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THE CHALLENGE TO GERMANY'S GLOBAL COMPETITIVENESS IN A NEW ENERGY WORLD

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Executive summary

Germany is at the crossroads of critical decisions about its future energy policy. The current national energy strategy has become disconnected from its original objective to deliver competitive energy while reducing CO_2 emissions. The Erneuerbare Energien Gesetz (EEG)—the Renewable Energy Act— has been an effective tool in increasing the share of renewables in Germany's electricity system, but this has come at a cost. Rising electricity costs present a challenge analogous to the one Germany faced a decade ago from a rigid labor market. Solving that problem was key to enabling Germany's formidable export performance in the years since. Today, a rigid and inefficiently organized energy market with rising costs puts Germany's international competitiveness, and thus its economy, at risk.

Rising electricity costs pose a particular challenge to Germany's export based economy. Exports of value-added goods and services made up 52 percent of Germany's gross domestic product (GDP) in 2012. This strong export based economy is highly sensitive to any change in its competitive position relative to its peers.

Energy prices are a key component of Germany's competitiveness. Rising electricity prices in Germany—and strikingly lower energy prices in North America—are making German products less competitive and forcing firms to relocate to other countries, a problem known as "investment leakage." In a highly integrated and specialized economy such as Germany's, investment leakage leads to the disruption of supply chains and the movement of companies out of Germany. Owing to the nature of Germany's economy, high energy costs flow from energy-intensive industries, mostly at the beginning of industrial value chains, to other parts of the manufacturing sector, dominated by the German Mittelstand, and to the broader economy.

This report examines the links among Germany's energy costs, competitiveness, and economic performance by quantifying and comparing the economic impact across two different energy price scenarios:

- The **high-price scenario** models a rapid development of renewables and the removal of exemptions from electricity cost surcharges and tax discounts that have partially shielded energy-intensive German industry from the rising cost of renewables support.

- The **competitive energy scenario** considers a more moderate pace of renewables development and an increased role for thermal generation, especially gas. Industrial exemptions are maintained.

This analysis shows that the high-price scenario leads to considerable economic losses, while the competitive energy scenario enhances economic growth potential for the whole German economy and for specific sectors that are key to Germany's export performance. The following key figures illustrate the impacts of the different scenario assumptions:

- Germany's 2030 GDP is €211 billion, or 6.2%, higher in the competitive energy scenario than the high-price scenario.

- Personal income is 6.3% higher and the average resident earns €1,590 more per year in 2030 in the competitive energy scenario compared to the high-price scenario.

- The energy-intensive chemicals sector sees only 0.7 percent growth in annual output under the high-price scenario. Its annual output grows at 1.8 percent (1.1 percentage points higher) under the competitive energy scenario from 2015 through 2030 and will contribute 40,000 more jobs in 2030 than in the high-price scenario.

- Machinery and motor vehicles industries also benefit from the competitive energy scenario, as their supply costs decrease and domestic suppliers within their supply chain are not forced to relocate relative to the high-price energy scenario. The result is an additional output in 2030 between the two scenarios of €43 billion and €65 billion for the machinery and motor vehicles sectors respectively, equal to 87,000 and 85,000 additional jobs for each industry relative to the high-price scenario.

The results show that Germany faces stark choices about the pace of renewables development and how it should be funded. These choices will ultimately have a significant impact on Germany's economic growth and its ability to remain globally competitive. This study quantifies the impact of these choices. Rapid and costly expansion of immature renewable technologies results in competitive disadvantages for Germany. Exempting energy-intensive industries from paying for increasing power system costs provides some protection, but a different mix of energy sources could bring lower costs in the energy system overall, directly benefitting all consumers.

The second phase of this study will go into further detail about Germany's energy mix and its role in economic growth, specifically the role that increased European gas production could play in moving Germany toward a lower-cost, low-carbon, economically competitive future.

Germany's energy challenge

Energy has become a central topic in Germany's domestic political debate. The reasons are obvious to every company and household paying rapidly rising prices for their electricity. Contrasted with falling gas prices and low electricity prices in North America, high electricity prices in Germany pose an increasing risk to the international competitiveness of German industry and exports, the economy's growth engine. Germany's industrial power prices are among the highest in Europe and 2.5 times those in the United States.[1]

International competitiveness is particularly important to Germany and its standard of living, owing to the country's high dependence on exports. Exports of goods and services made up 52% of GDP in 2012. Germany's ability to maintain its international competitiveness is not just an issue for some companies and some sectors. It will affect the entire economy, the German populace, and the fiscal position of the German state.

Germany's energy policy framework, the Energiewende, aims to achieve rapid deployment of renewable power. But the cost of supporting and integrating renewable power is the primary reason for the recent electricity price increases. The 2000 Erneuerbare Energien Gesetz (EEG)—the Renewable Energy Act—is Germany's primary implementation mechanism for the Energiewende, supporting renewables through a surcharge on electricity bills. The EEG has been an effective, but inefficient, tool in increasing the share of renewables in Germany's electricity system. Renewable generation accounted for 22% of the country's power production in 2012 and it will rise to almost 25% in 2013. On the current trajectory, Germany will exceed its 35% renewable power target in 2020.

Germany has made the greatest investment in renewable generation of any country. IHS estimates that consumers have committed to support costs of more than €185 billion (in real 2013 euros) over the next 20 years. Further support will be required to meet the 2020 renewable target and other longer term targets.[2]

A nearly 50% increase in the EEG surcharge between 2012 and 2013 has heightened concerns that the Energiewende, as it is currently formulated, is not meeting one of its primary objectives: providing competitively priced electricity for Germany.

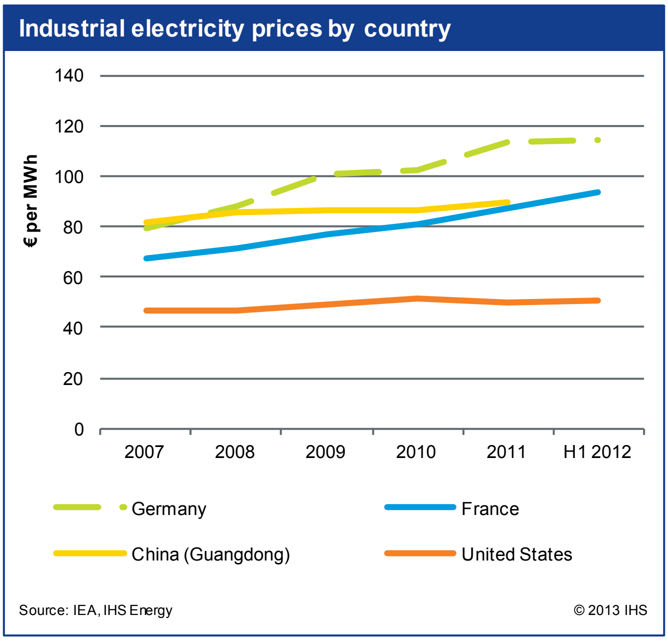
Germany's electricity prices are rising at the same time that development and production of new, low-cost natural gas resources in North America is reducing energy costs there. As a result, German industrial gas prices are now more than three times higher than those in the United States. Further, the effect of new natural gas supplies will not be limited to North America.

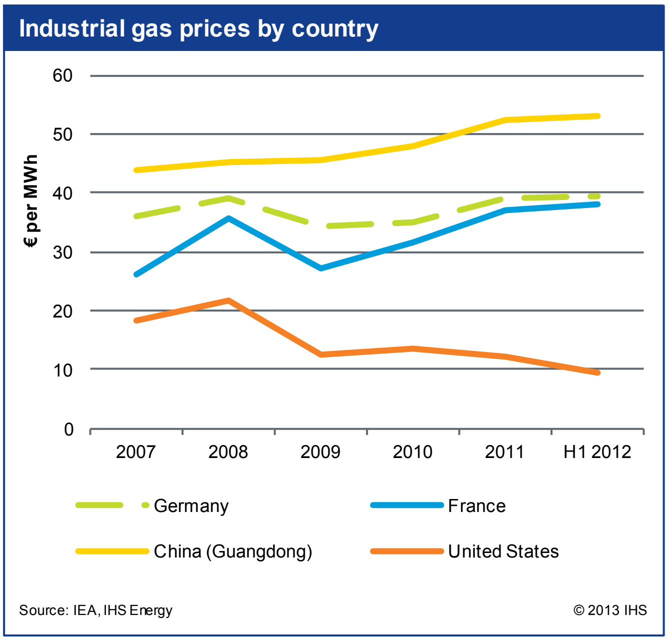
Many Asian markets that import large volumes of liquefied natural gas (LNG) pay the very high prices currently prevailing in the global LNG market (see chart below).[3] But as new sources of natural gas come online, international LNG prices will decrease, reducing Asia's gas prices. In contrast, LNG plays a minor role in determining gas prices in Northern Europe; the price of pipeline gas supply is of greater significance. As a result, European gas prices are unlikely to fall as much as they are expected to fall in Asia, compounding the competitive challenges that German industry faces in global markets.

1. IEA has been used for the international comparison of industrial energy prices as it is the only source for end consumer prices across a range of geographies.

2. €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 levels of feed-in tariffs, wholesale power prices, and renewable generation.

3. Guangdong is a coastal region of China and subject to the high prices prevailing in the global LNG market. Inland areas of China tend to have much lower end-user pricing in both the domestic and industrial sectors due to the increased role of indigenously produced gas.





The role of "policy costs" in German electricity prices

Regulatory measures taken as part of industrial and macroeconomic policy (known as "policy costs") have a significant influence on the energy prices paid by industry in Europe. Eurostat reports that taxes and other policy costs accounted for as much as 30% of Germany's industrial electricity prices in 2012.[4] In other major European economies, that burden on industry was as low as 3% in the United Kingdom and 9% in France. The policy costs and taxes that are part of German industrial electricity prices have tripled since 2007, more than offsetting downward pressure from decreasing wholesale market prices.[5]

The policy 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. In 2012, the net cost of support paid to renewable developers was €14 billion in Germany (0.5% of German GDP). This compares to only €2 billion in both France and the United Kingdom in 2012 (less than 0.1% of both France's and the United Kingdom's GDP), equal to about 15% of what Germany paid.[6]

Moreover, costs in Germany continue to increase as renewables deployment progresses. The direct net cost of renewable support is expected to exceed €19 billion for 2013. The full cost of integrating renewables is actually higher than indicated here, as these figures exclude the substantial costs of network development and management associated with rising renewable penetration.

A very different approach has been adopted in the United States, where support for renewables is provided in the form of a tax credit or support for capital investments. The cost of support is therefore an opportunity cost in the form of foregone tax revenue or is a lump sum payment from the government, rather than a charge on the end consumer. The foregone income tax revenue of programs for wind and solar photovoltaic (PV) in the United States totaled €6.4 billion in 2012. The difference in the treatment of renewable support costs increases the competitiveness challenge for German industry.

4. For an IF category end consumer with consumption of 70-150 GWh/year. The tax and policy costs share for other industrial end consumers was between 23% and 31%.

5. Eurostat only consistently reports prices for consumers up to 150 GWh per year across most EU markets. Consumers above this level often source directly from the power market and/or have their own generation.

6. Net cost refers to the volume of support payments less wholesale market revenue that is allocated to end consumers. It also does not account for additional costs, such as administrative expenses or costs absorbed otherwise in the form of deficits.

Energy costs and competitiveness

Energy costs are critical to Germany's industrial competitiveness in global and domestic markets. If electricity prices increase in Germany relative to the rest of the world, products made in other countries can replace German exports. At the same time, imported products pose a greater threat to cost-disadvantaged domestic producers. With imports rising and exports falling, net exports would decline.

Energy prices also impact the investment decisions made by German companies. In particular, high electricity prices force energy-intensive firms to relocate in order to stay competitive, a problem known as "investment leakage."

Lower net exports and investment leakage together lead to direct losses of output and jobs. In Germany's highly integrated and specialized industrial economy, supply chains and innovation networks would also be disrupted. Worse still, the relocation of a company could force other companies to follow, regardless of their energy-intensity, in order to hold on to their customers and suppliers. Indirect effects would thus multiply direct losses of output and jobs.

This report examines the links among energy costs, competitiveness, and economic performance by quantifying the economic impact across two different energy price scenarios.

Defining the scenarios

To consider the economic impact of potential reforms, IHS developed two alternative visions of the future of the German power system—the high-price scenario and the competitive energy scenario. The differing policy goals and reform paths in the two scenarios result in two distinct paths for Germany's electricity generation mix and for its electricity prices.

The high-price scenario assumes that Germany comfortably meets its long-term renewable targets, and it removes the industrial exemptions that now partially shield some German industries from the Energiewende's cost. This scenario involves substantial costs to German industry and the economy, widespread net export losses and investment leakage, decreases in the market shares of German companies, and disruptions to German industry's supply chains.

On the other hand, the competitive energy scenario develops renewables at a more moderate pace, with a focus on mature technologies and an increased role for conventional generation, particularly gas. The total cost of the power system is lower in this scenario. CO_2 emissions continue to decrease, but at a slower pace than in the high-price scenario. Existing industrial exemptions are maintained.

Economic results

IHS quantified the economic impacts of the high-price scenario and competitive energy scenario. To utilize the strengths and avoid the weaknesses of various modeling systems, IHS built an integrated methodology to assess the economic impact of the two energy scenarios on the German economy and to evaluate the global competitiveness of German manufacturing sectors.

IHS' approach accounts not only for the direct effects of higher energy prices on production, investment, and employment in energy-intensive industries, but also for the indirect effects on supplier industries and on private incomes throughout the broader economy. This analysis demonstrates that the dislocation of only a small share of energy-intensive industries—located at the beginning of highly integrated value chains—would have substantial cascading macroeconomic effects.

The chemical industry provides a good example of how the impact of the high-price scenario flows through the economy. The chemical industry's value chain typically starts with energy-intensive refineries and the production of base chemicals. Production then extends to a variety of industries in the value chain, which are organized within integrated production sites. A dislocation in the first part of this chain would result in strong negative effects on the profitability of less energy-intensive parts of the value chain. Furthermore, most chemical products themselves are inputs for many other industries, such as plastics and motor vehicles. Any dislocations to the chemical industry may increase supply costs for its industrial customers, negatively impacting their competitiveness as well.

Similar processes hold for basic metals (such as aluminum, copper, iron, or zinc), which are another starting point for an important manufacturing value chain in Germany's economy. The negative impacts of high energy prices also can be traced to business-related services, to the construction sector, and—via income and employment effects—to private consumption. Although most of the negative impacts in the manufacturing sector are directly to investment, production, and exports, negative impacts in the trade, transport, and service sectors typically indirectly affect incomes and employment as supply chains react to the primary price-driven effect.

Losses to specific industries and to the entire economy are predicated on three distinct effects:

- Direct effects on output and production capacity: weaker exports and import substitution dampen domestic output, while investment leakage curtails production capacity.

- Indirect effects on output and capacity: suppliers and customers in an integrated value chain are forced to follow the lead of the energy-intensive producers.

- Induced effects: reductions in economic activity stemming from the direct and indirect effects reduce employment and income levels, which in turn reduce expenditures throughout the broader economy.

These effects reverberate through the economic system in IHS' dynamic modeling approach. When moving from the high-price scenario to the competitive energy scenario, the lower energy costs reduce investment leakage, encourage local production, and generate more jobs and higher labor income.

The growth rates associated with each of the scenarios are displayed in the following table, along with the differences between them in terms of output and economic growth. In the high-price scenario that removes the energy surcharge exemptions and tax discounts, Germany loses competitiveness and economic growth. Conversely, under the competitive energy scenario, which maintains these exemptions, Germany's 2030 GDP is €211 billion (real 2013 euros), or 6.2%, higher and personal disposable income is 6.3% higher, with the average resident earning €1,590 more per year in 2030.

Compound annual growth rates (2015-2030) and difference (2030)

	Compound annual growth rates		Difference: High-price less competitive energy scenario	
	High-price scenario	Competitive energy scenario	Level	Percent
GDP	1.25%	1.60%	€211 bn	6.2%
Manufacturing exports	2.54%	3.83%	€452 bn	25.4%
Employment	-0.15%	-0.03%	€1.3 mil	3.0%
Personal disposable income	1.08%	1.45%	€129 bn	6.3%
Personal disposable income per capita	1.22%	1.58%	€1,590	6.3%
Government revenue	0.98%	1.27%	€81 bn	5.6%

Source: IHS Economics

Among the top three manufacturing sectors (chemicals, machinery, and motor vehicles), the chemicals and pharmaceuticals sector realizes the greatest gains when moving from the high-price scenario to the competitive energy scenario. The difference between the competitive energy scenario and the high-price scenario generates on average an additional 1.1 percentage points of annual output growth for 2015–2030 and 40,000 additional jobs in 2030. The chemical and pharmaceuticals sector, one of the most energy-intensive manufacturing sectors that is dependent on both gas and electricity, benefits in part due to its retention of market share and domestic capacity relative to the high-price scenario. Furthermore, this sector has highly integrated value chains, and the continued retention and/or growth in energy-intensive upstream capacities, including refineries, results in considerable gains in downstream activities as well.

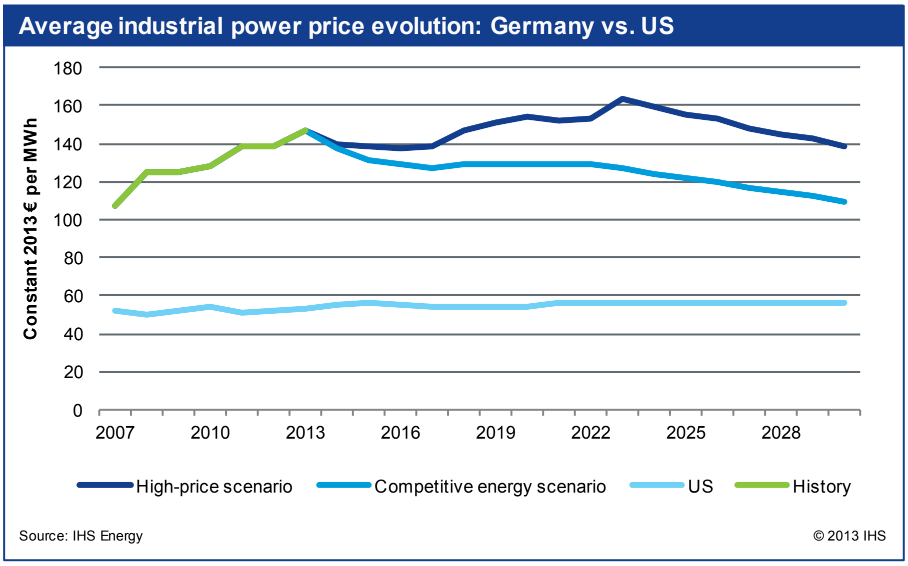
Relative to the competitive energy scenario, machinery and motor vehicles under the high-price scenario are projected to suffer primarily from negative indirect effects, as their supply costs increase and some of their suppliers are forced to relocate. Although manufacturing output in the high-price scenario is expected to grow by 0.8% on an average annual basis over the 2015–2030 forecast period, the pace of growth in the competitive energy scenario is expected to be more than twice that annual average growth rate at 1.7%. Similarly, the motor vehicles industry is projected to grow at only 1.6% under the high-price scenario, compared to 2.4% under the competitive energy scenario. Basic metals' output, while projected to grow 1.2% in the competitive energy scenario, declines by 1.0% per year on average over the 2015–2030 forecast period in the high-price scenario, reflecting the specific burden on energy-intensive production processes brought about by the high-price scenario.

Differences between the high-price scenario and the competitive energy scenario

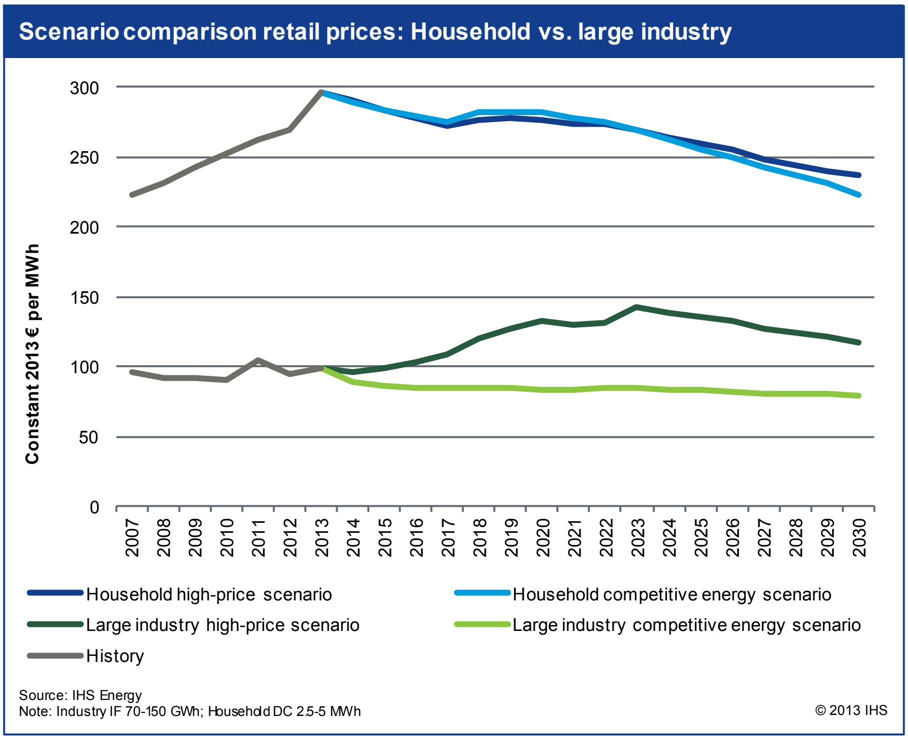
	Difference in average annual output growth: 2015 to 2030 (percentage points)	Difference in 2030 output (billion constant 2013 €)	Difference in 2030 employment level (1.000)
Chemicals and pharmaceuticals	1.1	€36	40
Basic metals	2.1	€34	45
Machinery	0.7	€43	87
Motor vehicles	0.8	€65	85
Total manufacturing	**0.9**	**€345**	**622**

Source: IHS Economics

EEG exemptions and German industry



Tax discounts and exemptions from the renewables surcharge have partially protected energy-intensive industries in Germany from recent increases in policy costs. A large industrial consumer in Germany pays almost €100 per megawatt-hour (MWh) today, compared to an average industrial price of over €145 per MWh.[7] However, even with this shield, German industry still faces an international competitiveness challenge. Industrial consumers in the United States pay less than €55 per MWh on average, and this cost advantage is expected to continue in the long-term. Even in the competitive energy scenario, IHS estimates that average industrial electricity prices in Germany will remain more than double the US level.[8] In the high-price scenario, German prices would peak at almost three times the US level.



The combination of a high cost power system and the phase out of industrial exemptions and tax rebates in the high-price scenario results in a substantial increase in power prices for currently exempt consumers.[9] A company that consumes between 70 and 150 gigawatt-hours (GWh) per year would see a power price increase in 2023 of almost €60 per MWh (in 2013 real euros), or nearly 70%, in the high-price scenario. For a large consumer consuming 150 GWh this is equivalent to paying an additional €8.5 million per year.[10]

The picture for smaller consumers is much more complicated, as there are a number of offsetting effects in the two scenarios:

- In the high-price scenario, consumers receive a small benefit from the phase out of the current industrial exemptions, but they are penalized by the high cost of electricity supply in addition to the indirect

7. Consumption category IF (70-150 GWh per year).

8. Chart shows average price for all industry in Germany and the United States. Underlying this average is a wide range of end-user prices, including prices for small, non-exempt consumers and prices for large, exempt companies.

9. No changes are assumed in exemptions from CO_2 emission payments (the Carbon Leakage List) between the scenarios.

10. Consumption category IF (70-150 GWh per year)

effects of substantially higher industrial power prices. The challenge to industrial competitiveness under this scenario results in a substantial reduction in average disposable income.

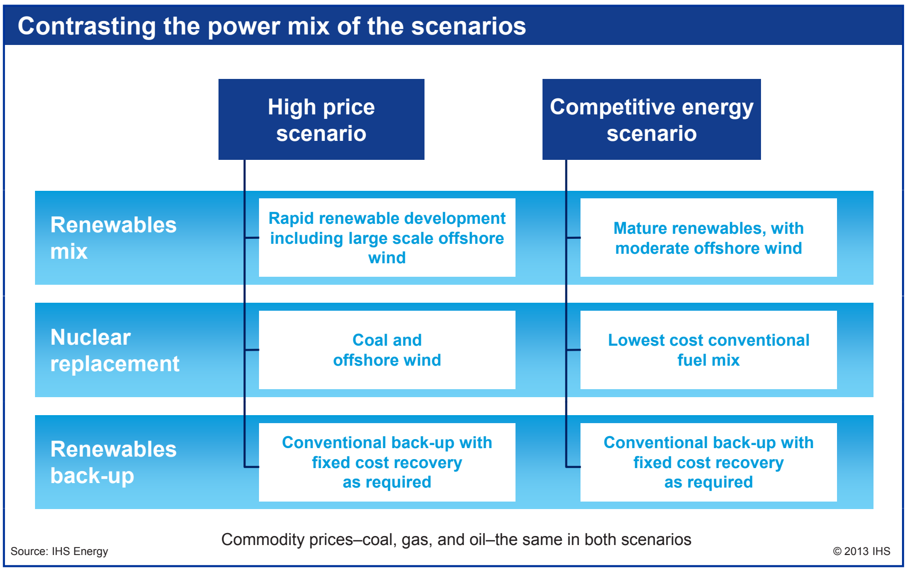
- In the competitive energy scenario, non-exempt consumers continue to pay the full cost of the EEG, but they benefit from a lower-cost electricity system and substantially higher disposable income.

In the competitive energy scenario, electricity prices for small consumers are slightly higher in the short term, but lower in the long term. Electricity bills for an average private household with 4 persons in the competitive energy scenario are around €10 per year higher than they would be in the high-price scenario in the period prior to 2022.[11] After 2022, bills are over €20 per year lower on average in the competitive energy scenario due to the lower cost of power supply. However, even the higher electricity bill under the competitive energy scenario is more than offset by additional income gains. On a per-capita-basis, annual income is nearly €1,000 higher in the competitive energy scenario compared to high-price scenario by 2020. That difference widens further to €1,590 in 2030. Specific individuals and households that do not directly benefit from positive income effects may carry a higher net burden; however macroeconomic benefits give substantial leeway to compensate for individual hardships. In both scenarios, smaller consumers benefit as increased competition in the supplier market drives down prices, particularly in the early years. The elimination of the EEG deficit incurred in 2012 and 2013 will also lead to reductions in the retail prices in the short term.

The role of the power mix in the energy supply system

In today's Energiewende deployment of significant offshore wind capacity is essential to meet Germany's renewable generation targets. Offshore wind is larger in scale and has a higher load factor than other renewable technologies, but it is costly and as yet unproven in challenging locations and requires construction of on- and off-shore transmission. Even with large-scale development of off-shore wind, conventional generation is required to ensure that peak demand can be met. As a result, large-scale accelerated development of offshore wind will considerably increase the cost of the power system.

However, other power generation mixes are possible. The competitive energy scenario relies on a combination of mature renewables (onshore wind and solar), a moderate deployment of offshore wind (7.5 gigawatts [GW] by 2030), and a greater role for conventional generation. Such a generation mix would be less costly and would meet the 2020 renewables target of 35%. The share of renewables in the competitive energy scenario continues to grow to nearly 40% by 2030, as opposed to the current target of 50%.



Two factors must be considered when comparing the installed capacity mix between the scenarios.

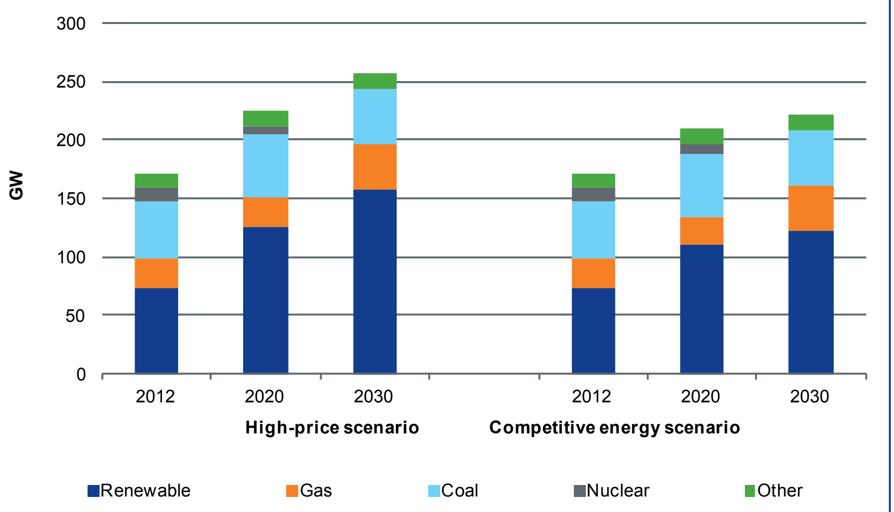
- **Dispatchable Capacity.** To guarantee supply, capacity must be available to meet peak demand. This capacity must be dispatchable, meaning that it will respond when called upon by the system operator. Solar and wind capacity are intermittent and, therefore, not dispatchable and provide very little in the

11. The average exemplary household is 4 persons, 4 MWh per year of electricity consumption. Consumption category DC (2.5-5 Mwh per year)

way of peak cover. The peak in Germany occurs early on winter evenings when output from solar is negligible.

Electricity storage could be used to firm up intermittent generation, but in the absence of affordable, large scale battery technology, 0.9–1 GW of thermal capacity is required to back-up every 1 GW of wind or solar, with flexible gas generation best suited to meet this need. As a result, the amount of conventional capacity that must be maintained is effectively independent of the volume of renewable generation.

Installed capacity: By fuel



Source: IHS Energy © 2013 IHS

- **Utilization of conventional capacity.** In the high-price scenario, the utilization rates for conventional capacity are very low, as the conventional capacity acts as back-up for times when renewable output is low. In the competitive energy scenario, the utilization rates for conventional capacity are higher.

As discussed above, the need for dispatchable capacity is similar in both scenarios. The higher level of intermittent renewable capacity is the key driver of higher costs in the high-price scenario. The increased utilization of thermal capacity in the competitive energy scenario offsets some of the difference due to its higher fuel and emissions costs.

Changing the fuel mix as outlined in the competitive energy scenario results in lower total system costs.[12] Between 2012 and 2030, system costs in the competitive energy scenario would be almost €85 billion (in real 2013 euros) lower than in the high-price scenario. These savings peak in the 2020s, when costs are 10% lower in the competitive energy scenario. Grid costs would be over €10 billion lower owing to lower costs of offshore grid development and onshore network expansion. The fixed costs of capital investment, operation, and maintenance decrease by more than €110 billion due to reduced investment in renewable technology. However, the combined cost of fuel and emissions rise by almost €40 billion, based on current expectations for fuel price developments, $C0_2$ prices, and technological efficiencies.[13]

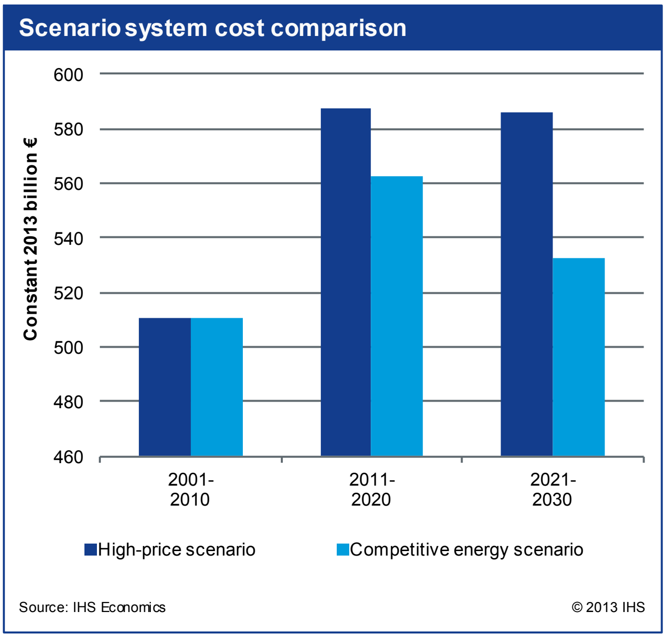
Commodity price assumptions: Scenario comparison
(Constant 2013 €)

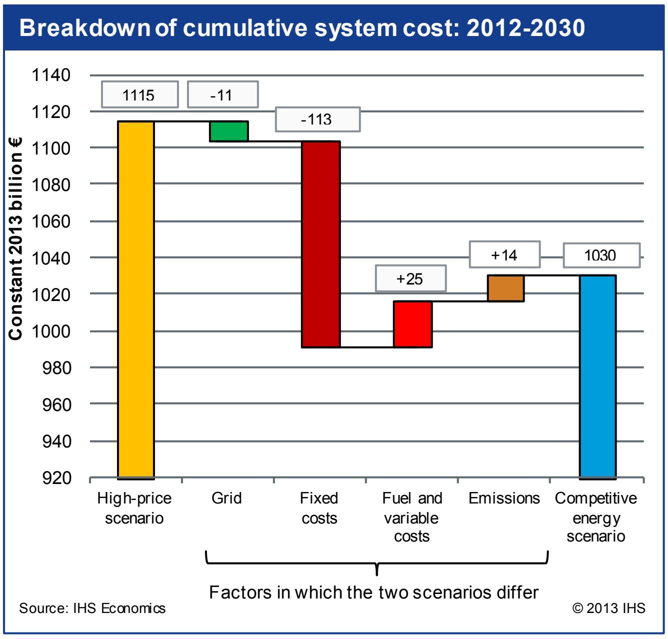
	Price	Unit	2012	2020	2030
Both scenarios	Gas	€ per MWh	26	24	23
	Oil	$ per barrel	113	97	98
	Coal	$ per metric ton	96	106	109
High-price scenario	Power	€ per MWh	45	43	41
	Carbon	€ per metric ton	8	14	21
Competitive energy scenario	Power	€ per MWh	45	44	45
	Carbon	€ per metric ton	8	15	22

Source: IHS Energy

12. The system cost is the cost of developing and supporting the power system. It includes capital costs, operation and maintenance costs, fuel and emissions costs, and network costs for transmission and distribution.

13. We expect CO_2 prices to remain below €25 per metric ton through 2030. This price outlook is based on a continued lack of demand for EU allowances and expectations that EU climate policy in the years to come will moderate in light of slow international progress on equivalent climate policies.





Although the exemptions from the EEG surcharge and a more efficient energy generation mix both contribute to economic gains in the competitive energy scenario, the exemptions are the main drivers of its economic benefits. The surcharge exemptions account for €140 billion, or two-thirds, of the difference in the impact of the two scenarios on Germany's projected GDP. The remaining €70 billion in 2030, or one-third, is due to the less costly generation mix.

Inefficiencies in the current Energiewende

One clear challenge facing the Energiewende is the systemic failure of the EEG to react to changes in technology costs. Solar PV technology provides the most obvious example. As solar PV costs dropped significantly between 2010 and 2012, high feed-in tariffs were maintained, although the cost rationale for them was quickly fading. Tariffs were not cut in time to keep up with declining costs. The result was a "rush-to-market" mentality among project developers, resulting in 22 GW of new capacity within three years. If feed-in tariffs had been more reactive, this capacity would have been added more gradually, allowing Germany to benefit from falling costs and reducing the year-on-year increase in the EEG. The government reacted to the EEG cost escalation with a 52 GW cap on solar PV subsidies and changes in the tracking mechanism to define and adjust the feed-in tariff.

Similar to the experience with solar PV, there are risks associated with setting future remuneration levels to encourage the development of renewable technologies. In the future, if the feed-in tariff is substantially higher than the cost of power generation, then over-investment will occur, but if it is set too low, investment will stall. In addition, sites differ in their resource endowments, making some installations more cost-effective than others. Mechanisms that completely eradicate windfall profits while maintaining adequate investment incentives are hard to design. Therefore, continuing significant uncertainties and the potential for cost inefficiencies in the support for renewable energies are not improbable.

Estimating the scale of this future inefficiency is challenging. It depends not only on the rate and scale of future cost reductions for renewable technologies, but also on how governments, regulators, and developers react to these reductions. A feed-in tariff for off-shore wind that exceeded the average long-run cost of generation by €10 per MWh would add €300 million per year onto the EEG surcharge through 2030 in the high-price scenario.

The challenge of reducing power demand in a growing economy

The level of power demand is a critical determinant of CO_2 emissions and the overall cost of the Energiewende. Energy efficiency, in the form of lower electricity consumption, is a fundamental component of the plan to decarbonize the German economy. Current government targets call for electricity demand reductions of 10% by 2020 and 25% by 2050, compared with the 2008 level. These are very ambitious targets and are without precedent in a growing economy.

Between 2008 and 2009, German power demand fell 5% due to the recession. Since then, it has recovered 2.5% and power demand appears likely to resume its long-term upward track. Rising power demand increases both the costs and the challenges of the Energiewende by increasing the need for zero carbon generation and the associated conventional back-up and network infrastructure.

Although there remains substantial potential for further energy efficiency gains, converting this potential into reductions in consumption is challenging. The challenge is greatest in the household and commercial sectors where growing use of electrical devices and increasing electrification of heat may outweigh efficiency gains. In addition, if Germany were to transition from a fossil-fuel transport fleet to an electrified transport network, this change would bring further strong upward pressure on electricity demand.

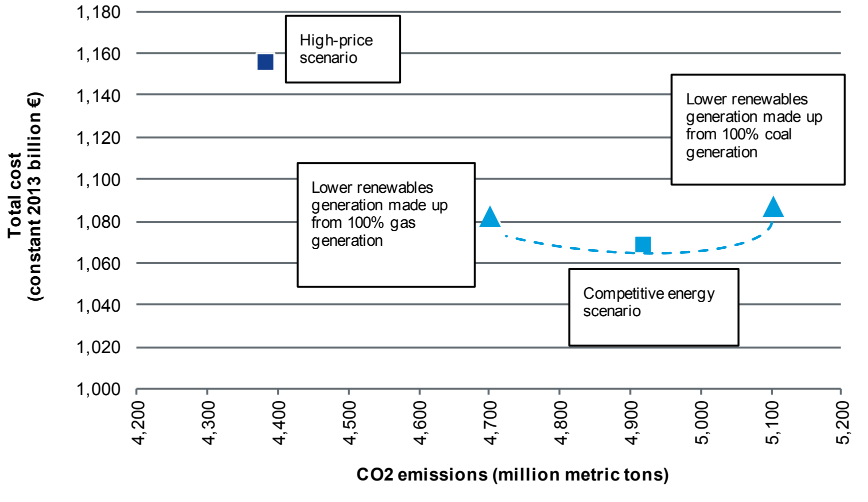
Trade-off between growth and CO_2 emissions

When Germany decided to phase out its nuclear power by 2022, it lost its zero-carbon bridging technology. The lowest cost substitute, coal-fired generation, has filled much of the gap left by retiring nuclear capacity. Future CO_2 emissions will largely depend on the choice between coal and gas to fill the gap left by nuclear in the medium term and to back up renewables now and in the medium and long term.

Given the share of renewables described above, the competitive energy scenario models the lowest cost fuel mix that would meet Germany's power demand. Power sector CO_2 emissions continue to decrease from current levels, but in aggregate they are 0.5 billion metric tons higher in the competitive energy scenario than in the high-price scenario between 2013 and 2030. Emissions in 2030 in the competitive energy scenario are 236 million metric tons. In the high-price scenario, CO_2 emissions in the power sector would decrease from 286 million metric tons in 2012 to 185 million metric tons in 2030. Given the €85 billion reduction of system costs in the competitive energy scenario, this difference in emissions implies a direct cost of CO_2 abatement between the scenarios of €170 per metric ton.

However, emissions in Germany should not be considered in isolation. Concentrating on the level of national emissions undermines one of the core benefits of the European Union's Emissions Trading System (EU ETS): its pan-European nature. The EU ETS was designed to ensure that the most cost-effective carbon abatement occurs regardless of location. Focusing on national targets risks uneconomic abatement occurring in some countries, while other member states do not pursue cheaper abatement opportunities.

CO2 cost trade-off: 2012-30



Source: IHS Energy

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The wide coverage of the EU ETS means that changes in the German power sector's emissions have only a small impact on the overall level of European emissions and on the CO_2 price. German power sector emissions accounted for approximately 15% of emissions covered by the EU ETS in 2012.[14]

The role of gas in the power mix

Lower CO_2 emissions in the competitive energy scenario are possible by decreasing the role of coal and increasing the role of gas-fired generation. Assuming current IHS CO_2 and gas price forecasts, the increase in power-sector CO_2 emissions could be cut by 40% for an incremental cost of €10 billion between 2013 and 2030 if gas were to dominate the non-renewable generation mix. For each unit of electricity generated, emissions of CO_2 from a best-in-class natural gas-fired power plant are about half those of a best-in-class coal plant.

Moving to a fuel mix dominated by coal would substantially increase CO_2 emissions, while also increasing costs over the competitive energy scenario due to the high capital cost of coal fired generation. IHS estimates the capital cost for a new combined cycle gas turbine at €1,087/kW, compared to €2,324/kW for steam coal (in real 2013 euros).

Gas-fired generation has many further advantages over coal in addition to lower CO_2 emissions. A key advantage in the context of the Energiewende is the ability of gas-fired generation to follow the fluctuations of renewable power generation—a quality lacking in the majority of older coal-fired capacity. Lead times for gas plant construction are short relative to coal, and public acceptance of gas-fired plants has typically been higher.

In the context of Germany's Energiewende, the results of this study emphasize the importance of gas-fired electricity generation as a cleaner and more flexible technology for bridging and backing up renewable power. More competitive natural gas prices would bolster the benefits of gas-fired generation. Germany's and Europe's prospects for developing natural gas resources and markets will be the focus of a subsequent in-depth study.

Conclusion

Germany finds itself at a critical decision point about its future energy policy. Energy costs are crucial to international competitiveness, which is the main growth driver of the German economy. Rising electricity prices in Germany are making German products less competitive and encouraging firms to relocate elsewhere. In a highly integrated and specialized economy like Germany's, this loss of domestic investment also leads to the disruption of supply chains.

This study presents a comparative analysis between a high-price scenario and a competitive energy scenario and demonstrates that transitioning to a lower-carbon energy policy can be compatible with maintaining German competitiveness. Key elements of such a transition include:

- Maintaining the current EEG exemptions to avoid additional costs for energy-intensive industries: this has positive macroeconomic effects not just for these exempt consumers, but for the entire economy, as measured by additions to GDP, employment, personal income, and government revenues.

- Balancing overall system costs and CO_2 emissions when deciding on a suitable mix of power generation: lower system costs come at the expense of higher CO_2 emissions, but investing in gas-fired power generation can minimize this trade-off.

14. EU ETS stationary installations, excluding aviation.

- Expanding gas-fired power capacity as a bridging technology to Germany's low-carbon future: as renewable technologies mature, gas would move into a back-up role, ensuring the security of Germany's power supply.

Further work

In Volume 2 of this study, we will extend this analysis by going into greater detail about Germany's energy mix, specifically considering the role that increased European gas production could play in moving the German economy closer to a lower-cost, low-carbon, competitive position. Volume 2 will include detailed estimates of gas resources in Germany and other European countries and the impact that these resources could have on European natural gas prices, potentially reducing prices by as much as 20% and making gas cheaper than coal for power generation. It will also detail the corresponding effects that additional gas production would have on the German economy, electricity prices, and CO_2 emissions.

Volume 2 will also extend the economic impact analysis to further assess structural changes to the German economy, including potential shifts in productivity, changes in Germany's industrial composition, and other long-run economic consequences.

Appendix A: IHS Macroeconomic Scenario Modeling Approach

To utilize the strengths and avoid the weaknesses of various modeling systems, IHS has built an integrated methodology to assess the economic impact of alternative energy scenarios on the German economy and to evaluate the global competitiveness of German manufacturing sectors.

Various economic models, including a stochastic model of industrial activity and energy prices, a Social Accounting Modeling (SAM) framework, and the IHS Macroeconomic Model of the German Economy, were linked and integrated to undertake the economic impact assessment.

The stochastic model of industrial activity measures the impact of alternative energy prices on industrial investment and output. This block, comprised of two distinct models, determines the direct impact of an energy price change, where different price effects are allowed to interact with each of the 18 unique manufacturing sectors examined independently.

The model evaluates a loss of competitiveness reflected in declining industrial investment and production. The model is based on results of econometric analysis proving that the cross-price elasticity (the change in investment due to change in the price of energy) is generally negative, as theory would suggest. Additional verification of the results was conducted by comparing response coefficients for capital investment and output with historic German capital-output ratios on an industry-by-industry basis. That comparison verified that the two elasticity models were internally consistent and consistent with economic behavior in the post-reunification German economy.

This complete methodology was implemented for the competitive energy scenario. Sector investment and output were derived for the forecast period. The electricity price forecast from the scenario was used as the driver for the model. Prices for all other energy sources were assumed to remain unchanged from the IHS baseline outlook. The impact of the electricity price on each sector's total energy costs was weighted by the sector's historical share of electricity cost.

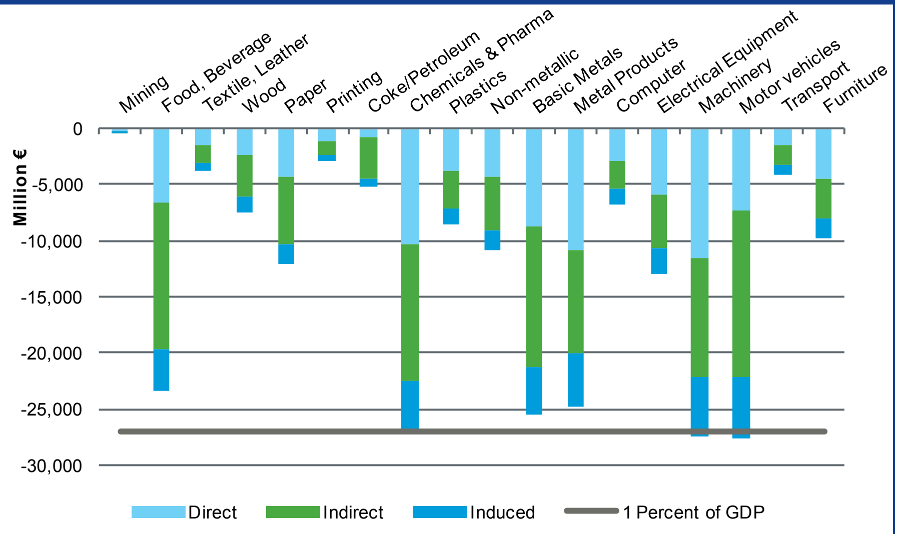
The SAM system yields the overall impact of alternative electricity prices through the supply chains in the German economy. The primary objective of this model is to present how a policy, in this case through electricity prices, flows through the national industrial economy. The resulting outcomes of the stochastic model of industrial activity were transformed and were used in this SAM modeling system.

The approach applied for the period in the high-price scenario when the exemptions for the EEG surcharge are phased out was slightly different. The phase-out causes such a sharp price increase for many industry sectors that the linear forecast model described above would not be able to fully capture the impact on output and investment.

Instead, we identified that part of the industry that currently benefits from the exemptions and considered the related value added to be "at risk" In the face of those exemptions being removed. As exemptions are phased out, using a SAM system, we estimated the direct, indirect and induced effects that are triggered by the relocation abroad of parts of the value chain. The model results show that for some sectors, including chemicals and pharmaceuticals, basic metals, metal products, machinery and also motor vehicles, value added of up 1% of GDP may be 'at risk' (see graph below). For the entire economy, nearly 10% of GDP would be directly or indirectly affected by the phase-out of the exemptions.

However, not all companies that are currently surcharge-exempt would actually relocate. A provisional estimate for the 18 manufacturing sectors in the sample has shown that approximately 13% of the value added, which is considered as being 'at risk' if exemptions are removed, would relocate. This share was assumed in the high-price scenario.

Value added at risk due to EEG exemption expiration



Source: IHS Economics

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As value added is lost, exports, consumption, and investment are reduced, while imports are increased to substitute for domestic production. This shock is then put into the IHS macro-economic model for Germany.

The IHS macroeconomic model for Germany, which is embedded in the IHS Global Scenario Model, was used to integrate supply-side impacts from the stochastic and the SAM models with demand-side impacts for the competitive energy scenario and to integrate supply side impacts from value added at risk-calculation with the demand side. The macroeconomic model incorporates global trade and investment feedback between Germany and its major trading partners.

The results from the SAM modeling system were calibrated with the results from the macroeconomic model to ensure a consistent and comprehensive assessment of the German economy. To prevent changes in fiscal policy from obscuring the scenario results, we left the main fiscal parameters unchanged from the baseline in both scenarios.

There are two exceptions to this, however: in the competitive energy scenario, a surplus of around 1% of GDP is generated permanently without policy changes. This surplus is assumed to be re-invested in the economy by the government. In the second exception, the state accumulates a growing deficit in the high-price scenario. Minding the constitutional debt rule ('Schuldenbremse'), we have reined in the deficit by curtailing fiscal spending in our modeling but without tightening fiscal policy too much to avoid the overall result being dominated by effects of fiscal tightening.

