INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries

GERMANY

2007 Review

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an inter-national energy programme.

It carries out a comprehensive programme of energy co-operation among twenty-six of the OECD thirty member countries. The basic aims of the IEA are:

- To maintain and improve systems for coping with oil supply disruptions.
- To promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations.
- To operate a permanent information system on the international oil market.
- To improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use.
- To assist in the integration of environmental and energy policies.

The IEA member countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Republic of Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States. The Slovak Republic and Poland are likely to become member countries in 2007/2008. The European Commission also participates in the work of the IEA.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of thirty democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Republic of Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States. The European Commission takes part in the work of the OECD.

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EXECUTIVE SUMMARY

Only a handful of countries can have as dramatic an impact on global energy policy as Germany. Its large size and strategic position within Europe give it great importance in the economic region and, by extension, the world. It is, therefore, vital that the country have sound energy policies and strong energy market design. The IEA is pleased to see that Germany is making progress in these areas, which we feel will lead to benefits not just for Germany, but for Europe as a whole.

Since our last review in 2002, Germany has maintained its commitment to the "3 Es" of good energy policy: energy security, economic efficiency and environmental sustainability. In the area of security of supply, Germany has continuously maintained its strategic oil stocks above the 90-day requirement, ready to respond to any oil emergency to the benefit of all oil-consuming countries. The country has maintained the focus of its gas policy on security of supply, seeking greater partnership with Gazprom, its largest supplier.

To enhance economic efficiency, the government has undertaken actions to help improve competition in its natural gas and electricity markets. Most notably, after installing a network regulator, the *Bundesnetzagentur*, in 2005, it is now increasing the regulator's power so that it can ensure open access for new entrants and create robust and competitive energy markets. In addition, the government is working to give its cartel office the tools necessary to effectively watch over the market, making sure market participants behave fairly. A government agreement has also been reached to complete the phase-out of hard coal subsidies by 2018 – a challenging, but necessary task as sustaining uneconomic hard coal production distorts the coal market and diverts economic resources better used elsewhere to the benefit of the German economy.

In the environment arena, few countries can boast Germany's record in bringing environmental issues to the forefront of policy making. The country is on track to meet its commitment under the Kyoto Protocol, growth of renewables has been rapid, biofuels are reducing the country's reliance on imported oil, the government has set ambitious energy efficiency targets and R&D funding for renewables and efficiency is on the rise. Linking economic efficiency and environmental sustainability, the country is giving the private sector the ability to meet its greenhouse gas commitments at a lower cost by starting to expand the use of international purchases, at the same time helping to drive the international market for carbon reductions.

In light of its evident commitment to good energy policy, this review highlights areas where the government should press forward with further improvements.

The three key policy challenges are the phase-out of nuclear power, energy market reform and climate change policy.

NUCLEAR PHASE-OUT

Under an agreement negotiated between the government and the utilities in 2000, nuclear power stations will be progressively shut down as they age – with complete shut-down of all plants estimated to occur by 2022. Currently, nuclear energy makes up a significant part of the country's energy mix, representing 12% of primary supply and over a quarter of electricity generation. Modelling results suggest that the nuclear shut-down can be completed without increased emissions of carbon dioxide, thanks to a greater role for renewables along with energy efficiency gains. However, in reality it is likely that the shut-down will result in increases of lignite-, hard coal- and gas-fired power plants, particularly as companies' current slate of proposed and planned power plants lean heavily on these fuels, leading to higher overall carbon dioxide emissions.

Regardless of how nuclear power is replaced, the early shut-down of these plants comes at a cost to energy security, economic efficiency and environmental sustainability, the tenets of Germany's energy policy. The loss of nuclear power will lead to reduced supply diversity, negatively impacting energy security. As a largely domestic resource, nuclear power reduces the need to rely on imports of other fuels, such as gas; increased dependence on fossil imports in the future would likely raise Germany's reliance on Russia's Gazprom, a company that already provides a very large share of total supply. Furthermore, the supply replaced by wind power, an intermittent source, will necessitate backup reserve capacity – most likely coal and natural gas. Overall, the elimination of nuclear is a liability for energy security, as it eliminates one potential generation option from a portfolio available to German companies.

The marginal costs of nuclear plants are low and stable relative to fossil fuels, which means they provide low-cost baseload power. Nuclear plants rarely set the marginal price of electricity, so their closure will have a limited effect on wholesale electricity prices. It will, however, have negative spillover effects on the economy. The shut-down of these productive assets will require additional near-term investments in new capacity, while continued operation would allow companies to invest the revenues from the plants in ways that are more productive for the economy. Deferring the shut-down would also reduce the need for new capacity, allowing for the development of more advanced technologies, including renewable energy technologies.

In the context of Germany's ambitious targets to reduce the negative environmental impacts of energy production, the shut-down of nuclear power plants might have the biggest effect on its environmental goals. While the

phase-out threatens to result in higher overall emissions of carbon dioxide than today, it will certainly prevent Germany from reaching its full potential over the longer term. With nuclear in the fuel mix, Germany's carbon dioxide emissions could be cut even further.

For these reasons, we strongly encourage the government to reconsider the decision to phase out nuclear power. Changes to the phase-out law and lifetime extensions for these productive power plants could also be linked to a reduction in free emission allocations for new and existing fossil fuel power plants, resulting in greater overall carbon dioxide reductions at no net cost, as well as to other concessions.

The government should initiate a national debate about the role of nuclear power in Germany's long-term fuel mix, with early attention paid to the possibility of extending the lifetime of existing plants in order to accommodate the country's climate change policy goals. Keeping nuclear in the country's energy mix will require gaining increased public acceptance for the technology. Recent information on public attitudes towards nuclear power shows that in Germany, as in many countries, obtaining higher levels of public acceptance hinges on the ability of the government to successfully address the radioactive waste disposal question. We therefore commend the governing coalition on its statement of intent to do this by the end of the current parliament, and we encourage the government to adhere to this deadline. Regardless of the path chosen, all citizens should be well aware of the impact of the phase-out on the country's economic, greenhouse gas and energy security goals.

ENERGY MARKET REFORM

The installation of a network regulator in 2005 signals Germany's acknowledgement that negotiated reform and internal regulation of the energy markets were unsuccessful. It also underlines the strong government commitment to genuine reform of its gas and electricity markets. In the electricity sector, real progress has been made in developing competitive energy markets and the government is working to enhance this progress by giving the competition authority more power to prevent anti-competitive behaviour. Nevertheless, the importance of establishing functional and competitive electricity and gas markets in Germany cannot be overstated, as it will lead to benefits for German customers as well as for the whole of Europe. We strongly urge the government to take further action to promote genuine competition in its energy markets.

Following the creation of a regulator, the next step in reforming the electricity and gas sectors is to institute functional access to gas pipeline and electricity transmission line networks for all market participants on an equal basis. Open,

equal access to the grids provides all market participants, including incumbents as well as potential and existing new entrants, with the ability to transport their products to market. Without this access, the benefits of reform will not materialise as a competitive market is impossible. Currently, Germany's gas and electricity networks are owned and operated by large vertically integrated incumbents. This makes it difficult to guarantee that potential competitors can gain equal access to transportation, as required by the European Union because the right incentives are not in place to make the provision of fair and equal treatment in the network operators' best interests. Furthermore, by operating these networks themselves, the companies have greater access to important information, such as about network flows and schedules.

The government has tried to limit this influence through legal unbundling of network assets from the competitive parts of the business. This is the weakest means of complying with the terms of the European Union's energy directives and a model that requires close, cumbersome and imperfect oversight of market operations. Germany should learn from its experience with negotiated third-party access to networks – which failed to create sufficiently competitive markets – and now go further than the minimum requirements for legal unbundling. We encourage the government to put in place the proper incentives for non-discriminatory access to networks. The creation of independent system operators for gas and electricity networks – giving independent entities control over the operation of network assets, but not the ownership of the assets themselves – would achieve this. As the model in place in many well-functioning energy markets in Europe, the United States and Australia, it has been found to level the playing field and create the necessary foundation for competitive energy markets.

Increasing market size provides greater economies of scale, reduces transaction costs and weakens the dominance of large incumbents. Germany's four electricity zones make system operations more complex as electricity does not flow along straight lines, but through highly meshed networks. Though meshed networks are inherently more secure than radial networks (networks that rely on more direct pathways), the 4 November 2006 electricity outage in Europe highlights the complex task of managing a grid. The lack of seamless co-ordination across system areas was one factor that exacerbated the negative impacts of an event that could have been better isolated from the wider European grid. In theory, Germany's system operators could work together seamlessly as if they were one, but in practice this is more easily accomplished when all the information is managed by a single entity. We encourage Germany to consider consolidating its electricity grid management under a single independent system operator.

In the gas sector, we also recommend that a single operator be given control of the many independent grids and existing zones. This would allow more

efficient, cheaper and safer operation of the existing separated pipeline networks of each company as well as enable investments in interconnections between them. A single operator would have direct access to more information about gas flows, which is essential information to guarantee security and competitiveness. Current information disclosure requirements for gas flows in Germany have resulted in little information being published. A fully independent operator would, in addition, be better able to identify bottlenecks, manage investment and administer the country's storage assets in normal or emergency conditions.

Enlarging the market area for both gas and electricity will also reduce the market concentration within Germany, a necessity given the dominance of gas and electricity incumbents in the country. Though Germany's electricity grid is well connected to its neighbours through cross-border connections, their chronic congestion signals the need for more capacity. We strongly urge the country to expand this capacity. Together, a smaller number of market zones and increased cross-border connections will not only weaken the dominance of the incumbents in Germany, but also help push the country towards an integrated European market that will enhance the stability of the region's grid and hasten the development of competition within Europe.

CLIMATE CHANGE POLICY

Germany is working to meet many targets and objectives that will lower the negative environmental impacts of energy use, especially its contribution to climate change. The country is well on its way to achieving its Kyoto Protocol target of a 21% reduction in greenhouse gas emissions in 2012 compared to 1990. In addition to this international target, the country took on the European Union target to have renewables provide 4.2% of primary energy supply by 2010, which it surpassed in 2006. The country is also on track to meet its domestic goal of producing 12.5% of electricity from renewable sources by 2010. Finally, the government has set an ambitious domestic target to double energy productivity – a measure of economic output per unit of energy – between 1990 and 2020. Taken together, these targets and the impressive progress towards adhering to them underscore the importance of environmental sustainability to Germany. However, despite this commitment, Germany lacks a co-ordinated and integrated environmental policy. While it spends a large amount of money and effort to tackle climate change with sound policies and actions, at the same time some of its other policies undermine many of its good efforts.

For example, as discussed above, the nuclear phase-out complicates the task of reducing greenhouse gas emissions, preventing the country from reaching its full potential for emissions reductions. Another measure not in line with its environmental ambitions is the country's initial proposal to the European

Commission to give relatively generous conditions for the provision of carbon allowances to new coal and lignite power plants under the European Union's trading scheme for greenhouse gas emissions. This is at cross-purposes with the target of reducing carbon dioxide emissions, as coal plants emit much more carbon than other types of power plants, most notably natural gas. The European Union's trading scheme should be used to create incentives to reduce emissions, not as a means to protect and expand coal-fired generation and enhance supply security. Efforts to promote coal-fired generation in the face of competitive and security of supply concerns should be done through means other than policies designed to provide price signals that reflect the costs of carbon dioxide emissions. A recent finding by the competition authority regarding the pass-through of emission permit costs may also have the effect of undercutting the purpose of Europe's greenhouse gas trading scheme. If companies are prevented from passing through the opportunity costs of carbon allowances, electricity prices will not reflect the cost of carbon emissions, suppressing price signals that create incentives for low- or no-carbon electricity sources. In short, it will undermine the intention of the trading scheme.

We also encourage the government to make cost-effectiveness a higher priority when selecting policies to promote renewables and between renewables policies and other policies, as this will allow it to maximise the value of its limited expenditures. The country's feed-in tariff for renewables has resulted in rapid deployment of new electricity capacity, but has done so at a high cost. Estimates show that between 2000 and 2012, the feed-in tariff will cost EUR 68 billion in total. In particular, the subsidies provided to solar photovoltaics are very high in relation to output; they will eat up 20% of the budget but contribute less than 5% of the resulting generation. In comparison, many energy efficiency measures cost multiples less in terms of their reductions in carbon dioxide emissions. The feed-in tariff has been a success at building renewable electricity capacity in the country, and we now urge the government to focus on creating sustainable market pressure to bring down the costs of operating and further developing its renewable energy resources. As renewables are well established in the market – they are set to increase to 20% of generation by 2020 – the government should consider moving towards a more flexible policy that meshes renewable resources with the full electricity market, providing additional R&D subsidies to particular technologies that require it. Not only would integrating Germany's electricity market with the internal European market be easier if its renewables promotion scheme relied more on market forces and less on government-provided guarantees, but integration would also provide renewables suppliers with incentives to build and operate the right kind of facilities in the right locations, and bring greater competitive pressure to lower costs. Turning to wind specifically, the government should continue its work to revise grid rules, regulations and operations in order to better integrate wind into the transmission system – rather than just accommodate it.

KEY RECOMMENDATIONS

The government of Germany should:

- *Reconsider the nuclear phase-out in light of the possible serious adverse consequences of its unaltered implementation for security of supply, economic efficiency and carbon dioxide emissions.*
- *Continue to reform the electricity and gas markets in order to set a level playing field for the development of genuine competition, particularly with respect to network access.*
- *Ensure consistent, co-ordinated and cost-effective climate change and renewables policy.*

Figure 1

Map of Germany

* *Länder* of the former German Democratic Republic (East Germany).

Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

Source: *IEA*.

COUNTRY OVERVIEW

The Federal Republic of Germany is one of the largest countries in Europe by many measures (see Figure 1). Its population is over 82 million people, compared with about 60 million each in the next largest European countries of France and the United Kingdom. Its economy is also the largest in Europe, the third-largest in the OECD and the fifth-largest in the world. In terms of geography, Germany is the fourth-largest country in the European Union (after France, Spain and Sweden), and shares borders with Denmark, Poland, the Czech Republic, Austria, Switzerland, France, Luxembourg, Belgium and the Netherlands. The country has almost 2 400 km of coastline along the Baltic and North Seas.

Since the reunification of Germany with the German Democratic Republic (East Germany) in 1990, Germany's population has remained nearly flat, and is forecast to possibly decline in the future. The largest city is Berlin, the capital, which has grown to a population of 3.4 million. In 1999, many governmental institutions, ministries and embassies were moved to Berlin from Bonn, the former capital of Germany. Other large metropolitan areas in Germany include the Rhein-Ruhr area (10 million), Frankfurt (5 million), Hamburg (4 million), Munich (3 million) and Leipzig (1.2 million).

Germany has a largely temperate and marine climate. Its terrain is a mix of lowlands in the northern part of the country, along with highlands in the centre and the Bavarian Alps in the southern region.

Germany is a federal democracy divided into 16 regions or *Länder*. At the time of this review, a grand coalition was in place between the two main parties in Germany, the Christian Democratic Union (*Christlich Demokratische Union Deutschlands*, CDU) and the Social Democratic Party (*Sozialdemokratische Partei Deutschlands,* SPD), along with the Christian Social Union (*Christlich-Soziale Union*, CSU). Germany has a bicameral parliament with a federal assembly *(Bundestag)* and federal council *(Bundesrat)*. The 614 members of the *Bundesrat* are elected by popular vote and serve four-year terms. The 69 members of the *Bundesrat* are not elected, but based on the composition of the 16 regional state governments; they are members of the state cabinets that appoint them and can remove them any time. As a result, the composition of the *Bundesrat* can change whenever one of the 16 *Länder* holds an election.

Germany is a modern and technologically advanced economy. The industrial sector continues to play a very large role, compared to many modern economies, contributing about one-quarter of gross domestic product (GDP). The main industries include iron, steel, coal, cement, chemicals, machinery, vehicles and electronics manufacturing. While the economy continues to grow relatively steadily, the country continues to suffer from high, though declining, unemployment (over 11% in 2005). In the long term, Germany faces challenges in managing its social pensions, as outlays of social security benefits exceed contributions, stemming from both the economic effects of the reunification of Germany and the aging of the population.

SUPPLY-DEMAND BALANCE

ENERGY SUPPLY

Germany's total primary energy supply (TPES) was 345 million tonnes of oil equivalent (Mtoe) in 2005 (see Table 1). While the country has a relatively balanced mix of fuels in its TPES, oil makes up the largest share of TPES at more than one-third, followed by coal (24%), natural gas (23%) and nuclear (12%). Compared to other IEA countries, Germany has a very high share of renewables in its TPES. Combined, renewables make up about 5% of TPES, with nearly three-quarters coming from combustible renewables and waste.

As shown in Figure 2, the shares of different fuels in Germany's TPES have remained relatively steady over the past decades. Looking back further, the share of coal has fallen from 40% in 1985 to less than a quarter in 2005, a decline that is less dramatic than in other countries. Similarly, natural gas as a share of TPES has grown from 13% in 1985[1] to 23% in 2005, a significant increase but less so than in other IEA countries such as Spain and Italy, where gas has grown dramatically over the last two decades.

Renewables in TPES have grown tremendously in recent years. Renewables (including biomass, solar, wind and geothermal, and excluding non-renewable waste) have grown from 1.8% of TPES in 1995 to 4.6% in 2005, equivalent to an average annual growth rate of 10.1%.

Germany relies on imports for over 60% of its energy needs. In addition to nuclear, Germany produces significant amounts of coal. In 2005, it provided about 70% of its 82 Mtoe of coal TPES. The country also produced 18% of its natural gas needs in 2005, along with less than 4% of oil supply. Energy production is presented in Figure 3.

1. For purposes of comparison, throughout this report, all pre-1990 Germany data have been modified to include both the Federal Republic of Germany (West Germany) and the German Democratic Republic (East Germany).

Table 1

Supply-Demand Balance, 2005

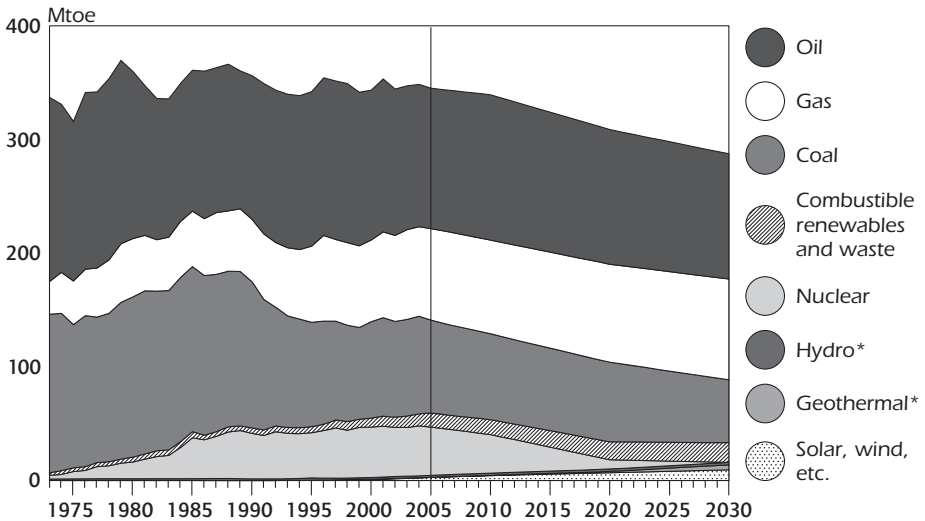
Unit = Mtoe	*Total*	*Oil*	*Coal*	*Natural gas*	*Nuclear*	*Biomass**	*Solar, wind, etc.*	*Hydro*	*Geothermal*	*Electricity*	*Heat*
Supply											
Production	134.5	4.6	56.5	14.2	42.5	12.2	2.7	1.7	0.1	0.0	0.0
Imports (net of exports)	214.5	123.4	25.7	65.7	0.0	0.0	0.0	0.0	0.0	– 0.4	0.0
Other	– 4.2	– 4.6	– 0.5	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total supply (TPES)	344.7	123.4	81.7	80.8	42.5	12.2	2.7	1.7	0.1	– 0.4	0.0
Demand											
Electricity production**	58.3	4.0	67.6	17.9	42.5	5.3	2.5	1.7	0.0	– 52.7	– 30.5
Industrial consumption***	83.2	26.9	7.3	21.4	0.0	0.0	0.0	0.0	0.0	20.0	7.8
Transport	63.3	60.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	1.4	0.0
Residential	63.7	16.9	0.5	29.0	0.0	4.8	0.2	0.0	0.1	12.2	0.0
Other sectors	50.7	8.1	0.4	10.9	0.0	0.0	0.0	0.0	0.0	11.0	20.4
Other (including losses)	25.5	7.6	5.9	1.7	0.0	0.1	0.0	0.0	0.0	7.8	2.4
Total	344.7	123.4	81.7	80.8	42.5	12.2	2.7	1.7	0.1	– 0.4	0.0
Fuel as share of total	100%	36%	24%	23%	12%	4%	1%	0%	0%	0%	0%

* Includes industrial and non-renewable municipal waste.
** The electricity generation row provides data on the fuel used to generate electricity and heat (141.5 Mtoe total from oil, coal, nuclear, natural gas, biomass, solar, wind, hydro and geothermal), the total output (83.3 Mtoe in the form of electricity and heat) and losses (58.3 Mtoe).
*** Includes non-energy use.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007.

Figure 2

Total Primary Energy Supply, 1973 to 2030

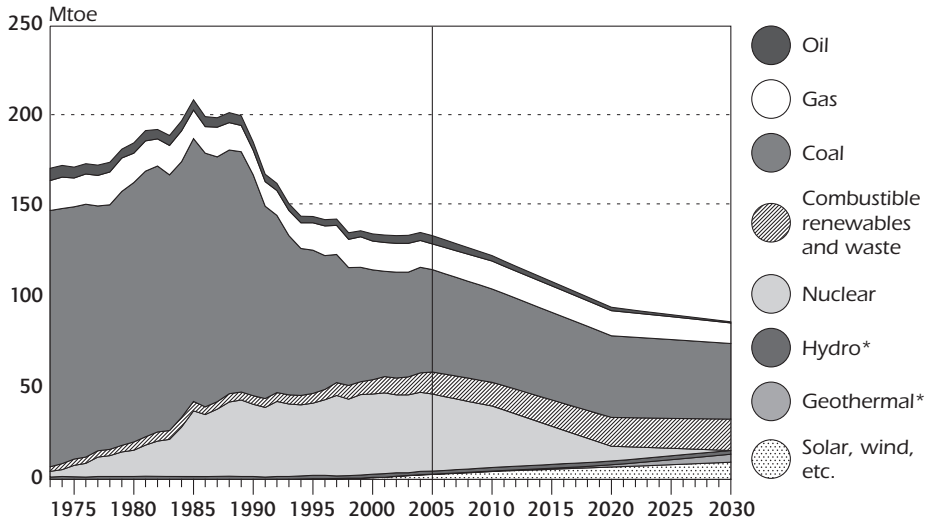


* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

Figure 3

Energy Production by Source, 1973 to 2030



* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

ENERGY DEMAND

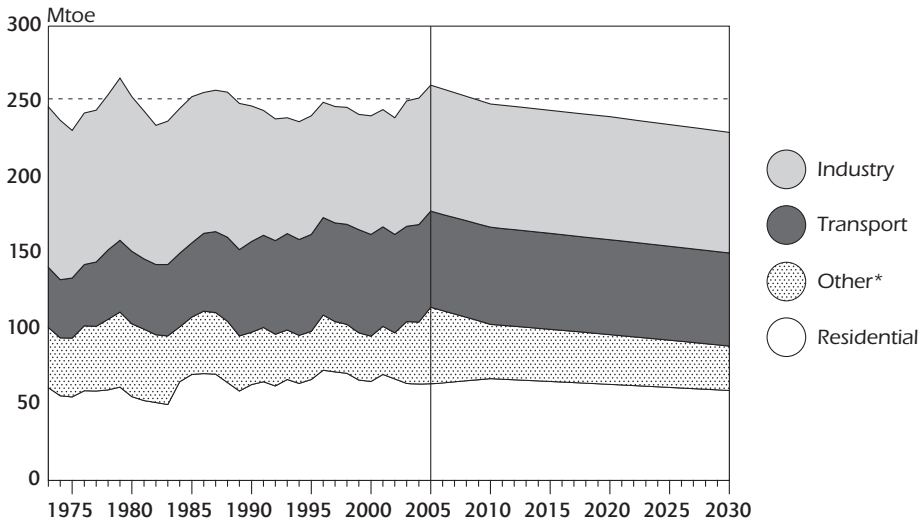
Total final consumption (TFC) in Germany was 261 Mtoe in 2005, an increase of 3.3% over 2004 (see Figure 4). The largest share of consumption is in the industrial sector, which consumes 32% of Germany's TFC, followed by the transport and residential sectors (24% each). The remainder is consumed by other sectors, including the commercial sector.

Mirroring Germany's flat TPES, its TFC has also remained relatively flat over the last two decades, though it exhibited a relatively large increase between 2004 and 2005. The share of TFC consumed in the industrial sector has fallen from 38% in 1985 to 33% in 1995, then fell to just under a third in 2005. The share of energy consumed in the transport sector has remained relatively flat since 1995, though its current share is an increase from 1985 when the transport sector comprised less than 20% of total consumption. Residential consumption has remained largely flat over the last decades.

Though TFC has increased by over 8% since 2000, absolute consumption in the transport sector has declined by nearly 6%, falling from 67.2 Mtoe to 63.3 Mtoe, in contrast to the trend in most IEA countries. Apart from efficiency gains, the consumption decline can also be attributed to an accelerated trend in road transport away from gasoline-fuelled and towards diesel-fuelled vehicles.

Figure 4

Total Final Consumption by Sector, 1973 to 2030



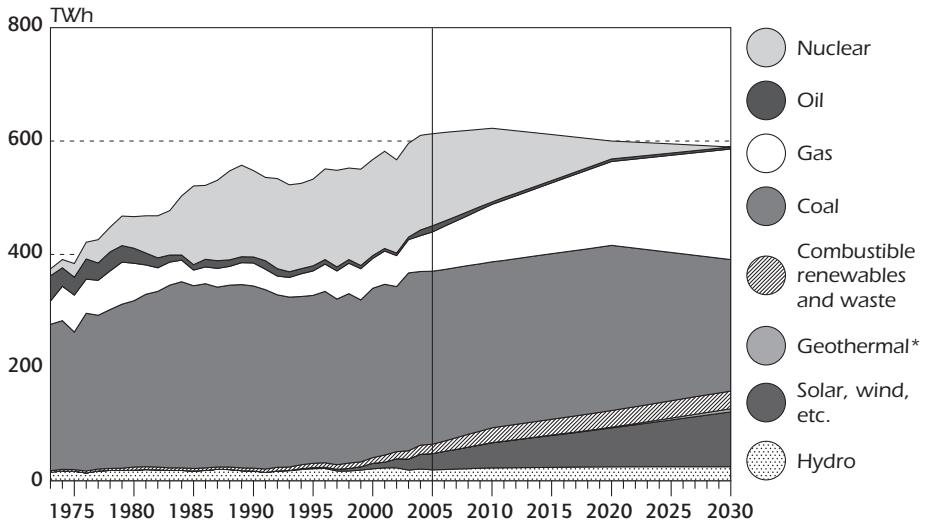
* includes commercial, public service, agricultural, fishing and other non-specified sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

ELECTRICITY GENERATION

In 2005, over 613 terawatt-hours (TWh) of electricity were generated in Germany, a slight increase from 2004 (0.5%) and an 8.1% increase from 2000 (see Figure 5). In 2005, the largest share of electricity was generated from coal, nearly 50%. This represents a large decline from 1985, when nearly 62% of electricity was generated from coal. At the same time, the amount of electricity generated from natural gas has more than doubled, from 5.4% in 1985 to 11.3% in 2005. The share of electricity generated from nuclear is 27%, the same as in 1995. This share has remained relatively steady since the mid-1980s. The largest growth has been in electricity generated from renewables (including biomass, solar, hydro and wind, and excluding non-renewable waste). The share has grown at an average annual rate of 9% since 1995, rising from 3.9% in 1985 to 4.9% in 1995 and to 10.1% in 2005.

Figure 5

Electricity Generation by Source, 1973 to 2030



* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

ENERGY FORECASTS

ENERGY SUPPLY AND DEMAND

Approximately every five years, the Federal Ministry of Economics and Technology (BMWi) commissions a long-term energy supply and demand forecast. The forecast is not done by the government, but by independent

scientific research institutes. The government uses the forecast for policy guidance, but does not officially adopt its findings. The most recent forecast, which was conducted by the University of Cologne's Institute of Energy Economics (EWI) and Prognos AG, was released in May 2005 with projections to 2030. However, in view of the current energy price trends, this forecast was supplemented by an alternative scenario in August 2006, the results of which are presented in Table 2. The new scenario is based on a significantly higher oil price trajectory as assumed in the reference forecast (a real oil price in 2030 of USD 60 per barrel instead of USD 37 per barrel).[2] The alternative scenario assumes an energy policy *status quo*, including that nuclear power will be phased out, according to the 1999 law. It also assumes that government support for renewables will continue and that greenhouse gas (GHG) emissions trading will expand. The alternative scenario is the basis for preparations for the final energy summit and resulting strategy.

According to the alternative scenario, TPES will decline through 2030, falling by 17.2% from 343 Mtoe in 2000 to 284 Mtoe in 2030, equivalent to an average annual decrease of 0.6%. The overall decline represents accelerating gains in energy efficiency. The most dramatic changes by fuel are forecast to come from nuclear and renewables. Some of the supply coming from nuclear will be offset by growth in renewables supply by 2030; the share of nuclear in TPES will go from 13% in 2000 to zero in 2030, while the share of renewables will go from 3% to over 15% over the same period. Supply from lignite (a domestically produced coal with low energy intensity) is also expected to cover some of the decline of nuclear, rising from less than 11% in 2000 to more than 12% in 2030. Hard coal supply is projected to rise slightly from 14% of TPES in 2000 to nearly 17% in 2030. The share of gas in Germany's TPES will also rise slightly between 2000 and 2030, from 21.1% to 22.5%, offsetting some of the nuclear phase-out. The share of oil in Germany's TPES is projected to decline from above 38% in 2000 to slightly above one-third in 2030.

Similarly, TFC is expected to decline from 221 Mtoe in 2000 to 193 Mtoe in 2030, a total decline of almost 13%, equivalent to an average annual decline of over 0.4%. In terms of energy consumption by sector, little change is projected through 2030. The share of energy consumed in the transport sector is expected to climb from slightly below to just above 30%. Similarly, the share of consumption in the household sector is projected to rise from 28% to 30%. Small decreases are expected in the commercial and industrial sectors.

GOVERNMENT AND REGULATORY INSTITUTIONS

Since the last in-depth review in 2002, energy policy institutions and structure have remained largely the same, with the exception of a new federal regulator for networks, the *Bundesnetzagentur*, which was established in 2005.

2. On average in 2006, USD 1 = EUR 0.80.

Table 2

Alternative Scenario Energy Forecasts to 2030*

	Unit	Absolute values				Average annual growth rate (%)			
		2000	2010	2020	2030	2000-2010	2010-2020	2020-2030	2000-2030
Indicators									
Population	million	82.3	82.4	81.3	79.3	0.0	-0.1	-0.2	-0.1
Households	million	38.2	39.7	40.0	39.7	0.4	0.1	-0.1	0.1
GDP (real 95)	billion EUR (1995)	1 970	2 197	2 544	2 887	1.1	1.5	1.3	1.3
Industry production (real 95)	billion EUR (1995)	403	439	506	575	0.9	1.4	1.3	1.2
Passenger cars	million	42.8	46.9	47.9	47.2	0.9	0.2	-0.1	0.3
Carriage (passenger-km)	billion (p-km)	1 051	1 093	1 062	1 026	0.4	-0.3	-0.3	-0.1
Carriage (tonnes-km)	billion (t-km)	491	591	702	774	1.9	1.7	1.0	1.5
Prices households (including VAT), real 2000									
Fuel oil (light)	e-cent(2000)/ℓ	40.8	59.4	60.3	75.0	3.8	0.2	2.2	2.1
Gas	e-cent(2000)/kWh	3.7	5.3	5.4	6.8	3.7	0.2	2.3	2.0
Electricity	e-cent(2000)/kWh	14.9	16.8	16.3	16.4	1.2	-0.3	0.1	0.3
Gasoline (unleaded)	e-cent(2000)/ℓ	100.0	123.6	126.4	139.2	2.1	0.2	1.0	1.1
Prices wholesale (without VAT), real 2000									
Fuel oil (light, industry)	EUR (2000)/t	381.5	556.4	560.9	695.3	3.8	0.1	2.2	2.0
Natural gas (industry)	e-cent (2000)/kWh	1.71	2.42	2.39	2.75	3.5	-0.1	1.4	1.6
Electricity (middle voltage)	e-cent(2000)/kWh	n.a.	8.4	8.3	8.8	n.a.	-0.1	0.6	n.a.
Electricity (high voltage)	e-cent(2000)/kWh	4.4	5.8	5.9	6.5	2.8	0.2	1.0	1.3
Total primary energy supply	**PJ**	**14 356**	**13 939**	**12 733**	**11 886**	**-0.3**	**-0.9**	**-0.7**	**-0.6**
	Mtoe	342.9	332.9	304.1	283.9	-0.3	-0.9	-0.7	-0.6
Oil	%	38.3	36.9	34.8	33.4	-0.4	-0.6	-0.4	-0.5
Natural gas	%	21.1	20.6	22.3	22.5	-0.2	0.8	0.1	0.2
Hard coal	%	14.0	15.2	17.5	16.6	0.8	1.4	-0.5	0.6
Lignite	%	10.8	11.1	11.8	12.6	0.3	0.6	0.7	0.5
Nuclear energy	%	12.9	10.0	2.7	0	-2.5	-12.3	-100	-100
Renewable energy	%	2.9	6.4	11.0	15.4	8.2	5.6	3.4	5.7
Total final consumption	**PJ**	**9 241**	**9 088**	**8 535**	**8 073**	**-0.2**	**-0.6**	**-0.6**	**-0.4**
	Mtoe	220.7	217.1	203.9	192.8	-0.2	-0.6	-0.6	-0.4
Households	%	28.2	30.6	30.4	29.9	0.8	-0.1	-0.2	0.2
Services	%	16.0	15.9	15.3	14.2	-0.1	-0.4	-0.7	-0.4
Industry	%	26.1	24.6	24.8	25.3	-0.6	0.1	0.2	-0.1
Transport	%	29.8	28.9	29.5	30.6	-0.3	0.2	0.4	0.1
Oil products	%	45.1	42.1	36.9	34.1	-0.7	-1.3	-0.8	-0.9
Natural gas	%	24.9	25.0	24.7	23.8	0.0	-0.1	-0.4	-0.2

Table 2

Alternative Scenario Energy Forecasts to 2030* *(continued)*

	Unit	Absolute values				Average annual growth rate (%)			
		2000	2010	2020	2030	2000-2010	2010-2020	2020-2030	2000-2030
Coal	%	5.3	5.6	5.5	6.0	0.6	-0.2	0.9	0.4
Electricity	%	18.8	20.0	21.5	22.4	0.6	0.7	0.4	0.6
District heating	%	3.5	3.5	3.4	3.2	0.0	-0.3	-0.6	-0.3
Renewables	%	2.3	3.8	8.0	10.5	5.1	7.7	2.8	5.2
Gross electricity generation	**TWh**	**575**	**589**	**586**	**586**	**0.2**	**-0.1**	**0.0**	**0.1**
Hydro	%	5.1	4.7	5.0	5.0	-0.8	0.6	0.0	-0.1
Nuclear energy	%	29.5	21.6	5.3	0	-3.1	-13.1	-100	-100
Hard coal	%	24.9	27.8	33.1	30.8	1.1	1.8	-0.7	0.7
Lignite	%	25.8	27.1	29.0	29.6	0.5	0.7	0.2	0.5
Natural gas	%	8.6	4.8	8.7	10.2	-5.7	6.1	1.6	0.6
Wind	%	1.7	7.3	11.2	15.8	15.7	4.4	3.5	7.7
Other	%	6.7	6.8	7.7	8.7	0.1	1.3	1.2	0.9
Efficiency indicators									
TPES per capita	Mtoe/capita	4.2	4.0	3.7	3.6	-0.5	-0.8	-0.3	-0.5
GDP/TPES	EUR/toe	5 736	6 615	8 374	10 174	1.4	2.4	2.0	1.9
Industry production/TFC	EUR/toe	6 992	8 206	10 049	11 765	1.6	2.0	1.6	1.7
Carriage (passenger-km)/TFC	p-km/kJ	539	587	643	642	0.9	0.9	0.0	0.6
Carriage (tonnes-km)/TFC	t-km/kJ	645	738	847	934	1.4	1.4	1.0	1.2
CO_2 indicators		**1990**	**2000**	**2010**	**2030**	**1990-2000**	**1990-2010**	**2010-2030**	**1990-2030**
CO_2 emissions	million tonnes	1 000	853	830	715	-1.6	-0.9	-0.7	-0.8
CO_2/GDP	g/EUR	614	388	326	248	-4.5	-3.1	-1.4	-2.2
CO_2/population	tonnes/capita	15.9	10.3	10.2	9.0	-4.2	-2.2	-0.6	-1.4

PJ = petajoule. n.a. = not available. * Data differ from IEA forecasts, as IEA forecasts use the reference scenario.

Sources: *Effects of Higher Oil Prices on Energy Supply and Demand: Oil Price Version of the Energy Forecast 2030,* EWI/Prognos, prepared for the Ministry of Economics and Technology, August 2006.

In energy policy, the federal state is primarily responsible for passing legislation and the *Länder* are responsible for administrative implementation of national law (although the central government has significant administrative powers). The individual states are involved in shaping energy

policy through the *Bundesrat*, ministerial-level conferences, a range of joint government and state committees and the working groups recently established at the national energy summit.

At the national level, responsibility for energy policy lies with the Federal Ministry of Economics and Technology (*Bundesministerium für Wirtschaft und Technologie*, BMWi). Market adoption of renewable energy sources and research on renewables is overseen by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit*, BMU). The BMU administers the Renewable Energy Sources Act (*Erneuerbare-Energien-Gesetz*, EEG) and is also responsible for environmental regulation that affects the energy sector (*e.g.* regulations relating to pollution abatement, climate change mitigation, nuclear safety and radiation protection). Issues concerning energy savings in buildings are dealt with by both the BMWi and the Federal Ministry for Transport, Building and Urban Affairs (*Bundesministerium für Verkehr, Bau und Stadtentwicklung*, BMVBS). The BMVBS is also in charge of the national fuel strategy. The Federal Ministry for Food, Agriculture and Consumer Protection (*Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz*, BMELV) oversees biomass issues. Energy taxation falls to the Federal Ministry of Finance (*Bundesministerium der Finanzen*, BMF) and its subordinate agencies.

The Federal Cartel Office (*Bundeskartellamt*), the national competition authority, and competition agencies in the individual German states are responsible for general matters like monitoring for abuses in the energy industry. The *Bundeskartellamt* also oversees mergers in the energy sector under Germany's Competition Act (*Gesetz gegen Wettbewerbsbeschränkungen*). The various decision divisions (*Beschlussabteilungen*) within the *Bundeskartellamt* each make competition-related decisions for a specific sector of industry following a quasi-judicial procedure. One such decision division is responsible for the energy sector. Decisions by the *Bundeskartellamt* may be contested through the civil courts.

Implementation of the EU directive on gas and electricity gave rise to a new energy policy framework, and the new Energy Industry Act (*Energiewirtschaftsgesetz*, EnWG) entered into force on 13 July 2005. Key secondary legislation on grid access and transit fees for gas and electricity has been in force since 29 July 2005. Enforcement of the new legal framework – in the case of grids that span two or more German states and for grid operators with 100 000 or more customers – lies with the Federal Network Agency (*Bundesnetzagentur*, BNetzA). Decisions of the BNetzA that are taken by independent ruling chambers can be appealed through the courts. Members of the ruling chambers of the BNetzA are not appointed and cannot be dismissed by the government. The president and vice president of the BNetzA are appointed by the government, but cannot be dismissed by the

government, except under very specific terms with approval from the cabinet of ministers. Decisions by the ruling chamber of the BNetzA cannot under any circumstances be overruled by the government.

The Monopolies Commission (*Monopolkomission*) is a body of scientists and legal experts appointed by the president at the government's recommendation to evaluate competition in Germany and publish biennial reports on competition trends in the gas and electricity markets.

Responsibility for monitoring security of supply in gas and electricity lies with the BMWi. As the German petroleum market has been fully competitive for many years, there is no dedicated regulatory institution. Responsibility for supply in times of oil crises lies with the BMWi.

Approval and monitoring of the construction, operation, decommissioning and dismantling of nuclear power plants is the responsibility of the individual German states, which are supervised and instructed in this regard by the BMU. Approval for transportation and intermediate storage of nuclear fuels and construction and operation of disposal facilities for radioactive waste falls under the jurisdiction of the Federal Office for Radiation Protection (*Bundesamt für Strahlenschutz*, BfS), which is an arm of the BMU. Supervisory activities in this sector are performed by the individual German states.

Administration of emissions trading and approval of joint implementation (JI) and clean development mechanism (CDM) climate change projects under the Kyoto Protocol's flexibility mechanisms fall to the German Emissions Trading Authority (*Deutsche Emissionshandelsstelle*, DEHSt) within the Federal Environment Agency (*Umweltbundesamt*, UBA). The pollution control authorities in the various German states are responsible for the approval of greenhouse gas emission allowances, these being an integral component of the approval procedures set out under pollution abatement law. The individual state administrations are also responsible for all issues concerning emissions monitoring and reporting.

The German Energy Agency (*Deutsche Energie-Agentur*, DENA) is the federal government's centre for energy efficiency and renewable energy sources. It is jointly owned by the German government and the KfW Bank Group, the German bank for reconstruction.

The government's leading geoscience advisory agency is the Federal Institute for Geosciences and Natural Resources (*Bundesanstalt für Geowissenschaften und Rohstoffe*, BGR). The BGR answers to the BMWi and advises the government on issues concerning the global availability, both in terms of region and quantity, of energy sources (particularly oil, natural gas, nuclear fuels and coal). Government agencies with a key advisory role include the Federal Statistical Office (*Statistische Bundesamt*, StBA) and the statistics offices in the individual German states, which perform the duties assigned to them under the Energy Statistics Act (*Energiestatistikgesetz*). Petroleum

statistics are collected and kept by the Federal Office of Economics and Export Control (*Bundesamt für Wirtschaft und Ausfuhrkontrolle*, BAFA). Other organisations responsible for statistics include the Working Group on Energy Balances (*Arbeitsgemeinschaft Energiebilanzen*, AGEB), which comprises representatives from the energy industry associations and energy research institutes and is supported by the StBA. Working on behalf of the BMWi, the AGEB produces Germany's national energy balances.

INTERNATIONAL LEADERSHIP

Germany held the presidency of the European Union (EU) for the first six months of 2007. For the whole of 2007, it also holds the presidency of the G8, a group made up of Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States that together represent about 65% of the world economy. During both presidencies, Germany has made energy matters top priority, particularly improvement of the functioning of the internal electricity and gas markets, expansion of cost-effective use of renewables, improvement in energy efficiency and the EU's international energy relations.

During the EU presidency, Germany is working to revise the directive on energy efficiency labelling, tackling stand-by power consumption, establishing targets for heating and cooling from renewable energies and updating the EU-wide targets for renewable energies for 2020.

For the G8 presidency, Germany is continuing efforts on energy efficiency begun at the 2003 G8 meeting in Évian, France and continued at the Gleneagles, Scotland meeting in 2005 and the St. Petersburg, Russia meeting in 2007, putting particular emphasis on the building and transport sectors.

KEY ENERGY POLICIES

Since the last in-depth review in 2002, the main changes with respect to Germany's energy policy are energy industry legislation in 2005 which installed a network regulator (BNetzA), the expansion of the use of renewable energy and the establishment of new energy efficiency targets. A new energy research programme with increased R&D budgets has also been released. In addition, an energy policy road-map is currently being prepared that will help guide Germany's energy policy for the coming decades.

ENERGY POLICY OBJECTIVES

German energy policy aims to combine security of supply and affordable energy prices with effective environment protection and climate change mitigation in an efficient manner. A central principle is individual responsibility of market participants. Investment decisions, for example, lie solely in the

hands of private energy suppliers. Nevertheless, the government believes that it remains one of its responsibilities to create conditions in which market forces can produce economically desirable outcomes. These conditions include the regulation of natural monopolies (such as gas and electricity grids), the development of market-based instruments for climate change mitigation (such as emissions trading) and the provision of subsidies for certain technologies that are not yet ready for the market (such as renewables).

PHASE-OUT OF NUCLEAR POWER

In 1999, the German government decided to phase out nuclear power in the country. A June 2001 agreement between the German government and energy utilities, as well as resulting amendments to the Nuclear Power Act enacted in April 2002, set out the terms of the planned phase-out of nuclear energy use for commercial power generation. The April 2002 changes to the Atomic Energy Act enshrined the nuclear phase-out in German law. The main feature of the legislation is a time limit for commercial electricity generation using nuclear power stations in Germany. Each power station is assigned a residual electricity output such that total output corresponds to an average 32-year lifetime. When a nuclear power station has generated the agreed output, taking into account transferred output allowances, it must be shut down. So far, two nuclear power stations have been taken off line: Stade (672 MW) in 2004 and Obrigheim (357 MW) in 2005. According to a rough estimate, all nuclear power stations in Germany will be out of service by around 2022. As output allowances can be legally transferred between power stations, it is not possible to forecast precise shut-down dates for individual power stations.

As the three parties in the current government do not share the same opinion on the use of nuclear power, their November 2005 coalition agreement includes language making it impossible to amend the phase-out agreement with energy utilities as well as the phase-out law.

Overall, a large part of the German population has strong reservations regarding the continued use of nuclear power in the country. However, according to Eurobarometer, which tracks public opinion in Europe, a significant proportion of those currently opposed to nuclear power would be prepared to accept it in the country's fuel mix if the issue of radioactive waste were solved.[3] The coalition agreement between the governing parties states their intention to resolve the matter of final disposal of radioactive waste, including high-level waste and spent fuel, within the lifetime of the present parliament.

3. Eurobarometer, *Radioactive Waste*, p. 30, June 2005; available from: //ec.europa.eu/energy/nuclear/waste/doc/2005_06_nucelar_waste_en.pdf

ENERGY SUMMITS AND ENERGY POLICY ROAD-MAP

The government believes it is important that market and policy conditions allow market players to base their investment decisions on a long-term planning horizon. For this and other reasons, in the second half of 2007, the German government intends to release an energy policy strategy road-map to 2020.

To underpin this energy road-map, the government planned to hold a series of three energy summits between April 2006 and the end of June 2007. In these meetings, representatives from the energy sector, industrial and private consumers, trade unions, research institutes and environmental and other non-governmental organisations were to develop recommendations for use as building blocks in drawing up the energy road-map. Three working groups were established, looking at national issues, international issues, and research and efficiency in preparation for the three meetings.

CLIMATE CHANGE AND ENVIRONMENTAL GOALS AND POLICIES

Under the Kyoto Protocol and the EU burden-sharing agreement, Germany agreed to reduce its emissions by 21% from 1990,[4] a target it is on track to meet. In addition to this international target, the country took on the European Union target to have renewables provide 4.2% of TPES by 2010, which it surpassed in 2006. Germany is also well on its way to meeting its domestic goal of producing 12.5% of electricity from renewable sources by 2010. Finally, the government has set a domestic target to double energy productivity – a measure of economic output per unit of energy – between 1990 and 2020. This will be a very challenging target to meet, requiring nearly doubling the 1.8% annual rate of improvement seen between 1990 and 2005.

Germany's rapid development of its renewables sector has been driven by its renewables promotion policy, a differentiated feed-in tariff. Under the differentiated feed-in tariff scheme, guaranteed rates range from a low of 3.78 eurocents per kWh for biomass to a high of 56.8 eurocents per kWh for photovoltaics, and are, in general, guaranteed for 20 years. The feed-in tariff rates are set so that all technologies are elevated to a level playing field; in

4. Countries can choose to measure emissions reductions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluroride (SF_6) against either a 1990 or a 1995 baseline.

terms of profit, an investor should be indifferent between the various renewable energy technologies. Annual degression rates between 1% and 5% are also applied to all technologies (except small hydropower), such that renewables installations going on line in future years receive progressively lower rates in order to account for technological and market learning. *Erneuerbare-Energien-Gesetz* (EEG), the Renewable Energy Act, guides the programme and mandates that the feed-in tariff programme be reviewed every four years in order to ensure that individual technologies are not oversubsidised.

Under the first national allocation plan (NAP) of the European Union Emissions Trading Scheme (EU-ETS), Germany gave a very generous allocation of carbon dioxide (CO_2) allowances to its coal-fired power plants and other energy installations, partly stemming from poor data quality. Learning from its experience with the first NAP, its recent second NAP proposed a somewhat less generous allocation for coal plants, giving energy installations free CO_2 allowances covering 85% of their 2000 to 2005 emissions. In addition, the proposal provided new entrants with significant levels of guaranteed free allowances for new plants of all technologies, including coal, for 14 years, and longer for some specific plants. To insulate energy-intensive industry from CO_2 costs given that they are subject to international competition with countries that do not have CO_2 reduction targets, as well as to ensure a diverse fuel mix, under the proposal these installations take on less stringent reductions in future. However, in November 2006 the European Commission ruled that Germany must amend its NAP to lower the overall allocation. Germany then announced its intention to amend its proposed allocation scheme in the energy sector, as well as to introduce energy efficiency benchmarks.

Germany's climate change policies, especially the CO_2 emissions cap for the energy sector and energy-intensive industries under the EU-ETS as well as the *National Climate Protection Programme* for all other GHG-emitting sectors, are designed to ensure that Germany meets its Kyoto and EU burden-sharing agreement obligations. Forecasts and projections of the federal government and independent studies by the IEA and the European Energy Agency indicate that Germany will be able to meet its target through domestic measures without a need on the national level to rely on the Kyoto Protocol's flexibility mechanisms, joint implementation (JI) and the clean development mechanism (CDM). JI and CDM are market-based mechanisms designed to lower the overall cost of reducing CO_2 emissions, as well as to spread CO_2-reducing projects and technologies to other countries. Germany is, however, a contributor to two public-private carbon funds (BASREC's NEFCO-managed Testing Ground Facility and the KfW Carbon Fund), with the goal to assist in their start-up phase and to encourage private sector engagement. Apart from this, Germany will allow EU-ETS participants to use the flexibility mechanisms for up to 20% of their CO_2 emissions.

STRUCTURE, OVERSIGHT AND REFORM IN ELECTRICITY AND GAS MARKETS

MARKET STRUCTURE

Electricity market

Four companies dominate the electricity market, E.ON, RWE, EnBW and Vattenfall (the Big Four). Combined, they have 70% of capacity and produce three-quarters of the electricity. There is no independent system operator. Rather, the Big Four each operate their own transmission systems and are obliged to provide third-party access[5] (TPA) to their networks. The Big Four also dominate retail supply and distribution, in part through cross-ownership of municipal utilities, or *Stadtwerke*. Together RWE and E.ON control 70% of the high-voltage network and 50% of the medium- and low-voltage networks. These vertically integrated companies are required to have legally unbundled their supply and trading arms from the monopoly sides of their businesses, namely transmission and distribution.

Natural gas market

Five companies control the high-pressure gas system in Germany (E.ON Ruhrgas, Wingas, VNG/Ontras, BEB and RWE). However, in total there are 750 local gas companies operating with geographic concessions at the city level. In most cases these are owned partly by local government and partly by one of the mega-utilities above. An entry-exit third-party access system to the transport pipelines has been required from February 2006, but the German gas network operators are still trying to implement a workable system given that most pipeline owners are financially dependent on companies involved in gas supply. The BNetzA has ruled against the current system, requiring further changes as discussed below.

MARKET OVERSIGHT

Changes to energy industry legislation in 2005 were made to improve conditions for competition in Germany's electricity and gas markets. Gas and electricity grid operators are now subject to regulation by the newly established BNetzA and by regulatory authorities in the individual German states. Among other things, grid operators are responsible for ensuring non-discriminatory access to the transmission networks.

5. In the United States, Australia and some other markets, "third-party access" is typically referred to as "open access". This regime gives all market participants non-discriminatory and transparent access to transportation regardless of transmission line or pipeline ownership or operation.

Bundesnetzagentur

The *Bundesnetzagentur* was established in July 2005 to regulate all network industries in Germany (including electricity, gas, telecommunications, postal and, since 1 January 2006, railway markets). An initial focus of the regulator has been grid fees, which are currently subject to *ex ante* regulation. The regulation requires that networks provide third-party access and allows customers to come to the BNetzA to obtain regulator-approved rates. In 2006, the BNetzA ordered many large gas and electricity network operators to lower their grid tariffs by between 6% and 28%. Following a 2006 report by the BNetzA proposing *ex ante* incentive-based regulation, the BMWi is drafting such legislation.

The BNetzA proposal contains two steps to fully implement *ex ante* incentive-based regulation. The first step is to institute a revenue cap aimed at reducing major differences in economic efficiency across grid operators within Germany and, with respect to transport networks, compared to benchmarking studies from outside Germany. The revenue cap would limit total revenues earned by grid operators. Progressive x-factors that reduce the revenue cap would attempt to reflect expected efficiency gains. The second step foresees imposition of "yardstick" regulation, which rewards network operators based on their performance compared with competitors.

Responsibilities of the *Bundesnetzagentur* include supervision of the implementation of unbundling in accordance with the EnWG, the new Energy Industry Act of 2005. Where transmission system operators and distribution system operators are part of vertically integrated entities, they had to be made independent (through legal and functional unbundling) from other activities not relating to transmission or distribution (*e.g.* generation, supply, trading). Distribution system operators may postpone the implementation of the legal unbundling provisions until 1 July 2007 while integrated electricity and gas entities serving less than 100 000 connected customers are completely exempted from the legal and functional unbundling provisions. Besides the legal measures for legal and functional unbundling, electricity and gas entities must keep separate accounts in their internal accounting for each of their transmission and distribution activities (account unbundling). Transmission and distribution operators must implement informational unbundling through measures to preserve the confidentiality of commercially sensitive information. The EnWG allows no exemption from the account and informational unbundling provisions.

The BNetzA has also begun to focus on gas sector reform. TPA to pipelines based on an entry-exit model requiring only a feed-in and withdrawal contract was to have taken effect in October 2006. However, the industry implemented and used a different model, the so-called "option model", which, in practice, was not very different from the previous regime, the point-to-point city-gate model. In November 2006, the regulator ruled the option model illegal and

ordered grid operators to solely implement an entry-exit model by April or October 2007, depending on when the relevant TPA agreements were reached. The entry-exit model was originally to have 19 zones, but this has since been reduced to 17. The BNetzA is now conducting consultations with market players aiming at a voluntary means of further reducing the number of market zones. If unsuccessful, the BNetzA is likely to open formal proceedings. Nuon Deutschland, a new energy market entrant, petitioned the regulator that this number was too high, but the BNetzA declined to lower the number of zones in a ruling in November 2006, finding the Nuon proposal unlikely to reduce the number of zones. The logistics of actually transporting the gas into and out of the zones, as well as delivering to final consumers in Germany, had been a key problem for new entrants in the previous model and this was not addressed in the new ruling.

The BNetzA is currently conducting training for the energy companies' compliance officers in order to better monitor and regulate functional unbundling, including informational and operational unbundling, within vertically integrated gas and electricity utilities.

Bundeskartellamt

The *Bundeskartellamt*, the Federal Cartel Office, has responsibility for merger control, as well as monitoring for anti-competitive behaviour. Efforts are under way to expand the powers of the *Bundeskartellamt*, making it easier to investigate and prosecute market power abuse cases.

The *Bundeskartellamt* is also looking into transparency of the energy markets, having found that more information, such as on electricity generating capacity, might promote competition.

SECURITY OF SUPPLY

Germany's indigenous production (including production from nuclear and renewables) peaked in 1985, when it met almost 58% of total consumption. Since then, as coal, oil and natural gas production have declined relative to total primary energy supply, total indigenous production now covers about 40% of supply.

While Germany has a relatively high share of oil in its TPES compared to other IEA countries, overall it relies on a diverse set of fuels to meet its supply needs. There is a falling reliance on oil, and a significant share of supply is provided from coal, natural gas and nuclear. Furthermore, the share of renewables has been growing quickly in recent years and combined renewables now make up about 5% of TPES, with around three-quarters coming from combustible renewables and waste.

COAL

Germany has ample reserves of lignite and bituminous coal, though production of the latter requires significant production subsidies as it is not competitive with the world market. As these subsidies are phased out and more mines are closed, Germany will be able to easily fill the gap from the competitive international market for bituminous coal.

OIL

Germany is heavily reliant on imports for its oil supply – it produces only 37% domestically, a share that continues to decrease. As a member of the IEA, Germany is required to hold 90 days of net oil imports in storage as strategic stocks, and Germany's stocks have never fallen below this level. This helps ensure that collective action by IEA member countries during supply disruptions is effective, such as the stock release following hurricanes Katrina and Rita in 2005.

NATURAL GAS

Germany produces less than one-fifth of its natural gas needs domestically, relying on imports from five countries to cover most of its needs. Russia's Gazprom supplies more than 40% of the total. Furthermore, this share has been increasing in recent years. As one supply pipeline transits through Ukraine (the other through Belarus), Germany was negatively affected by the January 2006 Russia-Ukraine gas dispute. Nord Stream, a direct pipeline under the Baltic Sea between Russia and Germany, is expected to come on line in 2010, providing another route for gas imports, though this will likely further increase reliance on Russian gas. Wingas (a Wintershall-Gazprom joint venture) is currently building two large underground storage sites, the first at Rheden in Germany and the second at Haidach at the German border with Austria in conjunction with an Austrian company, RAG. These will be two of the largest storage sites in Europe.

ELECTRICITY

In 2005, Germany had 132.3 gigawatts (GW) of installed generating capacity, up from 129.1 GW in 2004. It has the largest installed capacity base in the EU. Peak load hit almost 77 GW in December 2005. At the time an additional 6 GW of capacity was available, indicating sufficient reserves. Though the reserve margin statistic provides a more limited indication of supply security given that Germany has interconnections to 11 other countries, congestion on some of these interconnections limits import capacity and the

ability of Germany to rely on these interconnections to enhance security of supply. Electricity companies indicate that 40 GW of new capacity are planned, including 20 GW of new renewables capacity.

In November 2006, a transmission outage in north-west Germany resulted in power losses that eventually affected 15 million customers in parts of several European countries. Subsequent studies also found that aggravating factors included insufficient co-ordination between adjacent transmission system operators and an inability to control old wind installations' automatic disconnection and reconnection to the grid. (For further information, see the box in Chapter 9.)

TAXATION POLICY

On 1 April 1999, the first phase of Germany's ecological tax reform entered into force. The law launching the reform (*Gesetz zum Einstieg in die ökologische Steuerreform*, enacted on 24 March 1999) raised the petroleum taxes on motor and heating fuels and introduced a tax on electricity. Under a second law continuing the reform (*Gesetz zur Fortführung der ökologischen Steuerreform*, enacted on 16 December 1999), the petroleum taxes on motor fuels and the electricity tax rate were raised in four more phases on 1 January each year from 2000 to 2003. In the case of gasoline and diesel, the petroleum tax was additionally split from 1 November 2001 into two separate rates according to sulphur content, with a 1.53 eurocent per litre (ℓ) lower rate on low-sulphur fuels (initially those with a sulphur content of up to 50 mg per kg and from 1 January 2003 those with a sulphur content of up to 10 mg per kg). A third law (*Gesetz zur Fortentwicklung der ökologischen Steuerreform*, enacted on 23 December 2002) modified the fifth phase of the eco-tax reform from 1 January 2003, among other things by raising the petroleum tax rates on natural gas, liquefied petroleum gas (LPG) and heavy heating oil.

The ecological tax reform aimed to encourage energy savings through taxes that raised the prices of motor fuels, heating fuels and electricity. The final phase in 2003 essentially completed the ecological tax reform project. The former Petroleum Tax Act (*Mineralölsteuergesetz*) has now been replaced and the Electricity Tax Act (*Stromsteuergesetz*) amended by a new act on fuel and electricity taxation in force since 1 August 2006 (*Gesetz zur Neuregelung der Besteuerung von Energieerzeugnisse und zur Änderung des Stromsteuergesetzes*, enacted on 15 July 2006). This did not alter the prevailing standard tax rates, partly because the extra tax revenues from changes introduced under the ecological tax reform are still needed to fund additional pension policy measures (mostly to reduce pension contributions) and partly because the German government has ruled out further tax increases in view of recent rises in energy prices.

Standard tax rates for main energy products are given in Table 3.

Table 3

Tax Rates as of January 2007

Motor fuels	
Gasoline	EUR 654.50/1 000 ℓ
Diesel	EUR 470.40/1 000 ℓ
Heating fuels	
Heating oil	EUR 61.35/1 000 ℓ
LPG	EUR 60.60/1 000 kg
Natural gas	EUR 5.50/MWh
Electricity	EUR 20.50/MWh

Source: Country submission.

Certain tax exemptions serving economic, environmental or social policy objectives were reversed by modifications to the fifth phase of the eco-tax reform. Exemptions were further cut back in 2003 and 2004 in the context of efforts to reduce subsidies generally. The main exemptions apply for heating fuels and electricity used in manufacturing, farming and forestry; they aim to make up for the lack of tax harmonisation in the EU on behalf of business enterprises facing international competition. Farmers and forestry operators pay a reduced rate of tax on diesel used for agricultural or forestry purposes. Tax relief is also provided for combined heat and power (CHP) plants, for natural gas and LPG used as motor fuels, for rail transport and local public transport, and for organic motor and heating fuels.

The German government makes due allowance in energy and electricity taxation for the need to safeguard German industrial competitiveness. Other major policy objectives besides competitive energy prices include security of supply and climate change mitigation. In line with these objectives, from 1 January 2007 the petroleum industry is required to market a statutory minimum quota of biofuels. Diesel must on average contain a minimum of 4.4% biodiesel by energy content and gasoline must on average contain a minimum of 1.2% of bioethanol by energy content. The biofuels quota obligation largely replaces tax relief on biofuels, advancing the aims of subsidy reduction and national budget consolidation.

CRITIQUE

The government has made substantial progress in its energy policies since the IEA's last in-depth review in 2002. The decision to install a network regulator, the *Bundesnetzagentur* (BNetzA), not only sets a sound

foundation for genuine competition in gas and electricity markets to emerge, but also signals the government's firm commitment to getting energy market design and regulations right. We applaud the installation of the BNetzA; strong, independent institutions are necessary for energy markets to develop as they send signals to the market that a fair and stable environment for energy investment and trade is in place, encouraging new entrants and long-term investments. The BNetzA's actions to date show that it is already undertaking the hard work of regulating gas and electricity networks. Furthermore, we are pleased to see efforts to enhance the power of the *Bundeskartellamt*, the competition authority. Detecting and proving market power abuse in energy markets is notoriously difficult and the high levels of concentration in Germany's gas and electricity market underscore the need for vigilant and effective monitoring and enforcement of competition law.

Turning to renewables, we commend Germany for taking on ambitious renewables targets – and for meeting its primary energy supply goal early and being well on the way to meeting the electricity generation goal. While we believe that Germany should now undertake efforts to make its overall climate policies more co-ordinated and cost-effective, we commend the government's strong commitment to renewables deployment. Germany's strong support for these technologies helps to advance their development and lower their costs for all countries.

Owing to public support for the end of nuclear power in Germany, in 1999 the government passed legislation to permanently phase out nuclear power in the country, which resulted in a 2000 agreement with nuclear power plant owners. A number of IEA countries do not have nuclear power or have decided to phase it out, and the IEA duly understands that whether to have nuclear power is a political decision on the part of individual countries. However, nuclear makes up an important part of Germany's current energy mix – 12% of primary supply and 27% of electricity – and eliminating it from the fuel mix comes at a cost. First, these are depreciated assets that generate baseload power at low operating costs, many of which could continue to operate safely for decades longer than the 32-year average lifetime limit. (Many nuclear plants, if refurbished, operate safely beyond their rated lifetimes.) More importantly, in the context of Germany's overall climate change goals, generation from nuclear power plants does not produce carbon dioxide emissions. While estimates show that theoretically all supply from decommissioned nuclear plants could be replaced with a combination of renewables and energy efficiency gains, in reality the nuclear phase-out will result in some absolute increase of emissions as natural gas and baseload coal plants fill some of the gap. Furthermore, the intermittency of wind means that wind capacity also requires backstop reserve capacity – most likely coal, but also natural gas. Overall, the elimination of nuclear is a liability with respect to energy security, as there

will inevitably be greater reliance on natural gas imports from the world market. It will also prevent Germany from reaching its full potential for cutting carbon dioxide emissions beyond the first 2012 Kyoto Protocol commitment period.

For these reasons, we strongly encourage the government to reconsider the decision to phase out nuclear power. This will require gaining increased public acceptance for the technology. Recent information on public attitudes towards nuclear power shows that in Germany, as in many countries, obtaining higher levels of public acceptance hinges on the ability of the government to successfully address the radioactive waste disposal question. As discussed more fully in Chapter 10, the statement of intent to do this by the end of the current parliament is a positive step, and the government should be encouraged to adhere to this deadline. Engaging the public in an informed debate about the role of nuclear in the country's fuel mix – given the simultaneous economic, security and environmental goals – will be necessary. In light of the integrated nature of the European energy market, and the corresponding exchange of electricity between countries that have different fuels in their portfolios, German citizens should be aware of the real impacts of phasing out nuclear power on national safety and environmental goals, along with the effects on energy security and economic growth.

Turning to market reform, the IEA is pleased to see real progress on market reform since the last review in 2002, particularly in the electricity sector where a competitive market has begun to develop. The large size and strategic location of Germany's gas and electricity markets make their success pivotal to the success of EU-wide markets in gas and electricity. As in New Zealand, Germany originally undertook liberalisation without creating a strong institution to monitor and regulate energy markets. Recently, New Zealand reversed course and established regulators for gas and electricity after determining that strong institutions were required to ensure fair and competitive markets for all participants. Germany has come to a similar conclusion about the necessity of an energy regulator. As discussed earlier, the IEA welcomes the recent creation of an energy regulator, as it is a necessary condition for a well-functioning market.

Germany should now turn to ensuring open, non-discriminatory access to gas and electricity networks. Looking at the electricity market, in 2005, Germany implemented legal and functional unbundling of vertically integrated transmission owner-operators as a means of separating monopoly network assets from the competitive parts of energy businesses, the weakest means of complying with the terms of the EU's energy directives. Legal unbundling provides limited transparency of business operations, making it difficult to ensure that there are strict Chinese walls, or separation, between business units. Effective Chinese walls are necessary to prevent unfair information transfer and preferential treatment. The dominance of the Big Four electricity

companies in transmission, distribution and generation exacerbates this lack of transparency, making it even more critical to ensure non-discriminatory access to all market participants, particularly new entrants. Thus we are pleased to see the installation of the BNetzA as a regulator focused on network access and operations, as well as its efforts to closely monitor and enforce legal unbundling.

While legal unbundling of transmission assets alone can result in non-discriminatory access to networks, a more complete means of achieving this while still not requiring ownership unbundling is through the creation of an independent system operator. As opposed to transmission system operators that own and operate transmission system assets, independent system operators manage and operate transmission system assets without influence from transmission owners, but do not own the assets themselves. Particularly in electricity, it is not possible to set up detailed rules that govern network operations in all circumstances. Operators must often make choices among different options on how to run the grid and it is impossible to fully remove this element of choice in system operations – choices that have different costs and benefits to different stakeholders. It is therefore best to ensure that network operators do not have distorted incentives that might influence the choices they make. An independent system operator is the model in place in many locations, including throughout the eastern United States, in Scotland, in many Canadian provinces and in Australia. This model largely eliminates these distorted incentives from network operations and works to set a genuinely level playing field for network access to all existing and future market participants.[6] We strongly encourage Germany to move to this model, as it provides long-term confidence that all generators can access the transmission network on equal terms. Despite the legal and functional unbundling in place, the current system – where dominant incumbent generator-retailers are part of the same holding companies that also operate the transmission system – does not inspire the same confidence for potential new entrants. The German government is currently drafting an ordinance to support discrimination-free network access in addition to the existing legal unbundling provisions, helping to buttress existing third-party access conditions.

While the initial cause of the 4 November 2006 European electricity outage was human error, the effect was exacerbated, in part, by a lack of co-ordination among adjacent transmission systems. The relatively swift reconnection of all customers highlights German grid operators' successful implementation of the restoration procedures developed by the Union for the Co-ordination of

6. As compared to a system with ownership unbundling of transmission assets, *i.e.* where a transmission system operator owns and operates the network, there are some greater incentives for an independent system operator that does not own the assets itself to favour certain generation, particularly with respect to grid investment costs.

Transmission of Electricity (UCTE), and the effectiveness of those procedures. Nevertheless, the IEA urges more to be done to prevent such events from occurring in the first place. In part, this can be done by reducing seams between neighbouring systems. Germany has four transmission systems, each operated by one of the Big Four. The transmission systems are physically meshed, but operations are distinct; the four transmission operators co-ordinate across regions. However, the outage highlights the limits of existing co-ordination efforts, both between Germany and neighbouring countries and within transmission areas in Germany. Moving from four transmission operators to one would help alleviate reliability concerns, and further spur competition, as market participants would need to co-ordinate transactions with only one entity, thereby reducing transaction costs. While the geographic areas of the individual zones in Germany are larger than many European countries, we encourage the government to consider moving to a single independent system operator in the longer term in order to enhance reliability, competition and efficiency of operations. The rapid development of wind capacity further highlights the need for highly co-ordinated system operations, as larger market areas are better able to manage higher levels of wind penetration. Germany could look to the experience in the Atlantic region of the United States, where system operations of many different transmission systems were merged into a single entity, PJM, or the example of Australia, where responsibility for six of the country's regions were merged into one operator, NEMMCO.

Turning to the natural gas market, the complexity of Germany's gas transport network has prevented development of a well-functioning market. We are very encouraged by the BNetzA's rejection of the option model for transportation booking, and we look forward to the implementation of a functional entry-exit model in Germany in 2007. Nevertheless, we are concerned that the numerous balancing zones will inhibit the development of real competition, while the issue of organising and booking transportation capacity across various and diverse transmission companies remains open. Priority needs to be given to putting in place a sound framework for a gas market to develop as quickly as possible. As in the electricity market, an independent system operator for all gas transportation, at least within each balancing zone, would be best able to ensure non-discriminatory access and co-ordinate transmission booking, setting the foundation for a competitive gas market to develop.

Overall, reducing the complexity of transportation networks for gas and electricity and ensuring non-discriminatory access to them will help underpin continued development of energy markets in the country. It will encourage new entrants in both markets, reducing the large market shares of the dominant incumbents in the gas and electricity industries.

Germany has ambitious climate change policy objectives, including very stringent CO_2 targets in the long run. The country is well on its way to achieving its Kyoto Protocol target of a 21% reduction in greenhouse emissions in 2012 compared to 1990, although additional measures are necessary to achieve full

compliance. The nuclear phase-out complicates this task, especially when we take the challenging long-term targets into account. Another measure that is not in line with these ambitions is Germany's initial second national allocation plan under the European Union Emissions Trading Scheme (EU-ETS) that would give relatively generous conditions for the allocation of carbon allowances to new coal and lignite power plants. This is at cross-purposes with the target of reducing CO_2 emissions, as coal plants emit much more CO_2 than other fossil fuels, most notably natural gas. The EU-ETS should be used to create incentives to reduce CO_2 emissions. Efforts to protect and promote coal-fired generation in the face of competitive and security of supply concerns should be done through means other than the EU-ETS. Finally, henceforward Germany should use, to the fullest extent allowed by the EU, auctioning of carbon allowances, perhaps with revenue recycling. As allowance costs – real or opportunity – will likely continue to be passed on in wholesale prices, auctioning coupled with revenue recycling directly back to customers or through tax offsets would enhance incentives to the market to move towards low-carbon energy sources.

Market-based instruments like the tradeable certificates of the EU-ETS help reduce the costs of lowering CO_2 emissions. In this light, we are pleased to see that the government has increased the level at which companies are allowed to rely on the Kyoto flexibility mechanisms of joint implementation (JI) and the clean development mechanism (CDM) in order to meet their emissions limits under the EU-ETS, as these mechanisms provide a cheaper means of compliance with Kyoto objectives, as well as drive an international market for greenhouse gas emissions reductions.

We commend Germany for its leadership in promoting the deployment of renewables through an effective feed-in tariff policy that provides long-term security for investments in renewables. Clearly, the uptake of renewables in Germany has advanced substantially and rapidly. However, the cost-effectiveness of stimulating all renewables, including the most expensive technologies such as solar photovoltaics, is an issue to tackle henceforward. In fact, climate change policies across the board should make cost-effectiveness a key criterion. This will require, for example, ensuring that different policies to support renewables are compared not only between each other, but also to other policies that achieve the same goals, such as energy efficiency improvements. For example, Germany's feed-in tariff subsidises solar PV at 40 eurocents per kWh above the average cost of electricity. The benefit of this policy in terms of avoided CO_2 emissions corresponds to a carbon abatement cost of EUR 1 000 per tonne of CO_2 abated (assuming solar PV replaces gas-fired generation). Many efficiency improvements have negative carbon abatement costs; even relatively expensive efficiency retrofits of buildings have costs that are 30 to 50 times lower in terms of reduced CO_2 emissions.

Energy efficiency is a renewed priority of the current government. We commend Germany for putting this at the top of its list of priorities, in particular for elevating its importance to the international level through its current

presidencies of both the EU and the G8. However, the target of doubling energy productivity between 1990 and 2020 – equivalent to a 3% efficiency improvement annually until 2020 compared with an historical average of 1.8% annually since 1990 – is a very ambitious one. To become a realistic goal, a sound foundation is needed. At present, little is known on the policies and measures that will contribute to achieving this target. The government should work to quickly detail how it will ensure it meets its targets.

RECOMMENDATIONS

The government of Germany should:

- *Reconsider the nuclear phase-out in light of the possible serious adverse consequences of its unaltered implementation for security of supply, economic efficiency and CO_2 emissions.*
- *Improve competition in the electricity market and spur competition in the gas market by:*
  - *Supporting and, where needed, further empowering the BNetzA to vigorously pursue effective implementation of non-discriminatory access to electricity and gas grids.*
  - *Implementing genuinely independent transmission system operations and considering creating a single independent system operator.*
  - *Giving absolute priority to putting in place a framework that creates genuine competition in the gas market.*
  - *Encouraging new entrants in the electricity and gas markets.*
  - *Pursuing the proposed changes in the cartel law to act against possible abuse of dominant market position in the energy sector.*
- *Ensure a consistent and comprehensive climate change policy by:*
  - *Sending the same signals for low-carbon energy use across the board, irrespective of technology.*
  - *Avoiding over-allocation of allowances to high-carbon power plants in the new national allocation plan; promoting coal-fired generation through means other than the EU-ETS.*
  - *Making greater use of market-based instruments like tradeable certificates, joint implementation and the clean development mechanism (JI/CDM) to improve cost-effectiveness.*
  - *Making cost-effectiveness a key component of the renewables promotion scheme, in particular by reconsidering the generous feed-in tariffs for certain technologies, such as solar photovoltaics.*

Germany has taken on a target under the Kyoto Protocol to reduce its greenhouse gas emissions by 21% compared with the base year 1990.[7] The most recent data indicate that the country is on track to achieve this goal, though some additional measures are needed. Under the European Union's Emissions Trading Scheme, Germany has recently completed its national allocation plan for carbon allowances given to industry and power plants, a highlight of which is the long-term guarantee of allowances for new entrants. However, the EU has required that the plan be modified to lower the overall number of allowances given.

CARBON DIOXIDE EMISSIONS PROFILE

HISTORICAL EMISSIONS

Owing in large part to restructuring and modernisation in Germany's economy following reunification, particularly in the former German Democratic Republic (East Germany), energy-related CO_2 emissions fell by over 12% between 1990 and 2004 (see Figure 6). As shown in Table 4, this decline took place in the 1990s, when emissions fell steadily at an average annual rate of 1.5%. Despite the overall drop in emissions between 1990 and 2004 and the decline in the 1990s, since 2000 emissions have been rising modestly, increasing at an average annual rate of 0.6%.

The lion's share of the total decline since 1990 is from decreases in CO_2 emissions from coal-fired plants, which have fallen by 32% since 1990. Emissions from the combustion of oil also declined over the period, falling by nearly 7%. Some of these decreases were offset by increases in emissions from natural gas combustion, which grew by nearly 57% over the period.

PROJECTED EMISSIONS

According to government projections based on May 2005 studies conducted by the University of Cologne's Institute of Energy Economics (EWI) and Prognos AG, energy-related CO_2 emissions are expected to fall by a further 18% between 2004 and 2030, assuming large decreases in coal emissions, moderate decreases in oil emissions and modest increases in emissions from natural gas.

7. Countries can choose to measure emissions reductions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) against either a 1990 or a 1995 baseline.

Table 4

CO_2 Emissions by Fuel*, 1970 to 2030

Unit : $MtCO_2$	*Coal*	*Oil*	*Natural gas*	*Combustible renewables and waste*	*Total*
1970	581	377	28	0	**986**
1980	552	391	115	3	**1 061**
1990	517	327	118	5	**966**
2000	336	325	158	8	**827**
2001	339	331	165	10	**846**
2002	339	319	165	9	**833**
2003	342	310	185	8	**845**
2004	351	304	185	8	**849**
2010	303	308	190	8	**808**
2020	281	283	198	8	**770**
2030	224	261	203	8	**696**
Change (1990-2004)	–32.1%	–6.9%	56.6%	81.3%	**–12.2%**
Projected change (2004-2030)	–36.3%	–14.1%	9.7%	0.0%	**–18.0%**
Average annual growth rate (1990-2000)	–4.2%	–0.1%	3.0%	5.3%	**–1.5%**
Average annual growth rate (2000-2004)	1.1%	–1.6%	4.0%	1.9%	**0.6%**
Average annual growth rate (2004-2030)	–1.7%	–0.6%	0.4%	0.0%	**–0.8%**

* estimated using the IPCC Sectoral Approach. Data differ from data presented in Table 2, as those forecasts are based on the alternative scenario.

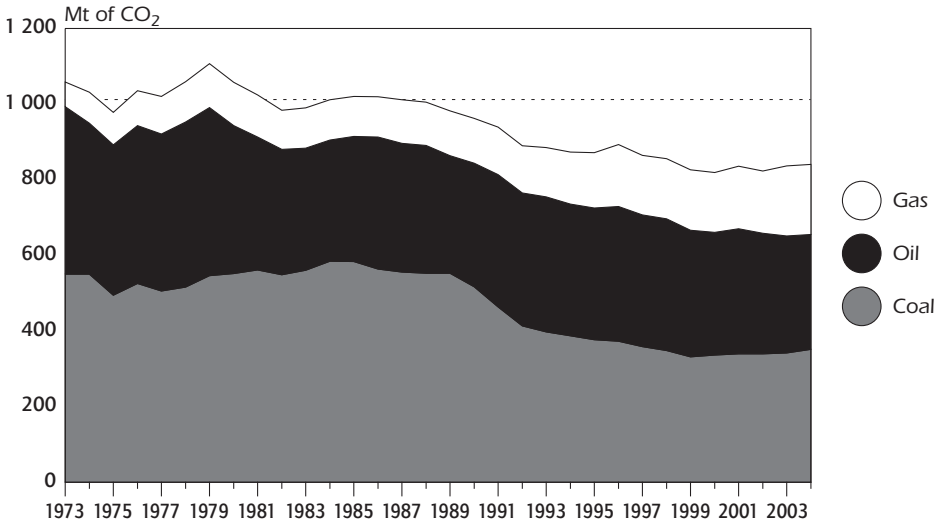
Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2007.

KYOTO TARGET

Germany ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 9 December 1993 and the Kyoto Protocol on 31 May 2002. As part of the agreement and the associated EU burden-sharing agreement, Germany has a target to reduce its greenhouse gas emissions by 21% by 2008 to 2012 compared with the base year 1990 (and,

Figure 6

CO_2 Emissions by Fuel*, 1973 to 2004



* estimated using the IPCC Sectoral Approach.

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2007.

in some cases, 1995). According to the most recent European Environment Agency report, Germany is on track to meet this target by 2010, assuming additional policies and measures are implemented. Through 2004, Germany reduced its total greenhouse gas emissions (including all six greenhouse gases) by 17.4%. When the effects of land-use change are included, Germany reduced its emissions by 18.5% as compared with its baseline.

CLIMATE CHANGE POLICY

INSTITUTIONAL ARRANGEMENTS

Climate change mitigation policy is the responsibility of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit*, BMU). At the time of this review, a grand coalition was in place between the two main parties in Germany, the Christian Democratic Union (CDU) and the Social Democratic Party (SPD). As part of this coalition agreement, the SPD has control of the BMU.

The German government established the Interministerial Working Group on CO_2 Reduction (IMA CO_2) in 1990. The group, headed by the BMU and including representatives from many federal ministries, issued its first *National Climate Protection Programme* in 2000, which was revised in 2005.

POLICIES AND OBJECTIVES

The grand coalition's governing agreement of November 2005 calls for Germany to continue to play a leading role in climate change mitigation activities. Domestic cornerstones and objectives for advancement of the *National Climate Protection Programme* as set out in the agreement include:

- Achieving a doubling of energy productivity, a measure of energy use per unit of GDP, by 2020 compared with 1990.
- Accelerating low-energy building rehabilitation.
- Promoting the modernisation of power stations.
- Promoting the expansion of decentralised power plants and ultra-efficient CHP plants.
- Supporting European initiatives to improve energy efficiency and work towards a European top runner programme for fuel economy.
- Continuing and expanding the German Energy Agency (*Deutsche Energie-Agentur*, DENA) initiatives for energy conservation in buildings, electricity consumption (*e.g.* by cutting stand-by power consumption) and transport.
- Supporting the establishment of an international climate protection regime for the post-2012 period by 2009.
- Making the system of allocating greenhouse gas emission permits more transparent and less bureaucratic.
- Enhancing the opportunities for German industry in foreign markets by making it easier to use international climate protection projects under the Kyoto Protocol.
- Increasing the share of renewable energy in electricity generation to at least 12.5% by 2010 and to at least 20% by 2020.
- Increasing the share of renewable energy in TPES to at least 4.2% by 2010 and to at least 10% by 2020.
- Further developing the fuel strategy with the objective of increasing the share of biofuels in total fuel consumption to 6.75% by the year 2010.

MEASURES TO ACHIEVE EMISSIONS REDUCTIONS

To fully achieve its Kyoto obligation, the *National Climate Protection Programme* was adopted on 18 October 2000, containing a package totalling 64 measures for seven sectors: households, transport, industry, energy, renewables, waste management and agriculture. It also identified and initiated cross-sectional measures. In 2005, Germany published its

revised *National Climate Protection Programme*, outlining measures to reduce GHG emissions, primarily in sectors and areas that are currently not covered by the EU Emissions Trading Scheme, including households and transport.

EMISSIONS TRADING

A large portion of Germany's total emissions reductions will stem from the EU Emissions Trading Scheme (EU-ETS), which began operation in 2005. Under the EU-ETS, countries allocate emission permits to their energy and industrial installations, subject to approval by the EU. Companies that exceed their emission allowances can buy from the European emissions market, and companies that have excess certificates through lower emissions can sell them to the market. In Germany, the so-called trading sector, which includes most industrial installations and larger power plants, covers about 55% of total CO_2 emissions.

The national allocation plan covering the 2008-2012 period (NAP II), approved by the German government in June 2006 for the second trading period of the EU-ETS, sets sectoral emissions targets and updates those contained in the first national allocation plan (NAP I). Total allocations for both plans are detailed in Table 5. The current plan reduces the amount of allowances given to installations covered by the first plan by over 12%. The total allocation represents 7% less than the first allocation, including allocations to installations not covered in the first plan, as well as reserves for new power plants entering the market. In November 2006, the European Commission (EC) accepted Germany's overall plan, but ordered that the total allocation be reduced from 482 to 453.1 million tonnes of carbon dioxide ($MtCO_2$), a 6% reduction. In addition, the EC refused certain allowance guarantees, as discussed below.

Emission allowances are grandfathered to installations, which means they are given for free according to historical emissions.[8] Germany's first national allocation plan was criticised as being too generous to coal-fired power plants. In the second plan, the government reduced allocations to power plants relative to industrial installations. Installations in the manufacturing sector were given allocations equalling 98.75% of their actual 2000-05 emissions, whereas power plants were given allocations covering 85% of their actual 2000-05 emissions (small installations in both sectors were given 100% of their 2000-05 emissions and CHP plants were given 98.75% of their 2000-05 emissions). These allocation factors are not category averages; they are the same for all individual installations. The government also decided that industrial installations subject to international competitive pressure will take on negligible reductions in future periods.

8. In the second trading phase, the EU-ETS allows for auctioning of up to 10% of emission allocations.

Table 5

National Allocation Plans, 2005-2012

Unit: $MtCO_2$ / year	*NAP I (2005-07)*	*NAP II (2008-12)*	*EC-modified NAP II (2008-12)*
Cap for installations covered by NAP I	495	456	425
Cap for additional installations not covered by NAP I	0	11	11
Reserve for potential new entrants	4	17	17
Total cap	**499**	**482**	**453.1**
Estimated emissions without EU-ETS cap	501	491.5	491.5
CO_2 reduction for the entire energy and industry sectors	2	9.5	38.4

Source: Country submission.

Germany's allocation plan submitted to the EC set aside 14 $MtCO_2$ annually for new power plants entering the market. These allocations would cover the full estimated emissions of new power plants for 14 years, regardless of fuel source or technology, assuming an 86% load factor. They are given on a first-come, first-served basis up to the 17 $MtCO_2$ set aside as reserves, including some planned power plants that have already received guaranteed allocations (some of which are for longer than 14 years). However, the EC has refused to allow Germany to provide for free all allocations needed for new plants in the energy sector for the first 14 years of their operation.

The first national allocation plan was not able to take advantage of the Kyoto Protocol's flexibility mechanisms, joint implementation (JI) and the clean development mechanism (CDM) because of technical limitations. Through these mechanisms, JI and CDM, a country or installation can purchase emission permits or credits from the international market, which count towards the country's own Kyoto target. However, under the rules of the second national allocation plan, individual installations that exceed their emission allowances will be authorised to purchase from the JI/CDM market, equal to 20% of their initial EU-ETS allocation, or 90.62 $MtCO_2$ per year (they can make unlimited purchases from the EU-ETS market). The 20% limit is a consequence of the EC decision to reduce the overall allowance cap; as a

concession to industry, the limit was increased from 12%. The government itself will not be purchasing from the JI/CDM market as it forecasts that its policies and measures will fully achieve the target without relying on the international market.

OTHER SECTORS

In addition to the reductions from the power and industrial sectors, reductions will also come from the sectors not covered by emissions trading, which produce the remaining 45% of Germany's CO_2 emissions, with vehicle emissions the largest single source. These sectors include households, transport and small businesses.

In 1990, total emissions in these sectors were 378 $MtCO_2$; to meet its overall Kyoto target, Germany has set an objective of reducing emissions in these sectors by 11.6%, equivalent to 334 $MtCO_2$ per year, during the 2008-12 period. So far, emissions have fallen by 9.8%. The major policies already implemented that are helping Germany achieve its targets in these sectors are:

- Ecological tax reform making energy more expensive and employment cheaper. (For further information, see Chapter 2.)
- Strengthening of the public transport system. (For further information, see Chapter 4.)
- Promotion of renewables through its renewables law (*Erneuerbare-Energien-Gesetz*, EEG) and the *Market Incentives Programme* (*Marktanreizprogramm*, MAP). (For further information, see Chapter 5.)
- Expansion and modernisation of combined heat and power (CHP) plants through the April 2002 enactment of the law on CHP (*Kraft-Wärme-Kopplungsgesetz*, KWK-G). (For further information, see Chapter 4.)
- Improved energy efficiency in buildings through streamlined regulations, the introduction of energy certificates, financial assistance for energy-saving measures and other measures. (For further information, see Chapter 4.)

Taken together, these policies, along with policies making smaller contributions to reduced emissions, are forecast to provide the lion's share of reductions that Germany needs to meet its targets in non-trading sectors. However, the government determined that some additional policies were needed to ensure full compliance. As a result, it will undertake further actions, as outlined in the *National Climate Protection Programme 2005*. Those actions with quantifiable reductions are detailed in Table 6.

Table 6

Future Actions in Non-trading Sectors with Quantifiable Emissions Reductions

Unit: $MtCO_2$ / year	*Emissions reduction potential*
Household sector	
Public relations campaign	*0.7*
Financial support measures	*2.8*
Regulatory measures	*0.4*
Reductions due to higher energy prices	*1.3-1.5*
Subtotal	5.3
Transport sector	
Fiscal incentives	*1.5*
Fuel modifications	*5.5*
Driving habit information campaign	*3*
Subtotal	10
Total	15.3

Source: Country submission.

In addition to the measures accounted for by quantifiable effects, further actions will be taken in the transport sector, the reduction effect of which cannot be reliably calculated. The government forecasts that on the basis of conservative estimates, the sum of these measures will be sufficient to meet its 2008-12 targets. These measures include:

- Upgrading of the toll system to set up a real road-pricing system on the basis of different local and time-related toll rates.
- Measures to eliminate distortions of competitive positions between different means of transport.
- Refinement of the promise made by the car industry to reduce specific CO_2 emissions in new vehicles.
- Introduction of new engine types and measures to increase engine efficiency.
- Expanded fitting of fuel consumption indicators in new vehicles.

CRITIQUE

There is much to praise in Germany's environmental policy. Despite a heavy burden to reduce emissions by 21% under the Kyoto Protocol, the country is on track to meet its target, a goal that many other IEA countries are not yet likely to achieve. Furthermore, through its additional targets beyond Kyoto, for renewables and energy intensity, Germany is showing its political commitment to real progress to reduce emissions and lower the threat of climate change. Building on this commitment, the IEA believes that some changes to its existing policies, as well as the implementation of some new policies, will allow the country to meet its objectives more cheaply, as well as help it attain even more ambitious goals in the future.

There are two pillars to Germany's approach to meeting its target: reductions from the EU Emissions Trading Scheme (EU-ETS) and reductions from the transport, household and small business sectors, including cross-sectoral areas like buildings. The government has tried to distribute the burden evenly between these two pillars and we encourage continued evaluation of the relative burdens between the trading and non-trading sectors to ensure that CO_2 reductions are extracted from all sectors in the most cost-effective manner. Within each sector, burdens should be allocated fairly across particular industries and areas.

Under the first national allocation plan (NAP) of the EU-ETS, Germany gave a very generous allocation of carbon dioxide permits to its coal-fired power plants, reducing the incentive towards less carbon-intensive power sources. Learning from its experience with the first NAP, in its recent second NAP, the allocation sought to correct the earlier deficiencies. Almost all power plants would receive CO_2 permits for free covering 85% of their 2000-05 emissions. In addition, provisions under Germany's proposed second NAP would guarantee new entrants free permits covering all emissions for new plants of all technologies, including coal. To insulate energy-intensive industry from CO_2 costs, given that they are subject to international competition with countries that do not have CO_2 reduction targets, the government has decided that these installations will take on negligible reductions in future periods.

Given that the EU-ETS is a tool to lower CO_2 emissions in European countries, the allocation of existing and future permits should discourage CO_2-intensive activities. Provisions in the original second NAP submitted to the European Commission that allocated permits for new power plants for 14 years – and longer for some specific plants – would have worked at cross-purposes to this goal. The policy would have neutralised the aim of the EU-ETS to encourage lower-carbon or carbon-free sources by providing sufficient CO_2 permits to all sources. As required by the European Commission, we are pleased to see that the government has revised this policy, as it undermines its costly efforts to reduce CO_2 emissions through renewables production and increased efficiency.

Efforts to protect and promote coal-fired generation in the face of security of supply concerns should be done through means other than the EU-ETS.

The Kyoto Protocol's joint implementation (JI) and clean development mechanism (CDM) are market-based mechanisms designed to lower the overall cost of reducing CO_2 emissions, as well as to spread CO_2-reducing projects and technologies to other countries. In this light, we are pleased to see that the government has increased the percentage by which companies are allowed to rely on JI/CDM to meet their emissions limits under the EU-ETS. Compared with other countries such as Norway, Japan, Spain, Italy, the Netherlands and the United Kingdom, Germany takes relatively less advantage of this market-based means of reducing greenhouse gas emissions. Henceforward, the government should consider expanding the use of JI and CDM, both by the private sector and the government itself, in the interest of spurring a global market for cost-effective CO_2 reductions and lowering the overall cost of Germany's own compliance.

Finally, we encourage the government to consider auctioning future carbon allowances to the extent allowed by EU law. Coupled with recycling of auction revenue – either back to the government to lower general taxes or for other purposes, or directly to customers – auctioning would ensure that all companies, and not just electricity customers, pay their fair share for emitting greenhouse gases. While power plants have been given these permits for free, they will still pass on the opportunity costs of the permits in electricity prices. (See Chapter 9 for further discussion of passing through the costs of emission permits.) Auctioning with proper revenue recycling would also enhance market incentives to move to low-carbon or carbon-free sources of energy.

RECOMMENDATIONS

The government of Germany should:

- *Remove the 14-year guarantee of emission permits for new power plants, as required by the European Commission, as this distorts the functioning of the carbon market.*
- *Promote more strongly the use of international joint implementation (JI) and clean development mechanism (CDM) projects, as this would spur development of a market that can reduce CO_2 emissions in a cost-effective manner for Germany and the world.*
- *Consider auctioning of future greenhouse gas emission allowances with revenue recycling back to the government or customers to create greater incentives for companies to move towards low-carbon or carbon-free sources of energy.*

ENERGY EFFICIENCY

In the context of Germany's environment and climate change objectives, energy efficiency is increasing in importance in the country's overall energy policy. While energy intensity – energy consumed per unit of economic output – has already been improving quickly, the government has set an ambitious target for 2020, one that will be difficult to achieve without additional policies and measures. Germany's energy efficiency policy focuses on industry, building performance and transport fuel consumption.

TRENDS IN ENERGY EFFICIENCY

Energy consumption in Germany has been stable or slightly declining for many years. Consumption peaked in 1979 and was 261 Mtoe in 2005, a decrease of 3.3% over 2004 (see Figure 4). Energy consumption in Germany has thus largely ceased to track economic growth. Germany does relatively well in international comparisons in terms of generally accepted energy efficiency indicators (see Figure 7). Germany's energy supply per dollar of gross domestic product (GDP) – its energy intensity – of 0.16 tonnes of oil equivalent (toe) per USD is above average for IEA Europe (0.15). Germany's energy intensity has significantly improved over time; the average improvement from 1990 to 2005 was 1.8%. Internationally speaking, this places Germany among the leading group of industrial nations. Much of the improvement can be attributed to reduced consumption in the transport sector. Though total final consumption (TFC) of energy has increased by over 8% since 2000, absolute consumption in the transport sector has declined by nearly 6%, a trend exhibited in very few IEA countries. In addition to vehicle efficiency gains, the consumption decline can also be attributed to an accelerated trend away from gasoline-fuelled and towards diesel-fuelled vehicles.

Energy efficiency is expected to continue improving. According to the Prognos Energiereport IV, average energy consumption per unit of GDP will decrease by 1.9% per year up to 2030 under the alternative policy scenario (see Table 2 in Chapter 2).

POLICIES AND MEASURES

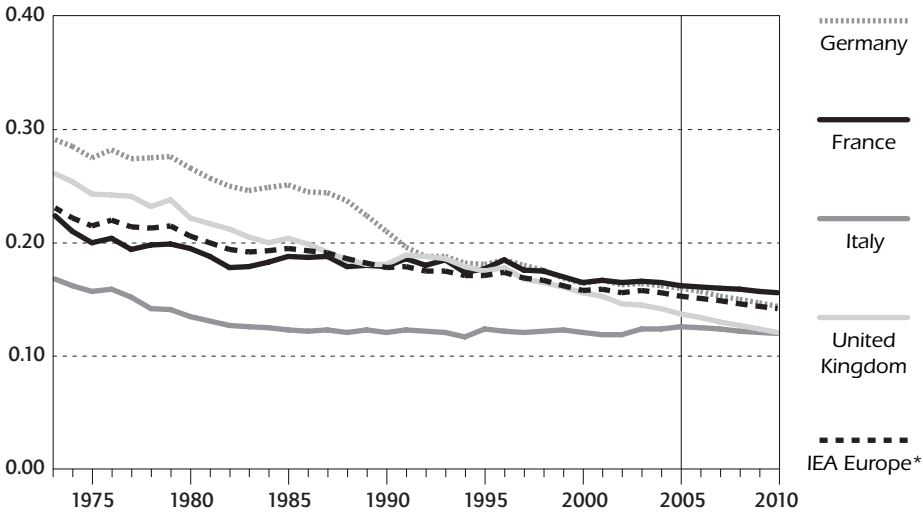
GOALS AND STRATEGIES

Underpinning Germany's climate change policy is its efficiency policy, which has been emphasised in recent years. In the coalition agreement of

Figure 7

Energy Intensity in Germany and in Other Selected IEA Countries, 1973 to 2010

(toe per thousand USD at 2000 prices and purchasing power parities)



* excluding Luxembourg and Norway throughout the series, as forecast data are not available for these countries.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 ; *National Accounts of OECD Countries*, OECD Paris, 2007 and country submissions.

11 November 2005, the governing parties laid down the following targets and measures for national energy efficiency policy:

- Increase the energy efficiency of the national economy with the objective of doubling energy productivity (a measure of GDP output per unit of energy use) by the year 2020 compared with 1990, requiring an annual increase of 3%.

- Increase funding for the CO_2 *Building Rehabilitation Programme* to at least EUR 1.5 billion per year; improve the efficiency and attractiveness of the programme (for example by switching to investment grants and tax relief measures and by including rental accommodation); and introduce an energy passport for buildings, with a target of improving energy efficiency in 5% of pre-1978 buildings every year.

- Modernise the existing stock of power stations and expand the use of decentralised power generation and ultra-efficient CHP plants.

- Review the funding criteria under the Cogeneration Act (KWK-G) based on a monitoring report to be compiled in the near future.
- Support European initiatives to improve energy efficiency and work towards a European top runner programme.
- Continue and step up the German Energy Agency's (*Deutsche Energie-Agentur*, DENA) initiatives for energy conservation in buildings, electricity consumption (*e.g.* by cutting stand-by power consumption) and transport.

The government is currently preparing an *Energy Efficiency Action Plan* in the framework of the EU's energy services directive, to be released in June 2007, which will be a comprehensive stocktaking and road-map of the government's energy efficiency policies and detail how its energy productivity target will be met.

Germany is also working to use its presidencies in 2007 of both the Group of Eight (G8) and the EU to foster energy efficiency on an international scale. With the EU presidency, Germany is focusing on revisions to the EU's appliance labelling directive, stand-by energy consumption and further efforts on building efficiency. Under the G8 presidency, the country is concentrating its efforts on the efficiency of buildings and transport, along with clean fossil fuels.

INDUSTRIAL SECTOR

Voluntary agreements

For many years, voluntary commitments by industry have been the primary instrument for reducing CO_2 emissions and hence to a great extent for improving energy efficiency in the industrial sector. In updated agreements of 1995, 1996, 2000 and 2002, industry committed to various measures to reduce CO_2 emissions, many of which are associated with improvements in energy efficiency. The introduction of the European Union Emissions Trading Scheme (EU-ETS) has also provided a key incentive to raise energy efficiency. Some aspects of the voluntary agreements deal with improvements in the efficiency of on-site electricity generation, particularly combined heat and power (CHP). For further information, including expected reductions, see the later section on the electricity sector.

Grants and loans

Further incentives to improve energy efficiency and implement energy savings in the industrial sector are provided by various informational and financial measures, often primarily targeting small and medium-sized enterprises (SMEs). The *Kreditanstalt für Wiederaufbau* (KfW) *Umweltprogramm (Environment Programme)* provides capital for investment in environmental

protection activities. The low-interest loans to SMEs can be used to supplement the *European Recovery Programme's Environment and Energy Saving Programme*. Up to 100% of the capital cost of energy-saving measures can be funded with the combination of both programmes.

Promotion of energy performance contracting has been stepped up substantially in recent years, among other things with eco-tax exemptions to encourage its more widespread adoption. For example, block-type CHP units attract tax relief as a common application in industrial energy contracting. KfW also promotes energy contracting in its various programmes. Energy contractors can also apply for grants under the market incentives scheme operated by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

Public information and advice

In a sub-project under the *Initiative Energieeffizienz* (Energy Efficiency Initiative) campaign, DENA, the German Energy Agency, offers advice primarily to SMEs on efficient use of electricity in trade and industry. The aim is to tap the considerable energy efficiency potential in this sector, for example in electromechanical systems such as pumps and fans.

RESIDENTIAL AND COMMERCIAL SECTORS

Building sector policies

Germany's building stock is already relatively efficient, primarily because it is comparatively new. In addition, many buildings in the East have been abandoned or destroyed because of migration of population from the East to the West. Germany also has strong building codes – current codes exceed the EU directive's requirements for buildings larger than 1 000 m^2, and will continue to significantly exceed them in future years. Building codes, which are set at the federal level, must be revised at least every five years. Nonetheless, an intensified effort to save energy in this sector is a major emphasis of the governing parties' coalition agreement and a central element of Germany's *National Climate Protection Programme*. Including the planned tax relief for home modernisation and maintenance and the provision of EUR 120 million a year for energy rehabilitation of government buildings, a total of EUR 1.4 billion a year is now available for energy rehabilitation in buildings.

EU directive on the energy performance of buildings

Several key elements of the EU directive on the energy performance of buildings were transposed into German law at an early stage. In the case of energy performance, legislation was transposed into the

Energieeinsparverordnung (EnEV), enacted in 2002 and amended to take account of technical progress in 2004. Pollution control legislation was transposed into the *Erste Bundesimmissionsschutz-verordnung*. The elements covered relate to energy standards for new buildings and major alterations to existing buildings, energy passports for new buildings and inspections of central heating boilers. Revisions to the Energy Performance Act *(Energieeinspargesetz)*, which was enacted in September 2005, established the legal framework to transpose further elements of the directive into national law – in particular those regarding provision for air-conditioning systems and built-in lighting installation and the introduction of energy passports for certain existing buildings. Details of these elements will be finalised soon in revisions to the EnEV.

Public information and consultations

Effective implementation of the measures for existing buildings continues to require additional advisory and financial support. To supplement the consulting services mostly provided by industry, architects and engineers, the German government plans to step up public relations activities on energy-saving construction via DENA.

The *Verbraucherzentrale Bundesverband* (VZBV), a consumer association working group, provides an energy advisory service in 400 major cities – mainly financed by the BMWi – on all questions related to economic and efficient energy use, including the use of renewable energy.

Working in co-operation with the Federal Office of Economics and Export Control (*Bundesamt für Wirtschaft und Ausfuhrkontrolle*, BAFA), the BMWi also provides, among other things, funding for in-depth on-the-spot consultations on individual buildings and heating systems. Under the consultation service, which is provided for existing buildings, a diagnostic survey and in-depth consultation partly paid for by the consumer lead to recommendations and a plan of action for improving energy efficiency in insulation and heating systems, including options for using renewables. The outcome is a comprehensive report that the energy consultant explains and leaves with the consumer. The energy consultant can be an architect or engineer with specific training and knowledge in energy consultancy, or a *Gebäudeenergieberater im Handwerk* – a member of the skilled crafts trade who has obtained accreditation to operate as a building energy consultant under the condition that he or she does not have a personal commercial interest in specific investments being made. The recommendations must be technically up-to-date, thus promoting the adoption of new energy-saving technologies. The resulting investment also helps promote the skilled crafts and retail trades.

The *Klima sucht Schutz* (Climate Seeks Protection) campaign sponsored by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety helps consumers estimate energy efficiency and provides them with online recommendations for action. The main features of the online campaign include a heat loss check (for heat insulation in buildings), a best-practice database for electrical appliances, recommendations for the best choice of heating system (new or replacement), a pump check (for central heating pumps), a modernisation adviser and a grants guide.

CO_2 Building Rehabilitation Programme

The number of applications for energy consultations increased from 1 000 in 1998 to nearly 7 000 in 2004; in 2005, 8 500 applications had been received by mid-October alone. The rapid growth in the number of applications is likely to reflect the increased funding of energy-saving measures under various KfW programmes (KfW's Housing Modernisation, Ecological Construction and CO_2 Building Rehabilitation programmes), in addition to higher energy costs. The *CO_2 Building Rehabilitation Programme* relaunched at the beginning of 2006 is particularly important when it comes to the rehabilitation of existing buildings.

The German government has increased annual funding for the KfW *CO_2 Building Rehabilitation Programme* from approximately EUR 360 million to EUR 1 billion for 2006 to 2009. This is sufficient to support loan applications totalling EUR 17 billion. In future, the programme will encompass low-interest loans as it has done since its last relaunch in 2001. When the most recent federal budget comes into effect, the programme will be extended to include investment grants.

The stepping-up of the *CO_2 Building Rehabilitation Programme* has so far met with a very positive response. In energy-related programmes for the building sector, over EUR 5 billion in loans had been approved by the end of May 2006 – more than two-and-a-half times the full-year 2005 figure of approximately EUR 2 billion. The re-gearing of the programme to include investment grants is currently under consultation.

Appliance standards and labelling

Implementation of the European Union's directive on appliance labelling has proved a large success in Germany, and the government is currently taking advantage of its EU presidency to revise and update the labelling directive for so-called "white goods" (mostly kitchen and laundry appliances for households).

TRANSPORT SECTOR

Energy consumption in the transport sector accounts for 26% of total final consumption (TFC), and after many years on an upward trend, has been in decline since the beginning of the decade.

To structure the transport sector in a way that is compatible with the environment and conserves resources, the federal government is pursuing a broad-based package of measures comprised of technical, regulatory policy, price policy and investment measures, along with publicity and information measures. Action is focused on incentive mechanisms to reduce transport intensity and increase transport energy efficiency, technical optimisation of means of transport and promotion of alternative fuels and innovative power-trains (vehicle components, including the engine and transmission).

Most of the scope for efficiency gains in road transport lies in exploiting technical means of reducing fuel consumption in cars and heavy trucks. Findings from an international transport study forecast major efficiency gains in motor vehicles for the period 2002 to 2020.[9] The efficiency of diesel engines can be improved by between 16% and 34%. Potential efficiency gains of 13% to 26% are assumed for spark-ignition engines.

Since 2000, technical efficiency gains in motor vehicles have exceeded the rate of increase in vehicle performance, resulting in a trend reversal in fuel consumption together with a corresponding reduction in greenhouse gas emissions. However, the effects of past technical efficiency gains have largely been cancelled out by growth in traffic volumes. Therefore, further action now targets personal circumstances affecting transport use (mobility patterns), organisational aspects (traffic management) and measures spanning all modes of transport to improve efficiency across the entire transport sector.

Germany is unique among IEA countries in not having mandatory passenger vehicle speed limits for most major motorways, particularly the *Autobahn*. A large part of the highway system has speed limits and transport control systems in place. Though the government has in the past considered imposing speed limits, both as a means of improving safety and lowering energy consumption and carbon dioxide emissions, this proposed change in policy is very unpopular though several options are being discussed internally.

Fuel economy standards and labelling

The fuel economy of Germany's vehicle fleet is governed primarily by the EU's voluntary agreement with industry, the target of which is to reduce the

9. Well-to-wheels report, CONCAWE/EUCAR/JRC, March 2007 (Version 2c) available from ies.jrc.cec.eu.int/wtw.html.

average CO_2 emissions from newly registered passenger cars to 140 g CO_2 per km by 2008 (the use of biofuels can partly offset this target). In 2004, Europe succeeded in lowering emissions to 161 g CO_2 per km. It is unlikely that all cars sold in Germany in 2008 will meet the EU's 140 g per km standard.

As part of this voluntary agreement, Germany and Europe are introducing vehicle labelling with information on fuel consumption and CO_2 emissions for new passenger cars being sold. The labelling, introduced in Germany under the *Personenkraftwagenenergieverbrauchskennzeichnungsverordnung* (passenger car energy consumption labelling ordinance), makes it easier for consumers to make direct comparisons between cars with regard to energy efficiency. The labelling must follow a uniform pattern showing consumption and emission figures.

Toll roads

Germany launched a toll system on its highways for heavy trucks on 1 January 2005. While the toll system is largely designed to properly apportion the costs of road use to domestic and foreign trucks, increasing revenue used for highway finance, it also provides economic incentives to use trucks that meet the latest emission standards.

Public transportation

On a daily basis, about 27 million passengers use public transportation in Germany, resulting in about 19 million avoided individual vehicle trips. In 2005, public transport use increased to over 10 billion trips, an increase that can be attributed to easy access to public transport facilities: 86% of all households take less than 10 minutes to reach the closest public transport stop on foot.

ELECTRICITY SECTOR

Cogeneration or combined heat and power (CHP) systems can improve the efficiency of electricity generation, but at 12%, it currently makes up a relatively small share of the country's electricity generation. To promote CHP, the government passed legislation on the modernisation and expansion of cogeneration (*Kraft-Wärme-Kopplungsgesetz*, enacted on 19 March 2002 to replace previous CHP legislation), which pursues the following objectives:

- Support for the operation of (old and new) existing plants, through a fixed financial add-on that varies by size and type of installation.

- Modernisation of existing plants; commissioning of the modernised plants to have taken place not later than 31 December 2005 and a number of other ancillary requirements to be complied with.

- Additional construction of small CHP plants (up to 50 kW or 50 kW to 2 MW) and of fuel cells, the bonus payments for plants in the 50 kW to 2 MW made on a declining basis and ending on 31 December 2010; by contrast, for small CHP plants up to 50 kW and fuel cells, the bonus payments are made for a total of ten years from the start of continuous operation of the plant.

The legislation is part of a package of measures adopted by the German government and German industry in an agreement to cut CO_2 emissions and promote cogeneration. The agreement calls for up to 45 million tonnes of carbon dioxide ($MtCO_2$) per year in emissions savings from the energy industry by 2010. This figure is to be attained by maintaining, modernising and building new CHP plants, with reduction targets compared to 1998 of 23 $MtCO_2$ a year overall and no less than 20 $MtCO_2$ a year as of 2010. Further CO_2 reductions totalling up to 25 $MtCO_2$ a year as of 2010 are to be achieved by measures in other areas. More than 11 000 CHP plants have been approved under the new legislation. In addition, CHP plants receive preferential tax treatment, as they are exempt from petroleum excise duties.

CRITIQUE

Through its G8 and EU leadership, Germany is elevating energy efficiency to the forefront of European and international policy, an emphasis the IEA applauds. Germany is already a leader among IEA countries in terms of its energy productivity, the amount of energy consumed per unit of economic output (usually GDP), and this work will help spread good efficiency policy to other countries. Building on its own good efficiency levels, Germany has set ambitious targets to double its energy productivity by 2020, as compared to 1990. This would require a 3% annual increase in energy productivity until 2020 – as compared with the current rate of increase of 1.8% per year since 1990. We acknowledge that targets are helpful not only because they set a baseline from which changes can be measured, but also because they provide an impetus to focus government attention on actions to improve efficiency. We commend the government for setting such ambitious goals, but we are concerned that the targets will be very difficult to meet. Germany's efficiency is already improving at a fast pace and meeting this target will require accelerating it even further. We encourage the government to evaluate the energy efficiency goals, ensuring that they are both realistic and contribute to Germany's overall energy and environment goals in a cost-effective manner compared with the country's other efforts. To that end, the action plan on energy efficiency that the government is preparing should be

completed as quickly as possible. It should include the policies and measures needed to achieve the government's energy productivity target, and how progress towards meeting it will be measured and evaluated. Sectoral targets along with the overall target might also be considered to the extent they are beneficial.

Total energy use in the transport sector has been falling in Germany, a trend exhibited in few IEA countries. However, for cultural and political reasons, addressing energy efficiency in the transport sector remains challenging. For instance, Germany is the only country in Western Europe without a universal motorway speed limit for passenger vehicles. Despite its already declining energy use, the transport sector offers Germany significant opportunities to improve energy efficiency, reduce CO_2 emissions and enhance energy security. For these reasons, we encourage the government to undertake a rigorous review of its transport-sector policies and, if necessary, consider implementing stronger policies such as road tolls and speed limits in order to improve transport efficiency. As part of a Europe-wide voluntary agreement, car manufacturers committed to reduce CO_2 emissions and raise the fuel economy of their cars. Though this approach has brought significant fuel economy improvements to the European vehicle fleet, EU car manufacturers are not on track to meet the voluntary agreement, preventing the full benefits from being realised. Mandatory standards for passenger cars may now be necessary, and Germany should take a leading role in promoting such a policy at the EU level.

Improved efficiency of household and office appliances can advance Germany's efficiency goals. Thus we endorse Germany's efforts to revise and update the EU-wide policy on appliance labelling and standards, encouraging the government to ensure that updated appliance labelling requirements give sufficient transparency on the energy use of appliances, and that updated appliance standards are sufficiently stringent given cost-effectiveness criteria. Considering the forecast growth in electricity consumption due to electronic devices, Germany and other countries should consider measures that target these products. This includes support at the EU level for a "horizontal" approach to stand-by power consumption, which addresses energy consumption by category and not by particular appliance, and domestic policies such as government procurement requirements for energy-efficient equipment.

As in many IEA countries, housing offers a very large opportunity to improve energy efficiency in Germany. Buildings are already comparatively efficient on account of the relatively new building stock. In addition, with the migration of population from the East to the West, very inefficient buildings in the East have been abandoned or destroyed. Furthermore, Germany has very strong building codes, more stringent than the EU directive requires now and for the foreseeable future. We are impressed with Germany's overall focus on energy efficiency in buildings and encourage the government to maintain its

rigorous, but cost-effective monitoring and enforcement of building codes so that its efforts continue to deliver their full benefits. The government might also explore policies and measures to further improve the efficiency of existing buildings, including expanding on its information campaigns or enhancing financial incentives, to the extent such measures are cost-effective.

Combined heat and power (CHP) provides a relatively small share of Germany's electricity portfolio (12% versus a share of 52% in Denmark and high rates in France, Finland and the Netherlands), despite its efficiency benefits. The government is working to increase the share of CHP through a fixed add-on for CHP installations, which varies by size and type of installation. The government should ensure that CHP is supported in a cost-effective manner. Market-based mechanisms should be considered when supporting CHP, as they provide greater downward pressure on costs over the long term.

RECOMMENDATIONS

The government of Germany should:

- *Complete and implement the energy efficiency action plan, ensuring that the suite of policies and measures selected will help Germany achieve its efficiency targets in a cost-effective manner.*
- *Consider establishing clear and achievable sectoral energy efficiency targets, including interim milestones.*
- *Continue to develop effective policies to improve efficiency in the transport sector.*
- *Review voluntary agreements with the car industry; consider taking a leadership role in EU efforts to establish mandatory standards where voluntary agreements have proven ineffective.*
- *Work within the EU context to revise and update appliance efficiency labelling and standards, including maximum stand-by power use, to the extent they are cost-effective.*
- *Ensure that support for CHP reflects the relative benefits of the technology, without oversubsidising it.*

Through ambitious policies, Germany has dramatically increased the amount of renewable energy in its supply mix, particularly biomass in the electricity and transport sectors and wind in the electricity sector. The government is on target to meet, or has already exceeded, German and European renewables targets, and forecasts show continued strong growth in the future.

PRODUCTION

TOTAL PRIMARY ENERGY SUPPLY

As shown in Table 7, continued growth of renewables supply has resulted in it now making up 4.6% of total primary energy supply (TPES) in Germany in 2005, ranking sixteenth among IEA countries. In absolute terms, Germany's 15.9 Mtoe puts it third among IEA countries, behind the United States and Canada. Germany's supply of wind, 2.3 Mtoe, is the highest in absolute terms of all IEA countries. Germany's supply of wind is 52% more than that of the United States, a country with a TPES that is five-and-a-half times greater than that of Germany. The country's biomass supply is the third-highest in absolute terms after the United States and Canada.

Since 2000, Germany's renewables supply has grown by 75%, increasing at an average annual rate of almost 12%. Some estimates forecast that while growth of renewables will not keep pace with the 12% annual growth rate, supply will continue to grow at an annual rate of 2.4% through 2030. Other estimates forecast that the absolute growth of the renewables sector will continue at the same rate in the coming decades, and the growth of renewables in the heating sector will also increase.

ELECTRICITY

Growing at an average annual rate of nearly 12% since 2000, renewables now make up over 10% of total electricity production in Germany, with wind providing the greatest share of renewables (see Table 8). Germany's share of wind in its total electricity generation, 4.4%, is the third-largest share in the IEA, following Denmark and Spain.

Table 7

Renewables Supply, 1970 to 2005

Unit: ktoe	*Biomass**	*Wind*	*Hydro*	*Solar thermal*	*Geo-thermal*	*Solar PV*	*Total (renewables)*	*Total (all energy sources)*	*Share of renewables in TPES*
1970	2 537	0	1 507	0	0	0	4 044	304 448	1.3%
1975	2 841	0	1 467	0	0	0	4 307	316 653	1.4%
1980	3 765	0	1 640	0	0	0	5 405	360 385	1.5%
1985	4 761	0	1 494	0	0	0	6 255	360 980	1.7%
1990	3 797	6	1 499	11	7	0	5 320	356 221	1.5%
1995	3 913	147	1 873	38	123	1	6 095	342 398	1.8%
2000	6 179	804	1 869	110	123	5	9 091	343 622	2.6%
2001	6 614	899	1 955	140	124	10	9 743	353 519	2.8%
2002	7 229	1 364	1 989	168	127	16	10 893	345 252	3.2%
2003	8 090	1 622	1 657	212	141	29	11 750	347 183	3.4%
2004	8 940	2 194	1 813	221	144	48	13 359	348 222	3.8%
2005	11 352	2 342	1 684	254	148	110	15 891	344 746	4.6%
Share of total TPES in 2005	3.3%	0.7%	0.5%	0.1%	0.0%	0.0%	4.6%		
Share of renewables TPES in 2005	71.4%	14.7%	10.6%	1.6%	0.9%	0.7%			
Growth rate (1990-2000)	5.0%	62.9%	2.2%	25.7%	33.3%	50.6%	5.5%	-0.4%	
Growth rate (2000-05)	12.9%	23.8%	-2.1%	18.3%	3.8%	84.5%	11.8%	0.1%	

* excludes industrial and non-renewable municipal waste.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007.

BIOFUELS IN TRANSPORT

After its introduction in Germany in 1992, consumption of biofuels in total transport fuel consumption has grown from 0.5% of the total by energy content in 2000 to 4.5% of the total in 2005. Owing to the introduction of a biofuels quota in 2007, biofuels are forecast to grow to 8% by energy content of all transport fuels by 2015.

INSTITUTIONS

Multiple government authorities play a role in renewables promotion and policy. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz und*

Table 8

Electricity Generation from Renewables, 1970 to 2005

Unit: GWh	*Wind*	*Hydro*	*Biomass**	*Solar PV*	*Total (renewables)*	*Total (all energy sources)*	*Share of renewables in total*
1970	0	17 527	2 544	0	20 071	308 771	6.5%
1975	0	17 053	1 103	0	18 156	383 770	4.7%
1980	0	19 069	2 852	0	21 921	466 340	4.7%
1985	0	17 371	2 832	0	20 203	520 560	3.9%
1990	71	17 426	1 595	1	19 093	547 650	3.5%
1995	1 712	21 780	2 433	7	25 932	532 814	4.9%
2000	9 352	21 732	4 331	60	35 475	567 122	6.3%
2001	10 456	22 733	4 590	116	37 895	581 820	6.5%
2002	15 856	23 124	5 309	188	44 477	566 905	7.8%
2003	18 859	19 264	7 982	333	46 438	595 646	7.8%
2004	25 509	21 077	9 357	557	56 500	609 988	9.3%
2005	27 229	19 581	13 533	1 282	61 625	613 164	10.1%
Share of total generation in 2005	4.4%	3.2%	2.2%	0.2%	10.1%		
Share of renewables generation in 2005	44.2%	31.8%	22.0%	2.1%			
Growth rate (1990-2000)	62.9%	2.2%	10.5%	50.6%	6.4%	0.3%	6.0%
Growth rate (2000-05)	23.8%	–2.1%	25.6%	84.5%	11.7%	1.6%	9.9%

* excludes industrial and non-renewable municipal waste.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007.

Reaktorsicherheit, BMU) is the authority responsible for renewable energy policy, including the Renewables Energy Sources Act (*Erneuerbare-Energien-Gesetz*, EEG), the *Market Incentives Programme* and R&D. The Federal Ministry for Food, Agriculture and Consumer Protection (*Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft*, BMELV) manages biofuels and parts of the biomass policy. The Federal Ministry for Transport, Building and Urban Affairs (*Bundesministerium für Verkehr, Bau und Stadtentwicklung*, BMVBS) is in charge of the national fuel strategy. The Federal Ministry of Finance (*Bundesministerium der Finanzen*, BMF) handles energy taxation, particularly of biofuels. Finally, the Federal Ministry of Economics and Technology (*Bundesministerium für Wirtschaft und Technologie*, BMWi) is responsible for the overall energy policy.

POLICIES AND MEASURES

Promotion of renewable energy plays a key role in the German government's climate change and sustainable energy policies. According to the EEG, Germany works to promote renewables to facilitate a sustainable development of energy supply, particularly for the sake of protecting the climate, nature and the environment; to reduce the costs of energy supply for the national economy, in part by incorporating long-term external effects; to contribute towards avoiding conflicts over fossil fuels; and to promote the further development of technologies for the generation of electricity from renewable energy sources. The government has taken on three renewables-specific targets and objectives:

- Increase the share of renewable energy in electricity generation to at least 12.5% by 2010 and to at least 20% by 2020.
- Increase the share of renewable energy in TPES to at least 4.2% by 2010 and to at least 10% by 2020.
- Further develop its fuel strategy with the objective of increasing the share of biofuels in total fuel consumption to 6.75% by 2010.

Germany's target for renewables as a share of TPES is half of the 20% target for 2020 adopted by the European Council in March 2007.

Germany's primary tool to promote renewables in the electricity sector is the EEG, enacted in 2000, and amended in 2004. The EEG replaced electricity feed-in legislation (*Stromeinspeisungsgesetz*, StrEG) enacted in 1990. The other major policies are a programme to provide financial incentives for installations that produce heat from renewables and the promotion of biofuels in transport.

There is now a substantial renewable energy industry in Germany. More than 200 000 people work in the field, of which 35 000 work in the solar sector.

ELECTRICITY

Under Germany's feed-in tariff, which was originally established in December 1990 under the law on the obligation to compensate for the input of renewable energy sources (StrEG), power companies were obliged to pay between 65% and 85% of the retail price of electricity to the renewables producers. This law was replaced by the EEG, which provided producers a guaranteed rate for electricity production according to a tariff schedule differentiated by renewable energy sources, location, size of the installation and technology. The relative differentiation of tariffs is based on equalisation of cost across all technologies; rates are set so that producers should make the same profit regardless of the cost of each technology, and therefore be

indifferent towards investing in any particular technology. The amount paid depends on the year in which the installation is built, with rates guaranteed for a term between 15 and 30 years, depending on technology. While the amount paid to a particular installation is fixed according to the year it goes on line, tariffs decline annually according to a fixed degression rate to take into account technical development in each technology. Tariffs, terms and degression rates are provided in Table 9.

Table 9

Feed-in Tariffs by Technology, 2006

Technology	*Tariff for installations built in 2006 (eurocents/kWh)*	*Guaranteed term of payments*	*Yearly degression rate*
Large hydropower (5-150 MW)	3.62-7.51	15 years	1.0%
Small hydropower (<5 MW)	6.65-9.67	30 years	0%
Biomass (<20 MW)	3.78-21.16	20 years	1.5%
Geothermal energy (<20 MW)	7.16-15.00	20 years	1.0%**
Wind energy (onshore)	8.36/5.28*	20 years	2.0%
Wind energy (offshore)	9.10/6.19*	20 years	2.0%***
Photovoltaics	40.60-56.80	20 years	6.5%

* installations receive the first rate given (the initial tariff) for x years, then the second rate given (the basic tariff) for the remainder (20-x); x depends on the quality of the site.

** starting in 2010.

*** starting in 2008.

Source: Country submission.

Under the terms of the EEG, renewable energy installations are also guaranteed priority grid access, transmission and distribution, and grid operators are obliged to purchase the electricity produced from these sources. The significant capacity of wind connected to the German electricity grid has resulted in periods of high congestion in certain areas, but secure grid operation was not endangered at any time. However, in some cases detrimental transmission effects occurred within Germany and at its border, particularly with the Netherlands, as the transmission system is currently not designed to properly handle significant wind integration. (For further information, see Chapter 9.)

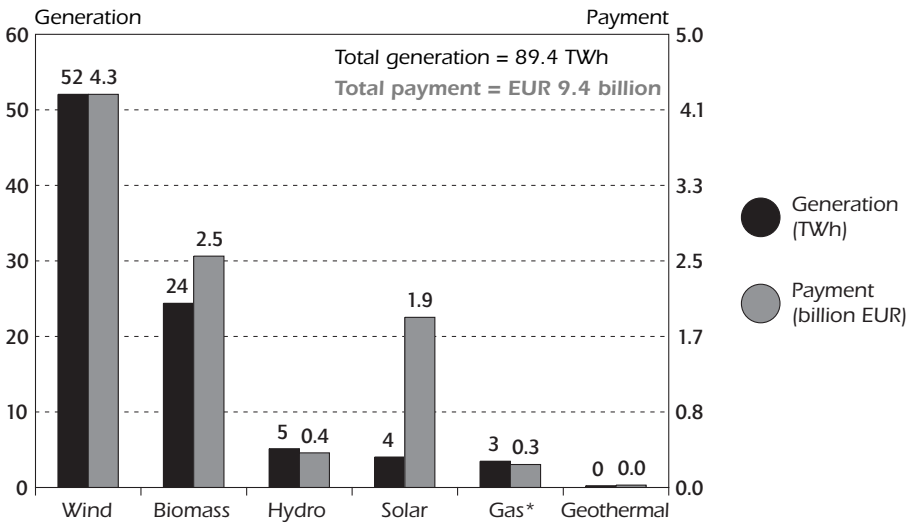
Payments under the feed-in tariff were about EUR 4.4 billion in 2005 and provided 44 TWh of electricity, equivalent to an average rate of nearly 10 eurocents per kWh. Medium-term forecasts by the country's association of

network operators (VDN/VDEW) estimate that in 2012, the feed-in tariff will provide 89.4 TWh of electricity with customer payments amounting to about EUR 9.4 billion, equivalent to an average rate of 10.5 eurocents per kWh (see Figure 8). The BMU expects somewhat lower figures: 82 TWh of electricity and payments of EUR 8.1 billion, equivalent to just under 10 eurocents per kWh.

According to VDN, wind, which is forecast to provide the lion's share of renewable electricity (over 58%), will also take up the largest share of the payments (46%). In contrast, solar, which will provide 4.5% of total renewable electricity, will take up nearly 20% of the total fees. Total payments under the feed-in tariff for renewable energy production between 2000 and 2012 amount to some EUR 68 billion. This includes additional costs of EUR 30 to 36 billion above the costs of procuring electricity without a feed-in tariff, depending on the price of electricity generated from conventional energy sources, to be paid by industry and private customers, and is estimated to provide about 650 TWh.

Figure 8

Forecast Quantities and Fees of Feed-in Tariffs in 2012



Share of generation	**58.2%**	**27.3%**	**5.8%**	**4.5%**	**3.9%**	**0.3%**
Share of fees	**46.0%**	**27.1%**	**4.0%**	**19.9%**	**2.7%**	**0.3%**
Avg. fee/kWh (Euro¢)	**8.3**	**10.4**	**7.3**	**46.0**	**7.2**	**10.9**

* includes landfill gas, sewage sludge gas, biogas and coal-bed methane.

Source: VDN, *EEG-Mittelfristprognose Entwicklungen 2000-2012*, 29 September 2006.

HEAT

Promotion of renewables in the heat supply sector has a long tradition in some German *Länder*. The prime aim of Germany's *Market Incentives Programme* (MAP) is to promote the use of biomass, solar energy and geothermal energy in heat generation through financial assistance. The funds available under the programme were EUR 190 million in both 2002 and 2003, and EUR 200 million in 2004. New January 2004 guidelines for the programme opened it to a larger circle of eligible applicants, and laid down progressive environmental requirements. In July 2005, assistance rates for solar collectors for combined water-heating and space-heating support increased, and assistance rates for solar collectors used exclusively for water heating decreased slightly. In 2006, though support rates for solar collectors and biomass heaters were significantly decreased, investment levels for these technologies were at the highest levels seen since the programme started. Since the programme was launched in 1999 until the end of 2005, funding was provided for more than 421 500 solar collector systems covering an area of 3.6 million square metres, and over 60 000 small-scale biomass boilers have been installed.

To promote larger systems, the KfW-Förderbank, Germany's bank for reconstruction, offers low-interest loans and debt relief for biogas systems, larger plants for burning solid biomass, plants for using deep geothermal heat and small hydropower plants. Between 2000 and 2005, 2 567 loans with a total value of EUR 741 million were granted.

TRANSPORTATION

To promote the market adoption of renewable fuels, in 2004 the existing petroleum tax exemption for biodiesel was extended to cover all kinds of biofuels, including bioethanol and ethyl-tertiary-butyl-ether (ETBE), a high-quality bioethanol-based gasoline component that can be mixed with fossil fuels. Immediately after, oil companies began mixing significant quantities of biodiesel with regular diesel, 5% by volume, the maximum allowed. In 2005, the share of biofuels in overall fuel supply reached 3.8%.

In light of the steep rise in the price of petroleum products, the tax exemption for biofuels was withdrawn on 1 August 2006 and replaced by a proportionate tax. For unmixed fuels like biodiesel and vegetable oil, this will involve a phased increase in the amount of tax charged, reaching 45 eurocents per litre by 2012, almost matching the full tax rate for diesel fuel (currently 47.04 eurocents per litre). The tax treatment is monitored and subject to adjustment if it is found to overcompensate for the cost differential between biofuels and fossil fuels.

As the preferential tax treatment has been eliminated, biofuels are now being promoted via a mandatory obligation to mix biofuels into regular gasoline and diesel. Starting on 1 January 2007, diesel must on average contain a minimum of 4.4% biodiesel by energy content and gasoline must on average contain a minimum of 1.2% of bioethanol by energy content. The required share of bioethanol in gasoline rises to 3.6% in 2010. The government originally proposed to increase the total share of biofuels in transport fuels to 6% by energy content by 2010. In December 2006 the parliament enacted the legislation, but raised the overall obligation to 6.75% in 2010 and 8% in 2015. The overall biofuels obligation can be met by either exceeding the individual bioethanol or biodiesel obligations, as well as by a combination of the two. The 6.75% obligation for 2010 puts it further ahead of the EU's biofuels directive target of 5.75% for the same year. Table 10 sets out the current obligations through 2015, along with Germany's proposed and enacted policies and the EU's biofuels directive targets.

Table 10

Biofuels Mixing Obligations, 2007 to 2015

	2007-2009	*2010 (old policy)*	*2010 (new policy)*	*2010 (EU target)*	*2010-2015*
Biodiesel (share of diesel by energy content)	4.4%	4.4%	4.40%	N/A	4.40%
Bioethanol (share of gasoline by energy content)	1.2%	3.0%	3.60%	N/A	3.60%
Biofuels (share of all diesel and gasoline by energy content); requires exceeding one or both of the above targets	No combined target	6.0%	6.75%	5.75%	Additional 0.25% per year, up to 8% in 2015

Note: The EU biofuels directive does not set specific biodiesel or bioethanol targets.
Source: Country submission.

CRITIQUE

Germany's efforts to increase the role of renewables in its energy mix have had striking results – in just the last five years total renewables supply has increased by 70% and Germany has already reached its 2010 goal for a 4.2% minimum share of renewables in TPES. The country is also well on its way to meeting its electricity goal that, by 2010, at least 12.5% of generation comes

from renewables. The government has done this through strong policies to promote renewables, most notably a differentiated feed-in tariff, but also through the *Market Incentives Programme*, the tax reduction for biofuels and renewable energy R&D. Recently, the government has passed a mandatory biofuels sales target to replace the preferential tax treatment. Under its previous tax policy, the country was one of only two that met the EU's biofuels target for 2006. The IEA commends Germany on its significant success in making renewables an important source of energy. Not only does this reduce the impact of energy consumption on the environment, but it also enhances supply diversity and security.

Germany is currently phasing out nuclear power, with some forecasts showing that nuclear power can be fully replaced in a way that avoids an increase in carbon emissions. In particular, renewables are forecast to take on a much more significant role. However, in light of the planned coal-fired and gas-fired electricity plants and the potential difficulties integrating large amounts of variable sources of energy, such as wind, into the electricity grid, the government should continue to evaluate all renewables projections and ensure that they are realistic. It should also ensure that sufficient policies and measures are in place so Germany can achieve its energy and climate targets along with its overall policy objectives.

Germany's primary means of promoting renewables is through its feed-in tariff for renewables in the electricity sector. The feed-in tariff's guaranteed rates provide high investor security. In addition, renewables are guaranteed priority access to the electricity network. These factors have made the feed-in tariff successful, resulting in rapid deployment of renewables, helping give the technologies a firm footing in the market. Furthermore, many new actors have entered the market, helping drive a steeper learning curve and pushing down costs. However, costs for most renewable energy sources for power generation are still higher than those for conventional power production (when externalities of and subsidies for conventional energy sources are excluded). The government is working to make the feed-in tariff less rigid by regularly reviewing tariff levels and setting higher degression rates that put greater downward pressure on industry costs. Henceforward, as renewables now make up a significant share of the market, the government might consider future policies that rely less on guaranteed long-term subsidies for suppliers and more on market forces and incentives that put downward pressure on prices and allow the market for renewables to integrate with the wider electricity market now developing in Germany and Europe. Particular technologies that need additional R&D support could be given supplemental subsidies.

While the feed-in tariff system is successful at bringing large amounts of renewables on line quickly, it does so by paying high rates to producers. Estimates by the association of network operators show that between 2000 and 2012, the feed-in tariff will lead to payments for grid operators of

EUR 68 billion and provide about 650 TWh of electricity – an average payment of about 10 eurocents per kWh – with between 44% and 53% of these payments due to excess costs above standard electricity provision costs. Annual payments will grow from EUR 4.4 billion in 2005 to EUR 9.4 billion in 2012, an average annual growth rate of 10.5%. The average payment per kWh is forecast to peak in 2009, and will be higher in 2012 than in 2005. Solar is the most expensive and will deliver a relatively small amount of power, in part because the feed-in tariff is used to fund technology development, not just deployment. With payments of 46 eurocents per kWh in 2012, solar will eat up 20% of the total expenditure of the feed-in tariff but provide less than 5% of the electricity. In comparison to the payments for renewables under Germany's feed-in tariff, electricity from conventional power plants running on fuels such as nuclear, coal and gas costs about 4 to 5 eurocents per kWh. As a result, between 2000 and 2012, the excess cost of promoting renewable electricity in Germany will be EUR 30 to 36 billion in total, about EUR 2.5 to 3 billion per year.

Considering the high costs of the feed-in tariff for solar photovoltaics, it is valuable to compare the costs to other policies to reduce CO_2 emissions, noting that renewables policy is not intended only to reduce CO_2 emissions. Germany's feed-in tariff subsidises solar photovoltaics at about 40 eurocents per kWh above the average cost of electricity. The benefit of this policy in terms of avoided CO_2 emissions corresponds to a carbon abatement cost of EUR 1 000 per tonne of CO_2 abated (assuming solar photovoltaics replace gas-fired generation).[10] In comparison, many efficiency improvement policies have the scope to deliver significant energy savings, and therefore major CO_2 emissions reductions. The carbon abatement costs of these policies range from the very negative range to upwards of EUR 100 per tonne of CO_2. For example, while many building efficiency measures have negative costs, even the more expensive building efficiency retrofit projects have costs only up to EUR 20 to 30 per tonne CO_2, making these policies 30 to 50 times less expensive than the feed-in tariff for solar PV in terms of abated CO_2. Overall, in addition to being much cheaper than renewables policies now, enhanced support for efficiency policies and measures could help drive technology development, lower their costs and install a world-class energy efficiency industry in Germany, as is the goal of the current feed-in tariff for solar PV.

We commend the efforts undertaken to lower the costs of the programme henceforward – annual degression rates between 1% and 6.5% are applied to most technologies, such that renewables installations going on line in future years receive progressively lower rates in order to account for

10. If renewables were to displace coal-fired generation, the cost would be EUR 350-400 per tonne of CO_2 abated. If renewables were to displace nuclear generation, the cost per tonne of CO_2 abated would be much higher as nuclear produces only very low levels of emissions, even when viewed on a full life-cycle basis.

technological and market learning. However, once given, a particular feed-in tariff is guaranteed to the producer for 15 to 30 years, with most guaranteed for 20 years; producers will continue to receive the same rate despite any reductions in operating costs. As a result, with the increasing share of renewables promoted by the feed-in tariff – including cost-intensive solar electricity – the total costs for German customers will increase over the next few years, reaching its maximum in 2017. On the other hand, the costs for existing and new renewables projects will decrease because of reductions in construction and operating costs.

In addition to the high prices paid to renewables producers, particularly the very high rates paid for solar photovoltaics, the feed-in tariff limits market flexibility and relies on the government to determine electricity payment rates, rather than letting market forces reflect costs dynamically. Though the government aims at setting feed-in tariff rates that accurately reflect market conditions and avoid oversubsidisation, the process relies on best estimates and is a second-best proxy for actual market prices. Furthermore, it creates a class of energy that requires fixed subsidies to survive; as seen in the coal sector, such subsidies can easily become entrenched and very difficult to remove. Whereas Germany's electricity industry is moving towards a liberalised market governed by competitive forces, the feed-in tariff is an administrative programme managed by the government. As renewable electricity is no longer inconsequential in the German market – it already makes up over 10%, and this amount is set to grow to at least 20% by 2020 – renewables supply should be integrated with the wider market instead of being walled off. Not only would integrating Germany's electricity market with the wider internal European market be easier if its renewables promotion scheme relied more on market forces and less on government-provided guarantees, but it would also provide renewables suppliers with incentives to build and operate the right kind of facilities in the right locations.

As Germany's renewables supply is now well established, we encourage the government to consider more market-based renewables promotion policies, such as a renewables obligation scheme, in the next phase of renewables promotion. Building on the success of the feed-in tariff, the government could move towards such a policy, which requires that a predetermined share of electricity from renewable sources be purchased. This system forces private renewables producers to compete against each other on price by lowering fixed and operating costs – and passing those savings on to German customers. Market-based renewables promotion schemes in Sweden, Australia and the United States (including in Texas and California) have produced promising results. This model provides sustainable downward pressure on prices through reliance on market forces rather than government actors working to approximate market outcomes, helping ensure long-term public support for renewables promotion. It is also more compatible with a liberalised electricity market, particularly one that is beginning to reflect the cost of

carbon emissions through the EU Emissions Trading Scheme. As prices for fossil sources begin to take into account costs for carbon emissions, renewables will become comparatively cheaper. Furthermore, a quota system could be easily linked with those in neighbouring countries, creating opportunities for gains from continental European trade. A static feed-in tariff is not able to incorporate dynamic changes in market conditions, but a renewables promotion scheme can.

Regardless of what scheme is chosen, the government should always keep cost-effectiveness as a critical component when deciding between policies and measures. Should the feed-in tariff continue, efforts should be made to continue to improve it so that it incorporates as many market-based elements as possible. A firm end date might also be considered to avoid the risk of entrenched long-term subsidisation. The government might also consider moving towards a premium system, which gives a guaranteed add-on for renewables and provides more investor security than an obligation system, but still exposes operators to the market price for electricity. This model is in place in the United States via a tax credit for wind; Denmark and Spain have also taken policy steps in this direction. R&D support for particular technologies that are not yet competitive with other renewables could be given additional targeted subsidies.

One particular area of concern in the field of renewables is the effect of the increasing amounts of wind energy on the grid. Not only does the feed-in scheme place an obligation on grid operators to purchase the electricity produced from renewables installations, but it also guarantees priority grid access, transmission and distribution. Combined with the lack of congestion pricing on its electricity network, this leads to detrimental transmission effects at its borders with other European countries. The government should implement revisions to the current feed-in tariff so that it provides signals to wind energy installations to build in locations that do not cause negative effects on the grid. In short, all policies and measures should ensure that the growing share of renewables does not result in dispatch that threatens grid reliability and adversely affects Germany's neighbours. Furthermore, as discussed in Chapter 9, efforts to better integrate wind on the transmission system – rather than just accommodate it – should be undertaken. For example, rules on the prediction of wind, timing of gate closures and charging of balancing costs could be revised. Thus we are pleased to see that DENA, the German Energy Agency, has undertaken work in this area. In addition, among the many benefits for security of supply of a larger, more integrated European market is the ability to reliably manage greater amounts of wind. To that end, Germany should ensure comprehensive integration of its electricity networks within the country, as well as with those of neighbouring countries.

RECOMMENDATIONS

The government of Germany should:

- *Ensure that long-term targets for renewables are realistic, and that sufficient and cost-effective policies and measures are in place to meet them.*
- *Evaluate the cost-effectiveness of policies to promote renewables; consider moving towards a more market-based means of promoting renewables in the future, particularly in the context of a liberalised electricity market.*
- *Consider policies other than very high feed-in tariffs to promote solar photovoltaics.*

Coal provides a large share of Germany's energy supply, comprising a quarter of primary supply and fuelling half of its electricity generation. Over two-thirds of this supply is produced domestically. While production of lignite is economically viable and unsubsidised, heavy subsidies support hard coal production. In February 2007, the government reached an agreement to phase out coal subsidies by 2018.

SUPPLY AND DEMAND

PRODUCTION

As shown in Table 11, Germany produces about 70% of its coal supply on an energy-equivalent basis, more than two-thirds of which is lignite, or brown coal, with the remainder being hard coal (including anthracite and bituminous coal). Since 2000, production of hard coal has declined by 25%. This decline in production has been offset by a revival in the production of lignite, which has risen by over 6% since 2000, and is a significant domestic energy source in Germany.

On a tonnage basis, 2005 coal production in Germany totalled 28.0 million tonnes (Mt) of hard coal and 177.9 Mt of lignite.[11]

Reserves

The Federal Institute for Geosciences and Natural Resources (BGR) reports that German hard coal reserves totalled 152 Mt at the end of 2005,[12] a figure that should be treated with some caution given that current production is uneconomic. The same report indicates that German lignite reserves are 41.2 billion tonnes, ranking Germany first globally. Of the total, 6 556 Mt are reserves of opencast lignite in permitted, operational sites with planning provisions. Germany's substantial national lignite resources are around 76 billion tonnes.

11. The large mass differential between hard coal and lignite production reflects the high energy content of hard coal and low energy content and high water content of lignite.
12. Rohstoffwirtschaftliche Länderstudien, Heft XXXIV – Bundesrepublik Deutschland – *Rohstoffsituation 2005*, Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, 2006.

Table 11

Coal Supply-Demand Balance, 1970 to 2030

Unit: Mtoe	*1970*	*1980*	*1990*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2010*	*2020*	*2030*
Supply												
Indigenous production	151.5	143.1	121.8	60.6	58.2	58.4	57.7	58.3	56.5	51.5	45.2	41.8
Imports	16.6	14.4	11.5	22.2	26.3	25.1	25.7	28.3	26.4	23.9	24.8	13.8
Exports	–20.4	–15.8	–8.2	–0.6	–0.5	–0.7	–0.6	–0.6	–0.6	0.0	0.0	0.0
Other	0.2	–0.8	3.4	2.5	2.5	1.3	2.2	–0.2	–0.5	0.0	0.0	0.0
Total supply (TPES)	147.8	141.0	128.5	84.8	86.5	84.1	85.0	85.8	81.7	75.4	69.9	55.5
Demand												
Electricity	66.1	81.0	84.0	68.9	70.3	70.7	71.1	72.3	67.6	62.6	59.0	45.4
Industrial sector	32.9	26.1	20.7	7.7	7.3	6.9	6.6	7.1	7.3	11.9	10.5	9.8
Other sectors	34.0	20.8	16.6	1.3	1.3	1.1	1.1	1.3	0.9	0.4	0.2	0.2
Other (including losses)	14.8	13.1	7.3	7.0	7.6	5.5	6.3	5.1	5.9	0.4	0.2	0.1
Total consumption	147.8	141.0	128.5	84.8	86.5	84.1	85.0	85.8	81.7	75.4	69.9	55.5

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007; country submission and *Development of Energy Markets up to 2030*, EWI/Prognos, 2005.

IMPORTS AND EXPORTS

German imports of hard coal totalled over 38 Mt in 2005, a decrease of over 3% from the previous year, but an increase of over 36% from 2000. Imports have more than doubled from 1995, the last year in which there were import quotas. In 2005, Poland, South Africa, Russia and Australia combined provided over 75% of imports

German hard coal exports were 255 000 tonnes in 2005, a reduction of over 85% compared with the 1.85 Mt exported in 1995. All exports comprise unsubsidised coal for the heating market.

Lignite is not subject to significant import and export trade, as the high water content in crude lignite (approximately 50%) and low energy density makes transportation over long distances uneconomical. Accordingly, lignite is used in power stations and upgrading facilities near mines. Some 85% of lignite upgrading products were sold domestically in 2005 and 15% exported.

CONSUMPTION

Nearly all coal is used in the electricity and industrial sectors. In 2005, the electricity sector accounted for 83% of consumption, with 11% used in the industrial sector.

Total hard coal consumption, including for electricity generation, has fallen by nearly 6% between 2000 and 2005 and by nearly 20% since 1990. Lignite consumption decreased by nearly 50% between 1990 and 2005, though it has increased by nearly 6% in recent years, between 2000 and 2005.

Power plant efficiency

The efficiency of lignite and coal-fired power stations has continuously improved in Germany. State-of-the-art lignite power stations currently achieve 43-45% efficiency rates (compared with 30% in the few 50-year-old power stations still in operation). Modern, hard coal-fired power stations achieve efficiency rates of 46-48% and there are a number of new project proposals in Germany with commissioning dates from 2010. In addition to lower coal needs, the efficiency gains have reduced emissions of sulphur dioxide (SO_2), nitrous oxides (NO_x) and particulates, improving regional air quality, as well as lower carbon dioxide (CO_2) emissions.

Coal- and lignite-fired power stations have not yet reached their theoretical limits as regards efficiency and CO_2 emissions. To further improve power plant efficiency and lower emissions, the government's clean coal strategy aims to push development of technologies for high-efficiency power stations, along with development of new technologies for low-carbon combustion. RWE announced in 2006 its intention to build a 450-MW (360-MW net) integrated gasification combined-cycle (IGCC) power station by 2014, complete with CO_2 capture and storage. The German government provides funding for research and development in this sector. (For further information see Chapter 11.)

INDUSTRY STRUCTURE

RAG

Nearly all production of hard coal is carried out by Deutsche Steinkohle (DSK) which is part of RAG, of which the majority shareholders are E.ON and RWE, the large incumbent electricity and gas companies in Germany. E.ON RAG-Beteiligungsgesellschaft mbH, a wholly owned subsidiary of E.ON AG, owns 39.2%; RWE AG owns 21.9%; Société Nouvelle Sidéchar, a wholly owned subsidiary of RWE AG, owns 8.3%; ThyssenKrupp AG owns 20.6%; and Verwaltungsgesellschaft RAG-Beteiligung mbH – 65% of which is owned by

ARBED S.A. and 35% of which is owned indirectly by RAG AG through subsidiaries – owns 10%.

In 2005, DSK had annual sales of EUR 4.5 billion and a workforce of 37 890. It now operates eight deep coal mines at sites in the Ruhr and Saar regions and in Ibbenbüren in North Rhine-Westphalia. The company faces continuing financial difficulties with production costs rising above revenues, requiring substantial government subsidies. In addition to DSK, the RAG Group has divisions for energy (STEAG), chemicals (Degussa) and property (RAG Immobilien). In 2005, mining made up 20.5% of the Group's EUR 21.9 billion sales revenue; over half of sales revenue came from chemicals, more than a quarter from energy and 2% from property. RAG plans for spinning off its non-coal activities are still subject to negotiation. The decision on phasing out coal subsidies by 2018 is an important step towards realising these plans.

LIGNITE PRODUCERS

Lignite is primarily produced from four regions: the Rhineland in North Rhine-Westphalia, the Helmstedt mining area in Lower Saxony, the Central German mining area in Saxony-Anhalt and Saxony, and the Lusatian mining area in Brandenburg and Saxony. Lignite mining in the Hesse coalfield ceased on 30 November 2003. In addition, lignite is mined on a small scale in Bavaria (32 000 tonnes in 2005), exclusively for the needs of two clay works.

Five companies operate opencast mines in the four principal mining areas, with the output mainly used for power generation at nearby plants and processed products. In most cases these power plants are owned by the company mining the lignite. RWE operates three opencast mines in the Rhineland coalfield. In the Helmstedt coalfield, lignite extraction has been reduced to a single opencast mine belonging to Braunschweigische Kohlen-Bergwerke, a wholly owned subsidiary of E.ON. Mining operations at the Helmstedt opencast mine are small, producing 2.1 Mt in 2005. At the Lusatian coalfield, Vattenfall operates four opencast mines and owns another one that was mothballed in 1999, but will reopen in 2010 to supply a new power station. There are three opencast mines in the Central German coalfield, two of which are operated by Mitteldeutsche Braunkohlengesellschaft (MIBRAG), a company owned by two American companies, NRG Energy and Washington Group International, and one of which is operated by Romonta.

SUBSIDIES

Lignite production is unsubsidised. However, because of its adverse geological conditions, costs of extracting hard coal in Germany significantly exceed the

world market price. The difference between the sales revenue generated on the basis of the average world market price and the cost of production is covered by government aid up to an approved ceiling.

In 1997, the German government, the state governments of North Rhine-Westphalia and Saarland (the two German *Länder* with major coalfields), the mining industry and the German miners' union reached a compromise on coal subsidies up to 2005. Under the compromise, annual subsidies have been cut from EUR 4.7 billion in 1998 to EUR 2.7 billion in 2005 – a decrease of 43%. From 2001 to 2005, the RAG Group additionally contributed EUR 102 million a year to support coal mining.

The German government decided in 2003 to continue supporting coal mining until 2012. Hard coal extraction is to be scaled back to 16 Mt in 2012, to be achieved without lay-offs. State aid for 2006 to 2008 was officially approved in 2004. The German government is granting up to EUR 5.699 billion total in aid from 2006 to 2008. RAG AG is contributing EUR 150 million per year. The state of North Rhine-Westphalia granted EUR 564 million in 2006, and will grant EUR 540 million in 2007 and EUR 516 million in 2008.

In February 2007, the government reached an agreement to phase out all subsidies, resulting in the shut-down of the remaining eight plants in North Rhine-Westphalia and Saarland by 2018. Some details of the agreement with industry must still be finalised. Exact subsidies as from 2009 have not been decided, but there will be no lay-offs of mine workers.

Under rules limiting state aid to particular domestic industries, subsidies to the coal industry have been approved by the European Commission, as has a long-term restructuring plan for German coal mining up to 2010.

CRITIQUE

Germany's energy sector relies heavily on coal. It provides nearly a quarter of total energy supply and fuels half of electricity generation. While coal's role in Germany is forecast to decline somewhat in the coming decades, it will continue to have a very prominent role in the country's energy mix. Current efforts to improve the efficiency of coal-fired power plants will help Germany produce more electricity with less coal, lower emissions of air pollutants in the region and lower emissions of carbon dioxide.

Subsidies currently drive Germany's hard coal industry – annual subsidies provided for hard coal production are nearly double the actual cost of purchasing the same amount of coal on the world market. However, the government continues to reduce the amount of subsidies provided, resulting in mine closures and reduced output. In fact, coal mines are closing faster than planned.

The phase-out of coal subsidies is a politically difficult feat to accomplish – the experience of other IEA countries confirms this – but it is necessary. Though hard coal is a domestic resource for the country, substituting hard coal imports for domestic supply will not diminish the country's security of supply as the world coal market is diversified and competitive. No single supplier or country can manipulate the market in any significant way. Sustaining uneconomic hard coal production distorts the coal market but it also, more importantly, diverts economic resources better used elsewhere to the benefit of the German economy. In this light, the recent government decision to completely eliminate subsidies by 2018 is welcome news. We encourage the government to complete the necessary steps to finalise this decision. To the extent necessary, coal subsidies can be replaced with direct social subsidies, as providing social support to mining areas does not have the same negative effects on the energy market.

The details of the RAG sell-off could have important implications for Germany's electricity market. As a stand-alone company, RAG's generation subsidiary, STEAG, would be the fifth-largest electricity company in Germany. The company currently sells its generation to E.ON and RWE, but if it were sold off, it could add to competition in the German electricity market.

RECOMMENDATION

The government of Germany should:

- *Complete the necessary steps to finalise the agreement to completely eliminate hard coal subsidies by 2018, providing social support where necessary as part of the structural change.*

Germany's oil market is fully liberalised, and characterised by a relatively large number of market participants. The country relies almost entirely on imports to meet its oil demand, but exports a large amount of refined product to Europe. German policy favours diesel-fuelled vehicles; diesel now fuels more than half of all new and nearly a quarter of all passenger vehicles. The country's emergency oil stocks are consistently above the IEA-mandated level of 90 days of net imports.

SUPPLY AND DEMAND

SUPPLY

Total primary energy supply (TPES) of oil has been generally declining after peaking in the 1970s (see Table 12). In 2005, total supply was 123 Mtoe, making up 36% of TPES of all fuels. Supply in 2005 represented a decline of 1.4% from the previous year, 6.3% from 2000 and 2.4% since 1990. Government forecasts estimate that oil supply will decline after 2010 to 2030, at an average annual rate of 0.7%, or 13.9% in total.

IMPORTS

Germany imports virtually all its oil supply, producing just 3.7% of its oil needs domestically in 2005. In 2005, the country imported 151 Mtoe of oil, including crude and petroleum products. The largest source was the former Soviet Union (33%), followed by the Netherlands (14%, mostly products), Norway (12%), the United Kingdom (11%) and Libya (9%). Supply from countries in the Organization of the Petroleum Exporting Countries (OPEC) covered 14% of supply. Supply from OECD countries totalled 45% of supply. To make up for declining domestic production and lower product imports, total imports of crude have been steadily increasing, rising by 8.3% since 2000 and 27.5% since 1990.

Germany imported nearly 35 Mt of products in 2005, nearly 60% of which came from the Netherlands. Belgium provided 11% of Germany's product imports and the former Soviet Union accounted for 7%. Though product imports increased in 2005 over 2004 by 2.6%, total product imports have been declining since the mid-1980s. Imports in 2005 were 17% lower than in 2000 and 31% lower than at the peak in 1986.

Table 12

Oil Supply-Demand Balance, 1970 to 2030

Unit: Mtoe	*1970*	*1980*	*1990*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2010*	*2020*	*2030*
Supply												
Indigenous production	7.9	5.7	4.7	3.9	4.0	4.2	4.4	4.4	4.6	3.0	1.8	0.6
Imports	145.0	160.6	132.9	149.6	152.8	144.7	146.1	147.8	150.9	131.6	124.2	116.8
Exports	–9.8	–11.2	–10.2	–22.2	–19.8	–20.2	–19.8	–25.3	–27.5	–3.7	–3.9	–2.8
Other	–5.3	–7.9	–0.9	0.4	–2.4	0.1	–4.2	–1.6	–4.6	–3.0	–3.6	–4.4
Total supply (TPES)	137.9	147.1	126.5	131.7	134.5	128.8	126.5	125.2	123.4	127.9	118.5	110.1
Demand												
Transport sector	31.4	46.5	58.8	65.6	63.9	63.1	60.9	62.1	60.0	61.1	56.7	53.5
Industrial sector*	40.6	37.0	27.3	28.2	27.6	27.6	27.1	27.4	26.9	27.5	28.0	27.0
Residential sector	27.1	25.5	18.4	19.8	22.6	20.0	19.6	17.7	16.9	19.9	17.2	15.3
Other sectors	16.8	18.5	13.2	9.1	10.4	9.4	9.2	8.5	8.1	9.3	7.5	6.1
Other (including losses)	21.9	19.6	8.8	9.0	9.9	8.7	9.7	9.6	11.6	10.1	9.1	8.3
Total demand	137.9	147.1	126.5	131.7	134.5	128.8	126.5	125.2	123.4	127.9	118.5	110.1

* includes non-energy use.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

REFINERY OUTPUT AND PRODUCT EXPORTS

In 2005, total refinery output in Germany was 124 Mt (see Table 13), representing a 7% increase from 2000 and a 17% increase from 1990. Exports of products have more than doubled since 1990. At more than 26 Mt, exports now represent over a fifth of total refinery output, compared to 10% in 1990.

CONSUMPTION

Total final consumption (TFC) of oil was 112 Mtoe in 2005 (see Figure 9; total demand in Table 12 includes electricity and other transformations). The largest share of consumption was in the transport sector, which accounted for over half of total consumption in 2005, followed by the industrial sector

Table 13

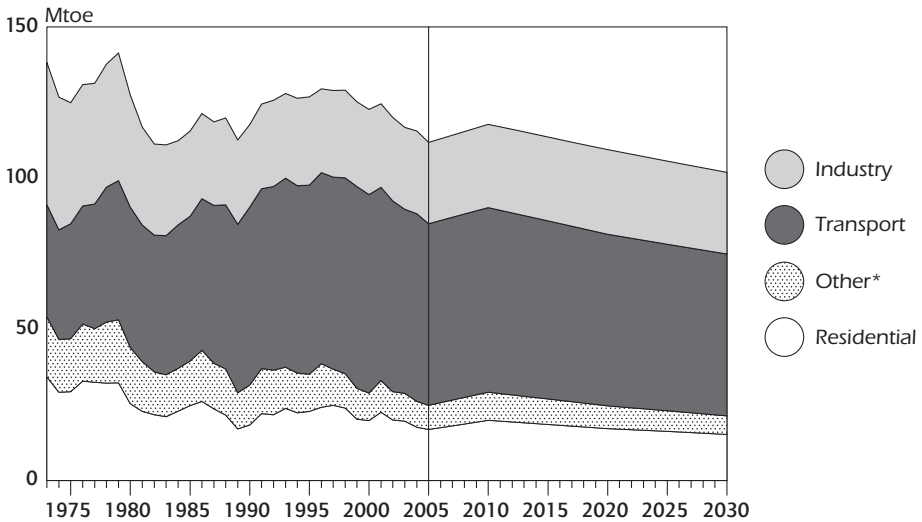
Refinery Output and Product Exports, 1970 to 2005

Unit: kt	*1970*	*1980*	*1990*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Gas and diesel oil	42 049	48 128	40 668	46 445	46 943	47 455	48 638	49 836	52 839
Exports	*1 792*	*2 123*	*3 518*	*5 448*	*5 576*	*6 242*	*6 328*	*8 150*	*10 003*
Motor gasoline	16 088	25 051	24 317	26 972	26 021	25 970	26 449	26 511	27 500
Exports	*1 097*	*1 451*	*1 841*	*4 609*	*4 659*	*4 397*	*4 153*	*5 263*	*5 706*
Residual fuel oil	39 855	34 607	13 075	13 068	13 192	12 183	12 232	14 013	13 340
Exports	*3 131*	*4 801*	*2 318*	*4 397*	*4 066*	*3 611*	*4 004*	*5 377*	*5 668*
Naphtha	4 918	9 371	8 554	9 024	8 495	8 663	8 693	9 389	9 063
Exports	*1 517*	*575*	*290*	*1 047*	*919*	*954*	*962*	*1 285*	*1 215*
Refinery gas	4 211	4 793	3 480	4 106	3 888	4 196	4 452	4 425	4 365
Exports	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Jet fuel	1 781	1 451	2 610	4 311	4 195	4 157	4 194	4 424	4 252
Exports	*110*	*61*	*83*	*289*	*513*	*384*	*289*	*534*	*455*
Other products	12 234	13 111	13 253	12 047	11 558	11 459	11 507	11 685	12 278
Exports	*1 887*	*2 170*	*2 103*	*2 811*	*2 762*	*2 996*	*3 110*	*3 210*	*3 254*
Total	**121 136**	**136 512**	**105 957**	**115 973**	**114 292**	**114 083**	**116 165**	**120 283**	**123 637**
Exports	*9 534*	*11 181*	*10 153*	*18 601*	*18 495*	*18 584*	*18 846*	*23 819*	*26 301*

Source: *Oil Information*, IEA/OECD Paris, 2007.

Figure 9

Final Consumption of Oil by Sector, 1973 to 2030



* includes commercial, public service, agricultural, fishing and other non-specified sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

(24%) and the residential sector (15%). As is true across the IEA, the share of oil used in the transport sector has been increasing, while in other sectors it has declined.

Consumption in Germany's residential sector was 17.7 Mtoe in 2004. The share of residential energy demand from oil was 28% in 2004, ranking ninth-highest of the IEA's 26 countries. (Natural gas makes up the largest share of residential energy demand, 45%, ranking it seventh among IEA countries.) In 2004, residential oil consumption made up 15% of total oil consumption, the fourth-highest level in the IEA.

INDUSTRY STRUCTURE

The German oil market is fully liberalised, with no government ownership. Despite major corporate mergers in 2002, Germany's downstream oil market retains a relatively large number of players.

UPSTREAM

Germany has limited upstream exploration and production activities. Total production was 3.6 Mt in 2005, with most production concentrated in the

Länder of Schleswig-Holstein and Lower Saxony. Germany's limited offshore production centres on the Mittelplate field, where output is planned to reach about 1.6 Mt annually. Known and likely crude oil reserves totalled 46.4 Mt as of 1 January 2006. Wintershall AG and RWE Dea AG dominate upstream activity, with 39.2% and 32.0% of oil output, respectively, in 2005. Gaz de France had 13.3% of output and BEB Erdgas und Erdöl GmbH had 11.5%.

REFINING AND RETAIL

Major changes in the German oil market structure came about with the takeovers of DEA Mineralöl AG by Shell in Germany on 1 July 2002 and Veba Oel AG by German BP on 1 October 2002, creating two strong oil companies with considerable market influence. The conditions attached to the competition authority's regulatory approval for the mergers included the sale to third parties of 5.3% and 4%, respectively, of Shell and BP's filling station network, along with the sale of 45% of BP's equity stake in the Bayernoil refinery.

Helped by the elimination of bottlenecks and expansion measures in existing plants, refinery capacity has increased slightly from 113 Mt in 2000 to around 115 Mt in the last few years. No major expansions are planned for the next few years. Currently, there are nine refining companies in Germany (see Table 14).

PKN Orlen, a Polish oil company, entered the German market with a purchase of around 500 filling stations in March 2003. Similarly, OMV has strengthened its position in Germany and especially in Bavaria by acquiring about 250 filling stations and a 45% stake in the Bayernoil refinery. ConocoPhillips acquired the

Table 14

Refining Companies by Share of Capacity, Year-end 2004

Shell Deutschland Oil GmbH	31%
Deutsche BP AG	25%
Total Deutschland GmbH	11%
Wilhelmshaven refinery	9%
OMV Deutschland GmbH	8%
Esso Deutschland GmbH	8%
Holborn refinery	4%
Agip Deutschland GmbH	3%
ConocoPhillips Germany GmbH	2%

Source: Country submission.

10.3 Mt Wilhelmshaven refinery as of 1 March 2006 and plans major investment in the refinery's distillation plant over the coming years, though the effects of this investment on capacity are not yet quantifiable.

The number of filling stations remains on a gradual downward trend, falling from 16 404 in 2000 to 15 187 at the beginning of 2006. In 2006, the largest operator in the filling station sector was BP/Aral, with 2 522 filling stations, followed by Shell/DEA with 2 220. The largest shares of the consumer transport fuels market are held by BP/Aral with about 22% and Shell with 21%. Medium-sized businesses account for 20% of the transport fuels market.

TRANSPORT FUELS

Under a long-standing policy, the German government promotes the use of diesel in passenger vehicles. As shown in Figure 10, in recent years gasoline consumption has been on the decline, thanks to more efficient vehicles, changes in consumer travel patterns in response to rising gasoline prices, growing numbers of motorists switching to diesel cars and increased numbers crossing the border into neighbouring countries to fill up on cheaper fuel. The same factors (except for the switch to diesel cars) have also begun to slow the increase in diesel consumption. Slightly more than 23% of all passenger vehicles in Germany are fuelled by diesel. In 2006, 44.2% of all new passenger vehicles purchased were diesel cars, up from 30.3% in 2000. Compared to other European countries, Germany has a relatively low uptake of diesel vehicles, ranking eighth out of 17 European countries in terms of the percentage of new cars that are fuelled by diesel (for example the rates are 75% for Luxembourg, 73% for Belgium and 69% for France).[13]

Biodiesel now plays an increasing role as a transport fuel, with consumption as high as 1.8 Mt in 2005. This includes 0.7 Mt sold in a maximum 5% mix with diesel and hence counted in the statistics on diesel consumption. (For further information on biofuels, see Chapter 5.)

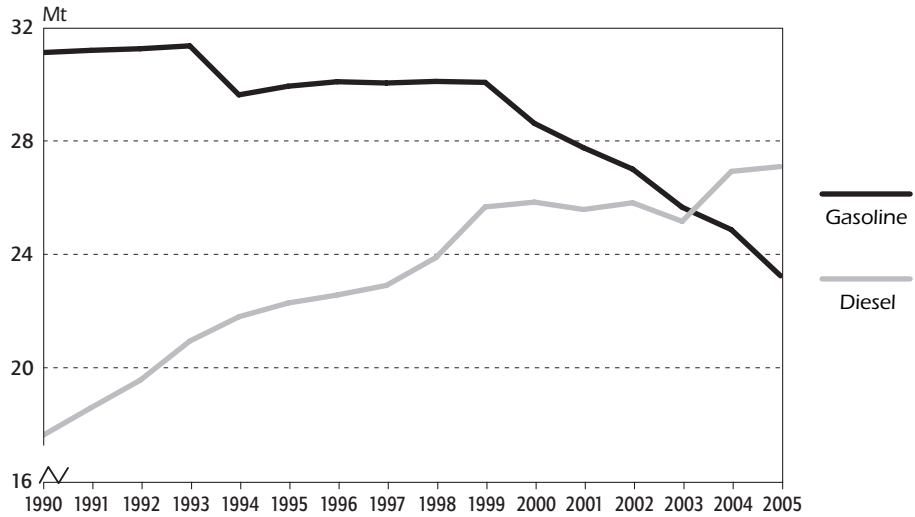
The prices of gasoline and diesel fuels are largely determined by taxes on petroleum products. Pre-tax prices in Germany have been among the lowest in the EU. In the second quarter of 2006, tax accounted for over 62% of the price of gasoline and 55% of the price of diesel, the second-highest tax rates behind the United Kingdom.

The most recent long-term forecasts from the oil industry assume a reduction in total annual miles driven per passenger car, greater substitution of gasoline-fuelled by diesel-fuelled passenger cars and increasing use of alternative fuels.

13. AAA (Association Auxiliaire de l'Automobile), *New Passenger Car Registrations*, 2005.

Figure 10

Consumption of Diesel and Gasoline in the Transport Sector, 1990 to 2005



Source: *Annual Oil Statistics*, IEA/OECD Paris, 2007.

According to the current forecast, the oil industry expects a further drop in transport-sector oil consumption over the next few years, estimating that consumption of gasoline in Germany will fall by 42% and consumption of diesel by 12% between 2005 and 2025.

EMERGENCY RESPONSE MEASURES

Oil stocks held by Germany's stockholding agency (*Erdölbevorratungsverband*, EBV) are consistently in compliance with the IEA's obligation that member countries hold 90 days of net oil imports. The EBV is responsible for maintaining 100% of the stock requirement; producer obligations were eliminated in 1998. Combined reserves held by EBV and industry have always been well above IEA requirements.

Following the oil stock release after hurricanes Katrina and Rita in the United States in 2005, Germany undertook modifications to its response protocol for international oil events, finding that stock release arrangements were geared more towards domestic events. Improvements were made to facilitate the process of making strategic stocks available to the international market as part of a collective response action to a regional or global oil supply disruption.

CRITIQUE

Germany has a competitive, well-diversified oil market with modern refineries that provide important product supply and diversity to Europe. Furthermore, the government has consistently maintained its emergency oil stocks above the IEA requirement, ensuring that it is ready and able to respond effectively to oil market disruptions. Following the stock release after hurricanes Katrina and Rita in 2005, the government identified areas where it could better respond to international emergencies, and proactively improved its release protocols. The IEA commends Germany for its efforts to maintain a well-functioning oil market and help underpin global security of supply.

The German government promotes the use of diesel in passenger vehicles, and as a result of this long-standing policy nearly a quarter of all cars and almost half of all new cars purchased are fuelled by diesel. Nevertheless, as compared to other European countries, this share is somewhat low, and the government could evaluate its current policies and measures to ensure its policy goals are being met, taking care to consider the promotion of diesel vehicles in the context of the environmental and efficiency benefits of other technologies and options. The possible tightening of the diesel market could undermine some of the relative benefits of Germany's preferential tax treatment for diesel.

The share of oil in Germany's TPES (36%) is similar to that of many IEA countries. Nevertheless, we encourage the government to consider measures to decrease this share, enhancing overall supply diversity. For example, Germany could work to reduce the use of oil for static applications, such as heating and industrial boilers, as movement away from this fuel could not only increase diversity, but also reduce negative environmental effects. The government might consider strengthening incentives to increase the share of alternative sources for heating, such as combined heat and power (CHP), taking care that any incentives are implemented in a cost-effective manner. Finally, the government could work to improve efficiency in the transport sector as discussed in Chapter 4, helping reduce oil consumption.

RECOMMENDATIONS

The government of Germany should:

- *Evaluate existing policies to support diesel uptake; consider providing cost-effective incentives to promote efficient and alternative engines in the transport sector.*
- *Consider measures to substitute the use of oil in static applications, such as by strengthening incentives to increase the use of alternative energy sources.*

SUPPLY AND DEMAND

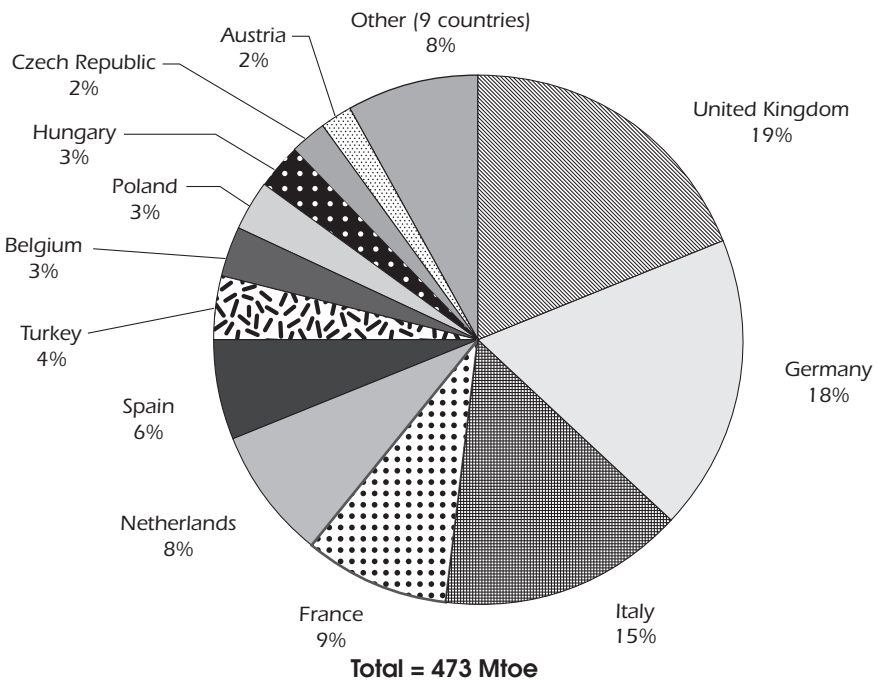
At the geographical centre of Europe, Germany has good access to natural gas supplies from the North Sea, the Netherlands and Russia as well as from indigenous production. Germany has the third-largest gas reserves in the European Union after the United Kingdom and the Netherlands, and currently produces about 18% of demand domestically.

DEMAND

Natural gas accounted for about 23% of total primary energy supply (TPES) in 2005. Consumption has risen steadily and the number of households supplied with gas has increased from 7.3 to 15 million over the last 20 years. Domestic natural gas consumption totalled 90.0 billion cubic metres (bcm) in 2003 and about 91.7 bcm a year in 2004 and 2005. This makes Germany the largest gas market in continental Europe, and a close second to the United Kingdom in the European Union (EU). German gas consumption accounted for 18% of the European total in 2004 (see Figure 11).

Figure 11

European Gas Demand, 2004



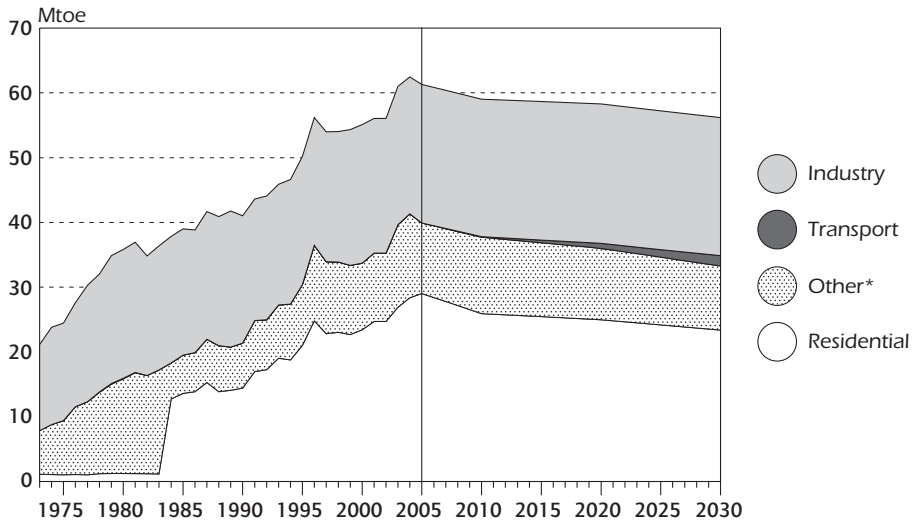
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007.

Total final consumption of natural gas in 2005 was 61.3 Mtoe (see Figure 12). The largest share of consumption is in the residential sector, which comprise 47% of the market. Industrial consumption (excluding non-energy use) makes up 18% of consumption. The remaining sectors, including the commercial and public sectors, represent 31% of total consumption. Residential gas demand per capita is expected to fall starting in 2010 for the next two decades as the energy efficiency of buildings improves.

As a share of total primary energy supply, gas used to generate electricity makes up 22% of the total. New gas-fired power stations are planned in Hürth, Hamm Uentrup and a number of other locations. (For further information, see Chapter 9.)

Figure 12

Final Consumption of Natural Gas by Sector, 1973 to 2030



* includes commercial, public service, agricultural, fishing and other non-specified sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

Peak gas demand

German gas consumption in January 2006 was 2.7 times that of August 2005 – a very high seasonality of gas usage. Peak gas demand is met through gas storage as well as supply flexibility.

As with many other areas of the German gas industry, statistics on consumption are not as reliable as in other IEA countries. According to the government, the large number of suppliers and asynchronous load peaking make cumulative peak winter gas demand for all gas suppliers in Germany impossible to determine. Coincident daily or hourly peaks as well as monthly peaks are only available for individual companies. There is no consolidated daily, hourly or monthly peak consumption value available.

Interruptible gas customers

Interruptible contracts are generally only entered into with industrial customers, who can often switch to alternative fuels by using dual-fuel equipment. Interruptible contracts are estimated to account for 10-20% by volume of gas sales. Legislation safeguarding the economy at times of crisis provides for state action to control consumption only in the event of disturbances that cannot be corrected by market-based means. As consumers do not yet have the opportunity to balance demand for themselves through gas hubs, instead relying on their existing contracts to provide flexibility, there is no consumer response visible in the market. (For further information see the later sections on hubs and liquidity, as well as pricing.)

Demand outlook

In the alternative scenario forecast, the shift away from coal, oil and nuclear energy in the future will amount to a modest increase in natural gas demand in coming years (see Table 2). Electricity generation and domestic heating will be the main drivers of this limited growth. In the domestic sector, gas is progressively replacing heating oil as the main residential heating fuel in Germany, a trend that is set to accelerate in coming years. Increasing efficiency in heating appliances and insulation will put a slight damper on the gas volume of this upward trend, but not the number of customers.

SUPPLY

Germany is a substantial gas producer, providing approximately 18% of its supply from domestic resources. Within the EU, Germany's natural gas reserves are the third-largest, behind the Netherlands and the United Kingdom. Nearly all of Germany's reserves are located in the north-western state of Lower Saxony between the Dutch border and the Elbe river.

The German Federal Institute for Geosciences and Natural Resources (BGR) puts Germany's natural gas reserves at 270 bcm. The current annual extraction rate is about 17 bcm per year, though increasingly difficult production conditions mean that the production trend has been flat since the late 1970s. However, the high level of current gas prices is expected to make enhanced extraction techniques

viable, countering the effect of natural decline over time. The prospect of discovering new reserves in onshore Germany seems unlikely. However, offshore areas in the North Sea might yield reserves if they were allowed to be drilled – these are currently protected by the Flora-Fauna Habitat law.

Trade and imports

Imports met over four-fifths of domestic demand in 2005. There is a broadly diversified geographical spread of import sources, with Russia accounting for 35% of total supply (42% of imports), Norway for 24% of total supply (29% of imports), the Netherlands for 20% of total supply (24% of imports) and others (mostly Denmark and the United Kingdom) for 4% of total supply and imports. Imports in 2005 decreased by 0.7% from 2004. Most imports to Germany are made as part of long-term gas supply contracts that are pegged to the price of oil products. Sufficient data are not available to show the proportion of future demand covered by these contracts, but it is known that the Netherlands will phase out their exports between 2015 and 2020. Meanwhile, Gazprom has extended its export contracts with E.ON Ruhrgas and Wingas to last until 2035. Contracts with VNG have also been extended until at least 2030. This underlines the importance of a diversified portfolio of contracts, including diverse contract terms and lengths.

While Germany is a large gas consumer, it also acts as a transit country for Russian and Norwegian gas and is, therefore, an exporter. As with many other areas of the German gas market, information on flows is very difficult to find. Nonetheless, information about some contracts is available to the public, such as those where gas transits Germany between Italian importers and Norwegian suppliers. Physical swaps often occur in Germany, meaning that the gas does not always flow physically along the contractual path. In France, daily flows at each entry and exit point to each transport system are published on a website with a one-day delay, giving companies much better information on supply and demand. In general, most contestable gas markets are required to offer standardised, online access to data on available gas transport capacity and flow rates. Indicative flows are published in advance, estimated flows are published in real time and actual flows are published shortly after the fact. In competitive markets, net flows are provided by the independent grid operator, avoiding any confidentiality issues. Germany's grid operators are legally unbundled from supply companies, and should, therefore, be forced to supply this information to the market.

Security and diversity

Security of gas supply is based on several pillars, including storage, diversification of sources and transportation routes; long-term gas supply agreements with domestic and foreign producers; and interruptible contracts. Companies are required to reserve sufficient storage and transportation

capacity to ensure security of supply for customers, including in exceptional situations (*e.g.* supply stoppages). Currently, Germany has gas storage capacity equivalent to about 80 days of Germany's average demand.

While relatively well diversified in terms of country of origin, Germany gets 35% of its gas supply (42% of imports) from one company, Gazprom, and this share is increasing. Russian imports reach Germany via two separate pipeline systems transiting either the Ukraine or Belarus. Nord Stream, a direct pipeline under the Baltic Sea between Russia and Germany, is due to come on line in 2010, providing a route for Russian gas imports that avoids going overland through transit countries. Norwegian and Dutch gas does not cross any transit borders in order to reach Germany.

Responsibility for monitoring security of supply in gas and electricity lies with the BMWi under the Energy Industry Act. The BMWi believes Germany is well placed on the grounds of its long-term supply agreements, a comparatively large storage volume (see later section on storage) and relatively broad diversification of sources.

INDUSTRY STRUCTURE

The historical development of Germany's gas industry has a large impact on the current issues affecting the sector (see box).

Historical development of the gas sector

Gas demand in Germany has grown rapidly from being predominantly reliant on small amounts of manufactured gas in the early 1960s to accounting for over 23% of TPES in 2005. The critical factor that accelerated the penetration of German gas, moving it from a niche fuel to a major energy provider, was the discovery of the Groningen field in its neighbour, the Netherlands, in the 1950s, leading to the first gas imports in 1967.

Dutch gas was marketed in Germany to compete with existing markets for gas oil and fuel oil. At the time, gas oil was the main fuel for residential heating and fuel oil for industrial boilers. The first long-term gas deals were signed for periods of 25 years with delivered prices of gas set to be equivalent on an energy basis to delivered prices of fuel oil and gas oil (less a marketing discount to aid penetration). A privately owned company, Ruhrgas, was financially strengthened by the owners of the Groningen concession (Shell and Exxon) and converted to act as a marketing agent for Dutch natural gas in West Germany. Ruhrgas was better geographically placed than its major competitor, Thyssengas and quickly became the agent for the Dutch gas sales company, Gasunie.

Ruhrgas assumed responsibility for building and operating pipelines on German soil, for guaranteeing to market certain volumes of gas and for ensuring the highest netback price (the price paid less transportation costs) to the producer on the oil-equivalent basis. In order to achieve this, it took financial stakes in regional distributors and local municipalities, *Stadtwerke*, and converted them to using gas.

With the success of the marketing operation for Dutch gas, in the 1970s negotiations began with the Soviet Union and Norway in order to import gas on the basis of the same pricing principle. Following extremely sensitive and complicated negotiations, Russian gas first flowed to East and West Germany in 1973, joined by Norwegian gas in 1977, both under 20-year contracts. Meanwhile, German domestic supplies were in production by the 1960s. After reunification, the gas assets of East Germany were consolidated into the gas company VNG, with equity from several interested parties, including Ruhrgas and a major supplier, Wintershall.

In 1991, Russia's Gazprom formed a joint venture with Wintershall (an affiliate of the chemical giant BASF) to compete with Ruhrgas, whom they suspected of overcharging for its services. This company, Wingas, failed to secure access to existing pipelines and so built its own German network. Initially suffering from poor credibility in the marketplace, Wingas is now the second-largest importer of gas in Germany, and has settled into a more established role with more than 12% of the German market by volume. Gazprom also continues to supply Ruhrgas.

Although under pressure from the EC, the same vertically collaborative structure of the industry has survived from the early 1970s to this day, and has also recently been strengthened. This historical development led to the relatively complicated ownership shares of gas companies across the value chain from producer to end-user – the chain is bound together by long-term contracts with prices determined by those of delivered oils.

PRODUCTION

Natural gas production in Germany was previously dominated by BEB (Exxon and Shell, 50%) and Mobil (Exxon, 25%). These companies also distribute and market natural gas in northern Germany. 50% of the joint production was sold to Ruhrgas under a take-or-pay contract. After Exxon bought Mobil, the marketing business was split. A joint venture of ExxonMobil and Shell operates the unbundled pipeline business, as well as the production, amounting to 80% of total German output. Most gas has the same lower-than-standard calorific content as Dutch gas and is produced onshore.

The remaining 20% is split between smaller gas producers, including RWE-DEA, Gaz de France and Wintershall.

THE "THREE LAYER" SYSTEM

The structure of the German gas industry is relatively complicated because the system was organised to aggregate demand so that gas could be marketed in Germany, rather than to create an efficient, competitive market. To aggregate demand in order to promote gas marketing, demand is split into three semi-distinct levels. At the local, or third, level, approximately 700 municipalities, or *Stadtwerke*, aggregate the demand for gas and other goods and services[14] on behalf of city residents and, often, some medium-sized industrial users in the area. The *Stadtwerke* companies themselves are usually majority-owned by the local government.

Demand from the majority of *Stadtwerke* and some other large users is aggregated by 30 or so regional gas utilities representing the second level (*e.g.* Gas Union, Bayerngas GmbH and Saar Ferngas AG). Some *Stadtwerke* and larger clients do not need this level of aggregation as they represent a very large pool of gas demand on their own and buy directly from the importers, for example Stadtwerke Düsseldorf, Hannover, Kiel and GASAG Berlin. In the traditional territories of importers like RWE/Thyssengas, the chain also used to be shorter, but both E.ON Ruhrgas and RWE have recently been creating midstream companies that handle imports and trading and serve their regional distributors, such as Avacon (E.ON), E.ON Hanse or RWE Rhein Ruhr.

In turn, the regional utilities, large *Stadtwerke* and even some very large industrial users take gas from the main pipeline systems owned by the three key players at the first level: E.ON Ruhrgas AG (55% by volume), Verbundnetz Gas AG (VNG, 10%) and Wingas GmbH (11%). In turn, these supra-regional utilities source the gas under long-term take-or-pay contracts from abroad or from domestic production sites owned largely by ExxonMobil and Shell. The other major player in the German gas industry is RWE (10%), which bought VEW and Thyssengas to become an importer, as well as Ruhrgas's largest distributor.

The relatively neat order of the German gas system was upset in the 1990s by Wingas, which built its own import pipeline from Russia to enter the market and aggressively built market share by selling gas directly to *Stadtwerke*, industrial users and regional utilities wherever it built pipelines. This sparked a series of similar moves by its rivals, each of which had committed to long-term supply contracts from further upstream and could not afford to be left with "stranded gas" volumes that were not taken. A degree of competition among the main players resulted, meaning that more profitable demand centres, such as large industrial users, switched from

14. Such as water, waste, telephone and internet.

their traditional supplier, while other demand centres disaggregated (*e.g.* a medium-sized industrial user leaving the umbrella of a *Stadtwerke* that used to aggregate its demand).

The companies comprising the production and the first and second distribution levels are commercial enterprises, in some cases listed on the stock exchange; the municipal utilities operating on the third level are private companies, often majority-owned by municipalities.

Some limited foreign penetration of the sector has occurred by French Gaz de France (GDF), Danish DONG, Dutch Essent, BP and Italian Eni. The largest foreign entrants are GDF, in the southern part of the country, and DONG, in northern Germany. The geographical location of most of these entrants close to their home markets suggests that most are only able to leverage existing assets rather than grow a new business in Germany. Still, no domestic or foreign player is able to compete across the country as are Ruhrgas and Wingas.

GAS HUBS

The given collaborative structure of the German gas industry, and its management of gas demand and supply from the bottom up, makes it difficult to establish deep, liquid trading hubs. Hubs are delivery points where large numbers of buyers and sellers can transact, in part because associated services such as storage and transportation are readily available. Several hubs have been founded but with limited success. For example, the Eurohub in Bunde operated for several years with minimal trading volumes and then failed owing to a lack of liquidity. Too few players were able to get access to the pipeline system so there was insufficient demand for hub services.

Secondary legislation governing access to the gas grid (*Gasnetzzugangs-verordnung*, GasNZV) requires system operators to install a common online trading platform. Until then, transmission system operators are required to install an online trading platform for capacity rights within their own network. This platform must be linked to the trading platforms of neighbouring network operators. The problem of arranging transportation across and between the three levels of gas companies is not addressed in the legislation.

As gas availability is the domain of private enterprise, policies to improve liquidity in the gas market cannot be directly implemented by the government except in the case of competition law. As part of the remedies for the controversial takeover of Ruhrgas by E.ON in 2003, a gas release scheme was implemented. This had the aim of boosting competition in the German gas market, but was poorly designed – the quantities of gas released by the first two annual auctions were unpopular as the winning bidder was not able to secure transportation capacity on the E.ON Ruhrgas network.

The government issued two pieces of legislation in the summer of 2005 based on the new Energy Industry Act with the primary focus on network regulation and unbundling of operations into separate legal entities – one ensuring transparent and non-discriminatory access to the gas grid, GasNZV, and one laying down a binding computation method for the trunk-line fees for which approval must be obtained (*Netzentgeltverordnung Gas*, GasNEV).

The only relatively liquid hub in Germany has been the BEB hub in the north-western part of the country, which came about with the divestiture of the BEB network by former owners Shell and Exxon. The equal access conditions negotiated by these companies on leaving the gas transportation business have allowed successful third-party access (TPA), and hence a liquid hub to develop.

COMPETITION

The legal framework to open up the entire retail market was in place as early as 1998. The Federal Cartel Office (*Bundeskartellamt*), the national competition authority, and competition agencies in the individual German states are also responsible for monitoring market abuse in the energy industry. The *Bundeskartellamt* also oversees mergers in the energy sector under Germany's Competition Act.

Gas-to-gas competition is new to the German gas sector. The sector has a collaborative history, and the very instruments of collaboration, the long-term supply contracts between the different links in the value chain, tie up the market. These domestic contracts frequently covered periods of 20 to 30 years and covered all the gas needs of a buyer, including flexibility provisions with capacity rights for the gas to be delivered all the way to the consumer. As discussed below, these long-term domestic gas contracts were recently ruled illegal by the *Bundeskartellamt*.

Two key issues have hindered the development of competition. The first issue is network access. Gas companies currently own and operate the pipeline systems needed to transport gas from the point of purchase to the point of sale to fulfil the contracts. In order to protect the existing customer base, there is a large incentive for these companies to obstruct potential competitors from gaining access to this pipeline system, despite the fact that legal unbundling has been mandatory for several years. While losing a customer to a competitor obviously does not affect the amount of gas that needs to flow down a particular line, many new entrants find that pipelines for their gas are already "fully booked" by the incumbent. The second issue is the availability of free gas. The *Bundeskartellamt* ruled in April 2006 that locking companies into buying all their gas needs from one supplier for long

periods of time was anti-competitive as it effectively sealed off the potential market. Further to the ruling, suppliers cannot sign two-year contracts if they cover more than 80% of total annual volume, nor four-year contracts if they cover more than 50%.

Gas importers argue that this ruling might affect the stability of demand, and thereby prevent new upstream and midstream investments, noting that any change in the contracts would seriously jeopardise the existing structure of the German gas industry. However, since the existing structure is not conducive to competition, changing it and prohibiting long-term domestic contracts with one supplier may well be a very significant step towards changing the German gas market from its collaborative structure towards a competitive market.

LIQUIDITY

The long-term contracts[15] that form the links between each chain of the German gas industry consist of a minimum volume of gas to be delivered to the importer and paid for over a certain time period. The importer then traditionally sold gas on a "100% of requirements" basis to customers. Given that the consumer's entire needs are met through this contract, and that it guarantees the maximum revenue to the producer, the chain is self-sufficient. This means that an individual *Stadtwerke* should have no need to buy or sell gas to or from a third party to manage its volume requirements. Similarly, an importer with a portfolio of contracts has enough flexibility to supply those down the chain.

Yet there are commercial incentives for companies to engage in secondary trading within this structure – each of these market participants will have a slightly different gas price. The opportunity for optimisation between the consumers would create incentives for trading if access to the transportation network was easy to obtain. However, so far this access has been difficult to guarantee – the ownership of regional pipeline systems by the major gas traders is likely to be a major factor in the lack of TPA to those regional systems, preventing liquid markets from developing. In almost all cases, having the trading company and the network manager owned by the same financial entity creates incentives for the network owner to discriminate in favour of the affiliated supply company.

15. Within Germany, these contracts cover all gas requirements of the customer and function as take-or-pay contracts for gas importers. Take-or-pay contracts require sellers to supply contracted volumes of gas and buyers to pay for the contracted volumes, whether the buyer takes them or not. There is typically a flexible component to the contract that can be requested if needed. Take-or-pay contracts are not standardised across the industry but are tailored to fit individual circumstances and generally provide both sides with significant flexibility.

CUSTOMER SWITCHING

The rate of customer switching is low in Germany – 302 customers switched supplier in 2005. The BNetzA is currently working on standardising the process to a uniform automated process across Germany. Instead, the primary benefit to consumers of the level of liberalisation so far seen is that they have been able to negotiate better prices with their existing supplier. Given that the importer has a long-term contract to market a certain volume of gas, the cost of losing its customer is very large (it must pay for the gas whether or not it sells it on). Given that most importing companies own a minority stake in downstream companies, this rigidity is passed to the whole market. The marketer is given incentives to eat into its own margins to preserve the market volume, and will often offer the customer a discount to do it. If the company also owns the gas pipelines, it has an incentive and an ability to protect its own market share. Because of this effect, many companies suggest that the figures on consumer switching understate the discounts and renegotiations that are benefiting the German consumer. This may be the case, but it also results in lower transparency and competitive pressure than in markets such as the United Kingdom where customer switching rates are the highest in Europe. The efforts to standardise and automate customer switching should improve transparency.

TRANSPARENCY

The German system is designed for marketing gas vertically from the import point in Germany to the burner tip. Under this model, there is little incentive or need to share information outside the value chain, unlike in a competitive market, where the regulated network has a huge incentive to advertise its services and where prices are set in open market exchanges through trading. In the absence of complete separation of the transportation networks, which would provide these incentives, minimum information disclosure obligations are imposed on pipeline operators via the *Gasnetzentgeltverordnung* and the *Gasnetzzugangsverordnung*. These stipulate that, under certain circumstances, transport companies need to publish other system data on a daily basis, including the total amount of firm and interruptible capacity available and the amount of available capacity between sub-systems, as well as a joint, detailed grid map for all of Germany. The IEA has not seen information of this nature for Germany. For comparison, in France, total capacity and total flow are reported on a daily basis, and in the United Kingdom, nominations and capacity are reported in advance. BEB, the only network in Germany not majority-owned by one supply company, publishes such flow-based information.

GAS NETWORK

REGULATION

The Energy Industry Act of July 2005 brought the grid sector under detailed regulation in accordance with the European Union's second gas directive. However, regulatory coverage is still patchy, with trunk lines excluded from the existing system. (For further information, see the later section on transportation.) Regulation is carried out at the federal level by the *Bundesnetzagentur*, the former Regulatory Authority of Telecommunications and Post (RegTP), an agency subordinate to the BMWi. Regulation of entities entirely operating within a single *Land* is done by regulatory agencies in that *Land*, except where it has conferred these powers on the BNetzA. The *Bundesnetzagentur* has powers to ensure non-discriminatory grid access *ex post* and to approve *ex ante* trunk-line fees. Under the EnWG, it has power to monitor abuses, *i.e.* to forbid grid operators from engaging in practices that constitute an abuse of their market position. Without effective competition, savings may be passed up the chain to the producer or retained by the gas company, with minimal impact on the consumer prices. Though changes to access charges have a limited effect on consumer prices as they only make up a small share of the delivered gas price, the current structure may prevent customers from seeing the benefit of policies to lower trunk-line fees. (For further information, see the later section on pricing.)

GAS QUALITY

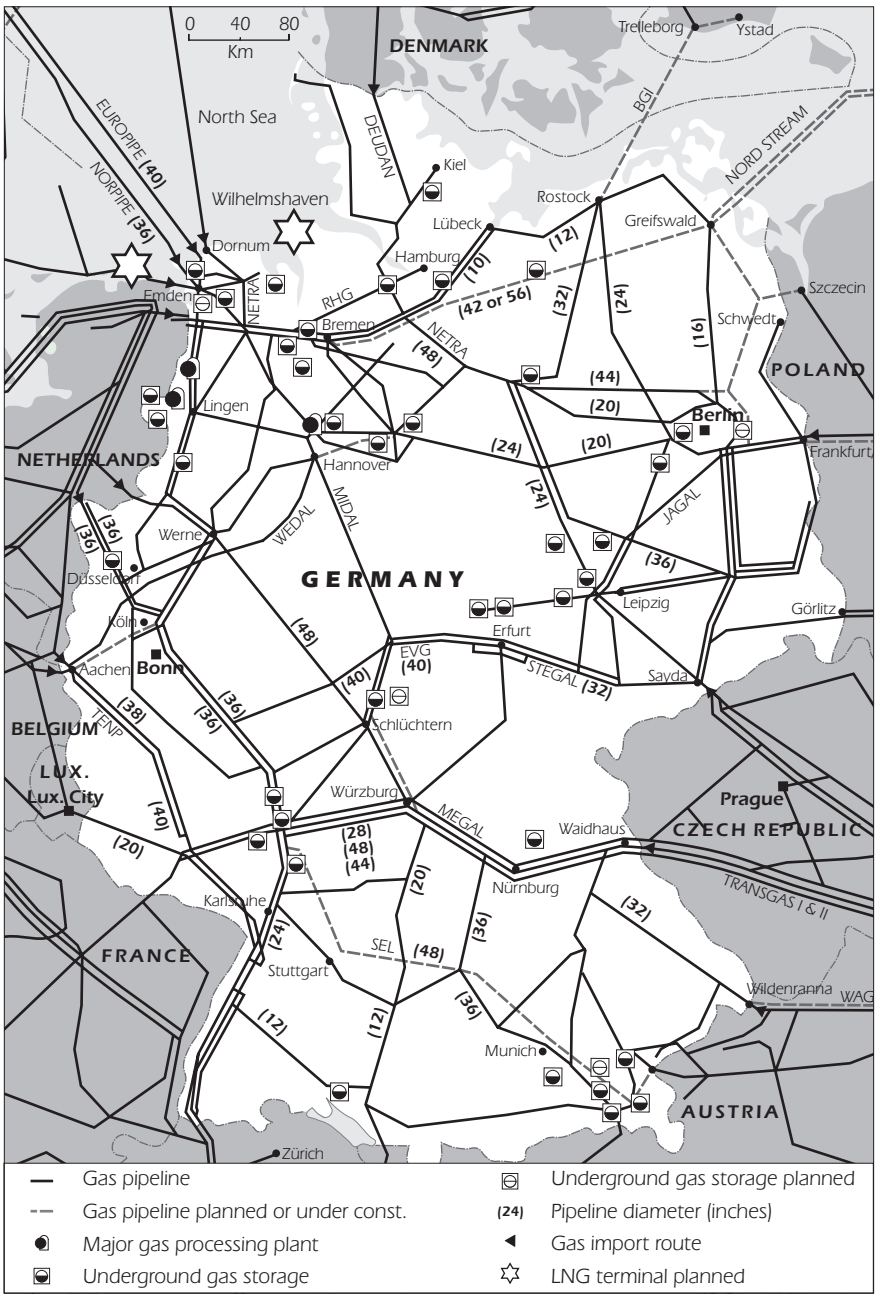
For the same historical reasons that underpinned the development of the gas sector, regional gas systems are operated with the quality of gas determined by the source – Norwegian gas having a higher calorific value than Russian gas, which is in turn higher than Dutch low-quality gas. The three gas qualities are distinct, and currently individual gas networks only carry one of the three. It is generally accepted that the two higher-quality specifications of gas, Norwegian and Russian, could be easily mixed and carried in the same networks. Furthermore, quality conversion facilities could be used at points where different gas-quality networks intersect, thus creating a single market for gas.

TRANSPORTATION

The total length of the grid is about 380 000 km. About 103 000 km (27%) is made up of high-pressure pipelines (100 bar down to 1 bar), about 150 000 km (39%) of medium-pressure pipelines (1 bar down to 100 mbar) and about 127 000 km (35%) of low-pressure pipelines. A map of existing and planned natural gas infrastructure is shown in Figure 13.

Figure 13

Gas Transportation Network



Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

Source: *Natural Gas Information*, IEA/OECD Paris, 2007.

In compliance with the new Energy Industry Act, which requires unbundling, the major gas utilities have each established separate legal entities to operate the transmission systems. The regional and local distribution networks are run by spin-offs of regional and local distributors, except where these networks supply fewer than 100 000 customers. The competition authority, the *Bundeskartellamt*, and the BNetzA are responsible for ensuring that these companies operate independently from their parent supply companies. Both entities can investigate and force action on their own or when another company files suit.

Grid access is now in transition to a regulated system. For the 2005/06 gas year, which starts 1 October of each year, the industry implemented the so-called option model, which required consumers to sign a contract with the marketing company at their level, a process that was then to be repeated all the way up the chain to the gas importer level. The industry intended to use the same model for the 2006/07 gas year, but in November 2006, the option model was ruled illegal by the BNetzA. Third-party access is now based on a simple, two-contract model (a so-called entry-exit model). Despite the change, companies have found this system to be relatively unworkable in the 2006/07 gas year, and there is no evidence that any successful trades have been done on the two-contract model in 2006, although data are difficult to find and the system is still relatively new.

Supplier switching under the new two-contract model will be facilitated by an arrangement under which capacity reserved with one supplier is automatically transferred to another with the gas supply contract – this will emulate the "rucksack principle" tried in Austria.

Trunk-line fees require *ex ante* approval, and fees are computed on a cost-plus basis. This does not apply at the long-distance supply level if there is properly functioning competition at that level. Wingas and E.ON have argued that where several pipelines run in parallel, this constitutes competition, and therefore these pipelines are temporarily not subject to *ex ante* tariff regulation. Nonetheless, *ex post* abuse control by the BNetzA and price control by the *Bundeskartellamt* are applicable. As a result, pending the completion of the investigation, all major trunk pipelines are currently excluded from ex ante tariff regulation.

In October 2006, the BNetzA ruled that the four regional grid operators must drop their gas grid access charges by 8-18%, reducing prices for smaller energy providers to access the network.

Beach imports

There are two significant terminals from which gas comes ashore directly to Germany: Emden and Dornum, both located in north-western Germany. Emden is the terminal for the Norpipe gas pipeline from the Ekofisk field in

the Norwegian sector of the North Sea that came on line in September 1977. It belongs to Norsea Gas, which is owned by Statoil, Conoco, Total, Agip and Hydro. Dornum is the terminal for the Europipe I and Europipe II gas trunk lines that came on stream in 1995 and 1999 respectively. Gas beached at Dornum from Europipe I is routed to Germany via Emden. Gas beached at Dornum from Europipe II is routed to eastern Germany via the Netra pipeline system.

Each of the pipeline systems is owned by a different consortium of private companies, usually representing the initial producer and final consumer nations. The pipelines have a total combined capacity of 54 bcm per year, but only 25 bcm passed through them in 2004.

A new pipeline project, Nord Stream, is planned to carry gas from Vyborg in Russia to Greifswald on the German Baltic coast. Construction of the approximately 1 200-km sea-floor pipeline is set to commence in 2008. The first phase of Nord Stream is planned to have an initial capacity of 28 bcm per year, but it is foreseen that this will be doubled by looping the line.

E.ON Ruhrgas has owned a site on which it could build a liquefied natural gas (LNG) terminal (at Wilhelmshaven) since the late 1970s when its negotiations to import North African LNG to Germany were dropped. The project has been recently revived as Germany's dependence on Russian gas has increased and is undergoing a feasibility study.

Overland imports

The Yamal Europe pipeline has a capacity to bring approximately 30 bcm per year of Russian gas from western Siberia through Belarus and Poland, but most Russian gas arrives in Germany through the Brotherhood and Transgas systems, which link western Siberian gas production to western European nations via transit through the Ukraine. Together, they have a joint annual capacity of 120 bcm per year, but only 70% of this capacity is dedicated to western Europe (Germany, France, the Netherlands and Italy). Information on physical flows is not available by pipeline. Furthermore, there are several large swap arrangements between the western European buyers, meaning that the gas does not necessarily follow the original route of the contracts.

Domestic trunk pipelines (transmission system operators)

Within Germany there are several major trunk pipelines that are very important routes for gas (see Table 15). What happens to the operation of these pipelines in the future may determine the success of the competitive gas market in Germany. At present these lines are not subject to *ex ante* tariff regulation, only *ex post* abuse control by the BNetzA and price control by the *Bundeskartellamt*.

Table 15

Domestic Trunk Pipelines

Name	*Capacity (bcm/year)*	*From*	*To*	*Start*	*Owner*	*Share*
Megal	22	Czech Republic	France	1980	E.ON Ruhrgas	50%
					Gaz de France	43%
					OMV	5%
					Stichting Megal	2.0%
TENP	7	Netherlands	Italy	1974	E.ON Ruhrgas	51%
					Snam Rete International	49%
Wedal	10	Aachen, Germany	Bad Salzuflen Germany (Midal)	1996-98	Wingas	100%
Midal	12.8	North Sea (Emden)	Ludwigshaven (near Switzerland)	1993	Wingas	100%
Stegal	9.8	Czech Republic	Germany (Midal, Jagal)	1992	Wingas	100%
	16.6 total (loop)	Connection to Jagal	Connection to Midal	2006	Wingas	100%
Netra	21.4	North Sea (Dornum)	Wilhelmshaven	1995	E.ON Ruhrgas	41.7%
					BEB	29.6%
					Statoil	21.5%
					Hydro	7.2%
Jagal I	23.7	Poland (Oder)	Brandenburg	1996/7	Wingas	100.0%
Jagal II	23.7	Jagal I	Stegal	1999	Wingas	100.0%
RHG	0.8	Midal	Hamburg	1994	Wingas	40%
					E.ON	60%

Sources: Company websites, country submission.

The Stegal, Wedal, Megal and TENP pipelines are currently being expanded by their respective owners; there was no "open season" for these projects, as is standard practice in contestable markets. A regulated open season process requires a pipeline builder to obtain financial commitments from multiple parties by selling future pipeline capacity before construction commences. Open season processes are required in contestable markets to prevent monopoly ownership of individual routes.

Domestic distribution (distribution system operators)

Some 30 regional distributors supply municipal utilities, as well as consumers from the medium-pressure grid. These companies are owned by consortia that include some of Germany's large incumbent utilities. There are over 700 local distributors who supply gas to end consumers on their individual low-pressure grids. These companies are usually owned partly by municipalities and partly by the large utilities that built the pipeline system to expand the gas market.

About 15 million households are supplied with natural gas in Germany, along with 100 000 industrial customers and 50 000 heating stations. While large regional distributors like EWE supply around 620 000 households, a small municipal *Stadtwerk* like Weisswasser GmbH might serve only 1 800, 300 times less. E.ON Hanse AG has sales volumes 8 000 times larger than Gasversorgung Waldbüttelbrunn GmbH.

Länder are tasked with the regulation of distribution systems operated entirely within their borders with fewer than 100 000 customers connected directly or indirectly to their system, though some *Länder* have elected to transfer these powers to the BNetzA.

STORAGE

Germany has the world's fourth-largest gas storage capacity following the United States, Russia and Ukraine. There are 43 natural gas storage facilities with a total capacity of 32.58 bcm with a total working gas capacity of 20 bcm, or about 80 days of Germany's average demand. Storage facilities are operated by major gas utilities such as E.ON Ruhrgas, Wingas, VNG and RWE, as well as by independent facility operators and regional and municipal utilities. Most storage facility operators have signed an agreement to offer capacity on GGPSSO terms,[16] although this is a voluntary agreement. In addition, the government has passed legislation requiring storage facility operators to offer negotiated, non-discriminatory third-party access where it can be proven that it is necessary for third-party access to pipelines. Storage adds to the flexibility of the supply portfolios built up by the large importers who have historically provided a one-stop-shop service to consumers.

INVESTMENT

In the north of Germany, geological conditions are favourable for the addition of further subterranean storage facilities. In the south, geological storage is much more scarce, hence expensive, and new storage for German consumers is

16. ERGEG, *Guidelines for Good TPA Practice for Storage System Operators (GGPSSO)*, 23 March 2005.

being constructed in Austria – tied only to the German grid. Fifteen salt cavern storage facilities are currently planned or under construction, with a capacity of 3.2 bcm. Capacity at existing salt cavern facilities is to expand by 620 million cubic metres (mcm). One new depleted field storage facility is being developed, adding 130 mcm of capacity, with capacity at existing fields set to expand by 670 mcm. Table 16 details current and planned storage capacity.

Table 16

New Storage Capacity

(Planned or under construction)

Unit: mcm	*Existing storage*	*Additional storage*	*Total storage*
Salt cavern storage	6 703	3 648	10 351
Operational	*6 703*	*620*	*7 323*
Planned/under construction	*0*	*3 028*	*3 028*
Depleted field storage	12 365	800	13 165
Operational	*12 365*	*670*	*13 035*
Planned/under construction	*0*	*130*	*130*
Total	**19 068**	**4 448**	**23 516**
Operational	*19 068*	*1 290*	*20 358*
Planned/under construction	*0*	*3 158*	*3 158*

Source: *Untertage Gasspeicherung in Deutschland*, Erdgasspreicherung, Tables 4 and 5, 2006.

TRADING

Gas trading in Germany has not enjoyed the relative success seen in neighbouring Belgium or the Netherlands – currently less than 1% of domestic consumption is traded on gas exchanges, with the majority on only one regional exchange, BEB. The major reason for the lack of activity is that Germany opted for negotiated third-party access to its networks after the first European gas directive, which made it difficult to obtain firm transportation rights over a significant distance or time, therefore stifling competition. The new regulated third-party access being implemented should significantly improve trading and liquidity.

Major gas companies in Germany suggest that their gas networks are already optimised to the greatest extent possible as they were built to import gas from source to demand centre. They also argue that competition is impossible on a nationwide scale as the regional networks have different qualities of gas, and were not designed to mesh with each other.

Proponents of competition in Germany counter that import pipelines are, for the most part, underused, implying a lack of optimisation, although data are very difficult to obtain. For example, Norwegian import pipelines were used at less than 50% capacity in 2005 when German customers paid record high gas prices. Further, it is argued that the distinct regional systems, if interconnected, could bring efficiency benefits and cost savings, which has been the experience of other IEA member countries in interlinking their electricity networks. Countries can rely on the slack in neighbouring systems, as the sum of individual peak gas demands across individual European countries is far higher than the peak demand of the EU region as a whole.

The German government and the European Commission have pursued a policy direction that will lead towards a European-wide gas market, leading to the interoperability of German regional grids with each other and with those of neighbouring countries.

SHORT-TERM CAPACITY AND BALANCING

Short-term capacity from time to time becomes available, and is offered to the market on an interruptible basis. This interruptible capacity is almost worthless for a new entrant because new entrants require firm capacity to build a business as a dependable supplier. Balancing services are provided by the main players at published rates, but these rates are high compared with liquid markets in the United Kingdom or the Netherlands. While it is possible for suppliers taking over existing customers to gain transportation capacity on constrained pipelines according to the "rucksack" principle, it is particularly difficult for companies with completely new customers to co-ordinate capacity rights across the multiple companies that offer transportation services within the system. This is made more difficult in cases where the incumbent supplier has a financial stake in the transportation companies.

LONG-TERM CAPACITY

The limited trading that has taken place has been around asset ownership brought about by large-scale capacity swaps and release programmes. The merger of E.ON and Ruhrgas was made subject to a gas release programme – E.ON committed to sell off a total of 19 bcm in six annual auctions until 2008. The first three years saw E.ON offer gas within Germany. A lack of associated transportation capacity, however, meant that the first release programmes were under-subscribed and they were regarded by the market as unsuccessful.

In May 2006, the annual auction was conducted with transportation capacity provided and was fully subscribed. E.ON Ruhrgas auctioned 3.7 bcm from its portfolio to seven unnamed bidders who took delivery over a three-year period

starting from October 2006 at Bunde/Emden, where Norwegian and Dutch imports arrive. Demand was significantly higher than in previous years with sales covering this year's entire 3.13 bcm basic volume, plus a 570 million cubic metre (mcm) carry-over from the less successful auction in 2005.

E.ON Ruhrgas must alternate its auction point annually between Waidhaus and Emden. When Emden is the point of auction, the gas is unlikely to enter the German market. Traders find it much easier to transport it through the Netherlands to liquid hubs in the United Kingdom, Belgium and France than try to get access to capacity in Germany. Nevertheless, some traders have managed to purchase long-term capacity on the TENP system in the past in order to transit gas from the Belgian hub at Zeebrugge down to Italy. The majority of this gas will not be delivered in Germany for the same reasons discussed above.

INVESTMENT

German gas companies have maintained their commitment to the new versions of the old gas model, and enhance their pipeline system infrastructure when they see fit. There is no system of auctioning unused capacity as in liquid gas markets in IEA countries. New large-scale investment in Germany will likely have to be driven by one of the large incumbent companies as new entrants cannot get access to the existing infrastructure. As was seen in the 1990s, the only means for Wingas to break into the German gas market was by constructing a separate pipeline system.

PRICING AND TAXES

PRICING

Gas pricing in Germany is based on the "market value" principle that the customer should pay no more and no less than the cost of the competing fuel, which is either gas oil or fuel oil. Thus the prices for gas are directly linked to oil, though there is a time lag for gas prices to change following changes in oil prices. Natural gas prices to industrial consumers in Germany are set on a quarterly basis relative to the average of the previous six or nine months of prices for fuel oil and gas oil. Other elements can be reflected as well, instead of oil. For example, in a minority of cases, the price is linked to coal or electricity prices. Domestic tariffs are linked to the price of gas oil and reset every quarter. This type of pricing ensures volume offtake, helping achieve stable market share compared to oil. Though gas now has a substantial market share, this pricing methodology, which eliminates any interaction between gas supply and demand and the price, has not been changed by suppliers. This is perhaps the clearest signal that there is a lack of gas-to-gas competition in Germany.

According to the "market value" principle, the consumer in Germany will pay the same price for gas as for oil products irrespective of the cost of producing and transporting gas. Therefore, reducing the transportation cost on high-pressure grids is likely to result in either the producer getting more netback revenue, or the transportation provider increasing the costs somewhere else in the value chain. Without gas-to-gas competition, the transportation provider has little incentive to eat into its margins and reduce the price for the customer by means of a marketing discount. It is for this reason that customer prices have not changed despite the decrease in regulated access charges by 8-18% in 2006.

However, written into the same pricing contract is the clause that if there is a substantial change in the gas market conditions in Germany, either party has the right to renegotiate the contract. Thus, if a gas hub were set up in Germany, this clause could be triggered, switching from gas pricing based on oil trading to pricing based on gas trading. Unfortunately, the same contracts tie importers into certain volumes of gas by way of take-or-pay clauses, meaning that some importers have not yet risked opening their network to competition as they might lose market share and face penalty clauses. E.ON Ruhrgas installed a so-called choice market to trade gas quantities, but few entrants have so far proved unwilling to contract from E.ON in order to take market share from E.ON. Commercially, it makes little sense to buy from a company in order to use its grid to serve its own customers.

A class-action lawsuit by a number of northern German consumers against the rising tariffs of a northern German subsidiary of gas major E.ON Ruhrgas led the company to publish its gas price calculations in November 2005. Germany's second-largest gas company, RWE, and a number of municipal suppliers have followed suit, publishing a detailed breakdown of their tariffs.

In 2006, the unweighted average wholesale prices in major IEA gas markets were USD 6.57 per million British thermal units (MBtu) at Henry Hub in the United States, USD 7.08 per MBtu for LNG purchased in Japan, USD 7.36 per MBtu at NBP in the United Kingdom and USD 8.31 per MBtu at the German border.[17]

Domestic consumer prices are controlled *ex post* by the *Bundeskartellamt* and the relevant *Länder* cartel authorities and can be forbidden if proven unreasonable.

TAXES

Having a low carbon footprint, natural gas has so far not been the focus of many direct German ecological taxes, but oil products have seen their taxes increased dramatically since 2000. The only tax increase that directly affects

17. *Natural Gas Market Review*, IEA/OECD Paris, 2007.

natural gas was the law enacted on 23 December 2002 that modified the eco-tax effective as from 1 January 2003. This law raised the petroleum tax rates on natural gas, liquefied petroleum gas (LPG) and heavy heating oil, among other things. The German government has now ruled out further tax increases in view of recent rises in energy prices. The standard tax rates for natural gas are EUR 5.50 per MWh. In addition, Germany also levies a value-added tax (VAT) on gas consumption.

SUBSIDIES

The manufacturing sector has its gas taxes capped because of a 40% refund on the additional mark-up due to the ecological tax. As the additional mark-up due to the tax is currently 0.3659 eurocents per kWh, the cap means that manufacturing companies pay only 0.2196 eurocents per kWh. This policy is designed to aid the international competitiveness of German industry. Effectively, this means that other consumers (predominantly in the domestic sector) subsidise large industrial users. Because local municipalities own shares in energy businesses such as *Stadtwerke*, they are able to use their income from energy-related businesses to support loss-making sectors such as transport, subsidising the provision of public transport.

CRITIQUE

Germany has played a leading role in the development of the European gas sector, being a foundation customer for Dutch, Norwegian and Russian gas exports. Sitting at the economic and geographical centre of Europe, Germany is its largest gas consumer and is home to some of its largest gas companies. For these reasons, the further development of competition in the German gas market is essential for the progress of the single European gas market. German companies and consumers are already benefiting from the opportunities in and security of the European power market, and it is impressive to see that German policy makers have realised that they stand to gain similarly from the single European gas market.

German gas supply is relatively well diversified, with pipeline interconnections from a variety of countries, but no LNG terminal. The largest supplier is Russia, with 35% of the German gas market (42% of imports). Germany should be wary that its security of gas supply depends to a large degree on the activities of one company, Gazprom. While the planned Nord Stream pipeline will help increase diversity of supply routes, it will inevitably further increase German dependence on Russian gas and, therefore, on Gazprom. In order to mitigate this effect, Germany should press ahead with market reform, as the single European gas market is dependent on Russian gas for only 26% of its gas supplies. Expanding the size of the liberalised

European gas market by genuinely implementing gas-sector reforms in Germany will lower Germany's effective Gazprom supply dependence, particularly as Europe has access to global LNG imports through existing LNG terminals.

The German gas market is heavily concentrated on security of supply and demand. Recently, it has refocused on economic efficiency, which provides security of supply through fully competitive markets. Supply diversity and energy security can also be improved through new suppliers to Germany within a competitive market framework. While many IEA countries have implemented reforms to their gas sectors over the last decade, Germany has lagged behind, often implementing too little reform too late. As a consequence, Germany has some of the highest wholesale gas prices and some of the poorest rates of customer switching in the IEA.

In the past two years, however, Germany has started to accelerate reforms in the gas sector, and is now catching up with the European average. The progress that Germany has made in this time is very impressive – it has set up a regulator and devolved power to that entity, and it has also implemented gas trading based on an entry-exit model, ruling the historical contracting method illegal. Several court decisions have been made in favour of new entrants regarding access to pipelines. A capacity management mechanism (the "rucksack" principle) has been implemented to manage shortages in available capacity. Given the size and strength of the entrenched corporate interests, the German government should be praised for the introduction of these reforms. While Germany is catching up fast, it still has much to do and therefore needs to maintain this pace of reform.

Experience of IEA countries has shown that the first step in introducing competition into the gas sector is to enforce third-party access to pipelines. Third-party access in Germany remains a key unresolved issue. Major trunk pipelines still do not have *ex ante* regulated rates. The industry-drafted "two-contract" model is a cumbersome system that may create barriers to entry. For a new supply company to transport gas across more than one market area, it must negotiate with multiple transmission system operators or give the TSO the mandate to negotiate on its behalf (though it is not clear clear why a company would choose this second option). A small company is unlikely to have the resources or the incentive to undertake the large effort required. Even if it were to attempt to gain transportation access, capacity may be unavailable or too expensive, so the companies would then have to appeal to the BNetzA.

To try to remedy this problem, greater co-ordination of pipeline access across the many network operators is being advanced by a co-operation agreement between these providers, but this voluntary initiative is unlikely to be

sufficient. Questions still remain as to the independence of these transportation providers, especially as the incumbent holding companies still have minority stakes in most gas system operators. With over 750 separate gas system operators of various sizes spread across the market's three different layers, a gas shipper entering the German market may face a large barrier to entry. Recently, improvements have been made to reduce the burden required to book capacity within a market area, but more work still needs to be done.

It would be far better for Germany to set up an autonomous entity – a so-called independent system operator – to manage system access that is not linked in any way with the existing operators. The regulator is trying to apply *ex ante* regulation of pipelines, but transportation companies are allowed to appeal, in which case the regulator must rule on a case-by-case basis (though transportation companies must implement the regulator's decisions in the interim). More effective *ex ante* regulation could prevent this laborious process. Furthermore, auction of capacity would avoid the need for the "rucksack" mechanism, an administratively cumbersome procedure for all companies. Finally, enlarging the size of the gas market through one independent system operator would allow it to operate the grid more efficiently, cheaply and safely. For comparison, the United Kingdom has a similar annual gas consumption to Germany's and uses only one balancing zone with one system operator.

Ultimately, Germany should aim to create a single zone for trading purposes. Fewer balancing zones greatly improve liquidity and transparency in the wholesale markets because the size of each market is expanded, lowering transaction costs and increasing the number of counterparties trading. The existence of three different gas qualities in Germany does not prevent the development of a single balancing zone. Through the use of quality conversion at grid interconnection points, the three gas qualities can be represented as one commodity for trading purposes. For example, in the Netherlands high-quality gas is converted to low-quality gas when required, and to match one of the gas qualities at the title transfer facility (TTF), the main Dutch hub. It world be beneficial if multiple gas qualities could be interchangeable within one market area or hub by assigning the job of quality conversion to the system operator.

Turning to transparency, much more information should be provided by the incumbent network operators. In France, information on daily border flows is available on the same day on a public website that also carries five years of historical data. In the United Kingdom, flow-based information is posted on the internet every two minutes. Flow information enables all market players to study the market and challenge network operators if they believe that they have been unfairly denied access to grids or granted access on discriminatory terms. In Germany, there is an obligation for system operators to publish this information, but only under certain circumstances.

These regulations are insufficient because the relevant information is not forthcoming or consistent. Without this information, effective third-party access relies on the regulator to investigate all potential abuses, an impossible burden to overcome. We encourage the regulatory authorities to put in place mandatory disclosure requirements that apply at least to all trunk lines, for the benefit of competition and supply security.

Germany currently has the fourth-largest gas storage capacity in the world, and it is a promising sign that many new storage projects are under way, providing a cushion against upstream problems. Once third-party access to pipelines is established, storage will quickly become a restrictive factor in gas trading. Existing and planned storage investments are controlled by vertically integrated utilities. The government will need to monitor developments in this sector to ensure that a storage market – a pillar of government security of supply policy – is open to third-party access. Storage services and flexible supply are essential to customers and therefore essential to suppliers. With such a wealth of storage capacity in Germany, it should be possible to auction this service on an annual basis to all market players rather than to let companies book the majority of capacity on long-term contracts. A lesson can be drawn from pipeline regulation where long-term contracts have resulted in low asset utilisation. For example, pipelines carrying imports from Norway have a total combined capacity of 54 bcm per year, but only 25 bcm passed through them in 2004.

There is reason to be cautious about German gas market reform given its history – by opting for negotiated access to storage facilities Germany risks making the same mistake it did with negotiated pipeline access in the past decade. Nevertheless, there are encouraging signs that both the BNetzA and the government have already recognised some of the weaknesses in the current German gas market model. There is much ongoing work in Germany by the BNetzA, including reducing the number of balancing zones, automating the customer-switching process, implementing regulation of trunk pipelines, effectively imposing *ex ante* network tariff rates and overseeing the co-ordination agreement between system operators. The IEA eagerly awaits the result of these and other investigations and urges the government to support the findings of the regulator by providing more powers of oversight to detect and prevent possible conflicts of interest in the market.

Overall, despite Germany's history of a slow approach to reform, there is reason to be cautiously optimistic about the reforms currently taking place and being considered. Most importantly, the IEA urges the regulator to use all its powers to implement a functional two-contract model that provides genuine third-party access to networks. This is the critical step to a fully contestable gas market in Germany and Europe.

RECOMMENDATIONS

The government of Germany should:

- *Press ahead with market reform and interconnections with the rest of Europe, as this will enhance supply diversity for Germany, such as through gaining access to existing European LNG terminals.*
- *Monitor the increasing concentration of external gas suppliers and encourage new gas sources to enter the German market,* e.g. *by greater investment in new infrastructure, including LNG import terminals in Germany.*
- *Ensure that adequate resources are available to the network regulator and competition authority and give them the power to act* ex ante *to demonstrate to the market that:*
  - *Gas networks are subject to practical third-party access conditions.*
  - *Unbundling of gas network companies is enforced to the extent required.*
- *Implement a functioning entry-exit system and reduce the number of balancing zones, with an ultimate goal of creating a single balancing zone.*
- *Consider establishing a single independent system operator for the country's gas transmission network.*
- *Ensure that all pipeline operators make historical and current entry and exit flow information available by pipeline on a daily basis via a publicly accessible website.*
- *Ensure non-discriminatory third-party access to gas storage facilities at fair market value, for example through auctions of standardised units.*

CAPACITY, GENERATION AND DEMAND

CAPACITY

Germany had over 120 gigawatts (GW) of capacity in 2005 (see Table 17). Coal made up the largest share; together, bituminous coal and lignite had 36% of capacity. Installed nuclear capacity comprised 17% of total capacity. While combined renewables (excluding hydro) provided about 10% of electricity generation (see Table 18), it represented a large share of capacity, with wind alone totalling 15%. This reflects the low capacity factor – the percentage of time a plant is generating power out of the maximum – of renewable energy technologies, a consequence of their intermittency. Natural gas, which provides about 11% of generation, had 14% of installed capacity.

Table 17

Generating Capacity by Type, 2005

	Capacity (GW)	*Share of total capacity*	*Capacity factor*
Bituminous coal	24.5	20%	51%
Nuclear	20.8	17%	86%
Lignite	19.6	16%	81%
Wind	18.4	15%	17%
Natural gas	17.2	14%	38%
Heating oil, pumped storage and other	14.7	12%	83%
Hydro, biomass and other renewables	7.4	6%	29%
Total	**122.6**	**100%**	

Source: Country submission.

ELECTRICITY GENERATION

In 2005, over 613 terawatt-hours (TWh) of electricity were generated in Germany, a slight increase from 2004 and an 8.1% increase from 2000 (see Table 18). Over the last decade, total electricity consumption has grown by over 15%, at an average annual rate of 1.4%. In 2005, the largest share of electricity (50%) was generated from coal. This represents a general decline since 1985, when nearly 62% of electricity was generated from coal. At the

Table 18

Electricity Generation, 1970 to 2030

Unit: GWh	*Coal*	*Nuclear*	*Natural gas*	*Solar, wind, etc.*	*Hydro*	*Biomass**	*Oil*	*Geothermal*	*Total*
1970	229.9	6.5	14.6	0.0	17.5	2.5	37.7	0.0	**308.8**
1975	242.8	24.1	65.0	0.0	17.1	3.1	31.7	0.0	**383.8**
1980	293.5	55.6	66.0	0.0	19.1	5.4	26.7	0.0	**466.3**
1985	322.4	138.6	28.0	0.0	17.4	4.5	9.6	0.0	**520.6**
1990	321.6	152.5	40.5	0.1	17.4	5.2	10.4	0.0	**547.7**
1995	296.4	153.1	43.2	1.7	21.8	7.7	9.0	0.0	**532.8**
2000	299.0	169.6	52.5	9.4	21.7	10.1	4.8	0.0	**567.1**
2001	301.6	171.3	58.4	10.6	22.7	12.4	4.8	0.0	**581.8**
2002	291.5	164.8	54.5	16.0	23.1	12.5	4.3	0.0	**566.9**
2003	314.2	165.1	58.5	19.2	19.3	14.7	4.7	0.0	**595.6**
2004	306.6	167.1	63.0	26.1	21.1	16.0	10.1	0.0	**610.0**
2005	305.4	163.1	69.4	28.5	19.6	16.6	10.6	0.0	**613.2**
2010	292.9	130.1	101.6	44.2	23.1	26.2	4.3	0.2	**622.5**
2020	291.4	31.9	148.3	68.4	24.9	29.6	4.2	1.3	**600.0**
2030	232.0	0.0	195.0	97.2	24.9	31.6	3.7	5.1	**589.5**
Share in 2005	49.8%	26.6%	11.3%	4.6%	3.2%	2.7%	1.7%	0.0%	
Change (1985-2005)	-5.3%	17.6%	148.0%	n.a.	12.7%	264.9%	10.3%	n.a.	17.8%
Average annual growth rate (1985-2005)	-0.2%	0.5%	3.1%	n.a.	0.4%	4.4%	0.3%	n.a.	0.5%
Change (2010-30)	-20.8%	-100.0%	92.0%	120.0%	8.0%	20.7%	-14.8%	2125.6%	-5.3%
Average annual growth rate (2010-30)	-1.2%	-100.0%	3.3%	4.0%	0.4%	0.9%	-0.8%	16.8%	-0.3%

* including industrial and non-renewable municipal waste. n.a. = not applicable.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

same time, the amount of electricity generated from natural gas has nearly doubled, from 5.4% in 1985 to 11.3% in 2005. The share of electricity generated from nuclear (27%) has remained mostly steady since 1985. The largest growth has been in electricity generated from renewables (including

biomass, solar, hydro and wind, and excluding non-renewable waste). The share has grown at an average annual rate of 9% since 1995, rising from 3.9% in 1985 to 4.9% in 1995 to 10.1% in 2005.

In order to match declining demand, from 2010 to 2030, total electricity generation is forecast to fall by an average annual rate of 0.3%, reflecting decreases in electricity produced from coal, oil and nuclear, along with increases in all other fuels.

DEMAND

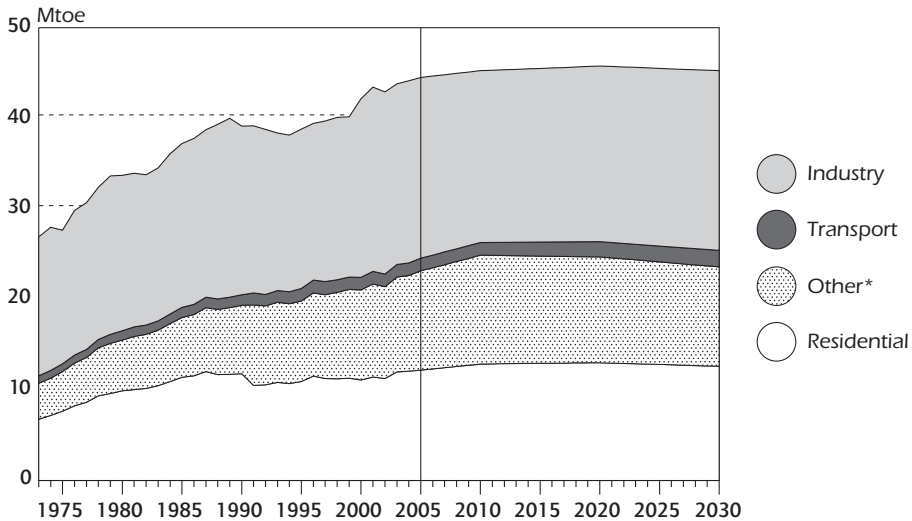
Total final consumption of electricity was 44.5 Mtoe in 2005, reflecting an average annual increase of 1.4% over the last decade (see Figure 14). Growth in the last decade outpaced growth from 1985 to 1995, which averaged 0.4% annually. The largest share of electricity, 45%, is used in the industry sector, followed by the residential sector and other sectors.

Total final consumption (TFC) of electricity is expected to hold flat between 2010 and 2030. Small increases in consumption in the industrial sector are expected to be offset by small decreases in residential and other sectors.

Germany's highest peak load in 2005 was recorded on 15 December at 76 700 MW, a slight decrease from the 2004 peak of 77 200 MW.

Figure 14

Final Consumption of Electricity by Sector, 1973 to 2030



* includes commercial, public service, agricultural, fishing and other non-specified sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

REFORM AND REGULATION

Germany is continuing the process of liberalising its electricity market, which began in 1998. Currently all customers are free to choose their own suppliers. However, price controls are still maintained for the smallest consumers – mostly households. Increases in such prices require approval from the regulatory agency in the relevant German *Land*. However, these customers are also free to switch suppliers and hence to obtain electricity at market prices.

Initially, third-party access (TPA) was to have been provided and regulated under *Verbändevereinbarung 1*, a 1998 voluntary agreement between associations of power producers and industry (VDEW, BDI and VIK), eliminating the need for government regulation. The first agreement was subsequently updated twice. Under the third iteration, *Verbändevereinbarung 2+*, grid companies set their own grid access conditions and grid fees through consultation with the industry associations. However, in 2003 it was determined that the voluntary agreement, which provided for complex, negotiated third-party access, was untenable. The switch from negotiated to regulated third-party access was made with the implementation of the EU's second internal market directive.

As a result, the energy sector in Germany was given a new regulatory framework by the new Energy Industry Act (*Energiewirtschaftsgesetz*, EnWG, in force since 13 July 2005) together with secondary legislation enacted under it (in force since 29 July 2005) governing grid access and transmission fees for electricity and gas. Enforcement lies with the network regulator (the *Bundesnetzagentur*, BNetzA), which regulates electricity, gas, telecommunications, postal and railway networks spanning two or more German states and network operators with more than 100 000 customers. Regulatory agencies in the individual German states are responsible for regulating network operators with fewer than 100 000 customers.

The main features of the new legal framework relate to network access and transit fees, and separating network operation from companies' other activities inside and outside the energy sector. Overall, Germany has elected to implement legal unbundling of monopoly networks from the competitive sides of the industry, the standard with respect to EU requirements. Transmission system operators were required to legally unbundle from 13 July 2005. Distribution system operators with more than 100 000 customers were required to implement functional and account unbundling from 13 July 2005; they are required to legally unbundle from 1 July 2007. Distribution system operators with fewer than 100 000 customers were required to account unbundle from 13 July 2005 and will not be required to strengthen this unbundling to legal unbundling.

For the first time, electricity and gas transit fees are generally subject to *ex ante* regulatory approval. The new EnWG has the objective of providing the public with, to the extent possible, a secure, affordable, consumer-friendly, efficient and environmentally compatible supply of grid electricity and gas. It provides the BNetzA with a clear legal mandate to keep down transit fees, while assuring security of supply. Network operators are required to operate a secure, reliable, high-capacity energy supply network, to maintain this network and to expand it in line with demand.

When the new act came into force, energy regulation was made a new department of the then Regulatory Authority for Posts and Telecommunications, now the BNetzA. The BNetzA is a public agency under the Federal Ministry of Economics and Technology. Its decision-making bodies are ruling chambers with quasi-judicial independence. Decisions of the BNetzA that are taken by independent ruling chambers can be appealed through the courts. Members of the ruling chambers of the BNetzA are officials who are not appointed by and cannot be dismissed by the government. The president and vice president of the BNetzA are appointed by the government, but cannot be dismissed by the government, except under very specific terms with approval from the cabinet of ministers. Decisions by the ruling chamber of the BNetzA cannot under any circumstances be overruled by the government.

Responsibility for approving electricity transit fees lies with the BNetzA and regulatory agencies in the individual German states. Approvals are currently in progress at these agencies. Recent BNetzA rulings have required electricity operators to lower their grid fees by between 6% and 28%. (For further information, see Chapter 2.)

The *Bundeskartellamt*, the competition authority, has responsibility for merger control, as well as monitoring for anti-competitive behaviour in upstream and downstream energy markets. Efforts are under way to expand the powers of the *Bundeskartellamt*, making it easier to investigate and prosecute market power abuse cases.

MARKET DESIGN

Under the *Netzzugangsverordnung*, the BNetzA has considerable authority to establish market design features. For legal as well as practical reasons, decisions concerning the design of Germany's electricity market are made after consultation with market participants.

Germany does not have a single designated market operator for the entire country. Instead, load-serving entities and generators buy and sell electricity either on the European Energy Exchange (EEX), where Germany's electricity is

traded, or contract bilaterally (directly with each other); there is no obligation to trade via EEX. The day before, balanced schedules for individual hours must be submitted directly to one of the four transmission system operators in the country by EEX or the bilaterally contracted parties. As congestion on Germany's electricity grid does not currently exist, it is not taken into account in any trading mechanism; the transmission system operator does not run security-constrained dispatch models in advance to determine if the scheduled generation or load can be served. Instead, security-constrained dispatch models are run after load is scheduled.

Intraday trading makes it possible for German market participants to change their schedules up to 45 minutes before every quarter-hour in order to be in balance. A balancing market could be used to manage supply and demand deviations following this trading, operating in real time. If a generator or load deviates from its day-ahead schedule, the transmission system operator procures the missing supply from, or sells the excess supply back to, the balancing market. Generators or load are charged the full costs incurred from their schedule deviations. Table 19 provides average balancing prices across Europe in 2005 (they are not necessarily reflecting two separate prices, but rather the average price when the TSO sold power and the average price when the TSO bought power).

Table 19

Balancing Spreads in Europe, 2005

€/MWh	*Market of fixed prices*	*Gate closure*	*Average TSO sell price €/MWh*	*Average TSO buy price €/MWh*	*Spread*
Austria	market	day ahead	51	24	27
Belgium	hybrid	"ex-post"	56	12	44
Denmark	market	1/2 hour	36	27	9
Finland	market	1/2 hour	32	27	5
France	market	6 times during day	50	45	5
Germany	**market**	**3 times during day**	**70**	**2**	**68**
Italy	market	Day ahead	102	23	79
Netherlands	market	1 hour	69	28	41
Spain	market	2 1/4 to 3 1/4 hours	–	–	0
Sweden	market	1 hour	32	28	4
United Kingdom	market	1/2 hour	55	39	16
Norway	market	1 hour	29	29	0
Poland	market	day ahead	37	24	13

Compared with other countries, the spread between the buy and sell prices in 2005 was very large in Germany, indicating that the balancing market was not operating efficiently. The sign of a well-functioning and competitive balancing energy market is that its average buy and sell prices converge towards the average spot price and that the spread between the two converges towards zero (*i.e.* buyers were generally able to buy power and sellers were able to sell power at roughly the same price). Part of the explanation of the large spread in Germany's balancing market and deviation from the average 2005 spot price of EUR 46 per MWh could be that it is, in effect, a mixture of a pure real-time balancing energy market and a market for capacity for operational reserves. In addition, in 2005, the number of market participants providing balancing energy was rather limited. In most markets it is possible to balance the system reliably and at low cost by allowing for trade in real time. Capacity is tendered separately as operational reserves to serve as a back-stop in case of unpredictable disturbances. In Germany's markets for secondary control and minute reserves, these capacity reservations are coupled with the balancing market's energy trading (though costs for capacity reservations are included in the transmission tariffs; the balancing group responsible pays for balancing energy only). The result seems to be more expensive balancing than in other comparable markets. On the other hand, some consider guaranteed capacity payments to be necessary to secure supply.

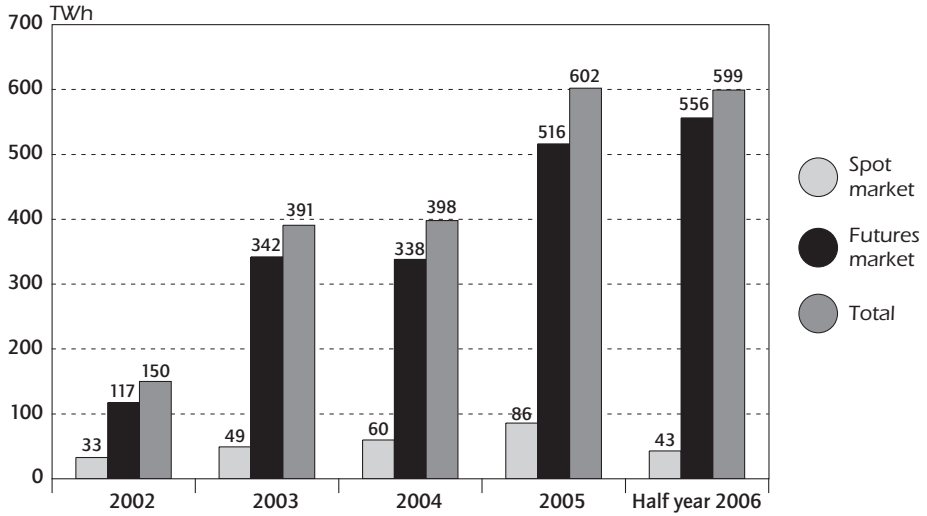
The BNetzA has recently approved changes to the balancing market, which will add transparency to the system and shorten the term, or duration, of products to 4-hour blocks (most countries use shorter periods, such as 15-minute blocks). In addition, the conditions for new entrants were improved, including making smaller units for bids possible and lowering the technical requirements for participation. Furthermore, a common balancing market for all German control areas has been introduced.

Market participants can buy and sell power in Germany's market day ahead through the EEX, the leading energy exchange in continental Europe in terms of turnover, second only to Nord Pool. In the German electricity market, EEX provides day-ahead trading for single hours or multi-hour blocks, as well as trading in electricity futures. It also provides clearing services for over-the-counter trades.[18] Liquidity in this market has been increasing, rising from 150 TWh in 2002 to nearly 600 TWh in 2006 (see Figure 15). EEX offers trading in the four transmission zones of Germany, but there has never been price separation between the four areas (or Austria). Buyers post bids and sellers post offers to the market and EEX clears the market, providing a single price for all power bought or sold in that hour.

18. Over-the-counter (OTC) trades are trades conducted outside a formal exchange, typically bilaterally between two counterparties. Often counterparties will purchase credit clearing services from formal exchanges to hedge credit risk. In recent years, some electronic OTC platforms have emerged, which explicitly match a buyer and a seller anonymously.

Figure 15

Trading Volumes on EEX, 2002 to 2006



Source: VDEW (association of power producers).

TRANSPARENCY

The transparency of Germany's electricity market has improved recently, with the posting on EEX of data beginning in April 2006, including installed and available capacity in real time, as well as *ex post* net production data, differentiated by fuel type. Data are voluntarily supplied by generators and no third-party verification of the data is performed; there have been cases where significant amounts of capacity were misreported on the website. VIK, the energy-intensive industry association, estimates that data are provided for about 55% of Germany's total capacity.[19]

In August 2006 the European Regulators' Group for Electricity and Gas (ERGEG) issued transparency guidelines to establish a common framework for all European electricity markets.[20] The guidelines, which are voluntary, set minimum standards for publication of data on system load, transmission and access to interconnections, generation and balancing energy, among other things. Many German companies have argued against the guidelines, in particular against one specific provision, noting that generation data are commercially sensitive and that unit-specific *ex ante* data should not be publicly released. One German TSO, E.ON, has recently started publishing *ex ante* data on generating capacity, such as thermal power plant blocks in inspection.

19. *Montel Power News*, "In the slow or fast lane?", p. 6, December 2006.
20. ERGEG, *Guidelines of Good Practice on Information Management and Transparency in Electricity Markets*, 2 August 2006.

INDUSTRY STRUCTURE

Germany's electricity market is characterised by a high degree of vertical integration, with large incumbents that own the majority of the generating capacity and also own and operate a piece of the transmission network. Furthermore, there is significant cross-ownership by these incumbents in retail and distribution.

GENERATION

Four large electricity companies dominate generation in Germany (E.ON, RWE, EnBW and Vattenfall). Combined, the Big Four have three-quarters of generation in the country (see Table 20). Over 85% of generation came from the Big Four in 2005; the remainder came from independent generators, industry self-generators selling back to the grid and industry producing for its own use.

Table 20

Capacity Ownership, 2005

	Capacity (MW)	*Share*
EnBW	14	11.4%
Vattenfall	17	13.9%
E.ON	26	21.2%
RWE	34	27.7%
Subtotal (Big Four)	91	74.2%
Others	31.6	25.8%
Total	122.6	100.0%

Source: Country submission.

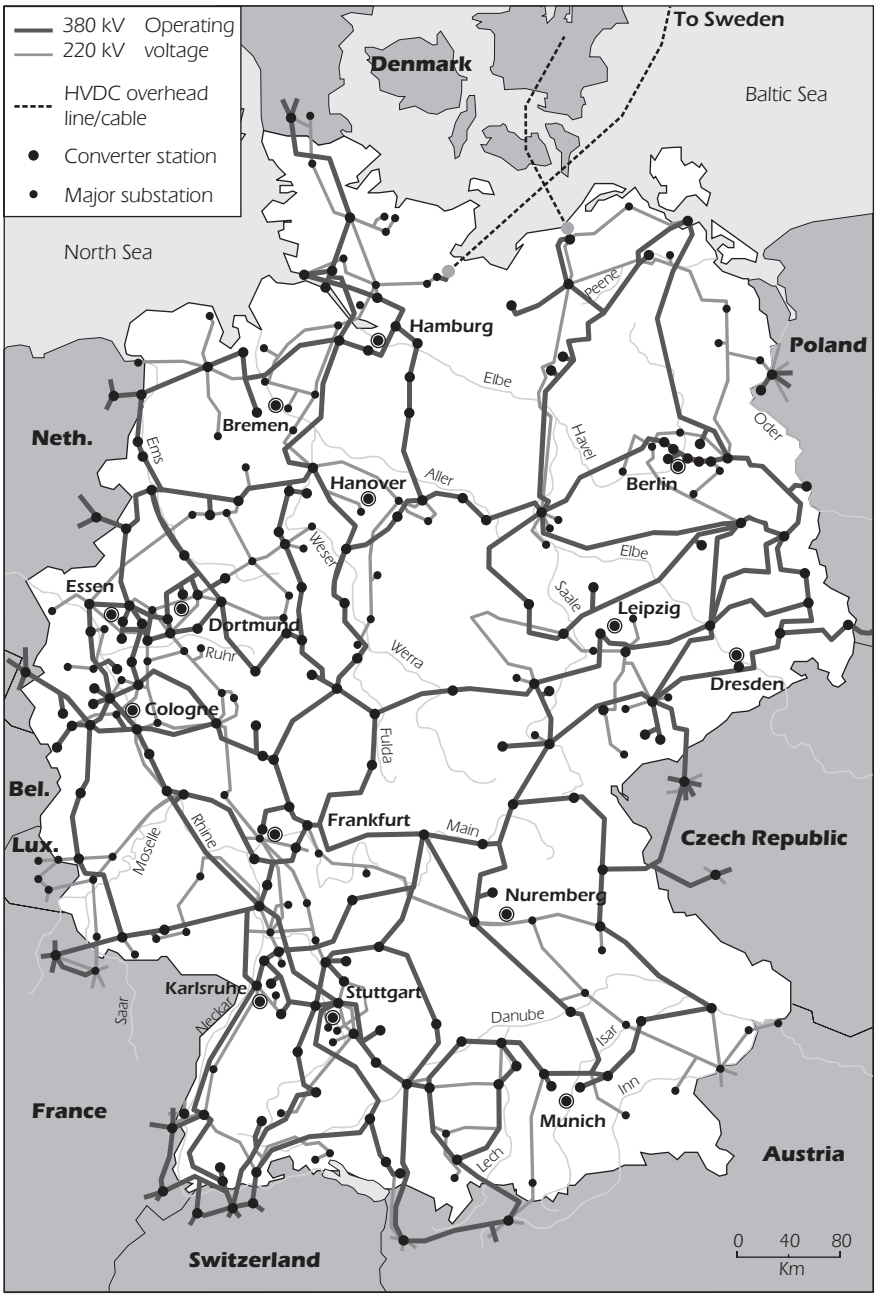
New generation

Though demand for electricity is forecast to remain relatively flat, construction projects for power plants using both conventional fuels and renewables are currently in the planning, preparation or building phase in order to replace existing plants, particularly nuclear plants slated for closure. While many of these plants will not ultimately be built, the plans provide an indication of future capacity additions. The German electricity association reports that 31 500 MW of new capacity is planned to be built by 2012, with 39% coming from hard coal, 26% from renewables, 24% from natural gas and 9% from lignite. By 2016, the industry forecasts that 44 500 MW of new capacity will be on line, with 34% coming from hard coal, 30% from renewables, 26% from natural gas and 8% from lignite.[21]

21. Data for 2012 and 2016 were reported before the release of Germany's revised second national allocation plan under the EU-ETS..

Figure 16

Map of Germany's Transmission Grid



Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

Source: Country submission.

TRANSMISSION

Germany's transmission grid, including major generation facilities, is presented in Figure 16. The network is made up of over 110 000 km of high-voltage transmission lines. Germany reports very little congestion, but data on transmission constraints are not publicly available. Transmission capacity made available for cross-border trade varies according to the operational situation within Germany, likely reflecting internal congestion that is being pushed to the borders rather than being managed within Germany.

Transmission system ownership and operations

The Big Four each own and operate their own transmission systems via legally unbundled companies, E.ON Netz, RWE Transportnetz, EnBW Tranportnetze and Vattenfall Europe Transmission, with the country divided into four large zones, plus two small zones, one covering the Hamburg metropolitan area managed by Vattenfall and one in southern Germany managed by RWE (see Figure 17). The four transmissions system operators must provide non-discriminatory third-party access[22] to their networks for all generators. The four grid operators co-ordinate their operations under the terms of the Union for the Co-ordination of Transmission of Electricity (UCTE), an association of transmission system operators from countries in western and central Europe. In addition, the four transmission system operators have formal agreements between one another governing their interactions.

In November 2006, a transmission outage in north-west Germany resulted in an outage that eventually affected 15 million customers in parts of seven European countries (see box).

The November 2006 electricity disturbance

On 4 November 2006, an electricity outage hit 15 million households in parts of Germany and several other western European countries, and extended as far as Morocco. The controlled load shedding followed the scheduled deactivation by E.ON of an ultra-high voltage transmission line across the Ems River in order to allow the Norwegian Pearl cruise ship to pass. Following the installed procedures, systems were generally stabilised after 38 minutes and normal conditions were established in less than two hours, by which time all customers were back on line. An internal E.ON investigation attributes the outage to human error and not technical failure. According to this investigation, grid staff did not make

22. In the United States, Australia and some other markets, "third-party access" is typically referred to as "open access". This regime gives all market participants non-discriminatory and transparent access to transportation regardless of transmission line or pipeline ownership or operation.

use of all options for a comprehensive situation analysis, but there was no evidence of any technical malfunction of the transmission lines, control or monitoring systems. A preliminary investigation by the Union the finding of the E.ON investigation about the primary cause of the for the Co-ordination of Transmission of Electricity (UCTE) concurred with disturbance. It also found that aggravating factors included insufficient co-ordination between adjacent transmission system operators, an inability to control old wind installations' automatic disconnection and reconnection to the grid, and a limited range of options for dealing with transmission congestion, including market options to procure additional resources from other areas. As a consequence of the load shedding and the investigations, standards for co-ordination between transmission system operators are being improved no evidence of any technical malfunction of the transmission lines, control or monitoring systems. A preliminary investigation by the Union for the Co-ordination of Transmission of Electricity (UCTE) concurred with the finding of the E.ON investigation about the primary cause of the disturbance. It also found that aggravating factors included insufficient co-ordination between adjacent transmission system operators, an inability to control old wind installations' automatic disconnection and reconnection to the grid, and a limited range of options for dealing with transmission congestion, including market options to procure additional resources from other areas. As a consequence of the load shedding and the investigations, standards for co-ordination between transmission system operators are being improved.

Source: E.ON Netz, *E.ON Netz reports on status of investigations*, press release, 4 December 2006 and UCTE, *System Disturbance on 4 November 2006*, Interim Report, 30 November 2006.

Cross-border transmission

Germany's network is linked to its neighbours' power grids via cross-border connections. Interconnection capacity in 2005 was 15 to 17 GW, equivalent to about 16% of total capacity and above the 10% interconnection level targeted by the EU (see Table 21). However, this capacity is often congested (see Table 22). Cross-border capacity is congested between 63% and 100% of the time on the borders with Denmark, the Netherlands and the Czech Republic.

Cross-border capacity is allocated to users using explicit auctions at borders with congestion (auctions are not used at the border with Austria as there is no congestion) under use-it-or-lose-it provisions; unused capacity must be offered back to the market. Under EU regulations, revenue from the allocation of congested capacity can only be used for guaranteeing the actual availability of the allocated capacity, network investments and

Figure 17

Map of Germany's Transmission Zones

Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

Source: Country submission.

Table 21

Available Transfer Capacities between Germany and its Neighbours, Winter 2006/07

Available capacities in MW	*To Germany*	*From Germany*
Austria	1 400	1 600
Czech Republic	2 260	700
Switzerland	4 000	2 400
France	2 850	3 300
Netherlands	3 000	3 800
Denmark-West	1 200	800
Denmark-East	550	550
Poland	1 100	1 200
Sweden	600	600
All neighbours	16 960	14 950

Note: Data for Belgium not available.

Source: ETSO; available from www.etso-net.org/NTC_Info/map/e_default.asp.

maintaining or increasing interconnector capacities, or to reduce the country's network tariffs. According to the European Commission's February 2006 sector inquiry into energy markets, from 2001 to 2005 the three German grid operators that manage interconnectors earned congestion revenues of EUR 400 million to 500 million from auctions. Of the total revenue, EUR 20 million to 30 million was spent to reinforce existing interconnections or build new ones. The transmission system operators report that the remaining revenue was used to reduce transmission tariffs.

Grid access and investment

The Energy Industry Act and the respective ordinance rule for discrimination-free access of new generation guides grid investment and connections. Connections of renewables operate under special rules, as they have priority network access and must be connected if certain minimum conditions are met. Costs for grid connections are apportioned according to the Energy Industry Act and the respective ordinance (*Netzentgeltverordnung*). A new ordinance that governs grid access for new power plants in more detail is currently being drafted. All decisions on grid access and access fees can be appealed to the BNetzA or the respective regional regulator, the *Länderregulierungsbehörde*.

Table 22

Cross-border Congestion in Europe, 2004 and 2005

	*Share of hours congested**	
	Jan-May 2004	*Jan-May 2005*
Slovakia –> Hungary	100%	100%
France –> Switzerland	100%	100%
Germany –> Denmark	**99%**	**100%**
Netherlands –> Belgium	96%	100%
France –> United Kingdom	95%	96%
Germany –> Netherlands**	**88%**	**90%**
France –> Spain	35%	81%
Czech Republic –> Germany	**69%**	**68%**
Netherlands –> Germany**	**63%**	**64%**
Belgium –> Netherlands	63%	63%
Germany –> France**	**0%**	**41%**
Czech Republic –> Austria	0%	37%
Germany –> Czech Republic**	30%	36%
United Kingdom –> France	32%	35%
France –> Germany	**48%**	**33%**
Spain –> France**	30%	33%
Poland –> Slovakia	0%	19%
Spain –> Portugal	8%	18%
Poland –> Czech Republic	16%	16%
Portugal –> Spain	27%	12%
France –> Belgium	30%	11%
Czech Republic –> Poland	0%	10%
Slovakia –> Czech Republic	1%	7%
Czech Republic –> Slovakia	2%	1%
Germany –> Switzerland**	**0%**	**1%**
France –> Italy	1%	1%
Austria –> Czech Republic	0%	0%
Switzerland –> France	0%	0%
Italy –> France	0%	0%
Belgium –> France	0%	0%
Germany –> Austria	**0%**	**0%**

* Hours when requested capacity exceeded available cross-border capacity as a percentage of all hours. The arrows indicate the direction per border, in some cases reported by different TSOs.

** Refers to an average of more than one interconnector between two adjacent borders.

Source: European Commission, *Sector Inquiry under Art. 17 Regulation 1/2003 on the gas and electricity markets*, Table 23, 16 February 2006.

Transmission system operators report no congestion in their grid areas. Nonetheless, in the seven years between 1999 and 2005, they have spent over EUR 4.9 billion to upgrade and expand their high-voltage transmission networks, with investment in 2004 and 2005 being 32% above investment in 2002 and 2003. As part of this investment, 1 200 km of new transmission lines were added.

Grid fees

Grid fees, which cover transmission operations and investments, are charged to distribution companies, which pass them on to end-use customers via retail rates. Transmission system operators charge distribution companies via a "postage stamp" rate, at a single flat rate per kW of maximum demand, similar to methods used in many parts of the United States. The rate is the same for all distribution companies. For further discussion of transmission network fees, see the later section on prices, including a table comparing grid fees across European countries (see Table 24).

Currently, grid fees are set by each transmission system operator and then subject to *ex ante* cost-plus regulation. In 2006, the BNetzA ordered many large gas and electricity network operators to lower their grid tariffs by between 6% and 28%. The BNetzA proposal contains two steps to fully implement *ex ante* incentive-based regulation in 2009. The first step is to institute a revenue cap aimed at reducing major differences in economic efficiency across grid operators within Germany and, with respect to transportation networks, compared to benchmarking studies from outside Germany. The revenue cap would limit total revenues earned by grid operators. Progressive x-factors that reduce the revenue cap would attempt to reflect expected efficiency gains. The second step foresees imposition of "yardstick" regulation, which rewards network operators on the basis of their performance compared with competitors.

Wind power integration

Under the Renewable Energy Sources Act (EEG), grid system operators are required to connect plants generating electricity from renewable sources to their system at standard rates and to guarantee priority purchase and transmission of all electricity by such plants. The large amount of wind capacity that has come on line in recent years – there were over 20 GW of wind capacity connected to the grid at the end of 2006 – has affected grid operations, though grid security was never in serious danger. Wind energy is intermittent, as production ramps up and down with little advance warning, making managing grid voltage and operations more difficult. Large amounts of wind generation can contribute to high levels of congestion on the grid, with spillover effects to neighbouring countries, particularly the

Netherlands and Austria. Modifications to grid rules, regulations and operations could alleviate negative aspects of wind integration.

In this light, in 2005, DENA, the German Energy Agency, published a study commissioned by the BMWi on the integration of wind power into the national grid, with the involvement of representatives from the wind industry as well as grid and power plant operators. The first part of the study, which addresses the expansion of wind power between 2005 and 2015 and disregards opportunities to optimise wind power integration, offers the following conclusions:

- The necessary new grid constructions up to 2015 will extend the existing transmission network by a total of 850 km. Although the identified grid extension measures account for only about 5% of the existing transmission network, there are various bottlenecks to rapid implementation. Compared with the new construction of recent years, the time frame for necessary network extension is very ambitious.
- In order not to endanger the further development of wind power, ongoing implementation of planning and investment decisions, particularly the legal approval procedures for network extension, must be accelerated.
- No additional conventional power stations will need to be built in order to provide the requisite balancing and reserve power.

DISTRIBUTION AND RETAIL

There are over 400 distribution network operators in Germany. While transmission is legally unbundled from other activities, full legal unbundling of large distribution network operators (more than 100 000 customers) from retail activities will not come into effect until 1 July 2007. Small distribution networks must only have functional and account unbundling, which was phased in for both large and small distribution networks on 13 July 2005.

There is significant cross-ownership of distribution and retail in Germany's electricity sector through the country's many regional and local utilities, or *Stadtwerke*. The Big Four have stakes in a large percentage of *Stadtwerke* (including many small distribution network operators with fewer than 100 000 customers), but the *Bundeskartellamt* has become more and more restrictive in its approval of such mergers even if the stake of one of the Big Four in a distribution service operator is a minority stake of 20% or less (this only applies henceforward; the Big Four are not required to divest existing ownership above 20%). Distribution grid operators are obliged to provide third-party access to their grids. For further discussion of distribution network fees, see the later section on prices, including a table comparing grid fees across European countries (see Table 24).

Table 23

Electricity Customer Switching Rates

Volume of electricity consumption switching suppliers since start of liberalisation

	Large and very large industrial	*Small-medium industrial and business*	*Very small business and household*
Austria	29%	29%	4%
Belgium	c. 20%	10%	
Czech Republic	5%	1%	0%
Denmark	> 50%	c. 15%	
Finland	> 50%	82%	30%
France	15%		0%
Germany	**41%**	**7%**	**5%**
Greece	2%	0%	0%
Hungary	32%		0%
Ireland	56%	15%	9%
Italy	60%		0%
Luxembourg	25%	3%	0%
Netherlands	–	–	11%
Portugal	16%		
Spain	25%	22%	19%
Sweden	> 50%	–	29%
United Kingdom	> 50%	>50%	48%
Norway	> 50%	>50%	44%

Note: Where the country does not report each category separately, the average across two or three categories is provided.

Source: European Commission, *Implementing the Internal Energy Market*, Annual Report 2005, Table 3.1.

Customer switching

A major indicator of a competitive retail market is the number of customers that have switched suppliers or renegotiated their contracts. In the industrial sector, all customers have negotiated new contracts and over 40% have switched suppliers. Customer switching is quite low in the household sector: only 2% since market opening, though this does not take into account renegotiated contracts. Table 23 shows customer switching rates by volume of electricity.

It takes about six weeks to complete a customer switch – customer switching is not automated, but is handled manually. The EC's 2006 energy sector inquiry found that Germany's switching procedures involved a heavy administrative burden, including onerous information exchange protocols and payment conditions. The BNetzA is currently working to streamline and

standardise the switching procedures. A first decision as from 11 July 2006 was made for the specification of uniform business processes and data formats.

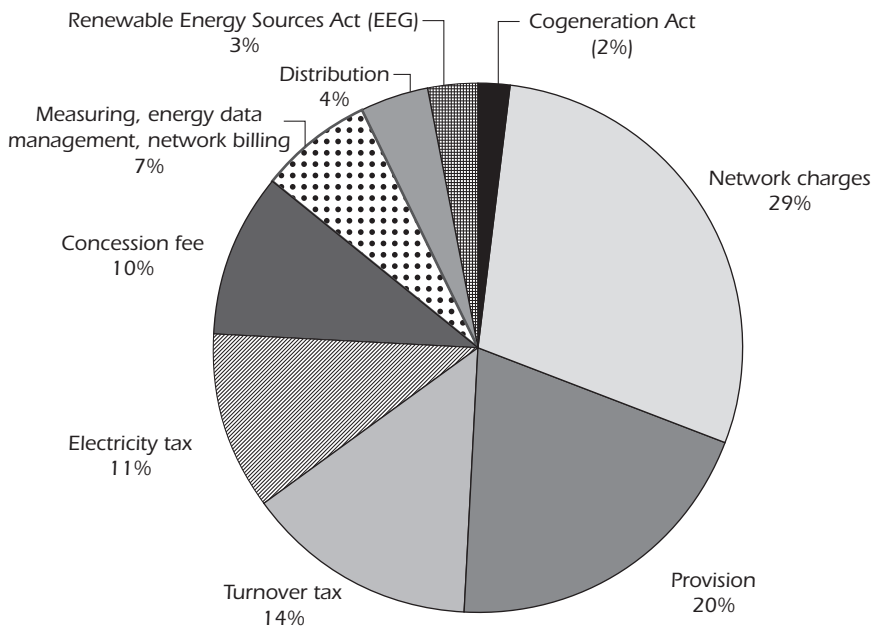
PRICES

WHOLESALE ELECTRICITY PRICES

Wholesale electricity prices in Germany, along with those of neighbouring European countries, are provided in Figure 19. As with prices across Europe, day-ahead German electricity prices were mostly on a rising trend through 2006, but have generally levelled, and declined somewhat, in 2007. Prices crashed in late April because of the sharp drop in prices for European Union greenhouse gas permits, but recovered somewhat by the end of 2006. Wholesale prices in Germany are above the prices in the Nordic market (which has a high share of low-cost hydro), but below those of the Netherlands. German prices had been below those of France, but have recently climbed slightly above them as French prices have fallen more quickly than those in Germany.

Figure 18

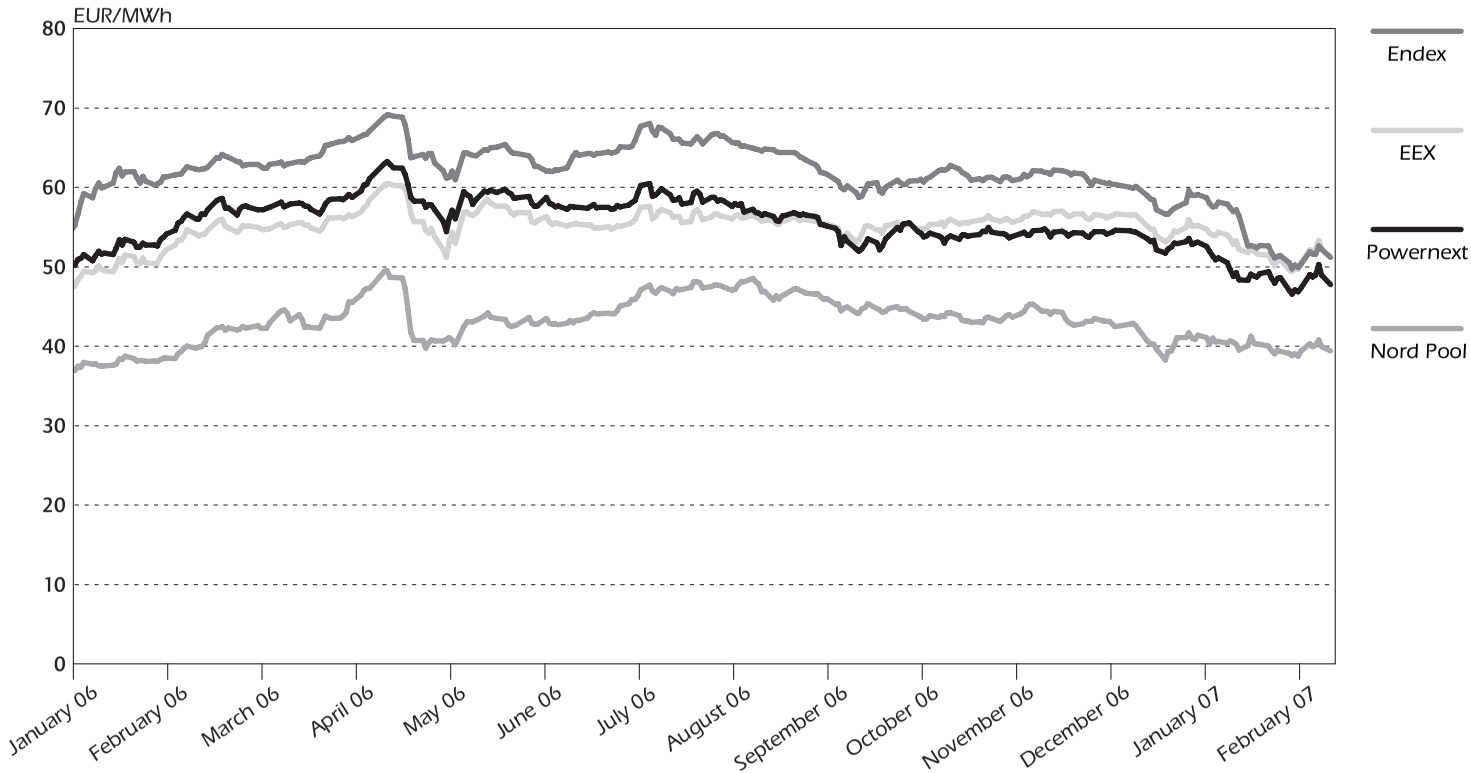
Electricity Prices for Residential Customers by Component, 2005



Source: VDEW/VDN, *Facts and Figures: Electricity Networks in Germany in 2006*, p. 9.

Figure 19

Wholesale Day-Ahead Electricity Prices in Europe, 2006 and 2007



Source: EEX.

RETAIL ENERGY PRICES

As shown in Figure 18, for a domestic customer, the largest single cost is the network charges, which make up almost 30% of the monthly energy bill. Following network charges, the provision of energy takes up about 20% of the total bill. In aggregate, government-mandated taxes and other charges make up the largest share (nearly 40%) of the total. Other fees make up the remaining 10%.

In order to keep German industries competitive with those of other countries, the government has capped the amount that industrial customers must pay for the EEG, which funds Germany's renewable feed-in tariff. While some industrial customers had to pay as much as 2 eurocents per kWh in recent years, as of December 2006, the charge was capped at a maximum of 0.5 eurocents per kWh.

Compared to other nearby countries, Germany's electricity prices for domestic and industrial retail customers are quite high (see Figure 20). In 2006, prices were more than 25% above the average price for domestic customers in twelve European countries, as well as higher than in the Netherlands, Belgium and Denmark. Eurostat prices for Germany also include relatively high fiscally induced charges, such as the concession fee, electricity tax, EEG and Cogeneration Act. Therefore, comparability to prices in other countries is limited. Average prices rose by 4% between 2005 and 2006.

Similarly, prices for industrial customers are also higher than in neighbouring countries (see Figure 21). Between 2004 and 2006, Germany's prices were 10-14% higher than European prices. Average prices in Germany rose by 19% between 2004 and 2006 and by 9% between 2005 and 2006.

NETWORK FEES

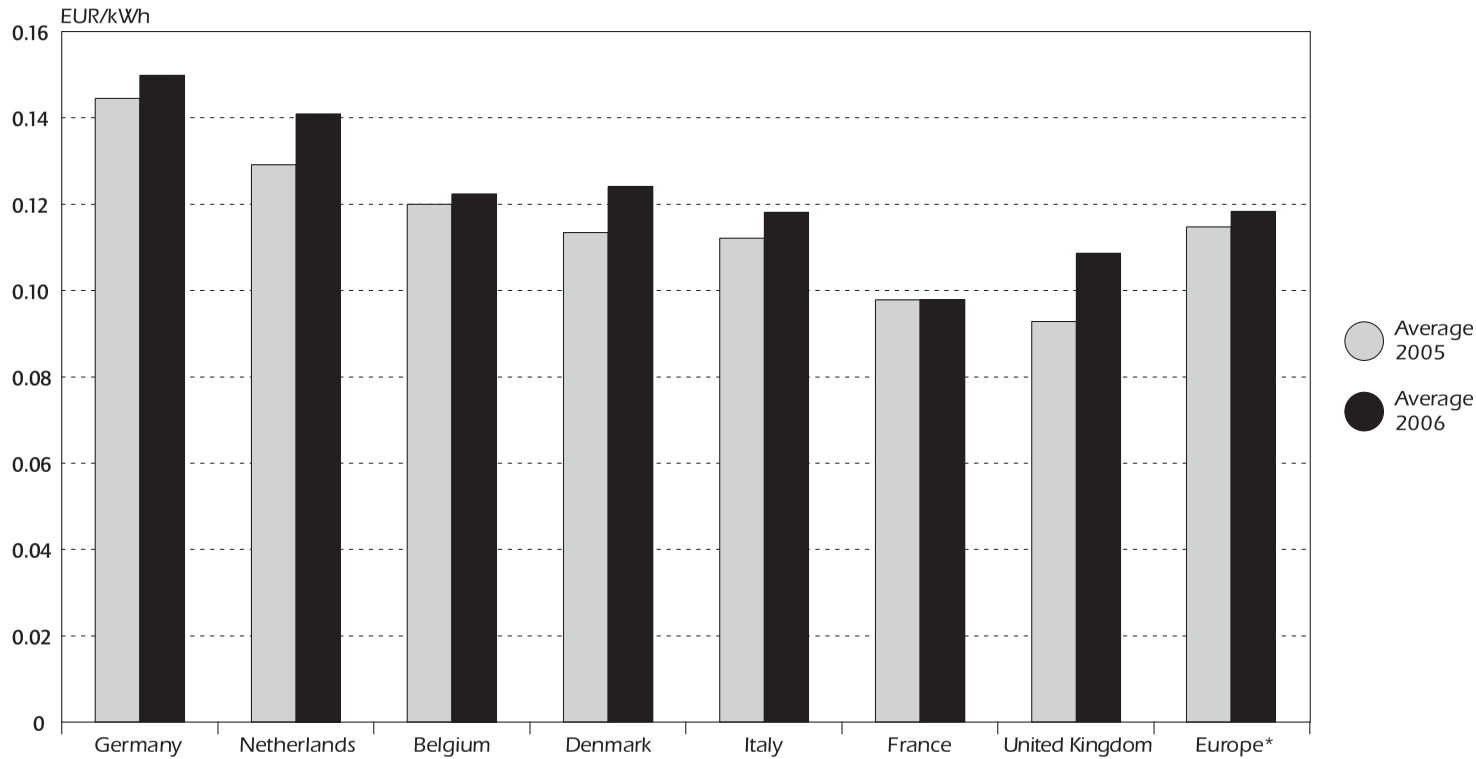
Grid fees across Europe are presented in Table 24, as reported by the European Commission, covering both transmission and distribution tariffs.

CRITIQUE

Given the large size and strategic location of the German electricity industry, the progress made towards a liberalised market since the IEA's last review is significant. Such improvements are critical for Europe to create a genuinely integrated market, something that can benefit German customers and all of Europe by lowering the costs of supplying power and ensuring reliability. We are pleased to see the German government provide the strong political will necessary to push liberalisation forward, in particular the recent establishment of a network regulator. We urge the government to maintain this commitment and press forward with continued reforms.

Figure 20

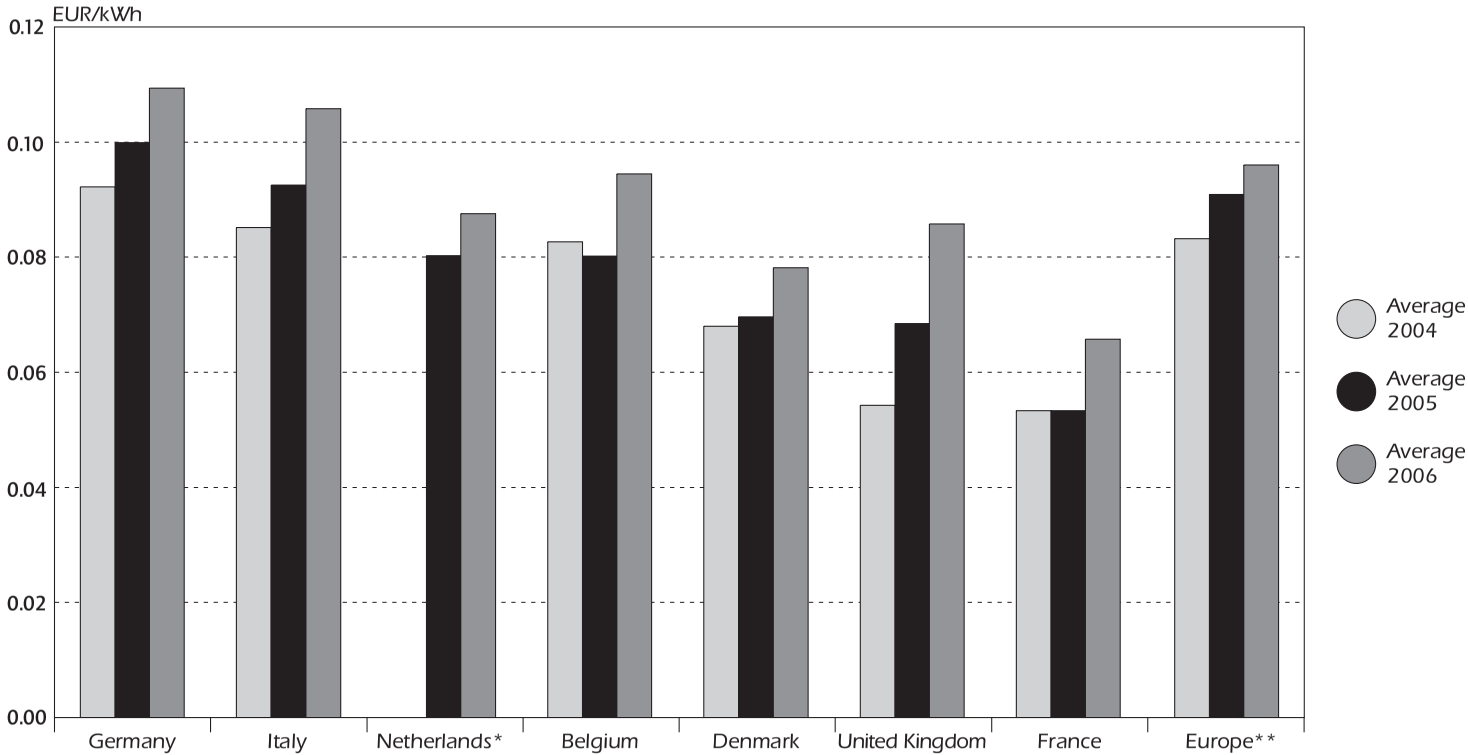
Household Retail Prices in Europe, 2005 and 2006



* includes Austria, Belgium, France, Germany, Finland, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain and the United Kingdom.
Source: Eurostat.

Figure 21

Industrial Retail Prices in Europe, 2004 to 2006



* data not available for 2004. ** includes Austria, Belgium, France, Germany, Finland, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain and the United Kingdom.
Source: Eurostat.

Table 24

Transmission and Distribution Network Fees

	Number of regulated transmission companies	*Number of regulated distribution companies*	*Approximate network tariff for large users (€/MWh)*	*Approximate network tariff for low-voltage commercial (€/MWh)*	*Approximate network tariff for low-voltage residential (€/MWh)*
Austria	3	133	10	51	53
Belgium	1	26	11	–	51
Czech Republic	1	327	3	–	36
Denmark	10	120	19	25	48
Finland	1	91	10	26	37
France	1	161	12	40	48
Germany	**4**	**950**	**9**	**53**	**62**
Greece	1	1	8	–	–
Hungary	1	6	2	48	30
Ireland	1	1	–	48	50
Italy	1	173	9	41	67
Luxembourg	2	10	7	62	72
Netherlands	1	12	–	–	40
Norway	1	170	11	25	–
Portugal	3	13	4	39	37
Spain	1	313	69	34	33
Sweden	1	184	10	17	40
United Kingdom	3	17	5-12	11-23	17-34
Highest			69	62	72
Lowest			2	11	17
Average			13	38	46

Source: European Commission, *Implementing the Internal Energy Market*, Annual Report 2005, Table 6.1.

A regulator that has a clear mandate, strong powers and sufficient independence from the government not only has the tools to ensure a well-functioning market, but also provides signals to existing and future market participants that a fair and stable regulatory environment will be in place for the long term. This encourages existing market participants to operate competitively and potential participants to enter the market, which will help to alleviate any high concentration in the market. Thus, the establishment of the regulator, the BNetzA, is a notable achievement, as it will help create a level playing field for all market participants, reducing market concentration and underpinning a genuinely competitive market.

Similarly, we applaud the efforts under way by the competition authority, the *Bundeskartellamt*, to better monitor legally unbundled business units. Furthermore, we strongly support the legislation currently being developed to expand the powers of the *Bundeskartellamt* in order to make it easier to investigate and prosecute market power abuse cases; this legislation should be implemented as soon as possible. Detecting and proving market power abuse is notoriously difficult in electricity markets, so stronger tools to make this easier without creating undue burdens on market participants are welcomed. These enhanced oversight tools will also deter actors from exercising market power in the first place. However, the recent decision by the *Bundeskartellamt* that finds that power producers are abusing their market position by passing through the cost of CO_2 allowances received for free is troubling. Under normal competitive conditions, companies are expected to pass through their marginal operating costs – whether real costs or opportunity costs. Interference by the *Bundeskartellamt* into the functioning of the EU Emissions Trading Scheme market will undermine the value of the scheme itself, which is to make the costs of CO_2 emissions transparent to the market in order to create incentives for the uptake of low- or no-carbon energy sources. We strongly encourage the competition authority to refrain from taking any action that will negatively affect the EU-ETS market and lead to non-competitive outcomes. Not only would such interference harm the carbon market, it would also distort the electricity market and discourage appropriate investments in new energy infrastructure.

The government should ensure that both the BNetzA and the *Bundeskartellamt* have sufficient powers and resources to properly oversee and regulate the market. This will also allow these entities to conduct frequent analyses of costs and prices, helping them better monitor the development of competition.

The current reliance on legal and functional unbundling of network and generation assets underscores this need for a strong regulator and close oversight. As currently structured, transmission assets are owned and operated by the Big Four companies, which combined have three-quarters of all generation assets. While the transmission companies are required to offer third-party access to all market participants on open, non-discriminatory terms, the individual companies' incentives are such that they will implement the minimum requirements for third-party access, but not undertake all efforts to ensure equal access to transmission for all market participants. One example where distorted incentives discourage competition is access to information. Germany's Big Four electricity companies, as operators of the transmission grid, have access to significantly more market information than generation companies without transmission assets, giving key insights on how to operate in the market most profitably. These companies have better information on how generation dispatch decisions are taken and how transmission flows affect the grid, giving them advantages over competitors in terms of how best to bid and operate their power plants, for example. They also have more information allowing them to take better investment decisions. While regulators monitor

the implementation of legal and functional unbundling to prevent discriminatory practices, this process is cumbersome and imperfect. Moving from a system where business units of generation companies own and operate the monopoly transmission assets to one where an independent system operator manages the grid would accomplish the goal of creating the right incentives for competition to develop without requiring the thorny task of ownership unbundling. Independent system operations without ownership unbundling is the model in place in many successful markets, including in Australia and in the PJM market in the Atlantic region of the United States. We strongly urge Germany to move to this grid management model.

While separate independent system operators could be put in place for each of the current four regions in Germany, a single independent system operator covering all four regions would have many advantages. Most notably, enlarging the size of the electricity market footprint would allow system operators to operate the grid more efficiently and safely, as they would have direct access to more information about electricity flows, allowing better schedule dispatch and management of the use of reserves. In theory, all system operators could work together seamlessly, constantly providing information about cross-border flows, but in practice this is more easily accomplished when all the information is managed by a single entity. The 4 November 2006 electricity outage in Europe highlights the complex task of managing a grid; the lack of seamless co-ordination across system areas exacerbated the negative impacts of an event that could have been better isolated from the wider European grid. We encourage Germany to consider consolidating its grid management under a single independent system operator. One step that should be undertaken immediately to help improve system security is to make reliability standards mandatory. UCTE, the association of transmission system operators in Europe, has reliability standards in place, but does not have the authority to enforce them. As was recently done in the United States following the August 2003 blackout, Germany should make meeting UCTE, or other reliability standards, mandatory – with penalties for non-compliance. As the EU moves towards an integrated internal energy market, the government should work with its neighbouring countries and the EU to develop and implement comprehensive, mandatory and enforceable reliability standards to ensure efficient and reliable cross-border electricity flows for the long term. The recent 10 January 2007 action plan of the European Commission includes proposals along these lines, a positive step.

As discussed, information asymmetry among market participants distorts the playing field by creating unfair advantages. To that end, the initiative by EEX, Germany's trading platform, to improve electricity market transparency on its website is a welcome development. The IEA encourages EEX to further develop this important initiative. Market operators often make the ability to trade in the market subject to mandatory transparency requirements. As the current effort is voluntary, reliability and incompleteness of the data have

limited its effectiveness at levelling the information playing field for market participants. In fact, the opportunity to provide some data, but not the obligation to provide all data, creates an opportunity to distort the market for personal gain. We encourage Germany to make minimum transparency standards mandatory and to require that an independent third party verify the accuracy of the data. The data provided should at least include *ex ante* available capacity, with immediate online publication of any changes to plant status. A third party that checks the data could also aggregate real-time unit-specific generation data and provide the aggregated data to the market, so that important market information is provided in a verified manner. ERGEG's transparency guidelines offer the opportunity to have standardised transparency provisions in all European countries, better enabling smooth market coupling and enhancing system operations. In addition to grid reliability standards, the recent 10 January 2007 action plan of the European Commission also includes such proposals, which we applaud.

The high concentration of generation in Germany can be effectively reduced through expansion of the relevant market – through policy harmonisation with the wider European market and sufficient cross-border interconnections. The implementation of auctions to allocate capacity at Germany's borders is helping improve competition in Germany, and we commend the country on its commitment to developing market-based means to manage transmission. However, congestion at many border points effectively separates Germany's market from the wider European one. While Germany's cross-border capacity exceeds the EU requirement, the chronic congestion signals the need for more capacity. Currently, revenues from cross-border auctions can be used for three purposes according to EU legislation, including to expand cross-border capacity, but also to reduce a country's network tariffs. Despite the congestion, German transmission companies use a very small amount of revenue to expand transmission capacity along its borders. While the revenues are used to reduce network tariffs internally, this has a small effect on actual tariffs as it is socialised across the whole system. Instead, transmission expansions would provide greater benefits to customers, as Germany could rely on cheaper outside generation and a larger, integrated market to help manage supply and demand, as well as system security. We strongly urge the country to require transmission operators to expand this capacity, either through auction revenues or other means.

Germany's balancing market is a hybrid market. In most countries, the market for balancing energy – energy used to balance the grid under normal conditions when supply and demand change – is operated separately from other markets for reserve capacity, such as operational reserves needed to manage system security in the case of emergency events. Germany has merged many functions into one market, with the result that the balancing market does not operate efficiently. The proposal by the BNetzA to add transparency to the market and shorten the length of individual trading

periods is a good first step and should be implemented without delay. Furthermore, the country should consider revamping the balancing market by making it a genuinely energy-only market that does not include other products, such as reserve capacity. The country can look to many examples of alternative balancing market designs in Europe, the United States and Australia that tend to deliver low-cost outcomes. Changes to Germany's existing balancing market will increase transparency of how energy is traded and provide greater liquidity, helping to lower overall costs.

Germany's transmission system operators report very limited congestion within the country, though the large amount of wind in the system has, at times, created significant congestion within Germany's borders that spreads to other countries, notably the Netherlands and Austria. Furthermore, the planned phase-out of nuclear power will result in the removal of generation from the southern part of the country at the same time that expected wind and coal expansions are mostly planned for the northern part of the country. As much of Germany's electricity demand is in the southern part of the country, this will likely add to congestion along north-south transmission lines over the longer term. Current market design will not help to manage this lopsided growth; there are no market signals to provide incentives for investors to build power plants in locations where they are needed. Furthermore, the market design does not have systematic policies that create incentives for the transmission system operators to build new transmission in places where it will alleviate transmission. As the rapid pace of building new wind plants continues, the need for locational signals to investors will rise. A continued lack of locational signals will result in higher costs – both in terms of the operation of the existing system and the need for costly new transmission lines. We encourage the government to put in place market-based incentives that drive sensible and cost-effective investments in generation and transmission – ensuring that enough infrastructure is built in the places where it is needed.

We are pleased to see that DENA, the German Energy Agency, has undertaken work to better integrate wind into the network. High levels of wind can have detrimental effects on network security, but these effects can be mitigated through revised grid rules, regulations and operations that better integrate wind into the transmission system – rather than just accommodate it. For example, rules on the prediction of wind, timing of gate closures and charging of balancing costs could be revised. Rules and regulations to seamlessly integrate wind on the grid should rely as much as possible on incentives and price signals for market participants, including wind generators and incumbent utilities.

We are pleased to see that the government has not undertaken any efforts to impose retail price controls in the face of political pressure stemming from rising world energy prices. While such price controls would appear to protect customers, in fact they would exacerbate the problem in the long term. Implementing regulated prices would further impede competition by leaving no room for retailers to compete on price.

RECOMMENDATIONS

The government of Germany should:

- *Continue efforts to improve the regulatory framework to further develop a competitive electricity market.*
- *Enable effective oversight and regulation of the market by:*
  - *Ensuring that adequate resources are available to the network regulator and competition authority.*
  - *Implementing the proposed legislation that will provide sufficient powers to the competition authority to monitor, detect, punish and prevent the abuse of market power.*
  - *Monitoring prices and competition intensity in the wholesale market, such as by conducting frequent analyses of costs and prices.*
  - *Refraining from interference in the market by the government, regulators or the competition authority in a way that distorts competitive market outcomes, such as by unduly limiting pass-through of environmental costs.*
- *Implement independent transmission system operations and consider creating a single independent system operator for the electricity transmission network.*
- *Work to improve transparency of the wholesale electricity market so that sufficient market information is easily available to all market participants on a non-discriminatory basis.*
- *Work actively to further integrate the German electricity market with neighbouring markets, in particular by encouraging companies to invest more in increased interconnection capacity to reduce congestion.*
- *Require transmission system operators to implement mandatory reliability standards with clear penalties for non-compliance.*
- *Reform the balancing market by creating a genuinely energy-only market.*
- *Provide market signals to encourage new generation and transmission to be built in locations where they are needed – and not in places where they will add to congestion.*
- *Continue to work to better integrate wind into the transmission network through revised grid rules, regulations and operations, relying as much as possible on market incentives and price signals.*
- *Promote competition through the removal of any regulated retail prices and resist efforts to impose regulated prices in the future.*

GENERAL OVERVIEW

The 17 nuclear power plants in operation in Germany, comprising 11 pressurised water reactors (PWRs) and 6 boiling water reactors (BWRs), have a combined net generating capacity of around 20 300 MW_e (see Table 25). All were constructed by domestic supplier KWU (part of the Siemens Group) in the 1970s and 1980s, and are almost entirely owned and operated by the Big Four private-sector utilities. In 2005, they contributed 26.6% of total electricity generation with a combined availability factor of 88%. Overall, the plants provide almost half the country's baseload power generation.

NUCLEAR POLICY

The 1998 federal election resulted in a coalition government committed to ending the use of nuclear energy. An agreement was negotiated between the government and the utilities in 2000 for the orderly phase-out of nuclear generation, the provisions of which were incorporated into the Atomic Energy Act by an amendment in April 2002. This allocated a residual lifetime generation allowance to each plant, roughly equivalent to a 32-year lifetime, thus requiring all nuclear plants to be closed by the early 2020s. Two older reactors have been shut down since the law was amended (Stade in 2003 and Obrigheim in 2005). The agreement also provided for the permanent shut-down of the Mülheim-Kärlich PWR owned by RWE, which had only been in operation for two years before being taken off line in 1988 because of legal issues surrounding its licensing.

Table 26 provides data on the remaining generation allowances for Germany's nuclear power plants, as well as estimates of their closure dates based on the 2005 load factor of 88%. Using these closure date estimations, Figure 22 provides nuclear capacity forecasts for 2007 to 2022, the estimated date of the final nuclear power plant closure in Germany under existing legislation.

The coalition agreement of the present government, negotiated following the 2005 federal election, acknowledged that the parties do not agree on the issue of nuclear power. Given this situation, where there is unlikely to be a majority in the present parliament for a change in the Atomic Energy Act, it was accepted that the existing policy towards nuclear energy must remain in force for the duration of the coalition government.

Table 25

Operating and Recently Shut-Down Nuclear Power Plants in Germany

Plant name	*Type*	*Capacity (MW_e net)*	*Year of grid connection*	*Operator*	*Ownership*
Biblis A	PWR	1 167	1974	RWE	RWE
Biblis B	PWR	1 240	1976	RWE	RWE
Brokdorf	PWR	1 370	1986	E.ON	E.ON (80%), Vattenfall (20%)
Brunsbüttel	BWR	771	1976	Vattenfall	Vattenfall (66.7%), E.ON (33.3%)
Emsland	PWR	1 329	1988	RWE	RWE (87.5%), E.ON (12.5%)
Grafenrheinfeld	PWR	1 275	1981	E.ON	E.ON (100%) E.ON (83.3%), Stadtwerke Bielefeld (16.7%)
Grohnde	PWR	1 360	1984	E.ON	
Gundremmingen B	BWR	1 284	1984	RWE	RWE (75%), E.ON (25%)
Gundremmingen C	BWR	1 288	1984	RWE	RWE (75%), E.ON (25%)
Isar 1	BWR	878	1977	E.ON	E.ON Stadtwerke München (25%)
Isar 2	PWR	1 400	1988	E.ON	E.ON (75%),
Krümmel	BWR	1 260	1983	Vattenfall	Vattenfall (50%), E.ON (50%)
Neckarwestheim 1	PWR	785	1976	EnBW	EnBW
Neckarwestheim 2	PWR	1 305	1989	EnBW	EnBW
Philippsburg 1	BWR	890	1979	EnBW	EnBW
Philippsburg 2	PWR	1 392	1984	EnBW	EnBW
Unterweser	PWR	1 345	1978	E.ON	E.ON
Total in operation		20 339			
Obrigheim (shut down)	PWR	340	1968	EnBW	EnBW
Stade (shut down)	PWR	640	1972	E.ON	E.ON (66.7%), Vattenfall (33.3%)
Total		21 319			

Sources: International Atomic Energy Agency, E.ON, EnBW, RWE and Vattenfall websites.

The Atomic Energy Act does allow for some flexibility in the closure of plants, in that it provides for generating allowances to be transferred from one plant to another (although this requires specific approval from the government where it involves a transfer from a newer to an older unit). In September 2006,

Table 26

Residual Electricity Generation for German Reactors and Estimated Dates of Shut-Down Under Existing Legislation

Nuclear power plant	*Residual electricity generation (TWh net)*		*Estimated closure date**
	At 1 January 2000	*At 31 July 2006*	
Biblis A	62.00	14.87	2008
Biblis B	81.46	26.03	2009
Brunsbüttel	47.67	16.25	2009
Neckarwestheim 1	57.35	17.70	2009
Isar 1	78.35	34.18	2011
Philippsburg 1	87.14	38.71	2012
Unterweser	117.98	56.81	2012
Grafenrheinfeld	150.03	84.22	2015
Gundremmingen B	160.92	94.77	2016
Gundremmingen C	168.35	103.17	2016
Krümmel	158.22	97.76	2016
Grohnde	200.90	129.53	2018
Philippsburg 2	198.61	129.40	2018
Brokdorf	217.88	144.74	2020
Isar 2	231.21	155.60	2020
Emsland	230.07	157.68	2021
Neckarwestheim 2	236.04	166.88	2022
Obrigheim	8.70	0.00	–
Stade	23.18	4.79	–
Mülheim-Kärlich	107.25	107.25	–
Total	**2 623.31**	**1 580.34**	

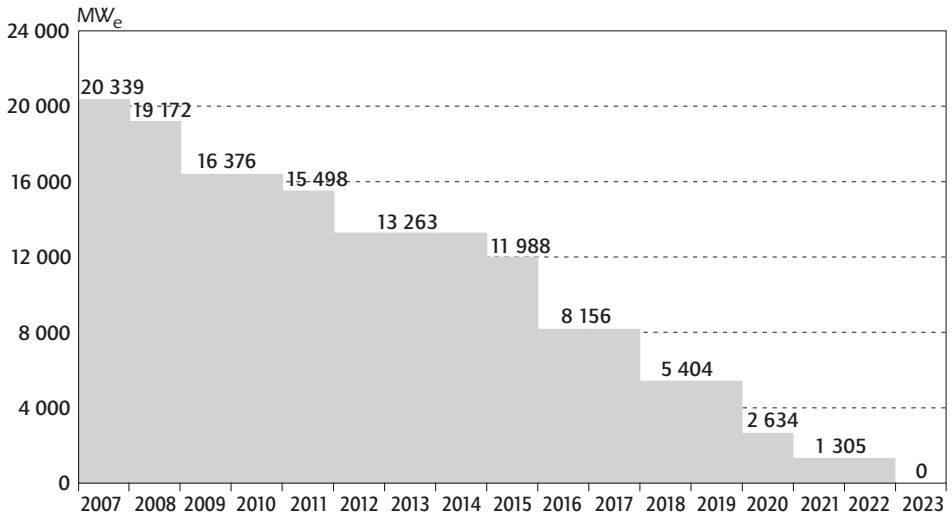
* estimated closure dates calculated assuming 88% capacity factor, and no transfer of generating allowances between plants.

Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) for residual generation data.

RWE applied to transfer some allowance to its Biblis A plant, which would allow the plant to continue in operation for a further three years, which is likely beyond the next election. Applications were also expected for further plants that will otherwise close in the next few years.

Figure 22

Estimated Nuclear Power Capacity, 2007 to 2023



Note: Estimated closure dates calculated assuming 88% capacity factor, and no transfer of generating allowances between plants.

Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) for residual generation data.

NUCLEAR FUEL CYCLE AND RADIOACTIVE WASTE MANAGEMENT

The reactor construction and nuclear fuel operations within the Siemens Group were merged with the French company Framatome in 2001. Following restructuring of the French nuclear industry, the German operations are now owned by Areva NP GmbH, which is jointly owned by the Areva Group of France (66%) and Siemens AG (34%). This includes the nuclear fuel fabrication plant at Lingen in Lower Saxony, which produces fuel for German and other nuclear plants. Most raw uranium concentrate, or yellowcake, is purchased from Canada, which provides slightly less than half of the supply.

The British-Dutch-German uranium enrichment company Urenco owns and operates a large centrifuge enrichment plant at Gronau in North Rhine-Westphalia, which began operations in 1985. In 2005 Urenco was granted a licence to increase the site's capacity from 1.8 million to 4.5 million separative work units per year, and this is expected to be implemented gradually over the coming years. The plant supplies enriched uranium for use in countries around the world.

Spent fuel from German reactors was in the past sent for reprocessing in France and the UK, and return shipments to Germany of canisters of vitrified high-level waste are currently being carried out. These are sent for interim storage at Gorleben in Lower Saxony. However, the amended Atomic Energy Act prohibited the sending of further spent fuel for reprocessing as from 1 July 2005 (once existing contracts had expired) and spent fuel is now kept in interim storage pending final disposal. Central storage facilities are in operation at Ahaus in North Rhine-Westphalia and at Gorleben, and additional facilities have been or are being constructed at each nuclear power plant site.

On radioactive waste disposal, planning approval for the Konrad repository in Lower Saxony for low- and medium-level waste was confirmed in March 2006. However, this is subject to continuing legal proceedings. Development of a repository for all classes of waste (including high-level waste and spent fuel) at Gorleben was suspended in 2001 for a period of between three and ten years to allow the disposal concept to be re-evaluated, and it remains suspended. However, the coalition agreement between the governing parties states their intention to resolve the matter of final disposal of radioactive waste – including high-level waste and spent fuel – within the lifetime of the present parliament.

INSTITUTIONAL AND LEGAL FRAMEWORK

The main nuclear energy legislation is contained in the Atomic Energy Act, originally passed in 1959 and substantially amended in 1985 and 2002. Under this legislation, detailed regulations are published by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). However, the regulations are actually applied by the responsible department in each *Land*, under the general supervision of the BMU and its agencies, including the Federal Office for Radiation Protection (BfS). Within this framework, the *Länder* authorities are responsible for the licensing of nuclear power plants. Approval for transportation and intermediate storage of spent nuclear fuel falls under the jurisdiction of the BfS, which also has responsibility for construction and operation of storage and disposal facilities for radioactive waste. Supervisory activities in this sector are performed by the individual *Land*.

CRITIQUE

The phase-out of nuclear energy in Germany presents a significant challenge. Despite greater supply from renewables and natural gas, the closure of nuclear plants will result in increased reliance on coal and lignite for power generation over the coming years, with the result that carbon dioxide

emissions will inevitably be higher than they would otherwise have been. The present law foresees the closure of over 7 000 MW_e of nuclear capacity by the end of 2012, which will significantly add to the challenge of meeting the country's commitment for emissions reductions under the Kyoto Protocol, even with increases in renewable capacity and energy efficiency.

A nuclear phase-out will also reduce energy security, reducing the diversity of energy supplies in the country through increased reliance on imports of fossil fuels. In particular, the higher gas needs that will arise from the phase-out will likely result in greater reliance on gas from Gazprom, a company that already supplies over a third of Germany's imported gas, further reducing the country's supply diversity. Furthermore, the closure of several nuclear plants in the southern part of the country will exacerbate the congestion on north-south transmission lines, which is expected to develop over the next several years, as most planned capacity additions of coal and wind are in northern Germany while much of the increased demand is in the southern part of the country. This will require greater investment costs for new transmission.

An additional consideration is the possible losses to the German economy from premature closure of fully depreciated generating assets that are potentially capable of many more years of safe and economic operation. The marginal costs of nuclear plants are low and stable relative to fossil fuels, which means they provide low-cost baseload power. While the closure of the nuclear power plants will have a limited effect on hourly electricity prices since nuclear plants rarely set the marginal price, it will have negative spillover effects on the economy. The shut-down of these productive assets will require additional near-term investments in conventional baseload lignite plants and other assets, while continued operation would allow companies to invest the revenues from the plants in ways that are more productive for the economy. Deferring the shut-down would also give more time until new capacity is needed, allowing for the development of more advanced technologies, including renewables.

Increased prices for fossil fuels, heightened concerns about security of supply and the need to curb carbon dioxide emissions have led in the last few years to renewed interest in nuclear power in many IEA countries. Within the EU, several member states are reconsidering their policy towards nuclear power. Among G8 countries, all except Germany and Italy are actively considering building new nuclear plants or are already doing so. If present policy remains unchanged, Germany may find itself phasing out nuclear power while other countries, including neighbouring countries, are launching new or expanded nuclear programmes.

In light of the negative consequences for carbon dioxide emissions, supply diversity and the economy, Germany should reconsider the phase-out. Changes to the phase-out law and lifetime extensions for existing power plants could

also be linked to reduced emission allocations for fossil fuel power plants, resulting in greater overall carbon dioxide reductions, as well as other concessions. Public acceptance will be critical to keeping nuclear power in the fuel mix. We encourage the government to engage the public in a national debate about the role of nuclear power in Germany's long-term fuel mix, with early attention paid to the possibility of extending the lifetime of existing plants in order to accommodate the country's climate change policy goals.

In the shorter term, approval of applications to transfer generating allowances to some of the older nuclear units (which will otherwise close in the next few years) would allow the option to be kept open of extending the lifetimes of these plants. In other countries, similar plants are expected to have operating lifetimes of at least 40 years, and in many cases up to 60 years. However, such lifetime extensions (beyond those due to transfers of generating allowances) would require an amendment to the Atomic Energy Act, which is not being widely debated at present.

Irrespective of whether the phase-out goes ahead as planned, Germany will need to decide on a way forward for the final disposal of radioactive wastes, including spent fuel and high-level waste from reprocessing. The statement of intent to do this by the end of the current parliament is a positive step, and the government should be encouraged to adhere to this deadline. As discussed in Chapter 2, recent public opinion data from Eurobarometer suggest that increased support for nuclear power is tied to solving the nuclear waste disposal issue.

RECOMMENDATIONS

The government of Germany should:

- *Reconsider the nuclear phase-out in light of its likely negative environmental, security of supply and economic effects.*
- *Initiate a national debate on the future role of nuclear power in the energy mix, starting with whether the operating lifetimes of existing plants should be extended to better accommodate energy and environmental policy objectives.*
- *Adhere to the commitment to decide on a way forward on radioactive waste disposal within the lifetime of the present parliament and establish a legal framework to accomplish this.*

POLICY OBJECTIVES AND PRIORITIES

The government's energy research policy rests on its fifth energy research programme, *Innovation and New Energy Technologies*, which was announced in June 2005 and submitted to the EU for the period up to 2008. The programme also forms the basis for national funding policy in the coming years. Through the funding of research and development (R&D) for modern energy technologies, the German government is pursuing the following goals:

- Making a sound contribution to fulfilling current policy requirements, which primarily involves securing a balanced energy mix to increase energy productivity, raise the share of renewables and secure reductions in energy-related greenhouse gas (GHG) emissions at minimum cost.

- Securing and expanding available technology to improve both responsiveness and flexibility in energy supply to allow industry and consumers the ability to adapt to new trends.

The government relies on a dual strategy in promoting energy technologies. First, clear priority is given to selected technologies that in either the short or medium term will contribute to a sustainable and secure energy supply. Second, a relatively broad approach is taken to technology sectors not classified as priority technologies. This dual strategy provides a high degree of flexibility to allow fine-tuning in specific areas as soon as there are signs of a breakthrough in the energy sector that will assist in securing a sustainable energy supply. For this reason, the energy research programme is subject to an ongoing evaluation process that is conducted jointly by industry and research. Current priority funding areas include:

- New power station technologies using coal and gas, including CO_2 capture and storage.

- Photovoltaics.

- Solar-thermal power stations.

- Offshore wind energy.

- Fuel cells and hydrogen.

- Technologies and processes for energy-optimised buildings.
- Technologies and processes for use of biomass for energy.

The programme also encompasses energy-saving technologies in industry, commerce, trade and services; all other renewable energy sources (hydro, solar, geothermal, etc.); research on nuclear safety and nuclear waste disposal; and research on nuclear fusion.

INSTITUTIONS

While R&D is primarily an industry responsibility, the government sees a specific need for targeted promotion of R&D by the government. Responsibilities for the federal energy research programme were redesignated in 2002 and spread across a number of government ministries. Since then, responsibility for the programmatic orientation of energy research policy and the federal energy research programme itself lies with the Federal Ministry of Economics and Technology (BMWi). The BMWi is also in charge of project-based R&D funding in non-nuclear energy research (excluding renewables), in efficient energy conversion and in nuclear safety and nuclear waste disposal. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) is responsible for project-based funding relating to renewable energy sources. Responsibility for project-based funding in bioenergy lies with the Federal Ministry for Food, Agriculture and Consumer Protection (BMELV). The Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung*, BMBF) is responsible for institutional funding of energy research covering technologies for efficient energy conversion, renewable energy sources, nuclear safety (in close co-operation with the BMWi) and nuclear fusion research. The BMBF also funds basic research on energy.

Alongside the German government, the individual German *Länder* also fund energy research for selected energy technologies that are of particular benefit to their specific regions. Public research foundations at both the national and state level, sometimes funded by public means, fund research projects on energy and climate change mitigation.

National and state research funding programmes are open to universities, public and private research institutes and private businesses. Joint projects conducted with partners from industry and science are considered particularly worthy of funding. The German government sees this not only as an opportunity to use limited funding to maximum effect, but more importantly as a means of accelerating market entry for energy technologies.

Given the range of different actors involved in the energy sector, there is a need for careful co-ordination. This comes in the form of standardised approval procedures, specially established advisory boards such as the National Hydrogen and Fuel Cell Strategy Council, which advises on hydrogen and fuel cell issues, and COORETEC, which oversees the promotion of new power station technologies. In addition, through research associations such as *Forschungsverbund Sonnenenergie*, which works on solar energy, *Kompetenzverbund Kernenergie*, which works on nuclear energy, and AG Turbo, which works on turbines, businesses and institutes join forces.

FUNDING

The German government's promotion of R&D for new energy technologies is based on two policy instruments:

- Institutional funding, which boosts the expertise of research institutes and the long-term strategic approach in the energy research community. This mostly focuses on basic research and takes up typical issues that, because of their complexity, size and specific equipment needs, are best placed in the hands of large research centres.

- Project funding for particular research projects with a limited life cycle and clearly defined subject matter conducted by businesses, research institutes and universities whose work focuses more on application and near-to-market issues.

Table 27 provides a general picture of federal funding for energy R&D in Germany under the *Fifth Energy Research Programme*. Funding has risen generally, and is expected to be increased further beyond 2008. The largest percentage increase will be in funding for biofuels, along with renewables. Apart from fusion, renewables and energy efficiency will receive the largest share of total R&D funding in 2008. Within its *Fifth Energy Research Programme*, the federal government will provide almost EUR 1.7 billion for energy R&D between 2005 and 2008. Considering all other activities touching energy research but not included in the *Fifth Energy Research Programme* (*e.g.* the *National Innovation Programme on Hydrogen and Fuel Cells*) the federal government will provide about EUR 2 billion between 2006 and 2009, reflecting a 30% increase between 2005 and 2009.

Table 27

Federal Funding for Energy R&D, 2003 to 2008

Unit: Thousand euros	*Actual*	*Planned*	*Projected*				*Share of*	*Change (2003-2008)*	
	2003	*2004*	*2005*	*2006*	*2007*	*2008*	*2008 total*	*Total*	*Annual*
BMWi									
Efficient energy conversion	65 958	78 496	71 244	70 994	70 994	70 994	17%	8%	1%
Nuclear safety and repository research	24 125	25 500	23 605	23 480	23 480	23 480	5%	–3%	–1%
BMU									
Renewable energies	67 798	60 083	80 394	83 366	88 366	93 366	22%	38%	7%
BMELV									
Biomass and biofuels	5 422	5 117	10 000	10 000	10 000	10 000	2%	84%	13%
BMBF									
Centres of the Helmholtz Association									
Efficient energy conversion	36 621	39 607	42 155	42 012	42 134	44 270	10%	21%	4%
Renewable energies	24 396	26 442	28 267	28 307	28 613	30 271	7%	24%	4%
Nuclear safety research	29 260	31 178	31 147	31 133	31 126	31 022	7%	6%	1%
Fusion research	115 298	115 000	115 000	115 000	115 000	114 900	27%	0%	0%
Networks of basic research into renewable energy and energy conservation	6 600	9 830	11 100	10 100	10 100	10 100	2%	53%	9%
Total	**375 478**	**391 253**	**412 912**	**414 392**	**419 813**	**428 403**		**14%**	**3%**

Note: Table does not include *Länder* government funding, or funding from outside the specified energy research programme (*e.g.* it does not include funding from the *National Innovation Programme on Hydrogen and Fuel Cells*).

Source: *Innovation and New Energy Technologies: The Fifth Energy Research Programme of the Federal Government*, BMWA, p. 22, July 2005.

KEY PROJECTS AND RESEARCH AREAS

While R&D funding spans many technology areas, some key research areas are discussed below.

ENERGY EFFICIENCY

Within the general topic of energy efficiency, one of Germany's main areas of focus is technologies and processes for energy-optimised building. In the case of new buildings, the goal is to reduce primary energy requirements, including the energy necessary for space heating, water heating, ventilation, air-conditioning, lighting and auxiliary power, by another half compared with today's levels. The long-term objective is zero-emission buildings. With regard to rehabilitation of existing buildings, the aim is overall improvement in options for systematic and sustainable building rehabilitation.

FOSSIL FUELS

By funding research and development, the government plans to increase the efficiency of coal- and gas-fired power plants by 20% over the next 15 years. This is largely due to the fact that more than 30% of Germany's power stations, representing around 40 GW installed capacity, must be replaced by 2020. The BMWi has worked with industry and researchers to develop the COORETEC (CO_2 Reduction Technologies) programme. One of the programme's aims is to improve facility efficiency, reducing the amount of coal and gas used in, and the costs of, electricity generation. The long-term goal is to produce zero-emission power plants. Development of carbon capture and storage technology is a priority research area.

RENEWABLES

The main aims of funding for renewables research are to reduce the costs of renewable energy technologies and increase their efficiency, to make environmental and climate-friendly advancements in renewable energy technologies, to improve integration of renewables into the public grid and to facilitate rapid technology transfer from research to market. In 2005, the BMU approved more than 100 new projects involving photovoltaics, wind energy, geothermal energy, solar-thermal heating and solar-thermal power stations, among other things. In 2006, research funding again targeted photovoltaics and wind energy, particularly the advancement of offshore wind farms. The BMU also funds projects on solar-thermal energy, solar-thermal power stations, geothermal energy, hydropower and cross-cutting research activities. In some cases the individual German *Länder* are also involved in projects, as is the case

with the FINO 2 and FINO 3 research platforms to exploit offshore wind potential. Jointly funded by the state of Mecklenburg West-Pomerania, FINO 2 is located in the Baltic Sea. FINO 3 will be situated in the North Sea and is part-funded by the state of Schleswig-Holstein.

In the solar-thermal energy sector, preparations are under way to build a solar-thermal power tower in Jülich. The project is jointly funded by the BMU, the states of North Rhine-Westphalia and Bavaria and by the city utility services in Jülich. A reflector area measuring 20 000 square metres (about the size of three football pitches) will feed solar energy into a receptor located at the top of a 50-metre solar tower. The resulting high temperatures will be used to generate steam that will then be converted into electricity via a turbine.

The BMELV promotes projects for the use of biomass as a raw material and for energy. Improved efficiency in the use of biomass for energy plays a key role in project approvals. An element of priority is placed on projects designed to increase both the economic and environmental efficiency of biogas facilities. New processes to use biogas in fuel cells or, after gas cleaning, as an engine fuel, play an increasingly important role. Of growing importance is the issue of the competing uses for domestic biomass potential as a food source, a raw material and an energy source. Efficient biomass logistics, improved use of forest timber potential and the planting of fast-growing timber crops on formerly non-productive land, such as reclaimed mine land, are another focus of the research activities funded by the BMELV.

NUCLEAR

Though nuclear power in Germany is currently being phased out, the government plans to step up research into safety and disposal, both to find a timely resolution for the issue of permanent disposal and to counter an imminent loss of expertise by fostering new talent. Research projects will be conducted to maintain the German government's capability to assess the safety of nuclear power stations, including those in neighbouring countries, and to follow developments abroad regarding how the aims of enhancing nuclear safety, improving cost-effectiveness, resisting proliferation and reducing radioactive waste are actually achieved. (Nuclear fusion is discussed below in the section on international collaboration.)

HYDROGEN AND FUEL CELLS

The *National Innovation Programme on Hydrogen and Fuel Cells* was jointly developed by the Federal Ministry for Transport, Building and Urban Development, the BMWi and the BMBF and presented in May 2006. In total, the federal government will be making about EUR 500 million available over

the next ten years. The aim of the programme is targeted support and promotion of the emerging hydrogen and fuel cell sector in order to accelerate growth in the market for mobile, stationary and portable fuel cell applications in Germany. A fundamental issue in this connection is to clarify how the necessary quantities of hydrogen can be efficiently produced in an environmentally sustainable way. The National Hydrogen and Fuel Cell Strategy Council and the respective government departments will jointly draw up a detailed working programme during 2007.

INTERNATIONAL COLLABORATION

Germany considers close co-operation with other countries to be of great importance because it fosters synergies between national and international promotion policies. German research and development is thus closely linked to European research and development policy. The *Seventh Research Framework Programme 2007-2013* further defines the European research area. Along with industry and research, the German government plays an active role in shaping this process.

In energy issues, international co-operation between Germany and its research partners mainly takes place in the work of the EU and the IEA. Germany is party to 25 IEA implementing agreements. In particular, these focus on rational energy use, renewable energy sources and nuclear fusion. Germany is also party to a number of implementing agreements relating to fossil fuels and clean technologies, participates in the expert groups on R&D priority-setting and basic research and is active in other *ad hoc* and expert groups.

Germany continues to play an active role in a number of thematic co-operation initiatives. These include the Carbon Sequestration Leadership Forum (CSLF), the International Partnership for the Hydrogen Economy (IPHE) and the Generation IV International Forum (GIF). It also engages in bilateral co-operation with non-OECD countries in work on technology transfer, particularly for renewables and energy efficiency. Close co-operation is also maintained with partners from Spain and California in work on solar-thermal power stations that can only be operated near the Earth's sunbelt.

At the international level, R&D work is increasingly focused on reactor systems for the future. Through EURATOM, Germany is an indirect member of the Generation IV International Forum (GIF), which engages in international co-operation activities to investigate the potential of next generation reactor models (ready for commercial use from 2020 onwards). One of GIF's development goals is environmentally sound and cost-effective production of hydrogen.

Germany is party to the International Thermonuclear Experimental Reactor (ITER), an international large-scale fusion experiment pending completion at Cadarache, France. Germany's research efforts under ITER focus on plasma

physics, technological development of suitable materials and ITER components, issues concerning plasma wall interaction and the fuel cycle in fusion experiments.

CRITIQUE

R&D into energy technologies has taken on renewed importance in the government's R&D funding portfolio in recent years. As a result, total funding – including research into renewables, gas and coal technologies, nuclear safety, energy efficiency and fusion – has grown, in contrast to the trend seen in many IEA countries. The IEA applauds this growth.

As in all IEA countries, a number of ministries are involved in energy R&D. The multiplicity of stakeholders involved makes it mandatory to establish and define a co-ordination process to avoid duplication of research themes and projects. We are pleased to see Germany address this challenge through standardised approval procedures, advisory boards and research associations. We encourage the government to continue to monitor R&D funding procedures, ensuring a high level of co-ordination and reducing any duplication of efforts.

Broadly speaking, 60% of the public energy R&D budget is devoted to energy efficiency and renewables. While Germany is focused on dramatically raising the share of renewables in its fuel mix, necessitating large outlays of funding for renewables R&D, cost-effectiveness should always remain a key criterion, not only between renewables projects but more broadly. For example, the government should study carefully how to allocate funds between renewables and energy efficiency, in light of the need to dramatically improve efficiency to meet government targets and the cost-effectiveness of efficiency improvements as compared to renewables deployment. Within renewables funding, second-generation biofuels should be given a significant share of the resources so that technology advances allow Germany to achieve its ambitious longer-term biofuels targets in a cost-effective and sustainable manner. In addition, given the large share of coal and lignite in Germany's fuel mix, we encourage the government to ensure that sufficient funding goes to R&D in this area, in particular on carbon capture and storage.

Whether or not the lifetimes of the nuclear plants are extended, there is a need to maintain the knowledge base necessary to support their continued safe and efficient operation. Therefore, we are pleased to see Germany maintain funding for nuclear R&D and we encourage it to continue this funding at adequate levels. Looking to the longer term, R&D on advanced nuclear energy systems is essential to ensure that this option is kept open for the future, and in this, Germany can play an important role, including in partnership with international programmes.

RECOMMENDATIONS

The government of Germany should:

- *Continue to monitor co-ordination procedures and processes among the different actors in the energy R&D field.*
- *Ensure that cost-effectiveness criteria are used when allocating R&D funding between energy technologies and subject areas, such as between renewables and energy efficiency.*
- *Provide R&D funding for projects to develop cost-effective and environmentally sustainable second-generation biofuels.*
- *Allocate sufficient R&D funding for energy technologies aimed at reducing carbon dioxide emissions, in particular from coal-fired power plants.*
- *Ensure that the national research base necessary for the continued safe and efficient operation of nuclear power is maintained, and that Germany can participate in international programmes designed to keep open the nuclear option for the future.*

ORGANISATION OF THE REVIEW

REVIEW TEAM

The IEA's 2007 in-depth review of the energy policies of Germany was undertaken by a team of energy policy specialists drawn from IEA member countries, the European Commission, the Nuclear Energy Agency and the IEA Secretariat. The team visited Berlin and the *Land* of North Rhine-Westphalia from 30 October to 3 November 2006 for discussions with energy administration officials, energy industry groups and non-governmental organisations. This report was drafted on the basis of those meetings and the government's official response to the IEA's policy questionnaire, along with other information. The team greatly appreciates the candour and co-operation shown by everyone it met. In particular, the review could not have been possible without the assistance and preparation of Wolfdieter Böhler and Christoph Scholten, both from the Federal Ministry of Economics and Technology.

The members of the team were:

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Jolanka Fisher managed the review and wrote the report, with the exception of the chapter on natural gas, which was drafted by Daniel Simmons from the IEA's Energy Diversification Division, and the chapter on nuclear power, which was drafted by Martin Taylor from the Nuclear Energy Agency. Monica Petit prepared the figures and Bertrand Sadin prepared the maps. Marilyn Ferris and Viviane Consoli provided editorial assistance.

ORGANISATIONS VISITED

The team held discussions with the following energy and environment stakeholders:

BDI (*Bundesverband der Deutschen Industrie e.V.*, Federation of German Industries)

BGW (*Bundesverband der deutschen Gas- und Wasserwirtschaft e.V.*)

BKWK (*Bundesverband Kraft-Wärme-Kopplung e.V.*)

BNE (*Bundesverband Neuer Energieanbieter*)

BUND (*Bund für Umwelt und Naturschutz Deutschland e.V.*)

EEX

EFET-Deutschland (European Federation of Energy Traders)

Electrabel

EnBW Energie Baden-Württemberg

E.ON/E.ON Ruhrgas

Federal Cartel Office (*Bundeskartellamt*)

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit*)

Federal Ministry for Transport, Building and Urban Development (*Bundesministerium für Verkehr, Bau und Stadtentwicklung*)

Federal Ministry of Economics and Technology (*Bundesministerium für Wirtschaft und Technologie*)

Federal Ministry of Finance (*Bundesministerium der Finanzen*)

Federal Network Agency (*Bundesnetzagentur*)

German Energy Agency (*Deutsche Energie-Agentur*)

Germanwatch

GEW RheinEnergie AG

Ministry of Economics, North Rhine-Westphalia

Öko Institute for Applied Ecology

RWE

Vattenfall

VDEW (*Verband der Elektrizitätswirtschaft e.V.*, German Electricity Association)

Verbundnetz Gas AG

VIK (*Verband der Industriellen Energie- und Kraftwirtschaft e.V.*, Association for Industrial Energy Consumers)

VKU (*Verband kommunaler Unternehmen e.V.*)

Wuppertal Institute for Climate, Environment and Energy

REVIEW CRITERIA

The IEA *Shared Goals*, which were adopted by IEA Ministers at their 4 June 1993 meeting in Paris, provide the evaluation criteria for the in-depth reviews conducted by the IEA. The *Shared Goals* are set out in Annex C.

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY

		1973	1990	2003	2004	2010	2020	2030
TOTAL PRODUCTION		**171.7**	**186.2**	**136.2**	**134.5**	**123.4**	**94.9**	**86.9**
Coal[1]		141.4	121.8	58.3	56.5	51.5	45.2	41.8
Oil		6.8	4.7	4.4	4.6	3.0	1.8	0.6
Gas		16.4	13.5	14.7	14.2	15.3	13.8	11.4
Combustible renewables & waste[2]		2.5	4.8	10.8	12.2	13.2	15.8	17.2
Nuclear		3.2	39.8	43.5	42.5	33.9	8.3	–
Hydro		1.3	1.5	1.8	1.7	2.0	2.1	2.1
Geothermal		–	0.0	0.1	0.1	0.2	1.1	4.3
Solar, wind, etc.		–	0.0	2.5	2.7	4.3	6.7	9.5
TOTAL NET IMPORTS[3]		**167.3**	**165.4**	**213.1**	**212.0**	**214.0**	**213.8**	**200.2**
Coal[1]	Exports	18.3	8.2	0.6	0.6	–	–	–
	Imports	15.2	11.5	28.3	26.4	23.9	24.8	13.8
	Net imports	-3.1	3.3	27.7	25.7	23.9	24.8	13.8
Oil	Exports	9.9	10.2	25.3	27.5	3.7	3.9	2.8
	Imports	171.1	132.9	147.8	150.9	131.6	124.2	116.8
	Bunkers	4.1	2.5	2.7	2.5	3.0	3.6	4.4
	Net imports	157.1	120.2	119.8	121.0	124.9	116.7	109.5
Gas	Exports	0.1	0.9	7.0	7.8	–	–	–
	Imports	12.4	42.7	72.8	73.5	67.2	72.4	77.2
	Net imports	12.3	41.7	65.9	65.7	67.2	72.4	77.2
Electricity	Exports	0.7	2.6	4.4	5.3	3.8	3.8	4.0
	Imports	1.7	2.7	4.1	4.9	1.8	3.7	3.8
	Net imports	1.0	0.1	-0.2	-0.4	-2.0	-0.1	-0.2
TOTAL STOCK CHANGES		**-1.1**	**4.7**	**-1.1**	**-1.7**	**–**	**–**	**–**
TOTAL SUPPLY (TPES)		**337.9**	**356.2**	**348.2**	**344.7**	**337.4**	**308.6**	**287.2**
Coal[1]		139.4	128.5	85.8	81.7	75.4	69.9	55.5
Oil		161.9	126.5	125.2	123.4	127.9	118.5	110.1
Gas		28.7	55.0	78.7	80.8	82.6	86.3	88.5
Combustible renewables & waste[2]		2.5	4.8	10.8	12.2	13.2	15.8	17.2
Nuclear		3.2	39.8	43.5	42.5	33.9	8.3	–
Hydro		1.3	1.5	1.8	1.7	2.0	2.1	2.1
Geothermal		–	0.0	0.1	0.1	0.2	1.1	4.3
Solar, wind, etc.		–	0.0	2.5	2.7	4.3	6.7	9.5
Electricity trade[4]		1.0	0.1	-0.2	-0.4	-2.0	-0.1	-0.2
Shares (%)								
Coal		*41.2*	*36.1*	*24.6*	*23.7*	*22.3*	*22.7*	*19.3*
Oil		*47.9*	*35.5*	*36.0*	*35.8*	*37.9*	*38.4*	*38.4*
Gas		*8.5*	*15.4*	*22.6*	*23.4*	*24.5*	*27.9*	*30.8*
Combustible renewables & waste		*0.7*	*1.3*	*3.1*	*3.5*	*3.9*	*5.1*	*6.0*
Nuclear		*0.9*	*11.2*	*12.5*	*12.3*	*10.0*	*2.7*	–
Hydro		*0.4*	*0.4*	*0.5*	*0.5*	*0.6*	*0.7*	*0.7*
Geothermal		–	–	–	–	*0.1*	*0.4*	*1.5*
Solar, wind, etc.		–	–	*0.7*	*0.8*	*1.3*	*2.2*	*3.3*
Electricity trade		*0.3*	–	*-0.1*	*-0.1*	*-0.6*	–	*-0.1*

0 is negligible. – is nil, .. is not available.

Please note: Forecasts are based on studies by the Institute of Energy Economics at the University of Cologne (EWI) and Prognos AG/Baselof. They are not official forecasts of the German government. All forecasts are based on the 2004 submission.

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	2003	2004	2010	2020	2030
TFC	**246.6**	**247.3**	**252.6**	**261.0**	**248.7**	**240.1**	**229.8**
Coal[1]	53.1	37.3	8.4	8.2	12.3	10.7	10.0
Oil	138.2	117.7	115.6	111.8	117.8	109.4	101.9
Gas	21.1	41.0	62.4	61.3	59.0	58.3	56.2
Combustible renewables & waste[2]	1.7	3.0	5.6	6.8	6.1	8.0	9.2
Geothermal	–	0.0	0.1	0.1	–	–	–
Solar, wind, etc.	–	0.0	0.2	0.3	0.5	0.9	1.1
Electricity	26.9	39.1	44.1	44.5	45.3	45.8	45.3
Heat	5.5	9.1	16.0	28.1	7.6	7.1	6.3
Shares (%)							
Coal	*21.5*	*15.1*	*3.3*	*3.1*	*5.0*	*4.5*	*4.3*
Oil	*56.0*	*47.6*	*45.8*	*42.8*	*47.4*	*45.6*	*44.3*
Gas	*8.6*	*16.6*	*24.7*	*23.5*	*23.7*	*24.3*	*24.4*
Combustible renewables & waste	*0.7*	*1.2*	*2.2*	*2.6*	*2.5*	*3.3*	*4.0*
Geothermal	–	–	–	–	–	–	–
Solar, wind, etc.	–	–	*0.1*	*0.1*	*0.2*	*0.4*	*0.5*
Electricity	*10.9*	*15.8*	*17.5*	*17.1*	*18.2*	*19.1*	*19.7*
Heat	*2.2*	*3.7*	*6.4*	*10.8*	*3.1*	*2.9*	*2.7*
TOTAL INDUSTRY[5]	**105.9**	**89.5**	**83.6**	**83.2**	**81.4**	**81.1**	**79.6**
Coal[1]	28.7	20.7	7.1	7.3	11.9	10.5	9.8
Oil	46.9	27.3	27.4	26.9	27.5	28.0	27.0
Gas	13.3	19.7	21.1	21.4	21.2	21.6	21.3
Combustible renewables & waste[2]	0.0	0.8	–	–	0.5	0.5	0.6
Geothermal	–	–	–	–	–	–	–
Solar, wind, etc.	–	–	–	–	0.0	0.0	0.1
Electricity	15.3	18.6	20.1	20.0	19.0	19.4	19.9
Heat	1.6	2.4	7.8	7.8	1.3	1.2	1.0
Shares (%)							
Coal	*27.1*	*23.1*	*8.5*	*8.7*	*14.6*	*13.0*	*12.3*
Oil	*44.3*	*30.5*	*32.8*	*32.3*	*33.8*	*34.5*	*33.9*
Gas	*12.6*	*22.0*	*25.3*	*25.7*	*26.1*	*26.6*	*26.8*
Combustible renewables & waste	–	*0.9*	–	–	*0.6*	*0.6*	*0.8*
Geothermal	–	–	–	–	–	–	–
Solar, wind, etc.	–	–	–	–	–	*0.1*	*0.1*
Electricity	*14.5*	*20.8*	*24.1*	*24.0*	*23.3*	*23.9*	*24.9*
Heat	*1.5*	*2.7*	*9.3*	*9.3*	*1.6*	*1.4*	*1.2*
TRANSPORT	**39.7**	**60.0**	**64.4**	**63.3**	**64.1**	**62.6**	**61.5**
TOTAL OTHER SECTORS[6]	**101.0**	**97.8**	**104.6**	**114.4**	**103.1**	**96.4**	**88.7**
Coal[1]	22.7	16.6	1.3	0.9	0.4	0.2	0.2
Oil	54.2	31.6	26.1	24.9	29.2	24.7	21.4
Gas	7.8	21.3	41.3	39.9	37.7	36.0	33.3
Combustible renewables & waste[2]	1.7	2.2	4.6	4.8	4.1	4.1	4.0
Geothermal	–	0.0	0.1	0.1	–	–	–
Solar, wind, etc.	–	0.0	0.2	0.3	0.5	0.8	1.0
Electricity	10.7	19.3	22.6	23.2	24.9	24.7	23.6
Heat	3.9	6.7	8.3	20.4	6.3	5.9	5.3
Shares (%)							
Coal	*22.5*	*16.9*	*1.2*	*0.8*	*0.4*	*0.2*	*0.2*
Oil	*53.6*	*32.3*	*25.0*	*21.8*	*28.3*	*25.6*	*24.1*
Gas	*7.7*	*21.8*	*39.5*	*34.9*	*36.6*	*37.3*	*37.5*
Combustible renewables & waste	*1.7*	*2.2*	*4.4*	*4.2*	*4.0*	*4.2*	*4.5*
Geothermal	–	–	*0.1*	*0.1*	–	–	–
Solar, wind, etc.	–	–	*0.2*	*0.2*	*0.5*	*0.8*	*1.1*
Electricity	*10.6*	*19.8*	*21.7*	*20.2*	*24.1*	*25.6*	*26.6*
Heat	*3.9*	*6.9*	*7.9*	*17.8*	*6.1*	*6.1*	*6.0*

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	2003	2004	2010	2020	2030
ELECTRICITY GENERATION[7]							
INPUT (Mtoe)	**98.6**	**141.2**	**144.2**	**141.5**	**133.3**	**112.2**	**100.6**
OUTPUT (Mtoe)	**32.2**	**47.1**	**52.5**	**52.7**	**53.5**	**51.6**	**50.7**
(TWh gross)	374.4	547.7	610.0	613.2	622.5	600.0	589.5
Output shares (%)							
Coal	*69.0*	*58.7*	*50.3*	*49.8*	*47.0*	*48.6*	*39.4*
Oil	*12.0*	*1.9*	*1.7*	*1.7*	*0.7*	*0.7*	*0.6*
Gas	*10.9*	*7.4*	*10.3*	*11.3*	*16.3*	*24.7*	*33.1*
Combustible renewables & waste	*0.8*	*0.9*	*2.6*	*2.7*	*4.2*	*4.9*	*5.4*
Nuclear	*3.2*	*27.8*	*27.4*	*26.6*	*20.9*	*5.3*	–
Hydro	*4.1*	*3.2*	*3.5*	*3.2*	*3.7*	*4.2*	*4.2*
Geothermal	–	–	–	–	*0.0*	*0.2*	*0.9*
Solar, wind, etc.	–	*0.0*	*4.3*	*4.6*	*7.1*	*11.4*	*16.5*
TOTAL LOSSES	**90.7**	**112.0**	**98.6**	**82.5**	**88.7**	**68.5**	**57.3**
of which:							
Electricity and heat generation[8]	60.0	83.4	74.3	58.3	71.0	52.5	42.8
Other transformations	7.0	8.0	5.6	5.4	1.4	1.4	1.3
Own use and losses[9]	23.7	20.5	18.7	18.8	16.3	14.7	13.3
Statistical differences	**0.5**	**–3.0**	**–2.9**	**1.2**	**–**	**–**	**–**

INDICATORS

	1973	1990	2004	2005	2010	2020	2030
GDP (billion 2000 USD)	1038.75	1543.20	1944.12	1961.79	2113.40	2476.96	2818.47
Population (millions)	78.96	79.36	82.50	82.46	82.40	81.30	79.30
TPES/GDP[10]	0.33	0.23	0.18	0.18	0.16	0.12	0.10
Energy production/TPES	0.51	0.52	0.39	0.39	0.37	0.31	0.30
Per capita TPES[11]	4.28	4.49	4.22	4.18	4.09	3.80	3.62
Oil supply/GDP[10]	0.16	0.08	0.06	0.06	0.06	0.05	0.04
TFC/GDP[10]	0.24	0.16	0.13	0.13	0.12	0.10	0.08
Per capita TFC[11]	3.12	3.12	3.06	3.17	3.02	2.95	2.90
Energy-related CO_2 emissions (Mt CO_2)[12]	1058.7	966.4	848.6	..	808.3	770.0	695.8
CO_2 emissions from bunkers (Mt CO_2)	21.8	22.1	31.7	..	34.9	41.3	48.0

GROWTH RATES (% per year)

	73–79	79–90	90–04	04–05	05–10	10–20	20–30
TPES	1.5	–0.3	–0.2	–1.0	–0.4	–0.9	–0.7
Coal	–0.2	–0.6	–2.8	–4.8	–1.6	–0.7	–2.3
Oil	–0.1	–2.2	–0.1	–1.4	0.7	–0.8	–0.7
Gas	10.2	0.6	2.6	2.7	0.4	0.4	0.3
Combustible renewables & waste	6.2	2.7	5.9	13.3	1.6	1.8	0.9
Nuclear	27.5	10.3	0.6	–2.4	–4.4	–13.1	–
Hydro	3.2	–0.5	1.4	–7.1	3.3	0.8	0.0
Geothermal	–	–	24.1	2.8	5.7	19.1	14.5
Solar, wind, etc.	–	–	42.7	9.9	9.9	4.5	3.4
TFC	1.2	–0.6	0.2	3.3	–1.0	–0.3	–0.4
Electricity consumption	3.8	1.4	0.9	0.8	0.3	0.1	–0.1
Energy production	1.0	0.2	–2.2	–1.2	–1.7	–2.6	–0.9
Net oil imports	0.2	–2.5	–0.0	1.0	0.7	–0.7	–0.6
GDP	2.6	2.2	1.7	0.9	1.5	1.6	1.3
Growth in the TPES/GDP ratio	–1.0	–2.5	–1.8	–1.9	–1.9	–2.4	–2.0
Growth in the TFC/GDP ratio	–1.3	–2.8	–1.5	2.4	–2.4	–1.9	–1.7

Please note: Rounding may cause totals to differ from the sum of the elements.

FOOTNOTES TO ENERGY BALANCES AND KEY STATISTICAL DATA

1. Includes lignite and peat.

2. "Combustible renewables and waste" comprises solid biomass, liquid biomass, biogas, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.

3. Total net imports include combustible renewables and waste and trade of heat.

4. Total supply of electricity represents net trade. A negative number in the share of TPES indicates that exports are greater than imports.

5. Industry includes non-energy use.

6. "Other sectors" includes residential, commercial, public service, agricultural, fishing and other non-specified sectors.

7. Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation.

8. Losses arising in the production of electricity and heat at main activity producer utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are based on plant efficiencies of approximately 33% for nuclear and 100% for hydro and photovoltaics.

9. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.

10. Toe per thousand US dollars at 2000 prices and exchange rates.

11. Toe per person.

12. "Energy-related CO_2 emissions" have been estimated using the IPCC Tier I Sectoral Approach. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2005 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

The 26 member countries* of the International Energy Agency (IEA) seek to create conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and to the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants.

In order to secure their objectives, member countries therefore aim to create a policy framework consistent with the following goals:

1. **Diversity, efficiency and flexibility within the energy sector** are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2. Energy systems should have **the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3. **The environmentally sustainable provision and use of energy** are central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should respect the Polluter Pays Principle where practicable.

4. **More environmentally acceptable energy sources** need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA member

* Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States.

countries wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5. **Improved energy efficiency** can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6. Continued **research, development and market deployment of new and improved energy technologies** make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7. **Undistorted energy prices** enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8. **Free and open trade** and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9. **Co-operation among all energy market participants** helps to improve information and understanding, and encourages the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at their 4 June 1993 meeting in Paris.)

GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention in each chapter, this glossary provides a quick and central reference for many of the abbreviations used. In addition, definitions of some often-used foreign words are also included.

BAFA	*Bundesamt für Wirtschaft und Ausfuhrkontrolle* (Federal Office of Economics and Export Control)
bcm	billion cubic metres
BfS	*Bundesamt für Strahlenschutz* (Federal Office for Radiation Protection)
BGR	*Bundesanstalt für Geowissenschaften und Rohstoffe* (Federal Institute for Geosciences and Natural Resources)
BMBF	*Bundesministerium für Bildung und Forschung* (Federal Ministry of Education and Research)
BMELV	*Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz* (Federal Ministry for Food, Agriculture and Consumer Protection)
BMF	*Bundesministerium der Finanzen* (Federal Ministry of Finance)
BMU	*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit* (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
BMVBS	*Bundesministerium für Verkehr, Bau und Stadtentwicklung* (Federal Ministry for Transport, Building and Urban Affairs)
BMWi	*Bundesministerium für Wirtschaft und Technologie* (Federal Ministry of Economics and Technology)
BNetzA	*Bundesnetzagentur* (Federal Network Agency)
Bundeskartellamt	Federal Cartel Office

Bundesrat	one-half of Germany's bicameral parliament; members are not elected but are appointed and removed by regional cabinets
Bundestag	one-half of Germany's bicameral parliament; members are elected by popular vote
BWR	boiling water reactor
CDM	clean development mechanism (a flexibility mechanism under the Kyoto Protocol)
CDU	*Christlich Demokratische Union Deutschlands* (Christian Democratic Union)
CHP	combined production of heat and power; sometimes when referring to industrial CHP, the term "co-generation" is used
CO_2	carbon dioxide
CSU	*Christlich Soziale Union Deutschlands* (Christian Social Union)
DENA	*Deutsche Energie-Agentur* (German Energy Agency)
EC	European Commission
EEG	*Erneuerbare-Energien-Gesetz* (Renewable Energy Sources Act)
EEX	European Energy Exchange
EnEV	*Energieeinsparverordnung* (energy saving directive)
EnWG	*Energiewirtschaftsgesetz* (Energy Industry Act)
ERGEG	European Regulators' Group for Electricity and Gas
ETSO	European Transmission System Operators
EU	European Union
EU-ETS	European Union Emissions Trading Scheme
EUR	Euro (?); EUR 1 = USD 1.26 (average exchange rate in 2006)
EWI	University of Cologne's Institute of Energy Economics
HVDC	high-voltage direct current
G8	Group of Eight, an international forum for the governments of Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States
g	gramme

GDP	gross domestic product
GHG	greenhouse gas
GIF	Generation IV International Forum
GW	gigawatt, or 1 watt $\times 10^9$
GWh	gigawatt-hour = 1 gigawatt $\times$ 1 hour
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ITER	International Thermonuclear Experimental Reactor
JI	joint implementation (a flexibility mechanism under the Kyoto Protocol)
kcal	kilocalorie, or 1 calorie $\times 10^3$, equivalent to 10^{-7} toe
KfW	*Kreditanstalt für Wiederaufbau* (Bank for Reconstruction)
kg	kilogramme
kJ	kilojoule
km	kilometre, or 1 metre $\times 10^3$
kt	thousand tonnes
ktoe	thousand tonnes of oil equivalent; see "toe"
kV	kilovolt
kW	kilowatt, or 1 watt $\times 10^3$
kWh	kilowatt-hour = 1 kilowatt $\times$ one hour = 1 watt $\times 10^3 \times$ one hour
KWK-G	*Kraft-Wärme-Kopplungsgesetz* (law on CHP)
ℓ	litre
Länder	regions of Germany (there are 16 in total); singular is *Land*
LNG	liquefied natural gas
LPG	liquefied petroleum gas
m^2	square metre
MAP	*Marktanreizprogramm (Market Incentives Programme)*

mcm	million cubic metres
mg	milligramme
MBtu	million British thermal units
Mt	million tonnes
$MtCO_2$	million tonnes of carbon dioxide
Mtoe	million tonnes of oil equivalent; see "toe"
MW	megawatt, or 1 watt $\times$ 10^6
MW_e	megawatt of electric capacity
MWh	megawatt-hour = 1 megawatt $\times$ one hour
NAP	national allocation plan (under the EU-ETS)
NTC	net transfer capacity
OECD	Organisation for Economic Co-operation and Development
PJ	petajoule
PJM	an independent system operator in the United States (it has expanded to cover states in addition to Pennsylvania, New Jersey and Maryland, the origin of the name)
PV	photovoltaics
PWR	pressurised water reactor
R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well
SME	small and medium-sized enterprise
SPD	*Sozialdemokratische Partei Deutschlands* (Social Democratic Party)
Stadtwerke	municipal utility
StrEG	*Stromeinspeisungsgesetz* (feed-in law)
t	tonne
TFC	total final consumption of energy
toe	tonne of oil equivalent, defined as 10^7 kcal
TPA	third-party access; in some regions the term "open access" is used in place of TPA

TPES	total primary energy supply
TSO	transmission system operator
TWh	terawatt-hour = 1 terawatt × 1 hour = 1 watt × 10^{12} × 1 hour
UCTE	Union for the Co-ordination of Transmission of Electricity
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USD	US dollar ($); USD 1 = EUR 0.80 (average exchange rate in 2006)
VAT	value-added tax

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