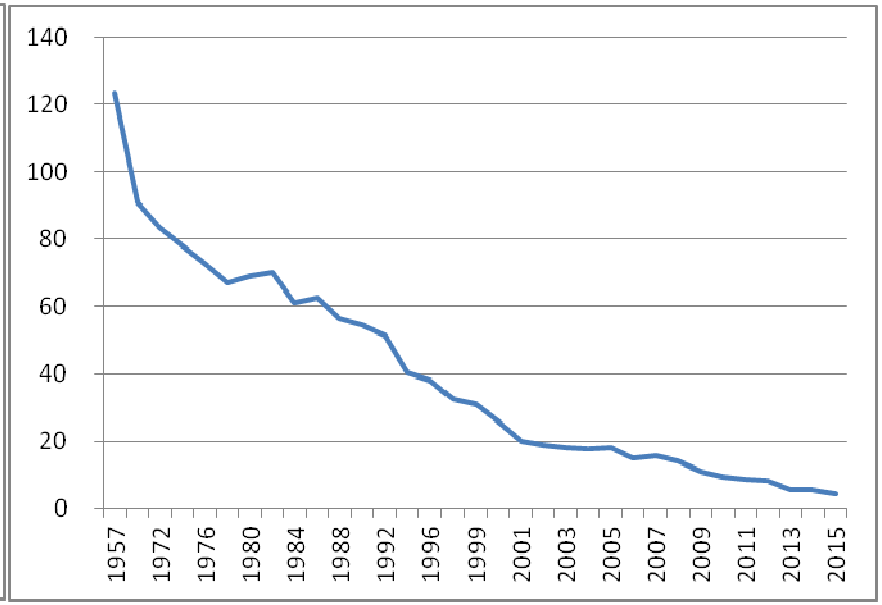
Collapse of hard coal mining in NRW

E3G

Hard coal mining jobs Ruhr area



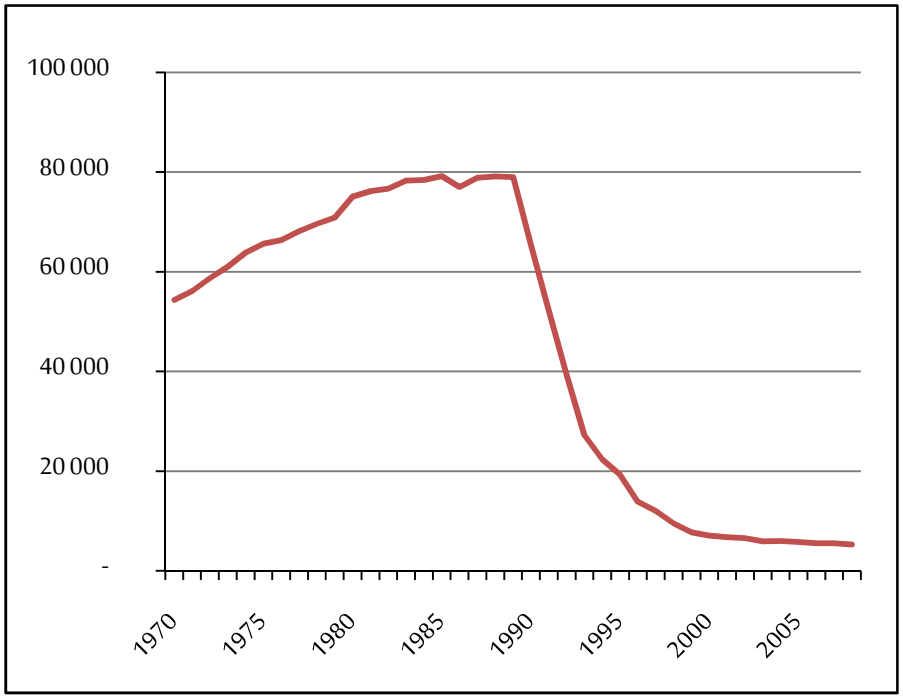
Hard coal production Ruhr area (mn tons)



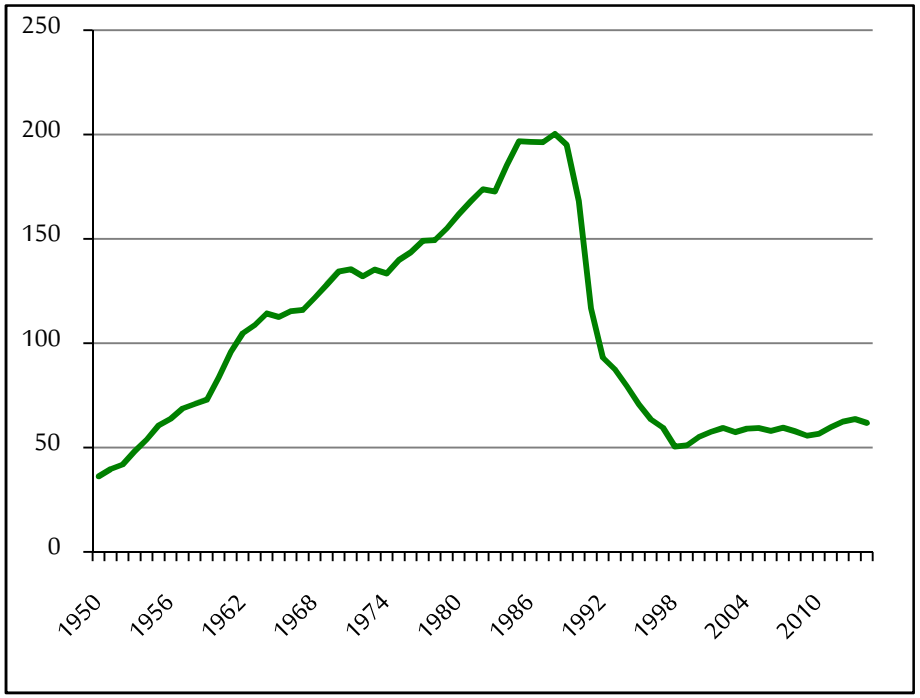
Collapse of lignite industry in Lusatia

E3G

Lignite mining jobs in Lusatia



Lignite production in Lusatia (mn tons)



Political reaction: hard coal collapse after 1960

Aid for hard coal miners

- Anpassungsgeld (early retirement); 2015: € 116 mn, € 13.500 anually on avg
- Anpassungsbeihilfe (retraining and job market entry)

Successive structural policy programmes

- Development Programme Ruhr (1968-72), DM 17bn
- Technology Programmes Energy/Mining/Economy → Action Programme Ruhr (1974-1984), DM 6.9 bn
- Zukunftsinitiative ("future initiative") Montanregionen/ der Regionen Nordrhein-Westfahlens (1984-1999)
- Cluster-oriented regional policy 2000-

Consensus-oriented framework agreements

- Successive "coal rounds" negotiated gradual reduction of hard coal mining subsidies; 2007: agreement on 2018 phase-out, RAG foundation established

Political reaction: lignite collapse after 1990

E3G

Aid for lignite employees

- Severance package negotiated with companies; attractive early retirement package, retraining measures, short-time work arrangements
- LMBV established for land recultivation (initially 20,000 jobs)

Structural policy

- “Aufbau Ost”, e.g. Solidarpakt I + II (1995-2019), € 200 bn

Consultation/participation in phase-out process: missing

Instruments of structural policy

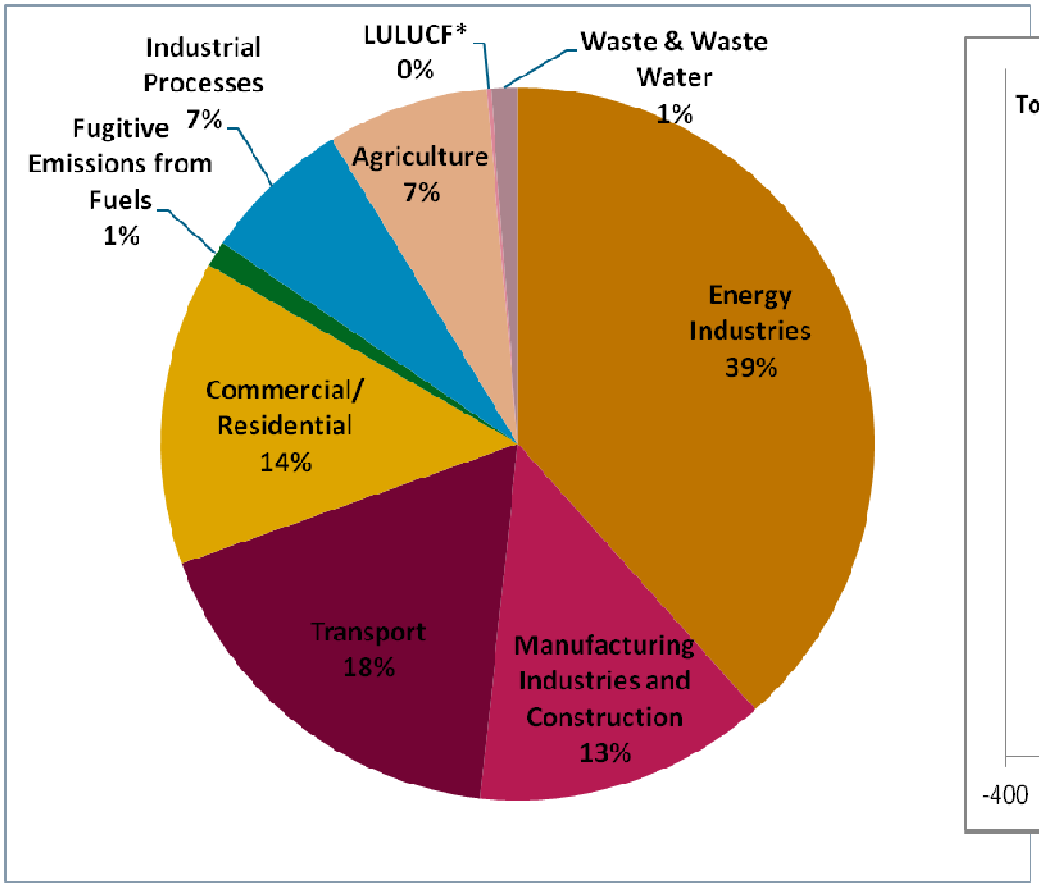
- Forums of Participation and Dialogue
  - Top-down framework agreements or bottom-up participatory planning
- Support and compensation schemes for workers in affected sectors (short term)
- Regional support schemes to promote economic diversification and reorientation (long term)

Additional slides

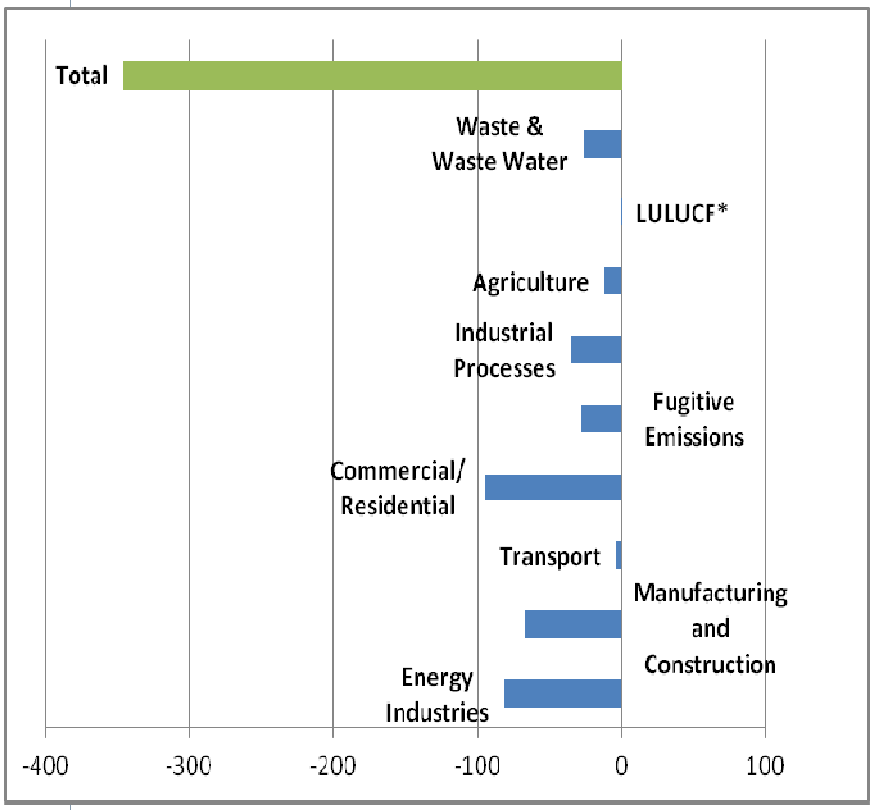
German GHG emissions by sector (1)

E3G

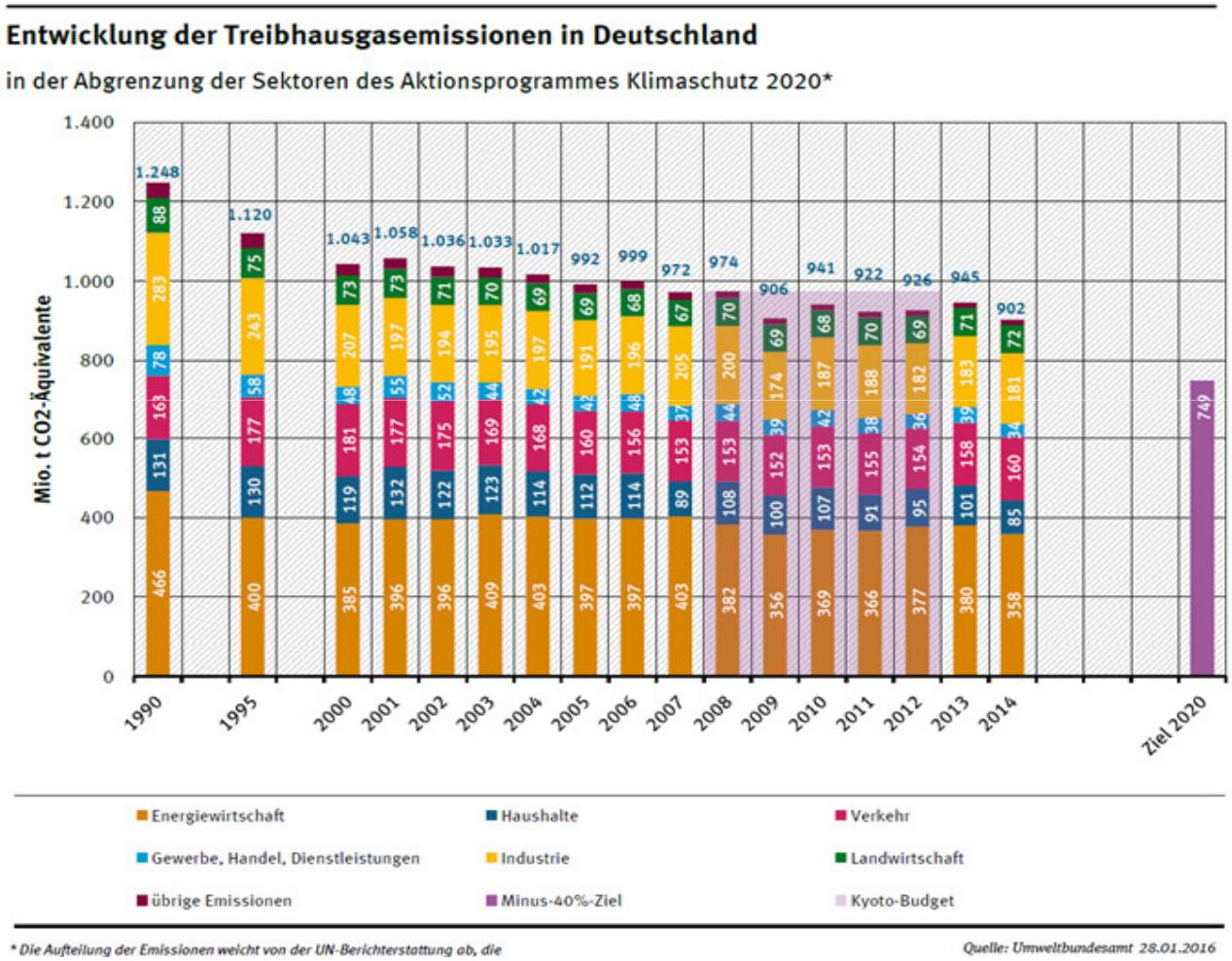
2014 German GHG emissions



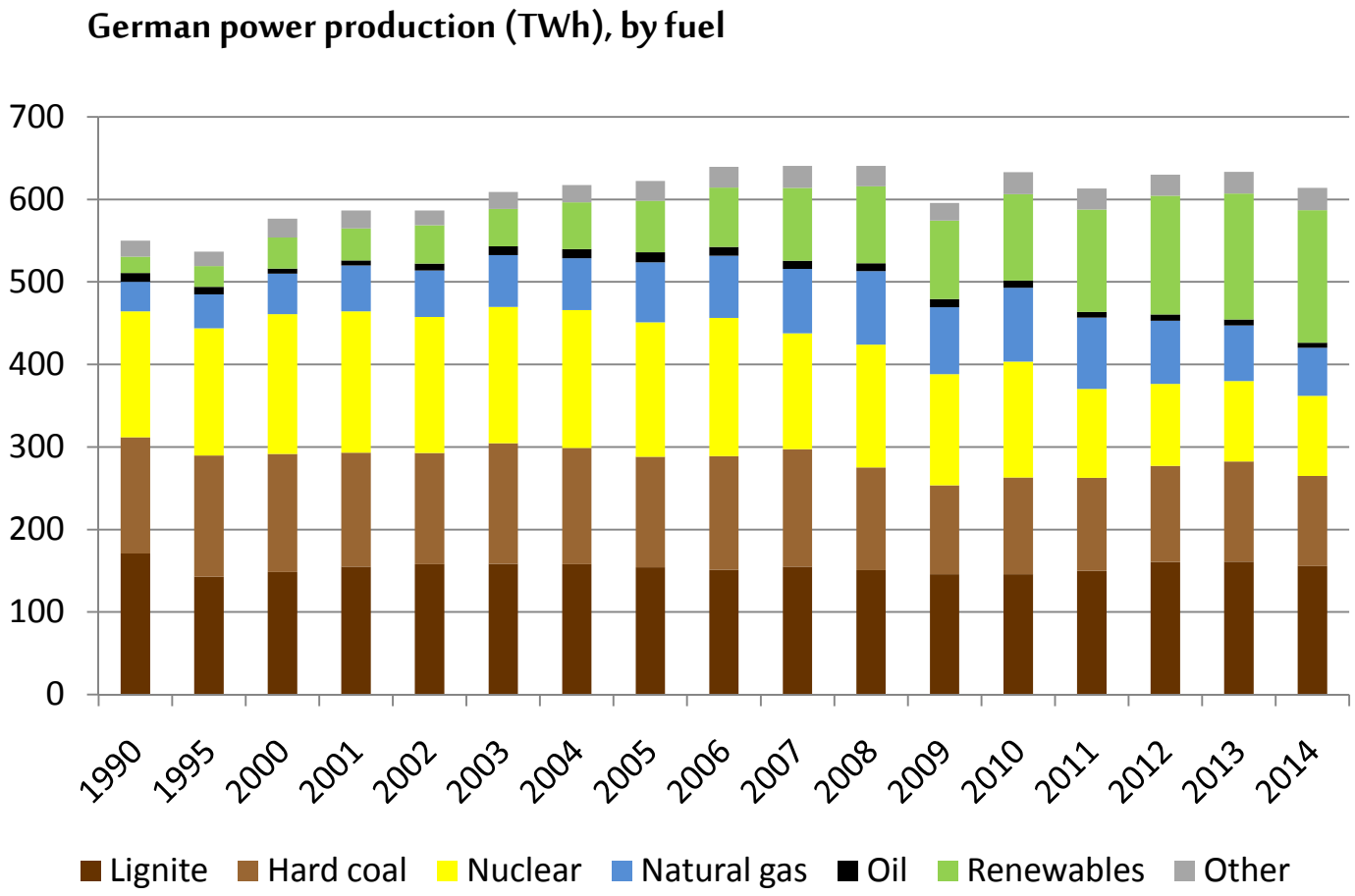
Absolute change in GHG emissions by sector (Mt CO2, 1990/2014)



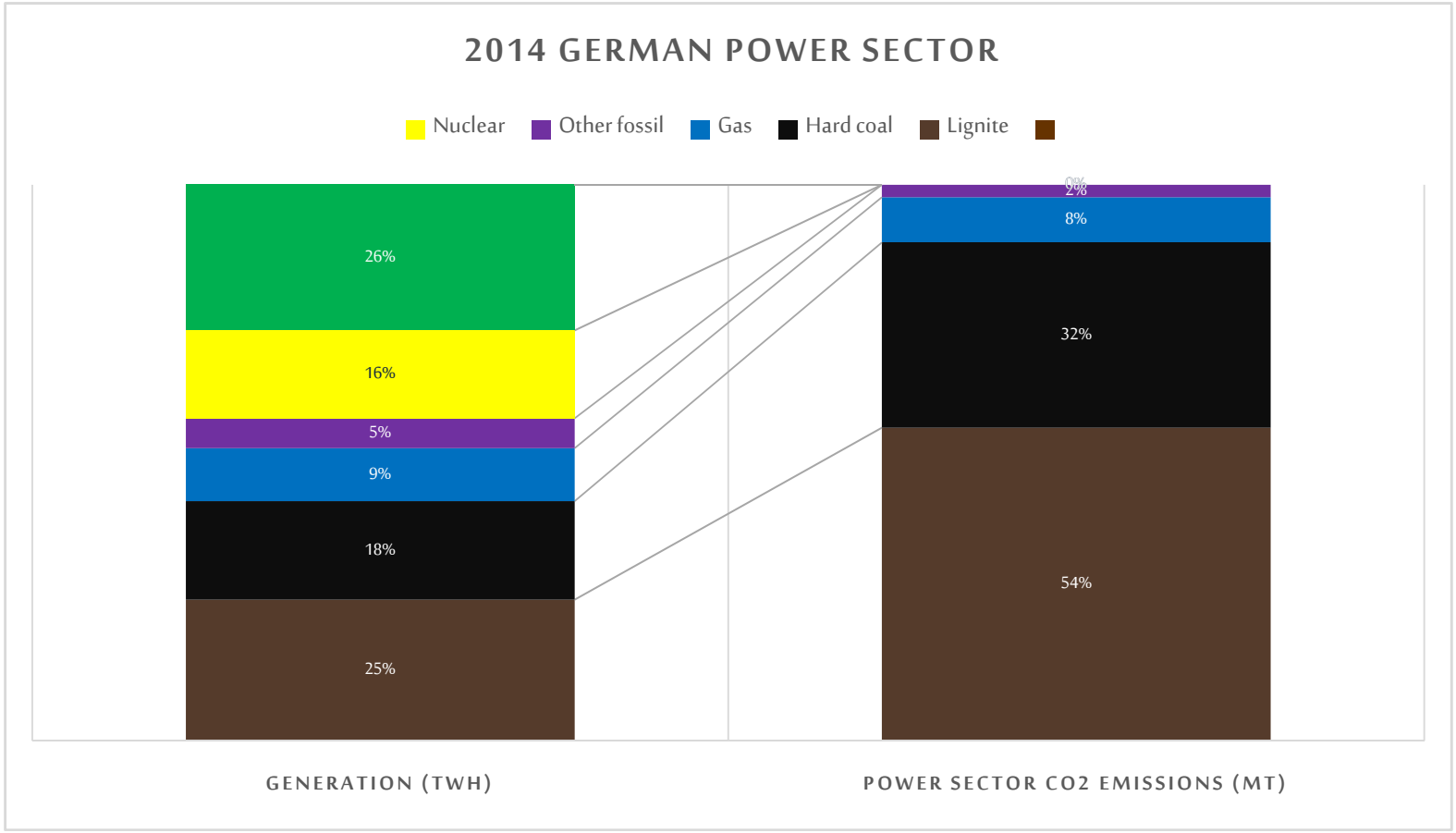
German GHG emissions by sector (2)



German power mix

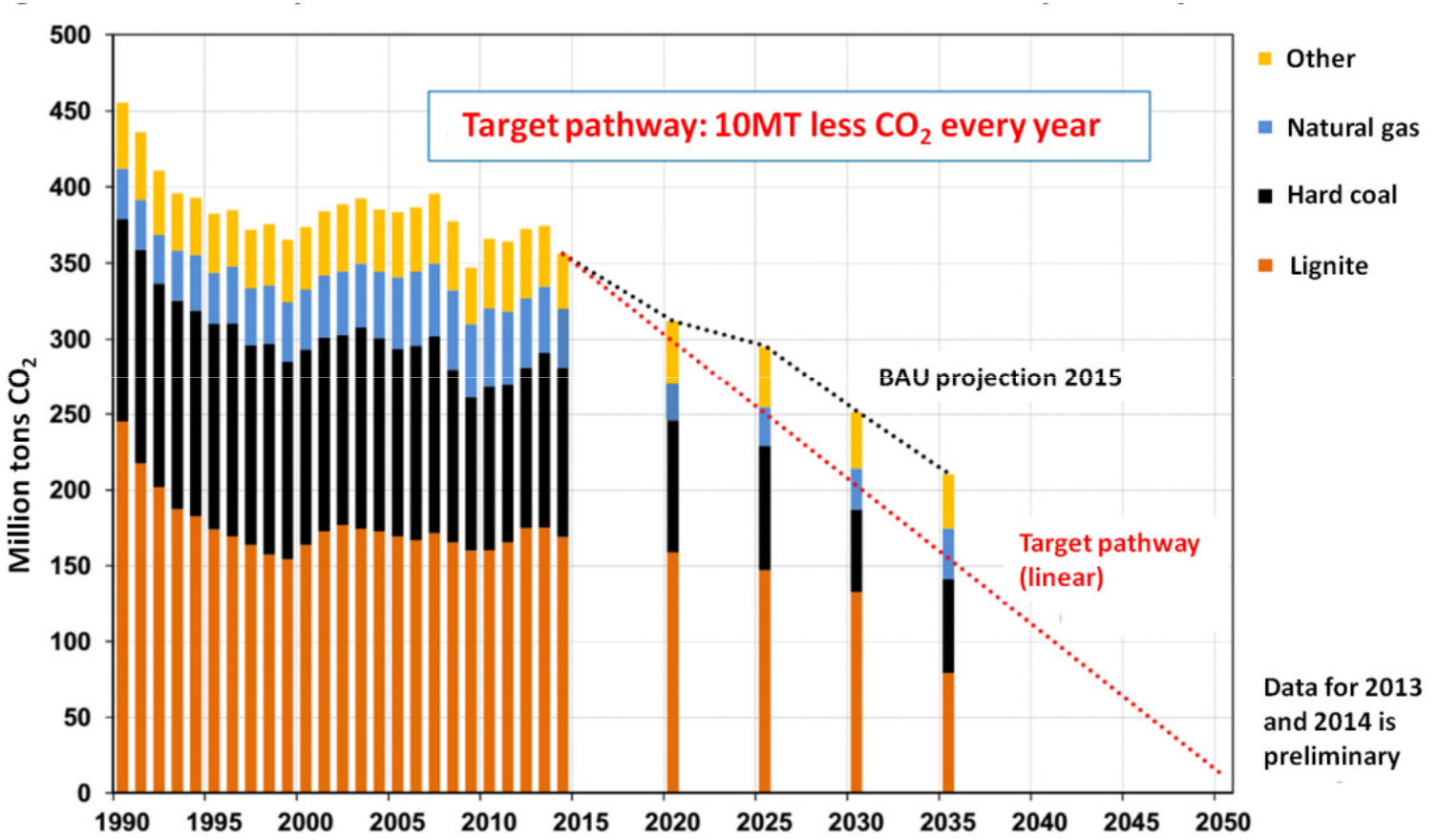


Power sector emissions by fuel



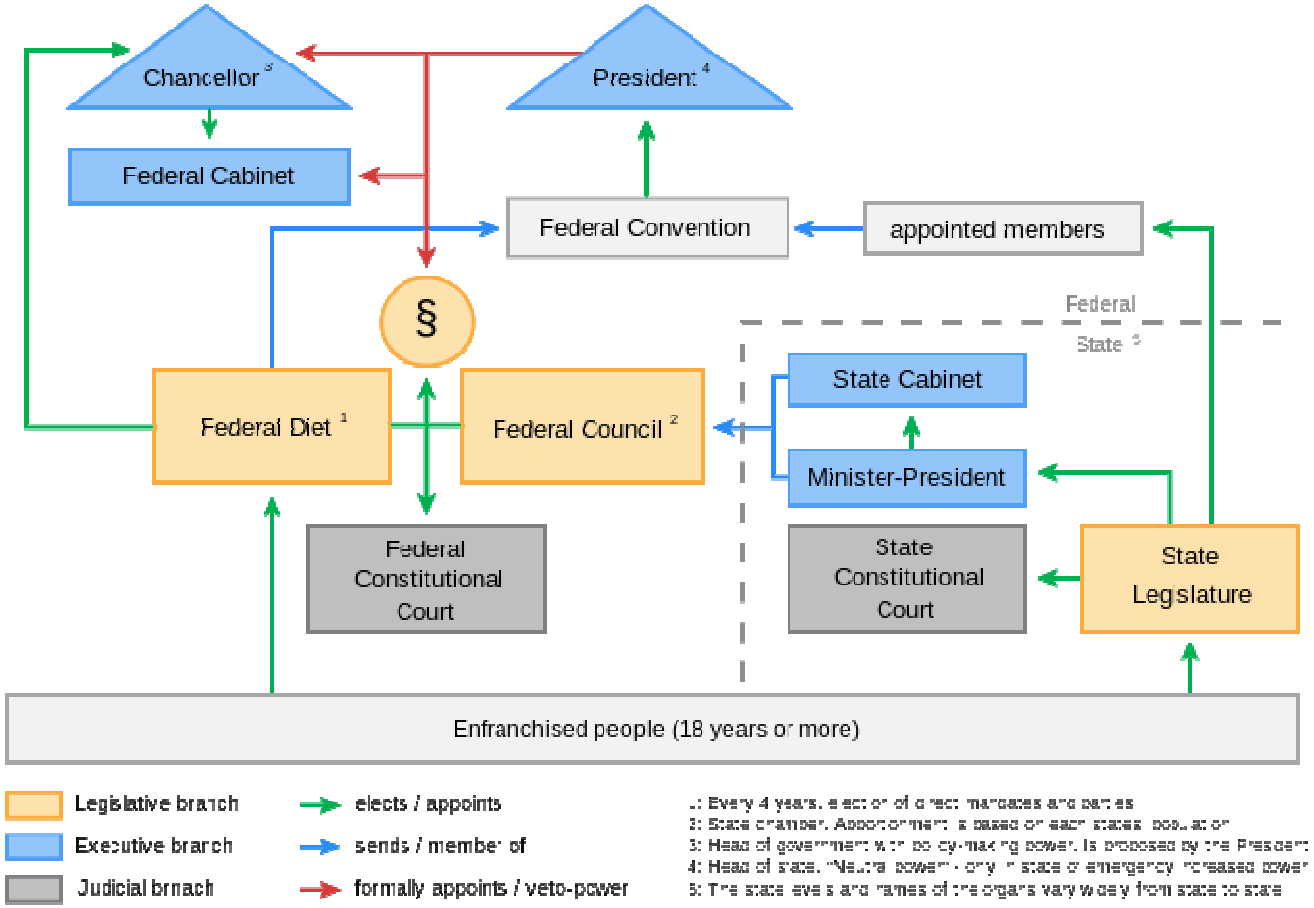
Source: BNetzA, UBA

German power sector emissions and reduction pathway



Source: *Institute for Applied Ecology presentation at* ***parliamentary hearing*** *on 15/09/2015, based on official data*

Political System of Germany



Comparing German lignite regions

E3G

Lignite area	Jobs (direct)	Jobs (indirect)	% of jobs	Value added (€, %)*	Production (Mt, 2014)	PP capacity (GW)	Unempl. area**	Unempl. state**
Lusatia	8,316	7,158	3.69%	<3.51 Mrd. €, <15%	61.8	6.7	9.8%	BB: 9.2% SN: 8.5%
Rhenish region	10,146	7,376	2.77%	3.3 Mrd. €, 11%	93.6	10	7.2%	NRW: 8%
Central German	2,565	1,795 (gesch.)	1.05%	850 €m (est.)	21	3.2	9.2%	SN: 8.5% ST: 10.3%

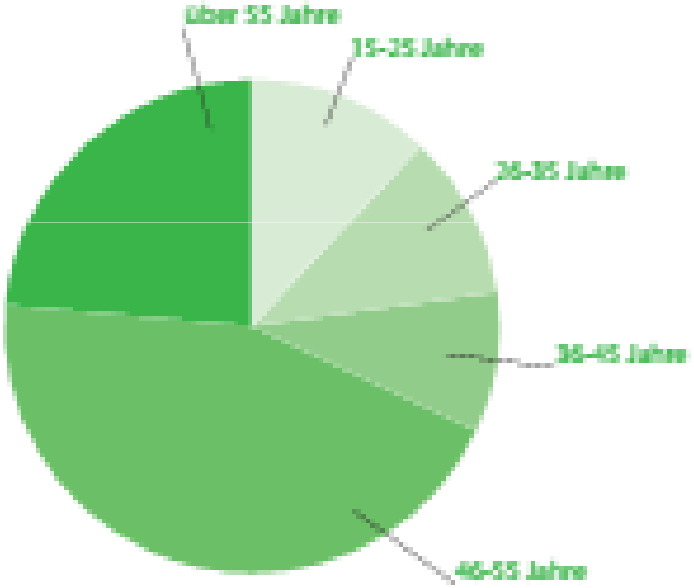
* Figures for 2009 in Central German are and 2010 for Lusatia/RR. Value added is currently much lower because of low power prices.
** As of March 2016

Sources: ***Statistik der Kohlenwirtschaft*** *2016,* ***EEFA*** *2010,* ***ifo-Institut*** *2013,* ***Prognos*** *2010,* ***Bundesagentur für Arbeit*** *2016*

Age structure German coal mining

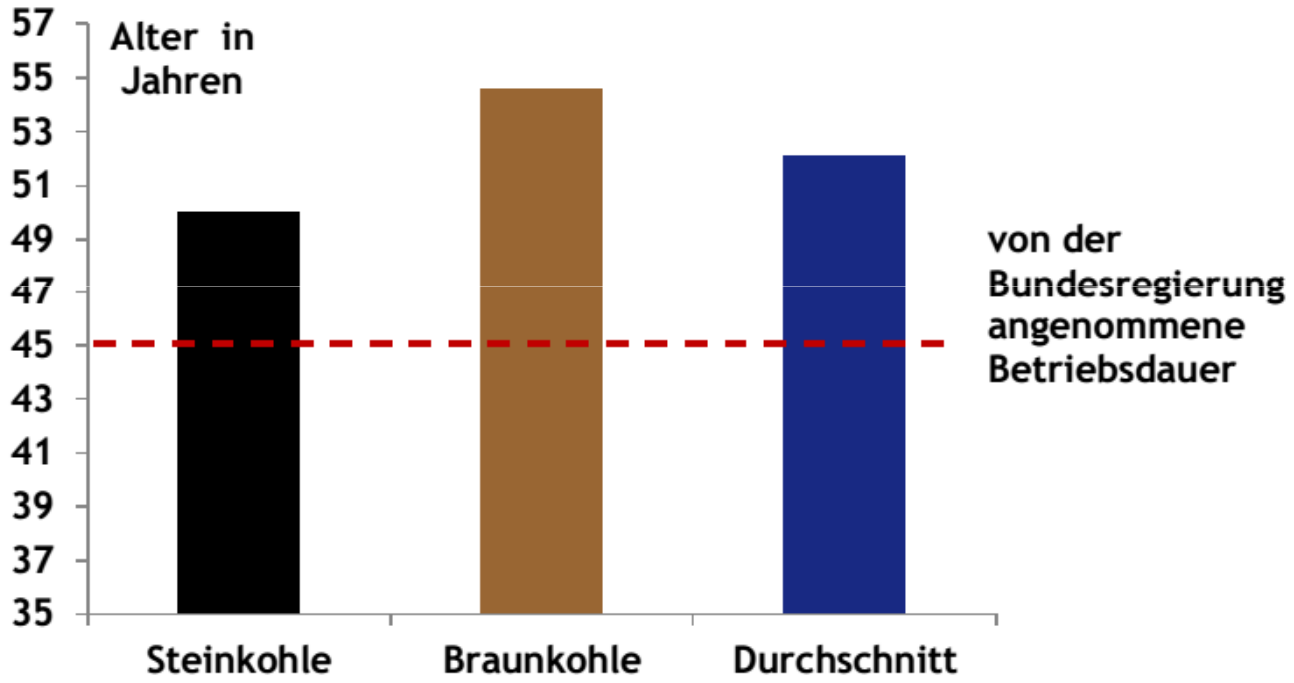
Altersgruppe	Anteil
15-25 Jahre	12,10 %
26-35 Jahre	10,69 %
36-45 Jahre	9,41 %
46-55 Jahre	44,31 %
Über 55 Jahre	23,48 %

Quelle: Statistik der Kohlenwirtschaft[5]



Average retirement age of coal power plants

Abbildung 8 Durchschnittliches Kraftwerksalter bei Stilllegung (2011-2013)

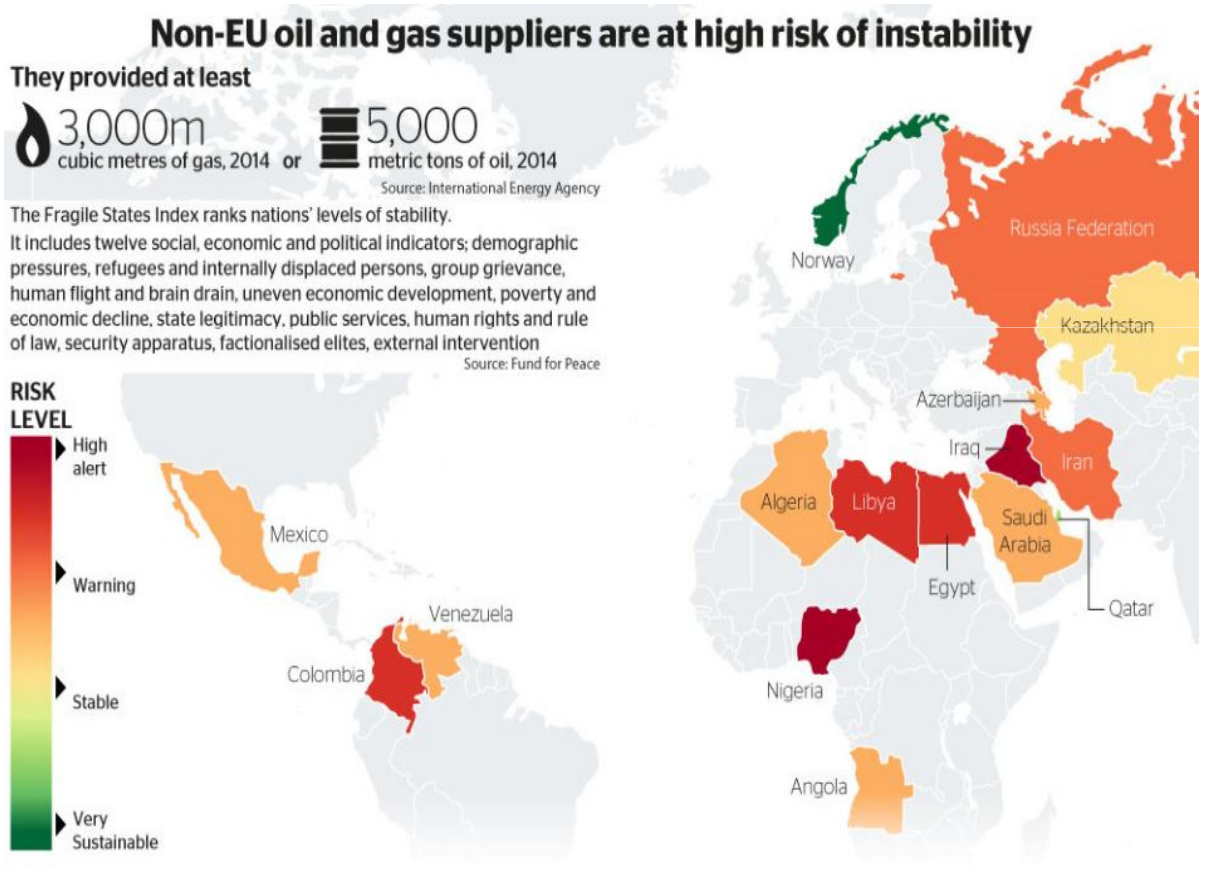


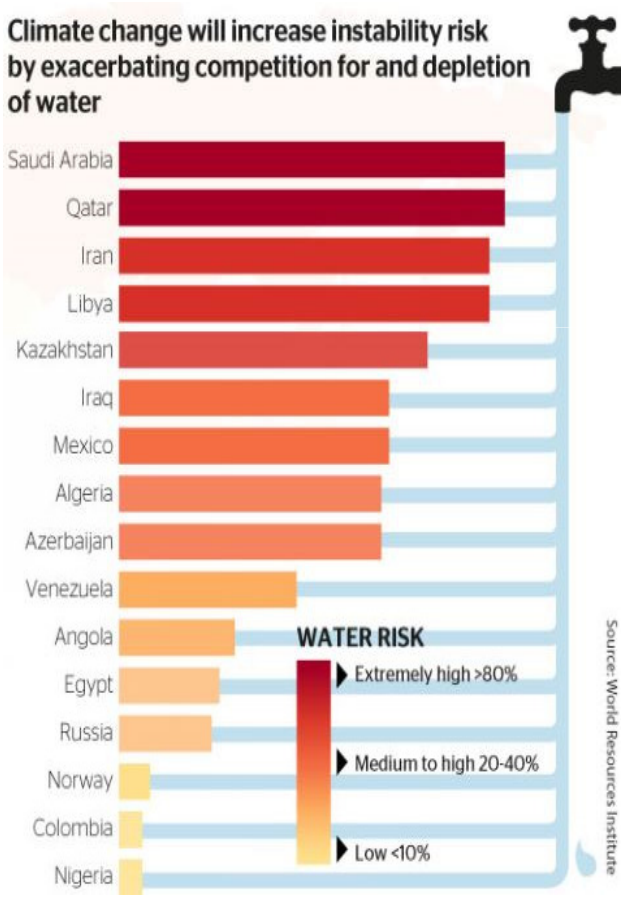
Quelle: Eigene Zusammenstellung auf Basis von Daten der Bundesnetzagentur (vgl. BNetzA 2014a)

FÖS (2015) Factsheet Kohlekapazitäten im deutschen Kraftwerkspark

EU has other reasons to act e.g. geopolitical risks of fuel supply

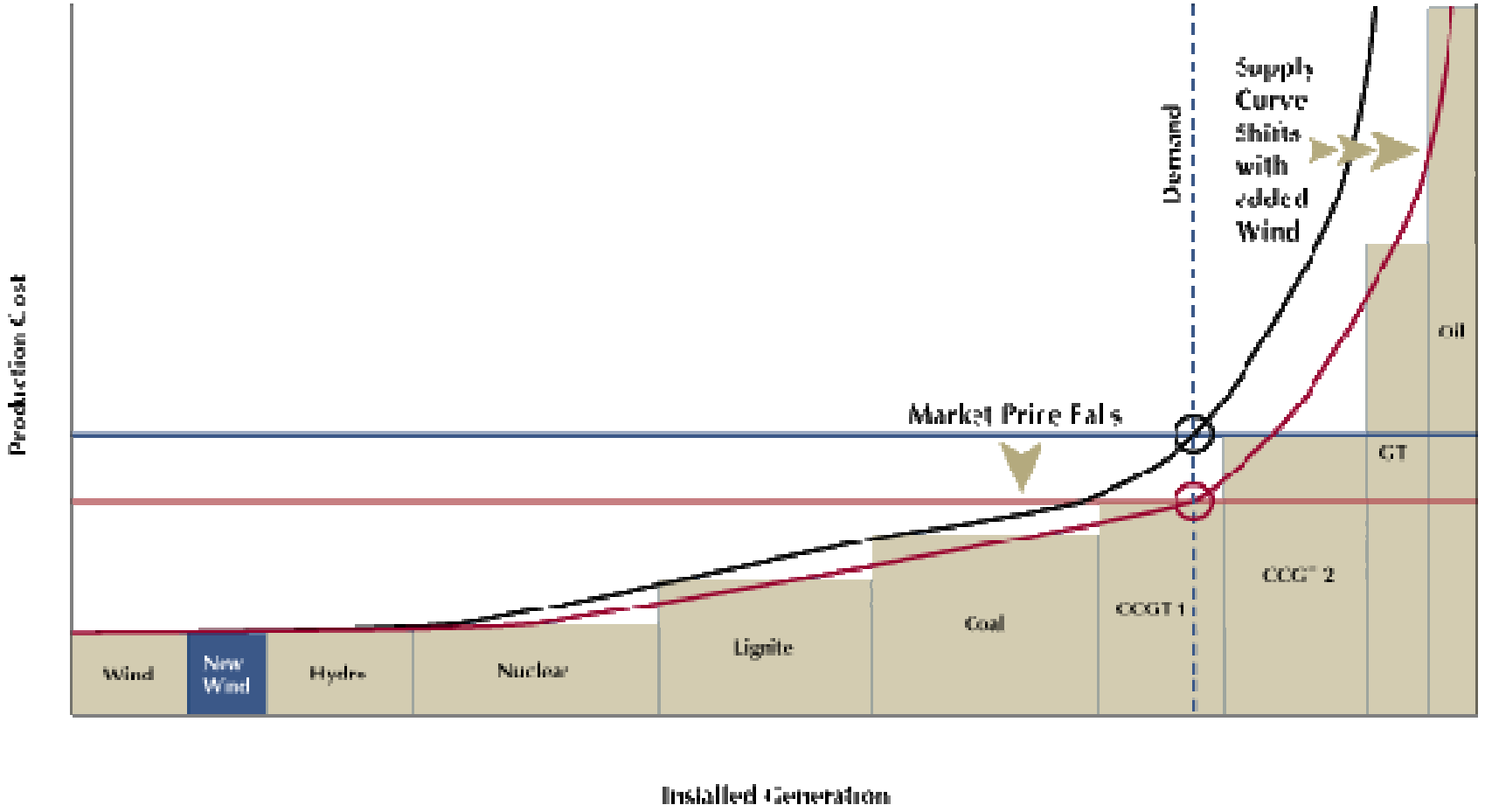
E3G



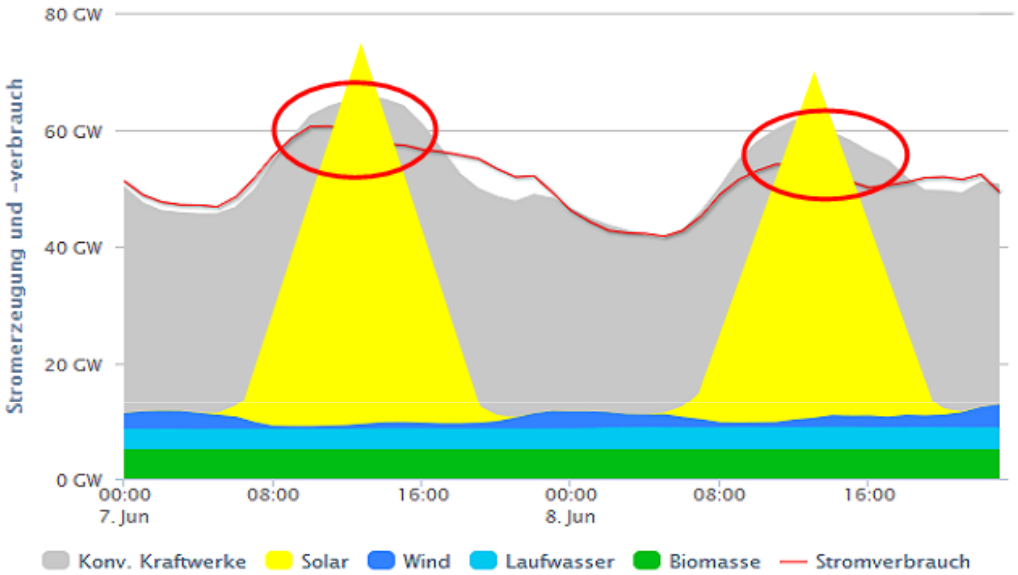


Merit order curve

E3G



Coal power plants too inflexible for high RES-share power system



Source: AGORA Energiewende (2014)

Start-up times of different technologies*

		Lignite	CCGT**	OCGT**
Change of load	[%P_{max} p. minute]	**1** / 2,5 / 4	2 / 4 / **8**	8 / 12 / **15**
Hot start-up (<8h)	[h]	**6** / 4 / 2	1,5 / 1 / **0,5**	**< 0,1**
Cold start-up (>48h)	[h]	**10** / 8 / 6	4 / 3 / **2**	**< 0,1**

*) Read as current / state of the art / optimisation potential
**) Combined Cycle Gas Turbine; Open Cycle Gas Turbine

Source: VDE (2012)