International Energy Agency

Energy Policies of IEA Countries

Germany

2013 Review

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Germany

Since the IEA last reviewed Germany's energy policies in 2007, the country has taken two fundamental policy decisions that will guide its energy policy in coming decades. In September 2010, the federal government adopted the Energy Concept, a comprehensive new strategy for a long-term integrated energy pathway to 2050. Following the Fukushima Daiichi nuclear accident in March 2011, Germany decided to accelerate the phase-out of nuclear power by 2022 starting with the immediate closure of the eight oldest plants. This decision resulted in the adoption of a suite of new policy measures and determined renewable energy as the cornerstone of future energy supply, a set of policy instruments commonly known as the *Energiewende*.

In order to achieve the ambitious energy transformation set out in the *Energiewende*, by 2030 half of all electricity supply will come from renewable energy sources; Germany must continue to develop cost-effective market-based approaches which will support the forecasted growth of variable renewable generation. Furthermore, the costs and benefits need to be allocated in a fair and transparent way among all market participants, especially households.

In the future, renewable energy capacity must expand in parallel with the timely development of the transmission and distribution networks. In addition, a stable regulatory system is necessary to ensure long-term finance to network operators. Furthermore, close monitoring of Germany's ability to meet electricity demand at peak times should continue in the medium term.

Energy policy decisions in Germany inevitably have an impact beyond the country's borders and must be taken within the context of a broader European energy policy framework and in close consultation with its neighbours.

This review analyses the energy-policy challenges facing Germany and provides recommendations for further policy improvements. It is intended to help guide the country towards a more secure and sustainable energy future.

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INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 28 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

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The European Commission also participates in the work of the IEA.

International Energy Agency

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EXECUTIVE SUMMARY

German policy makers have taken a fundamental policy decision to move towards a sustainable energy supply over the long term. In September 2010, the federal government adopted a comprehensive new strategy, the Energy Concept, which established the principles of a long-term, integrated energy pathway to take the country to 2050 and which determined renewable energy as the cornerstone of future supply. The Energy Concept built on the success of previous policies, notably the Integrated Energy and Climate Programme of 2007, but adopted more ambitious goals. The federal government deliberately set Germany on the path towards becoming one of the worlds most energy-efficient and environment friendly economies, while at the same time seeking to maintain affordable energy prices and a high level of economic prosperity. A key feature of the Energy Concept was a proposal to extend the operating lifetime of the German nuclear power fleet by an average of 12 years, therefore postponing the nuclear power phase-out agreed by the former government.

Following the Fukushima Daiichi nuclear accident in March 2011, a political decision which enjoyed extensive public support was taken to accelerate the phase-out of Germany's nuclear fleet by 2022 starting with the immediate closure of the eight oldest plants. This decision, combined with the political target to further progress towards a low-carbon energy sector, had a major impact on the German energy policy outlook, which resulted in the adoption of a second package of measures, needed to accelerate the energy transition. This second Energy Package, which completed what is commonly known as the *Energiewende*, contained seven legislative measures to support renewable energy and grid expansion, promote energy efficiency, fund the reforms and reverse the previous decisions to extend the lifetime of the nuclear plants.

The scale of Germany's ambitions, coupled with the size and energy intensity of its economy, and location at the heart of Europe's energy system, mean that further policy measures are necessary if Germany's energy transition is to maintain a balance between sustainability, affordability and competitiveness. Furthermore, decisions of this magnitude on German energy policy inevitably have an impact far beyond the country's borders and have to be taken within the context of a broader European energy policy framework and in close consultation with its neighbours.

STEADY PROGRESS

Over the last two decades, Germany has successfully decoupled greenhouse gas (GHG) emissions from economic growth and is well on track to meet its Kyoto target, without recourse to flexibility mechanisms. It also remains on course to meet its target under the EU Effort Sharing Decision with existing measures. In the context of the Energy Concept (*Energiewende*), the German government has confirmed a GHG reduction target of 40%

below 1990 levels by 2020 and set additional reduction targets of 55% by 2030, 70% by 2040 and 80% to 95% by 2050, each relative to 1990. Additional measures, however, may be required to meet the 40% reduction target by 2020 in the absence of a sustainable Europe-wide emissions trading scheme.

Energy efficiency is an important pillar of the *Energiewende* and the country has set a target of 20% reduction in primary energy consumption by 2020 and 50% by 2050 when compared to 2008. To date Germany has made good progress and has implemented a broad sweep of programmes across all sectors. Nonetheless, there is much to be done if Germany wishes to meets its 2020 targets and a comprehensive assessment of the energy saving potentials and targets for the individual sectors is needed, notably, in the industry and transport sectors.

Together with energy efficiency improvements, large-scale deployment of renewable energy is at the heart of the *Energiewende*. Since its inception in 2000, the Renewable Energy Sources Act (EEG) has proven very effective in introducing renewable energies; notably electricity generation from biomass, wind energy and solar photovoltaics (PV). This policy instrument has also proven successful in bringing costs down, as reflected in particular in the decrease in feed-in tariffs (FITs) for PV as a response to the rapid growth in take up of the technology over the past four years.

Germany is at the heart of European natural gas trade and enjoys robust supply and storage infrastructure and benefits from strong domestic utilities. The market has seen a number of positive developments, which have resulted in increased competition over the five years since the previous review: the Federal Network Agency has implemented an entry-exit system, reformed the balancing rules and rationalised the number of market areas, from more than 20 in 2006 to six in 2009 and only two today. Diversification of gas supply routes into Germany has also improved, notably with the opening of the Nord Stream pipeline, which added 55 billion cubic metres (bcm) annually to import capacity. The transmission system operators (TSOs) developed a national ten-year gas grid development plan in 2012, which has been approved with a request for changes by the Federal Network Agency. Germany's natural gas data, however, have become a source of uncertainty and there is a need to establish a consistent national data base of German gas market information.

Oil remains a main source of energy in Germany although its use has declined over the past decade. The country has few domestic oil resources and relies largely on imports to meet demand. It has well-diversified and flexible oil supply infrastructure, which consists of pipelines and import terminals. The domestic market is liberalised and characterised by a large number of market participants. Oil supply is secure and the country consistently meets its 90-day International Energy Agency (IEA) stock-holding obligation and generally holds storage well in excess of the prescribed amount. In 2011, the amount of stock held in excess of the 90-day obligation was the equivalent of 50 days of consumption.

Regarding coal production, a decision has been taken since the last review was conducted in 2007, to phase-out subsidies for domestic production of hard coal and to decommission all hard coal mines by 2018. Furthermore, substantial volumes of coal-fired capacity are likely to be decommissioned following the implementation of the EU Large Combustion Plant Directive. On the other hand, currently several large new coal-fired power plants are under construction, representing one of the biggest investment waves into domestic coal capacities since the post-war reconstruction. These new coal-fired power plants will have a technical lifetime at least until 2050 and are likely to

remain a cornerstone of Germany's electricity production well into the medium term. The Energy Concept supports the testing and, where appropriate, the use of carbon capture and storage (CCS) technology. Despite some setbacks, a regulatory framework for CCS has been established although progress to date has been slow and some planned projects cancelled. More efforts are needed to encourage CCS demonstration and testing in new coal-fired power plants and to explore and test CCS storage options, especially in the North and Baltic Seas, together with neighbouring countries.

Electricity is at the core of the *Energiewende* and Germany has a large diversified electricity system which benefits from strong interconnections with neighbouring countries. Owing to its sufficient domestic thermal power generation capacities and strong interconnections, the system has coped to date with the shutdown of 8.4 gigawatts (GW) in nuclear capacity without major energy security concerns although the situation in winter 2011/12 was severely strained. The Federal Network Agency is monitoring the situation and regularly reports its findings.

The federal government published its new Energy Research Programme in August 2011 which promotes research and development activities to achieve the policy targets contained in the Energy Concept. Accordingly, the federal government has been increasing its research and development, and the budget funding will increase from EUR 1.9 billion over the period 2006-09 to EUR 3.5 billion for the period 2011-14. This commitment to energy-related research, development and deployment (RD&D) activities and encouragement of the federal government to further increase in spending on energy RD&D is very welcome.

CONTROLLING THE COSTS

A robust German electricity market, fully integrated in the EU internal market for energy, can provide one the most cost-effective solutions to achieve the ambitious energy transformation set out in the *Energiewende*. The aim of the German government is to support efficient wholesale and retail markets, which can provide households and industries with a secure, competitive and environment friendly supply of energy while providing adequate investment signals for the market.

While the energy transformation will bring with it significant long-term benefits, the costs of meeting the *Energiewende* are large and include the EEG and other supporting measures such as the costs of the transmission and distribution grid expansion programmes, research and development in energy-related technologies. Additional costs of electricity generation from renewable sources will be recovered from final customers via the EEG surcharge, which has increased significantly over the past three years and depending on a number of factors such as on the rate of renewables expansion, weather conditions and the wholesale electricity price, might increase again in 2014.

The EEG has come under renewed criticism because of the high costs for consumers owing to the fixed FIT payments to operators of renewable power plants and a decreasing amount of chargeable energy consumption to which costs can be allocated. In February 2013, the Federal Minister of Economics and Technology and the Federal Environment Minister presented a joint proposal for a short-term amendment of the EEG to claw back the rising EEG surcharge and expressed their will to fundamentally alter the EEG in the long term.

Despite its success in attracting investment in renewable energy, the federal government has been less successful in controlling the volumes of renewable energy connecting to

the system each year. The question remains, therefore, whether steering deployment volumes via a per kilowatt hour (kWh) remuneration will remain effective over the medium to long term. To date, German consumers have absorbed the costs of the EEG but the growing burden on households has ignited a political debate in Germany about the costs of the *Energiewende.*

Developing renewable energy in locations where it is needed most, in terms of system stability, and where the costs of connecting to the system are optimal, requires a carefully designed connection policy. In the case of wind energy this could mean those places where wind coverage is highest or in the case of solar PV where radiation levels are greatest. Furthermore, the costs of connecting to, and reinforcing the grid, also need to be taken into account in the process for connecting new capacity to the grid. Network charges should provide an incentive for new capacity to connect where the system needs it most. A further concern in this regard is competition between the Länder for renewable energy developments, which provide a source of revenue to the host area. Discussions between the Länder and the federal government should aim to eliminate this concern and develop a mechanism to ensure that the fiscal benefits of renewable energy location do not have a distortionary impact on development. Creating a regulatory environment to allow variable renewables to provide system services, such as participating on the balancing markets, is an important element in this regard.

German energy policy goals are long term and in order to realise their targets, a predictable political and regulatory framework is necessary. Sudden changes to the support regime while reducing costs in the short term can undermine investor confidence and will drive up costs over the long term as a result of higher risk premiums. Retroactive tariff cuts in any form or for any length of time will send the wrong signal to the market. Reforms of the EEG will need to realise the benefits of competition, locate and pace new deployment in line with the required infrastructure and provide sufficient certainty for investors while meeting demand for energy.

There is also debate regarding the allocation of the costs of the *Energiewende* with some arguing that household consumers carry a disproportionate share of the burden. Under existing arrangements, large consumers of electricity that use more than 10 gigawatt hours (GWh) of electricity per year pay a reduced surcharge (EUR 0.0005 per kWh) on 90% of the electricity they consume with the full surcharge payable on the remaining 10%. Electricity-intensive industries that consume more than 100 GWh, and whose electricity bills represent more than 20% of total costs, may pay the lower surcharge on all of their consumption. These large energy users also benefit from lower wholesale electricity prices brought about by the growth in renewables. Large numbers of producers, who have erected solar PV systems and connected to the distribution system, receive a revenue stream via the EEG. While these producers deliver significant benefits in terms of energy output, they also impose costs on the system, in terms of developing the distribution system and may sometimes act as a disincentive to reduce energy consumption. The federal government should ensure that the regulatory system captures these costs and allocates them appropriately among producers and consumers.

A further concern is the exemption of network charges applied to large consumers, which was introduced in 2011. It could be argued that the exemption of these charges, which are recovered from smaller users of electricity via a special Section 19 of the regulation on network charges (*Netzentgeltverordnung*), distorts electricity prices and trade and imposes an unnecessary burden on small consumers. The federal government

intends to revise the regulation and has to this end initiated the interdepartmental co-ordination on its draft amendment in March 2013.

The household electricity bill in Germany is relatively complex and contains a number of components unrelated to the supply of electricity to final users. To the extent that these charges are independent of the supply of electricity they should be eliminated and recovered via more appropriate mechanisms.

The cost impact of the EEG needs to be assessed in the context of overall energy sector developments. Recent increases in electricity costs have put low-income households, in particular, under pressure, while large consumers have been shielded from the surcharge while benefitting from the renewable-induced reduction of wholesale prices. In addition, energy poverty is equally driven by the steep increase in fossil fuel costs. The costs, but also the benefits, of renewables need to be allocated in a fair and transparent way.

GETTING THE GRIDS RIGHT

The expansion of the transmission and distribution networks is seen in Germany as the most important means of moving energy supply away from nuclear power and coal towards greater levels of renewable energy. The forecast growth in renewable electricity generation capacity, and the need to bring the electricity output to market, must be complemented by timely, large-scale, cost-efficient investments in the electricity transmission and distribution systems. At present, transmission infrastructure carrying power from northern Germany to the south is increasingly congested, and likely to become more so. The geographic concentration of large volumes of wind power, as much as 25 GW by 2030, in northern Germany, a region with low electricity demand, and the need to transport it to the industrial south where demand is will place further strain on the networks. Major power flows in Central Europe, including loop flows, originating in Germany, in the north-south direction through the Czech Republic and Poland, are among the drivers of the need for enhanced operational co-ordination, financial settlement and infrastructure investment in Central Europe.

As a result of changes to the German Energy Act (EnWG), the four TSOs are required to prepare a joint network development ten-year plan. The first such plan – the Electricity Grid Development Plan 2012 (NEP 2012) – which was subject to public consultation before examination and approval by the Federal Network Agency in November 2012, contains plans for the reinforcement of approximately 2 900 km of lines and construction of 2 800 km of new power lines. The approval supported 51 of the 74 projects proposed by the TSOs. Cost estimates for this work vary but are somewhere in the region of EUR 20 billion to EUR 30 billion over the next ten years.

As most renewable electricity generation is connected to the distribution system, rather than the transmission system, large investments are also required in the country's 870 distribution systems. Once more, estimates of the scale of investment and works vary but a study published by the German Energy Agency forecasts that capital investments of between EUR 27.5 billion and EUR 42.5 billion are required over the next ten years. So far, strong focus has been given to development of the transmission system which is commendable; however, as the greater share of investment will take place in the distribution networks, the focus of future policy by the government and Federal Network Authority needs to be on distribution.

To date, Germany's record with regard to the construction of new grid infrastructure is patchy and planning and consenting procedures present a major stumbling block. Increased and effective co-operation between the Länder and between the federal government and the Länder is also necessary to make possible the *Energiewende*. Accordingly, a welcome measure is the Network Expansion Acceleration Act (NABEG), which was introduced in order to facilitate network expansion; this will link the north with large centres of consumption in the south. A welcome component of this measure is the comprehensive and timely participation by the general public as well as industry stakeholders.

To date, many grid projects have been delayed or stopped at Länder borders. NABEG intends to streamline and accelerate the permitting procedure by mandating that a federal planning procedure be carried out that determines corridors for the power lines, which are binding for the subsequent plan determination procedure. At present, the procedures for individual power line projects are conducted by the respective authorities of the Länder. This can lead to delays when two or more jurisdictions are involved and NABEG may confer this competence to the Federal Network Agency, a measure that could accelerate the permitting process without compromising the integrity of the process.

Further implementation measures must be considered, which aim at more transparency and public involvement in the decision process of grid extension. The NABEG provides part of the solution, as does the appointment of the network regulator as one-stop shop for projects of national interest. The preparation of the first joint Network Development Plan by the four electricity TSOs is a welcome step in this regard. Similarly, in response to the growth in variable renewable energy, investing in electricity storage capacity and improving energy efficiency in electricity transmission and distribution must be considered. Furthermore, a stable regulatory system is required to ensure the availability of long-term finance to network operators.

GENERATION ADEQUACY

The German electricity system is regarded as a secure system and over the past 20 years, the country has enjoyed the benefits of reserve capacity, both in generation and transportation networks, most notably in the distribution grid.

Generating capacities are sufficient to cover peak demand under existing market conditions. Notwithstanding the nuclear phase-out starting with the closure of 8.4 MW of capacity in 2011, reserve margins are satisfactory until 2015 at least. Nonetheless, concerns remain as to the extent to which the current electricity market arrangements can deliver the necessary investments to maintain secure and reliable electricity services. At present, as a result of weak carbon prices and high gas prices in Europe, existing gas-fired plants have lost competitiveness and evidence suggests that some are being taken off-line. The average load factor of combined-cycle gas turbine plants (CCGTs) in Germany is around 3 000 hours and they struggle to make a return despite the flexibility they offer to the market. The growth in renewable energy forecast for the medium term may compress the wholesale market further and make it more difficult to recover fixed capital costs. This has led to a discussion on the need for capacity mechanisms and other investment incentives in Germany.

Present reserve margins, the measure of available capacity over and above the capacity needed to meet normal peak demand levels, suggest that there is no urgent need to develop some form of capacity mechanism; nonetheless, there is a need to adapt

existing markets arrangements. Changes can help defer, or potentially avoid the implementation of further regulations and maintain efficient energy-only markets. For example, Germany should utilise existing mechanisms to seek to harmonise security of supply rules, procedures and reserves similar to, for example, arrangements in Nord Pool, the Nordic power exchange.

To the extent that the federal government must contract for capacity as a short-term measure for maintaining network reliability, as already happens, such contracting should be done on a transparent and open basis, for example, by public tender. Such measures should be supported by network-based incentives on generators to optimise their location decisions from a system-wide reliability and cost perspective. Furthermore, there is a need for transparent and widely understood triggers — response mechanisms which are linked to the fundamentals of demand and supply rather than price — in order to minimise the risk of crowding out incremental capacity. These triggers should be seen as a transitional measure to assist with the potentially difficult medium-term adjustment.

Germany has time to adjust its energy-only market design; it runs a sufficiently high reserve margin and is well interconnected with neighbouring countries. Close monitoring is required and should continue in the medium term. Germany should strengthen its energy-only market by improving demand elasticity, establishing targets for reserve margins, introducing cost-reflective reimbursement for network services, applying market price-sensitive renewables and introducing price caps, and enhancing EU co-ordination. Examples from other regions exist, such as Texas or the National Electricity Market in Australia. Germany should take advantage of this collective experience.

In unexpected cases, the reserve margins could fall below what is desired; when this happens Germany should start looking into options to complement its liquid and efficient energy-only market with market-based instruments. A targeted and temporary capacity mechanism, with the phase-out timed around managing the peak period of uncertainty while the nuclear capacity is being replaced, should be the aim. Germany should also monitor network-related aspects of reliability to better balance the overall electricity system.

A FUTURE FOR GAS

The strategic role of natural gas in the *Energiewende* needs further clarification and greater thought should be given to its use and place in the electricity supply mix of the future. Natural gas can provide a flexible source of electricity supply in the medium term and, as nuclear capacity is phased-out, can help smooth the path to a low-carbon power sector. The nature of Germany's energy supply over the coming decade suggests that there is a need for more mid-merit electricity capacity to offset variations in output from wind and solar PV. Furthermore, if Germany is to meet its 2020 GHG emissions reduction target of 40% without much of its nuclear fleet, a cleaner alternative to coal use needs to be found. Furthermore, as coal use in North America falls as a result of the boom in unconventional gas, the region's exports are driving greater use of relatively cheap coal in Europe. Recent evidence suggests that German utilities are consuming larger volumes of coal and displacing natural gas from the generation mix. In the absence of an effective carbon price in Europe, this will drive up Germany's GHG emissions while capping investment in cleaner gas-fired technologies.

KEY RECOMMENDATIONS

The government of Germany should:

- *Ensure that the large-scale transmission and distribution developments, including investments that are necessary if the Energy Concept (*Energiewende*) is to succeed, are put in place in a timely manner and maintain a regulatory system that provides sufficient financial incentives and investment security for mobilising the necessary investments in distribution.*
- *Develop suitable mechanisms to manage the cost of incremental renewable energy capacity via cost-effective market-based approaches, which will support the forecast growth of variable renewable electricity generation that brings new capacity closer to market needs, supports investments in appropriate locations and complements planned network expansion.*
- *Assess, in co-ordination with all relevant stakeholders, the extent to which the present market arrangements enable the financing of economically viable investments in new flexible gas-fired generation and cost-effective electricity storage. Part of this assessment is the need to examine the suitability of capacity markets as a transitional measure to support the adjustment to a post-nuclear power system.*
- *Take strong measures to ensure that the costs of the* Energiewende *are minimised and allocated fairly and equitably across customer categories and limit the growth of the Renewable Energy Sources Act (EEG) surcharge attributable to the deployment of additional renewable energy capacities, while drawing all benefits from the rapid decrease in technology costs that has occurred.*
- *Develop policies that convey a clear understanding of the role of gas in the* Energiewende *and ensure that the short-term boom in coal use by the electricity sector does not crowd out investment in flexible gas-fired capacity.*

PART I
POLICY ANALYSIS

Figure 1. **Map of Germany**

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

2. GENERAL ENERGY POLICY

Key data (2011)

Total Primary Energy Supply (TPES): 311.8 Mtoe (oil 32.7%, coal 24.8%, natural gas 22.3%, renewables 11.3%, nuclear 9%), -7.4% since 2000

TPES per capita: 3.8 toe (IEA average: 4.6 toe)

TPES per gross domestic product (GDP): 0.11 toe per USD 1 000 GDP purchasing power parity (PPP) (IEA average: 0.14 toe per USD 1 000 GDP PPP)

Electricity generation: 602.4 TWh (coal 45.1%, renewables 22%, nuclear 17.9%, natural gas 13.9%, oil 1.1%), +5.3% since 2000

Electricity consumption per capita: 9 MWh (IEA average: 10.6 MWh)

Inland energy production: 124.2 Mtoe (coal 37.5%, renewables 28.3%, nuclear 22.7%, natural gas 8.8%, oil 2.8%), -8.2% since 2000

COUNTRY OVERVIEW

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.

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. 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 flat and is forecast to decline in the future. The largest city is Berlin, the capital, which has grown to a population of 3.5 million. In 1999, many governmental institutions, ministries and embassies were moved to Berlin from Bonn, the former capital. Other large metropolitan areas in Germany include the Rhein-Ruhr area, Frankfurt, Hamburg, Munich and Leipzig.

Germany is a federal democracy divided into 16 regions or Länder. It 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 governments of the 16 Länder; 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.

ECONOMY

Germany is a leading exporter of machinery, vehicles, chemicals, and household equipment and benefits from a highly skilled labour force. The economy is in relatively robust condition and is expected to grow by 0.4% in 2013 and by 1.6% in 2014. Over the course of 2012, growth slowed as a result of the weak global economic development and the Eurozone, but over the course of 2013, growth is likely to pick up again, largely driven by domestic demand.[1]

Long-term and continuous economic growth on the basis of the Social Market Economy is the clear principle for the federal government's economic policy. Unemployment barely increased during the crisis and has fallen significantly since then – in stark contrast to almost all other OECD countries. This is due to a decline in structural unemployment as well as a significant increase of flexibility in working hours, demonstrating the beneficial affects of past labour market reforms. Regarding government finances, public debt has increased notably in the crisis, but the budget deficit is the lowest among the G7 countries, partly thanks to the good performance of the labour market.

Current economic projections are characterised by a high degree of uncertainty. It is possible that the euro area will recover sooner and the world economy will accelerate faster than assumed. In this case, the German economy, in view of its sound underlying health, may be expected to utilise the additional growth opportunities that arise. Downside risks nonetheless predominate. Should global economic growth remain below expectations or should the debt crisis escalates further in some countries, it is probable that the German economy may follow a weaker course than the one assumed in the baseline scenario.[2] An affordable and secure supply of energy is a core component for sustainable growth and prosperity in Germany. To this end, the federal government is pursuing a market-oriented approach based on competition and cost-efficiency.

SUPPLY AND DEMAND

SUPPLY

Total primary energy supply (TPES) was 311.8 million tonnes of oil equivalent (Mtoe) in 2011, its lowest level in 30 years. Germany’s energy supply has been on a downward trend over the past three decades, albeit at a modest rate. Since 2000, TPES has declined at an annualised rate of 0.7%, ranging from a high of 346.7 Mtoe in 2001 to a low of 311.8 Mtoe in 2011. The federal government anticipates that energy supply will continue to fall over the following two decades, down to 216.7 Mtoe in 2030.

Germany has the third-highest level of TPES among IEA members, behind the United States and Japan. Among IEA Europe members, Germany recorded the highest level of total energy supply in 2011, followed by France and the United Kingdom. However, TPES per capita was 3.8 tonnes of oil equivalent (toe) in 2011, which is lower than the IEA average of 4.6 toe per capita.

1. *Jahreswirtschaftsbericht 2013*, BMWi, 2013.
2. *Monthly Report*, Deutsche Bundesbank, December 2012.

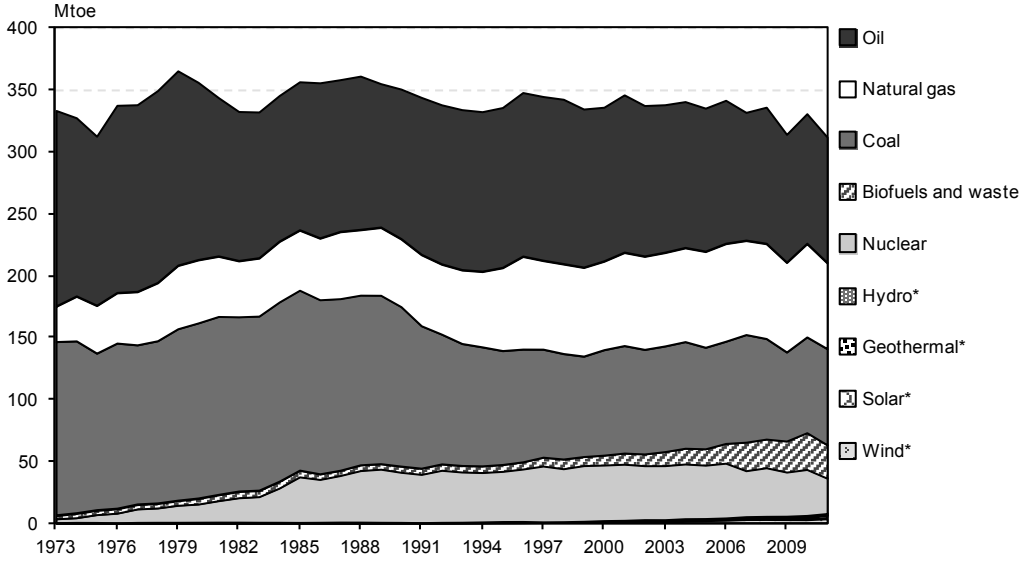
Oil is the most significant source of energy in Germany. In 2011, it contributed 101.9 Mtoe to TPES, representing 32.7% of the total. Since 2000, energy from oil has decreased by 18.3% from 124.7 Mtoe, with its share in the energy mix falling from 37%. Over the next two decades, the government has forecast that oil use will continue to decline; nonetheless, it will remain the most significant source of energy at 28.2% of TPES in 2030.

Energy from coal and gas amounted to 77.4 Mtoe and 69.6 Mtoe in 2011, respectively. Coal represented 24.8% of TPES, while natural gas had a 22.3% share. Over the 11 years since 2000, the share of both coal and natural gas in the energy mix has remained relatively stable, with energy from these fuels falling in line with TPES. Government projections indicate that natural gas will remain an important source of energy for the next two decades, increasing to 25% of TPES by 2030. Conversely, energy from coal will decline by two-thirds to represent only 12% of total supply in 2030.

Energy from renewable sources represented 11.3% of TPES in 2011, 8.5% of which was from biofuels and waste (26.6 Mtoe). Renewable energy has experienced strong growth in the past ten years, with the share of biofuels in the energy mix up from 2.3% in 2000, while wind and solar have been boosted from negligible levels to around 1% each in 2011. In the next 18 years, renewables are expected to make a significant shift in the energy mix, up to 33.2% of the TPES in 2030, with biofuels at 21.6%, wind at 5.6%, solar at 3.2%, geothermal at 1.9%, and hydro remaining at around 1%.

Nuclear energy totalled 28.2 Mtoe in 2011, accounting for 9% of TPES. This is a decrease of 36.3% from 44.2 Mtoe in 2000, and down from a 13.1% share in the energy mix. By 2022, nuclear energy will be phased out in Germany as the government plans to progressively shut down all nuclear reactors.

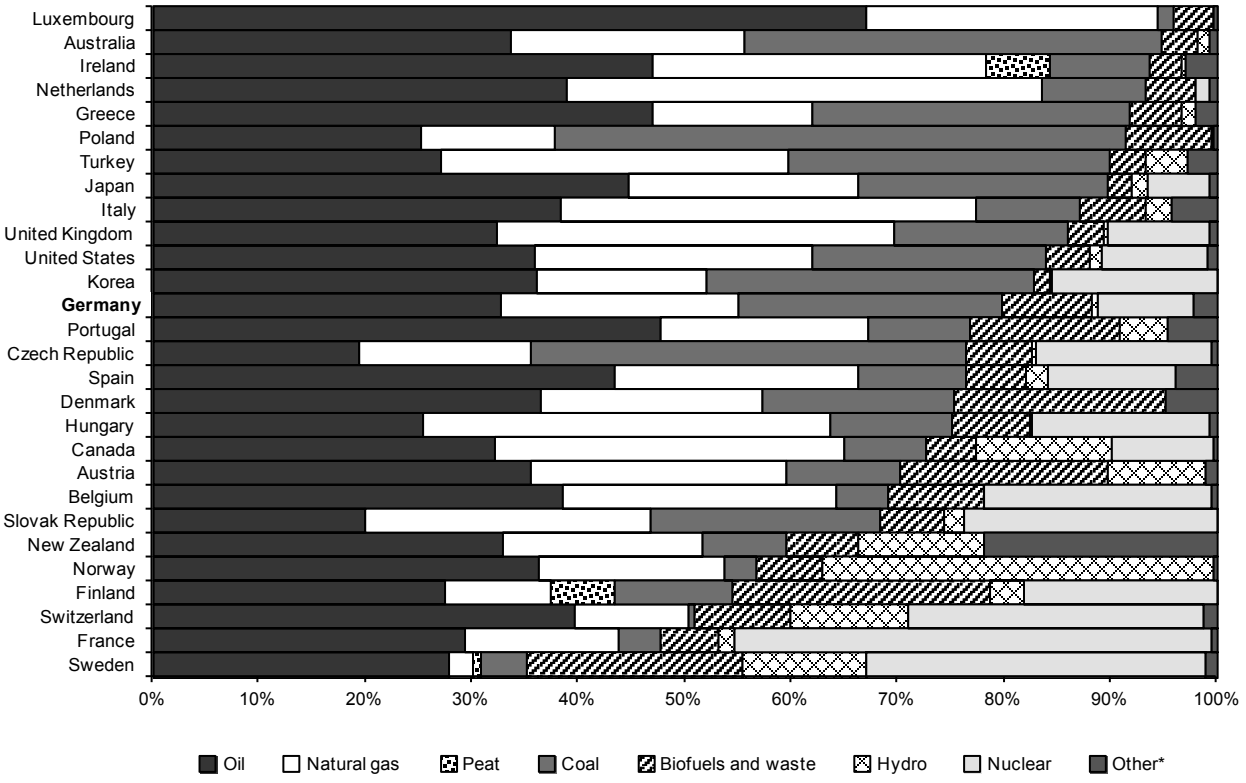
Figure 2. **Total primary energy supply, 1973-2011**



* Negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and country submission.

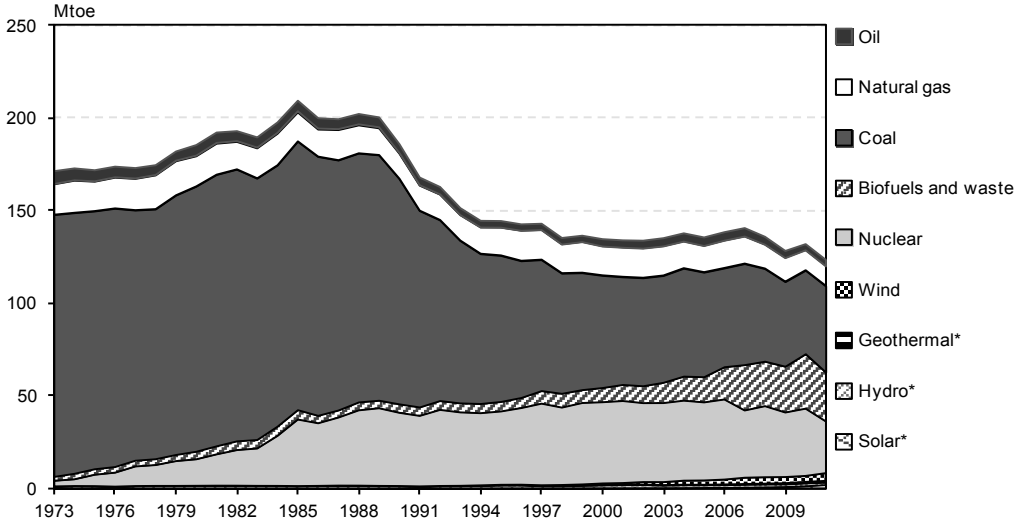
Figure 3. **Breakdown of total primary energy supply in IEA member countries, 2011**



* *Other* includes geothermal, solar, wind, and ambient heat production.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and country submission.

Figure 4. **Energy production by source, 1973-2011**



* Negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and country submission.

Compared to IEA member countries, Germany ranks at a median level with regard to a share of fossil fuels in TPES, at 79.7% in 2011 (Figure 3). With respect to nuclear penetration, Germany is the third-lowest after the Netherlands and Japan, among the 16 IEA members with nuclear energy production in their supply mix. It has the seventh-largest share of biofuels in TPES among all IEA members.

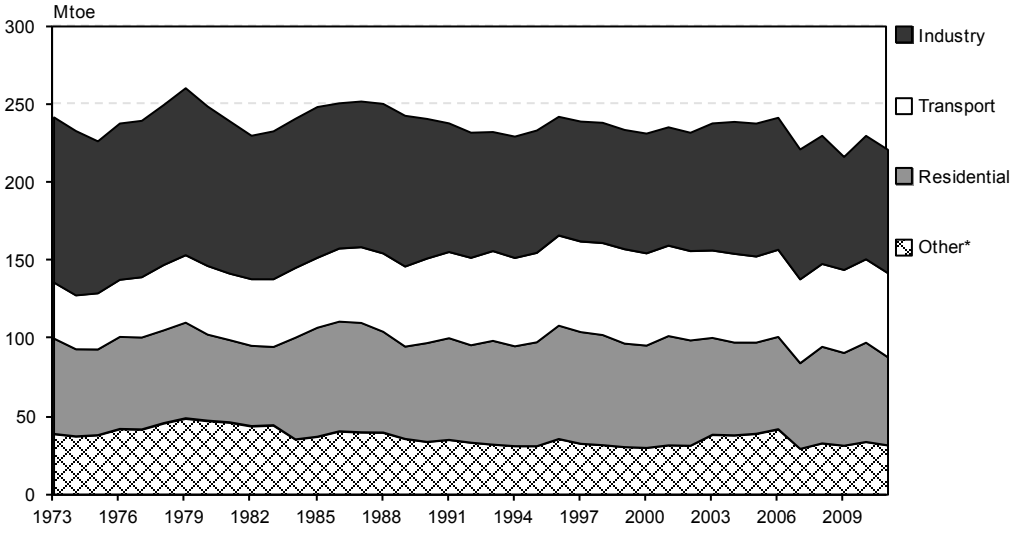
Inland energy production in Germany was 124.2 Mtoe in 2011, which accounts for 39.8% of total energy supply. Germany is a significant producer of coal, with 46.5 Mtoe in 2011 or 37.5% of total energy production. It is the largest producer of lignite among IEA member countries, and third only to the United States and Australia in hard coal production. Nuclear energy represented 22.7% of total production in 2011, followed closely by biofuels and waste at 21.5%. Natural gas represented 8.8% of total energy produced.

Inland energy production has decreased by 8.2% since 2000. Conversely, energy from biofuels and other renewable sources has experienced strong growth, increasing from a total of 8% of production in 2000 to 28.3% in 2011. This includes hydro, which has remained a constant share of 1%.

DEMAND

Germany's total final consumption (TFC) of energy was 221 Mtoe in 2011, which is 3.9% lower compared to the previous year and 2.1% higher than in 2009. Final consumption of energy has also been in modest decline over the past three decades, falling by 4.5% since 2000. Oil products are the largest fuel consumed, accounting for 41.6% of TFC in 2011, followed by natural gas and electricity at 23.2% and 20.3% respectively. Biofuels, heat and coal are less significant in final use, representing 6.2%, 4.5% and 3.7% in that order.

Figure 5. **Total final consumption by sector, 1973-2011**



* *Other* includes commercial, public service, agricultural, fishing and other non-specified sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and country submission.

The industry sector is the largest end-user of energy. It accounted for 35.6% of TFC in 2011 (78.8 Mtoe), increasing from 33.3% during the recession in 2009. Residential use

totalled 56.1 Mtoe in 2011 (25.4% of TPES) while the transport sector consumed 54.2 Mtoe (24.5%), mostly oil products. Commercial and other services consumed 32 Mtoe. The government forecasts that TFC will continue to decline over the years to 2030, with similar shares per sector remaining.

INSTITUTIONS

Since the last in-depth review in 2007, energy policy institutions and structure have remained largely the same. In energy policy, the federal government is primarily responsible for introducing legislation and the Länder are responsible for administrative implementation of national law (although the government has significant administrative powers). The individual Länder are involved in shaping energy management and state committees.

At national level, the primary responsibility for energy policy rests with the **Federal Ministry of Economics and Technology** (*Bundesministerium für Wirtschaft und Technologie*, BMWi). Responsibility for monitoring security of supply in gas and electricity and for supply in times of oil crises lies with the 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 responsible for environmental regulation that affects the energy sector (*e.g.* regulations relating to pollution abatement, climate change mitigation, nuclear safety and radiation protection).

Matters concerning energy savings in buildings are shared between BMWi and the **Federal Ministry of Transport, Building and Urban Development** (*Bundesministerium für Verkehr, Bau und Stadtentwicklung*, BMVBS).

The **Federal Ministry for Food, Agriculture and Consumer Protection** (*Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz*, BMELV) oversees policy matters relating to biomass. 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 Länder are responsible for general matters such as market monitoring and abuse of dominance in the energy industry. The *Bundeskartellamt* has oversight of mergers in the energy sector under the Competition Act (*Gesetz gegen Wettbewerbsbeschränkungen*). The various decision divisions (*Beschlussabteilungen*) within the *Bundeskartellamt* each take competition-related decisions for a specific sector, including the energy sector, of industry following a quasi-judicial procedure. *Bundeskartellamt* decisions may be contested through the civil courts.

The **Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railways** (*Bundesnetzagentur*, BNetzA), headquartered in Bonn, is a separate higher federal authority under the aegis of the BMWi. The task of the Federal Network Agency is to provide, by liberalisation and deregulation, for the further development of the electricity and natural gas markets. The president and vice president of the Federal Network Agency 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 Federal Network Agency cannot under any circumstances be overruled by the government.

The **Monopolies Commission** (*Monopolkommission*) is a body of 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.

Approval and monitoring of the construction, operation, decommissioning and dismantling of nuclear power plants is the responsibility of the individual Länder, 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 fall 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 Länder.

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 Länder are responsible for the approval of licences to emit GHGs, these being an integral component of the approval procedures set out under the Pollution Abatement Law. The Länder administrations are also responsible for all matters 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 government's 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 matters 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** (*Statistisches Bundesamt*, StBA) and the statistics offices in the individual Länder, which perform the duties assigned to them under the Energy Statistics Act (*Energiestatistikgesetz*).

Petroleum statistics are maintained 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.

KEY POLICIES

INTEGRATED ENERGY AND CLIMATE PROGRAMME OF AUGUST 2007

The federal government adopted in August 2007 an integrated energy and climate programme consisting of 29 separate measures in the field of energy and climate. It underlined the goals of the federal government at that time in the field of energy and climate policy, *e.g.* the reduction of German GHGs by 40% below the level of 1990 as a contribution towards global emissions reductions or an increase in the proportion of

electricity generation accounted for by renewables to at least 30% by 2020. It was an important package of measures – without describing a long-term development path up to 2050.

THE ENERGY CONCEPT 2010

Germany has taken the fundamental decision that, over the long term, it will obtain the greater part of its energy supply from renewable energy sources. Accordingly, in September 2010, the federal government adopted a comprehensive new Energy Concept, that sets its course for the move into the age of renewable energies. In doing so, the federal government established guidelines for securing an environmentally sound, reliable and affordable energy supply and its aim is to implement a long-term, integrated strategy through the year 2050.

The aims, approaches and instruments of the federal government's Energy Concept of September 2010 are broader and deeper than those of the Integrated Energy and Climate Programme. The Energy Concept is Germany's roadmap for implementing a long-term strategy for an environmentally sound, reliable and affordable energy supply system by 2050. The transformation sets out to increase energy efficiency, expand renewable energy sources and reduce GHGs and includes the phasing-out of nuclear energy by the end of 2022.

The Energy Concept draws together several energy policy goals: of securing supply and protecting the climate while at the same time promoting the growth and competitiveness of German industry. Its aim is to make Germany a world leader in the fields of energy efficiency and environmental protection while simultaneously maintaining competitive energy prices and a high level of prosperity.

The federal government has set itself the objective of making Germany one of the worlds most energy-efficient and environment friendly economies, while at the same time enjoying affordable energy prices and a high level of prosperity. It argued that the objectives adopted in the Energy Concept are ambitious, but achievable.

Ambitious climate protection remains at the core of the Energy Concept: its key goals are to achieve a 40% cut in GHGs by 2020, 55% by 2030, 70% by 2040 and between 80% and 95% in 2050, compared to 1990 levels. The purpose of these targets is to send strong signals to encourage investment in innovations and technological progress.

It is a comprehensive package containing policies for the electricity, heating and transport sectors containing interim milestone targets for 2020, 2030 and 2040. Major policy actions, such as the expansion of renewable energy supply, an increase in energy efficiency, and the development of the electricity networks, are elaborated in the Energy Concept. It is based on scenario calculations produced by independent institutions, and studies underlying the concept map out how the energy and climate policy targets can be most efficiently achieved.

The Energy Concept contains a wide variety of specific measures to meet these targets. On top of this, there is an immediate action programme consisting of ten especially urgent measures. The immediate action programme focuses in particular on the expansion of offshore wind power and the expansion/upgrading of power grids.

Every three years, commencing in 2013, the federal government has committed to conduct a monitoring process to review the status of implementation of the Energy

Concept. Furthermore, the Energy Concept contains a solid plan for financing the necessary measures over the long term. For this purpose, the federal government established a special Energy and Climate Fund.

Table 1. **Targets contained in the Energy Concept/Energy Package**

	2012	2020	2030	2040	2050
Reduction in GHGs (base year: 1990)	-27%	-40%	-55%	-70%	-80%
Share of renewable energies in total final energy consumption	10%	18%	30%	45%	60%
Share of renewable energies in electricity consumption	20%	35%	50%	65%	80%
Reduction of primary energy consumption (base year: 2008)	-5%	-20%			-50%
Reduction of electricity consumption (base year: 2008)	-1%	-10%			-25%
Reduction of final energy consumption in the transport sector (base year: 2008)		-10%			-40%

Source: BMWi.

THE ENERGY PACKAGE 2011

Following the Fukushima Daiichi nuclear accident in March 2011, the federal government began to reconsider the long-term role of nuclear power. Analyses prepared by the Reactor Safety Commission (RSK) and the Ethics Commission, supported the decision, by means of an incremental process to be completed by the end of 2022 at the very latest, that Germany will abandon the generation of electricity from nuclear power stations.

The RSK found that Germany's nuclear power stations are highly robust facilities and the ethics commission found that the reality of a reactor accident has a substantial impact on the way the risks of using nuclear power are assessed, and that the possibility that such an accident could prove unmanageable is of central importance in Germany's national framework. Following consideration of the findings of the two commissions, the federal government decided to phase-out the use of nuclear power for commercial electricity generation at the earliest possible time – on a staggered schedule. To that end, on 30 June 2011, the *Bundestag* (parliament) passed the Thirteenth Act amending the Atomic Energy Act (*Dreizehntes Gesetz zur Änderung des Atomgesetzes*). The Act entered into force on 6 August 2011.

In order to phase-out nuclear power more quickly, however, the process of reorganising Germany's energy supply at a fundamental level – a process which had already begun with the Energy Concept – needed to be substantially accelerated (the *Energiewende* or energy shift). To this end, the Federal Cabinet, the Bundestag and the *Bundesrat* adopted a comprehensive package of legislation (energy package) in June and July 2011. The Energy Package consists of seven acts and one ordinance, *e.g.* on expanding renewables, on expanding the grid, on energy efficiency and on the funding of the reforms. The Energy Package marked a second significant step by the federal government towards the restructuring of the energy supply.

An important aim of the legislative package was to ensure that the nuclear phase-out could proceed as fast as possible and in an irreversible and orderly manner, with the eight oldest nuclear power plants not being reconnected to the grid. Compensation costs are to be borne by the federal government. Should back-up capacity be needed, it will

be provided by conventional power plants. Shortly afterwards, the Federal Council followed the *Bundestag*'s vote and approved the energy legislation. The key elements of the Energy Package 2011 adopted in July 2011, based on the Energy Concept of 2010 are:

- Act to Accelerate the Expansion of Electricity Networks (NABEG): acceleration of spatial planning;
- Energy Industry Act (EnWG): transposition of Third Internal Market Directive;
- Renewable Energies Act (EEG): cost-efficient expansion of renewables;
- Nuclear Energy Act: phase-out of German nuclear power plants until 2022;
- Energy and Climate Fund Act;
- Act to Strengthen Climate-compatible Development in Cities and Municipalities;
- Act on Tax Incentives for Energy-Related Modernisation of Residential Buildings;
- Ordinance on the Award of Public Contracts.

The German government will review the implementation of the programme of measures annually on the basis of a sound monitoring system. A progress report after three years will assess the implementation of the measures and the foreseeable course on the way to achieving the objectives of the Energy Concept. The monitoring process will also be supported by an independent commission of four experts who will examine and comment on the federal government's report.

In December 2012, The Federal Minister of Economics and the Federal Minister for the Environment presented the first monitoring report *Energy of the Future* for the reporting year 2011. The report confirms that the *Energiewende* is making progress, but it faces many challenges.

TAXATION

Germany was one of the first IEA member countries to successfully implement ecological tax reforms. Reform commenced in April 1999, with the enactment of the Act on the Introduction of the Ecological Tax Reform of 24 March 1999 (Ecological Tax Reform Act), which gradually increased the excise duties applied to fossil fuels and implemented a tax on electricity consumption. The objectives of the tax were twofold: to mitigate carbon dioxide (CO_2) emissions and to boost job creation and boost innovation.

The Ecological Tax Reform Act provided for increases in four further steps from 1 January 2000 to 1 January 2003 but tax rates have remained unchanged since then. A defining feature of the tax was the use of a large portion, up to 90%, of the revenue derived from the tax to offset payroll contributions from employers and employees with much of the remainder going towards the funding of renewable energy schemes. An additional feature of the tax was the provision of special exemptions for trade-exposed energy-intensive manufacturers. The current statutory tax rates for the most important energy products are as follows:

The eco-tax reform programme has contributed to reducing energy consumption and GHG emissions most notably in the transport sector, where emissions have decreased significantly despite greater use of road transport. Between 2000 and 2010, the amount of goods hauled by the German heavy-duty fleet increased by almost 12% while the

number of passenger miles driven increased by 7%.[3] Environmental taxes on transport (fuel and other taxes) as a percentage of total taxation were 4% in 2010 compared to 5.2% in 2005. From 2013 onwards, in order to create a further incentive for increasing energy efficiency in the manufacturing sector, the German government will only grant the top rate of energy and electricity tax relief when energy efficiency targets are achieved by the industry as a whole and companies introduce energy management systems or equivalent measures.

Nonetheless, and despite the benefits of the ecological taxes, there are inherent weaknesses in the mechanism that have lessened their potential impact. Their application appears arbitrary at times; there is no correlation between the level of emissions and the amount of tax levied. Furthermore, diesel is taxed less than petrol but it has a higher carbon content than petrol, and diesel-powered vehicles generate higher levels of nitrogen oxides and fine particles than comparable petrol-fuelled vehicles. A further problem is that the rates have remained static since 2003 although there have been some amendments in 2011.

ENERGY SECURITY

OIL AND NATURAL GAS

Germany has little domestic oil and natural gas production and relies heavily on imports. It has well diversified and flexible oil supply infrastructure, which consists of crude oil and oil product pipelines, and crude oil and oil product import terminals. Oil continues to be the main source of energy in Germany although it has declined markedly since the early 1970s. It now represents approximately 33% of Germany's TPES.

Oil stock levels are generally well above the 90 days required by the IEA. Total oil stock levels in Germany were equivalent to 140 days net imports in April 2012. Since 1998, Germany's Oil Stockholding Agency (EBV) has been responsible for meeting the 90-day IEA stockholding obligation. The Oil Stockholding Act stipulates that the EBV shall constantly maintain stocks of oil and petroleum products at a level equivalent to or above 90 days of net imports. There is no minimum stockholding obligation on industry, so industry's commercial stocks are held in addition to the EBV stocks.

Natural gas is imported into Germany exclusively by means of a series of cross-border pipelines. The country has no liquefied natural gas (LNG) infrastructure, although some German companies have booked capacities in overseas LNG terminals. There are several legal tools available to German authorities for natural gas emergency response. These include laws that can be used to restrict the sale, purchase or use of goods, both in terms of quantity and time, or permit them only for certain priority purposes, to ensure that vital energy needs are met.

Germany maintains the largest gas storage facilities in Western Europe. There are 47 gas storage facilities in Germany, with a total capacity 20.9 billion cubic metres (bcm). German firms also have access to natural gas storage in Haidach (Austria) which has a capacity of 2.6 bcm. There are no compulsory natural gas storage requirements in Germany and no state-owned storage facilities. Operators of gas storage facilities must

3. *EU Transport in Figures; Statistical Pocketbook 2012*, European Union, 2012.

grant other companies access to their storage facilities and auxiliary services at a fair market price.

ELECTRICITY

In accordance with section 13(1) of the German Energy Act (EnWG), the four TSOs are both authorised and obliged to remedy any threat to or malfunction in the electricity supply network through the adoption of system-related and market-related measures.[4] To the extent electricity distribution system operators (DSOs) are responsible for the security and reliability of the electricity supply in their networks, they are also authorised and obliged to implement such measures under section 14(1) of the EnWG.[5]

The shut down of 8.4 GW of nuclear capacity in 2011 reduced Germany's electricity generating fleet to approximately 174.4 GW and additional 12 GW of nuclear power will be decommissioned by 2022. This loss of capacity will be offset by fossil fuel-fired capacity that is likely to be built over the same period, alongside substantial growth in renewable energy supply, suggesting that the electricity system is relatively secure over the coming decade. This is unlikely to be the case, however, as many uncertainties must also be taking into account, for example, the changes in electricity demand and the rate of network capacity expansion. The Federal Network Agency has prepared three reports on the implications of the decommissioning of nuclear capacities for the transmission systems and the security of supply. Generally, these reports have shown that although the present network situation is manageable, it requires network operators to intervene with increasing frequency in system operation. Nonetheless, network infrastructure in the electricity sector remains stable and secure. In the event of any threat to, or malfunction in, the electricity supply network, TSOs are both authorised and obliged to remedy the associated problems through the adoption of network and market-related measures.

To counteract any short-term problems as a result of the nuclear shutdown, the TSO contracted 2 GW of reserve capacity plus Biblis Nuclear Power Plant Unit A for phase-shift operations to contribute to network stability. The Federal Network Agency has also started continuous monitoring on generating capacity developments and has recommended the urgent commissioning of specific transmission lines.

ASSESSMENT

Germany is the largest economy in IEA Europe and has weathered the global economic crisis better than most. Its economy is in robust condition and is expected to continue to grow in the medium term, largely driven by domestic demand and a strong manufacturing sector. Over the past two decades, Germany has made considerable progress in reducing the carbon and energy intensities of its economy. It decoupled GHG emissions and economic growth in the 2000s, and domestic GHG emissions have declined more than required by the Kyoto target. Energy efficiency improvements and the rapid development of renewable energy sources were among the key drivers of this decline. Conversely, Germany's energy and electricity mixes remain very dependent on fossil fuels, notably oil and domestically produced lignite.

4. Ampiron GmbH, TenneT GmbH, TransnetBW GmbH and 50Hertz Transmission.

5. *Monitoring Benchmark Report 2011*, published under section 63 (4) and (5) in conjunction with section 35 of the Energy Act, Federal Network Agency, 2012.

The cornerstone of German energy policy is the *Energiewende* based on the twin pillars of the federal government's Energy Concept of 2010 and the Energy Package of 2011. The Energy Concept was established in September 2010 when the federal government set out Germany's energy policy until 2050 and determined a suite of specific measures for the development of renewable energy sources, power grids and energy efficiency. This strategy built on the success of previous policies and took into account a decision to phase-out nuclear power by 2036.

Following the Fukushima Daiichi nuclear accident in March 2011, the federal government reassessed the residual risk of nuclear power and decided to phase out the use of nuclear power at a much faster rate than originally signalled in September 2010, a decision influenced by the recommendations of the Ethics Commission and the Reactor Safety Commission. An amendment to the Atomic Energy Act laid down a clear and binding step-by-step plan for the phase-out and the last nuclear power plant is scheduled for decommissioning by the end of 2022 at the latest with eight power plants already closed.

This latter decision, the accelerated phase-out of nuclear power, presents Germany with an immense challenge: in 2010, nuclear power provided Germany with 22.6% of its electricity needs and accounted for 13% of its generating capacity.

The Energy Package of 2011 concentrates on five major spheres of action: upgraded electricity grid infrastructure, a flexible electricity system, growing renewable energies, increased energy efficiency and greater investment in research and development, notably in storage technologies. The Energy Package marked a second significant step by the federal government towards the restructuring of the energy supply and was complemented by a major new programme of investment in the energy-related research and development. A notable feature of the implementation of the *Energiewende* is regular monitoring by an independent panel of experts who report their findings to the federal government.

The most recent broad amendment to the Renewable Energy Sources Act (known as EEG 2012), which became effective on 1 January 2012, made the targets set out in the Energy Concept legally binding: by 2020 at the latest at least 35%, by 2040 65%, and by 2050 80% of German power supply is to be provided by renewable energies and the corresponding quantities of electricity fed into the power supply system. The expansion of the transmission and distribution networks is seen in Germany as the most important means of shifting energy supply away from nuclear power towards greater levels of renewable energy. Notwithstanding the significant investment in renewable generation capacity, these must be matched by timely large-scale investments in the electricity transmission and distribution systems. The 2012 Electricity Grid Development Plan 2012 (NEP 2012), approved by the Federal Network Agency in November 2012, contains plans for the reinforcement of approximately 2 900 km length of lines and 2 800 km of new power lines. Cost estimates for this work vary but are somewhere in the region of EUR 20 billion to EUR 30 billion.

As most renewable generation is connected to the distribution system, rather than the transmission system, large investments are also required in the country's 870 distribution systems. Once more, estimates of the scale of investment and works vary but a recent study published by the German Energy Agency (DENA) forecasts that network expansions of between 135 000 km and 193 000 km are needed while

approximately 21 000 km to 25 000 km of networks will need to be converted. The study estimates that this level of expansion will require capital investments of between EUR 27.5 billion and EUR 42.5 billion.

To date, Germany's record with regard to the construction of new grid infrastructure is patchy and planning and consenting procedures presents a major stumbling block. The Energy Industry Act (EnWG) made provision for a binding and co-ordinated network development plan, prepared jointly by the TSOs, for the major electricity transmission and gas pipeline networks (ten-year network development plans). This plan has to be submitted to the Federal Network Agency no later than 3 March every year (2012 was an exception) and the plan is published for public consultation. The introduction of the co-ordinated ten-year development plans is a necessary and welcome step as are measures to monitor implementation but obstacles remain.

Greater co-operation between the Länder and between the federal government and the Länder is also necessary to make possible the *Energiewende*. Accordingly, a welcome measure is the Network Expansion Acceleration Act (NABEG), which was introduced in order to facilitate network expansion, which will link the north with large centres of consumption in the south. The Act makes provision for the planning and permitting procedures for supra-regional transmission lines to be carried out, subject to certain conditions, by the Federal Network Agency. This ensures that permitting procedures rest with a single accountable source and are based on harmonised rules. A welcome component of this measure is the comprehensive and timely participation by the general public as well as by industry stakeholders.

To date, many grid projects have been delayed or stopped at Länder borders. NABEG intends to streamline and accelerate the permitting procedure by mandating that a federal planning procedure be carried out that determines corridors for the power lines, which are binding for the subsequent plan determination procedure. At present, the procedures for individual power line projects are conducted by the respective authorities of the Länder. This can lead to delays when two or more jurisdictions are involved and NABEG may confer this competence to the Federal Network Agency, a measure that could accelerate the permitting process without compromising its integrity.

Further implementation measures must be considered, which aim at more transparency and public involvement in the decision process of grid extension. The Network Acceleration Expansion Act provides part of the solution, as does the appointment of the network regulator as one-stop shop for projects of national interest. The preparation of the first joint Network Development Plan by the four TSOs is a welcome step in this regard. Similarly, in response to the growth in variable renewable energy, investing in electricity storage capacity and improving energy efficiency in electricity transmission and distribution must be considered. Furthermore, a stable regulatory system is required to ensure the availability of long-term finance to network operators. The announcement in March 2011 of the establishment of the Future-oriented Grids Platform, supported by the Office of the Grids Platform in the Ministry of Economics and Technology, as a body where major stakeholders involved in grid expansion are brought together is another welcome step.

The Federal Network Agency has been tasked with the role of continuously monitoring generating capacity developments and it maintains the view that while a capacity mechanism is not needed at the moment, a suite of other measures to secure the system are necessary. Alternative policy that may similarly help to address some of the concerns includes providing a reliable and predictable policy environment, promoting demand

response, facilitating market entry and setting locational incentives. This appears to be a sensible approach and one which should be maintained over the short term.

Promoting energy efficiency in the industrial sector and for buildings is a key priority of German energy policy. According to the Energy Concept, up to EUR 10 billion of savings are available annually to German industry through investment in energy efficiency. At the same time, the federal government launched a number of initiatives to reduce emissions from the building sector, *e.g.* by promoting renewable energy-based heating systems and increasing the energy efficiency of buildings. Targets have been determined for 2020 and 2050 and it would be desirable to complete the scientific and empirical basis for exploiting the efficiency potential. Monitoring and evaluation can further strengthen this process.

Considerable efforts are underway in energy-related research and development (R&D), for which government support is already strong. The importance of co-ordination – between different branches of government (ministries, agencies) or different levels of government (federal, state, local) – is important in order to achieve coherence of incentives provided by a package of policy instruments, along with the development of the necessary infrastructure. Establishing a platform for the co-ordination of research policies is a welcome step. The challenges facing Germany are of such magnitude that it must sustain its high level of support for R&D in the long run.

In general, it is necessary to have effective monitoring tools to systematically analyse the progress made towards achieving the ambitious goals that Germany has set in terms of the profound transformation of its energy policy. In this regard, the establishment of a monitoring process and an Energy Policy Monitoring Commission is a welcome measure. The monitoring process could be strengthened further by intensifying contacts with industry stakeholders and representatives of small energy consumers, thereby providing an organised voice to those bearing the costs of the transformation.

Germany is an important part of the European energy system. Its decisions on energy policy are likely to result in the import and export of greater volumes of electricity to and from its neighbours over the medium to long term than would otherwise have been the case. To ensure that security of electricity supply is optimised, Germany must increase structural co-operation at regional level, and within existing European mechanisms, in order to enhance security of supply at reasonable cost, especially under extreme weather conditions or periods of prolonged high demand.

Energy policy making, and therefore policy implementation, is somewhat complicated in Germany owing to the division of responsibility within federal government and between the federal government and the 16 Länder. Primary responsibility for energy policy rests with the Federal Minister of Economics and Technology (BMWi) to whom a number of agencies such as the Federal Network Agency and the Federal Cartel Office report. On the other hand, responsibility for renewable energy, climate policy, energy efficiency and nuclear safety falls within the realm of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Federal Ministry for the Environment BMU) to whom the Federal Environment Agency reports. The independent Reactor Safety Commission (RSK) and the Commission on Radiological Protection (SSK) also report to BMU. Furthermore, while the federal government is primarily responsible for introducing legislation, the Länder are responsible for its administrative implementation and are involved in shaping energy government and state committees as well as regulation of local energy utilities. Meeting Germany's ambitious energy policy targets and objectives

requires very close co-operation between policy makers to successfully manage the immense challenges of implementing the necessary changes in energy policy.

RECOMMENDATIONS

The government of Germany should:

- *Take steps to maximise co-ordination between the Federal Ministry of Economics and the Federal Ministry for the Environment on matters relating to energy policy complemented by measures to involve the Länder and the two ministries to ensure the effective delivery of Germany's long-term goals.*
- *Ensure that efficient and streamlined planning and consenting procedures for essential energy infrastructure are put in place and complemented by regulatory measures to ensure the cost-effectiveness of new network infrastructure.*
- *Strengthen regional co-operation to ensure a structured exchange of information, data, goals and plans to increase security of electricity supply as well as the acceptance of increased variability of electricity generating capacities. This co-operation should also extend to natural gas.*

3. ENERGY EFFICIENCY

Key data (2011)

Energy supply per capita: 3.8 toe (IEA average: 4.6 toe), -6.9% since 2000

Energy intensity: 0.11 toe per USD PPP 1 000 (IEA average: 0.14 toe per USD PPP 1 000), -18.4% since 2000

TFC: 221 Mtoe (oil 41.6%, natural gas 23.2%, electricity 20.3%, biofuels and waste 6.2%, heat 4.5%, coal 3.7%, geothermal 0.3%, solar 0.2%)

Consumption by sector: industry including non-energy use 35.6%, residential 25.4%, transport 24.5%, commercial and other services 14.5%

OVERVIEW

Energy efficiency plays an important role in the 2010 Energy Concept. One of its aims is to make Germany one of the worlds most energy-efficient and environment friendly economies, while at the same time offering affordable energy prices and a high level of prosperity.

FINAL ENERGY USE

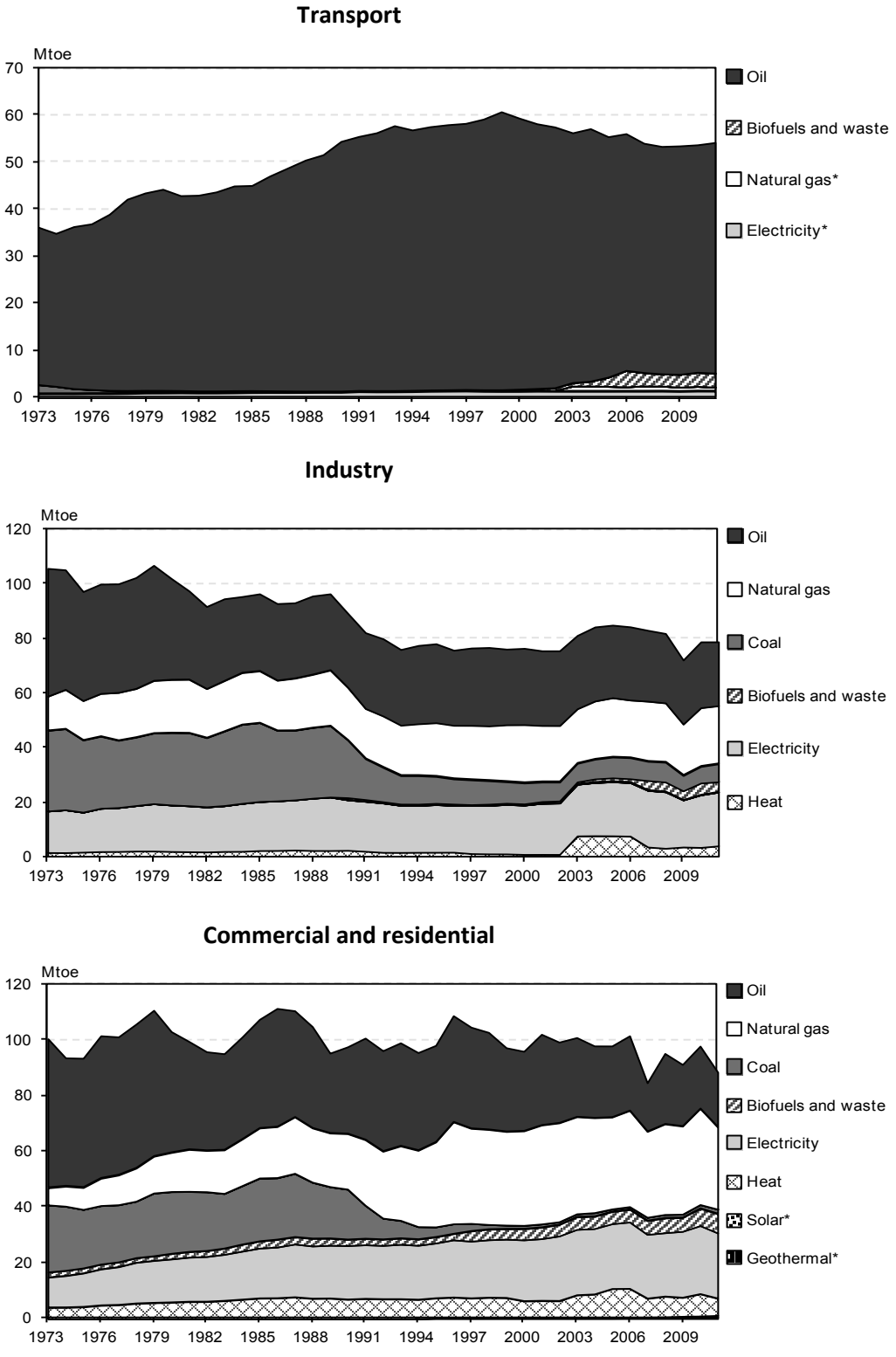
FINAL CONSUMPTION PER SECTOR

Total final consumption (TFC) has remained relatively unchanged over the past three decades, ranging between 215 and 250 million tonnes of oil equivalent (Mtoe). In 2011, consumption was 221 Mtoe, with the industry sector consuming 35.6%. Residential sector and transport accounted for 25.4% and 24.5%, respectively, while commercial and other services shared 14.5% of TFC in 2011.

Germany's share of industry in TFC is in the mid-range compared to other IEA member countries, as is the share of transport. However, the share of the residential sector is high among IEA members, ranking ninth-largest in 2011. TFC in the industry sector has increased by 3.1% since 2000, while usage in the transport sector and the commercial and residential sectors combined fell by 8.8% and 7.9%, respectively.

Over 85% of energy consumption is from oil, natural gas and electricity. Oil products represent 41.6% of TFC, with more than half consumed by transport. Natural gas and electricity account for 23.2% and 20.3% of energy consumption, respectively, and are primarily used in industry and in the residential and commercial sectors. Biofuels and waste consumption has grown strongly over the past decade, increasing from 2% of TFC in 2000 to 6.2% of TFC in 2011. Higher use of biofuels in industry and transport has partially offset the use of oil in those sectors.

Figure 6. **Total final consumption by sector and by source, 1973-2011**



* Negligible.

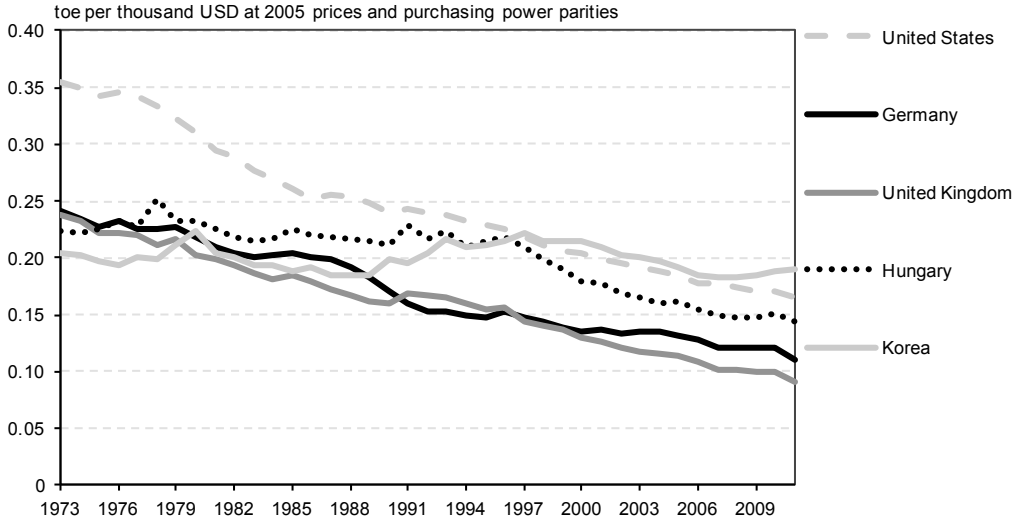
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and country submission.

ENERGY INTENSITY

Energy intensity, measured as the ratio of energy supply by GDP, decreased by 18.4% since 2000. Germany has an energy intensity of 0.11 tonnes of oil equivalent (toe) per thousand USD at PPP, which is lower than the IEA average of 0.14 toe per 1 000 USD PPP, and ranked tenth-least intensive in 2011. This is an improvement from 2000, when Germany ranked thirteenth-least energy intensive country among IEA members.

The most significant decline of 8.2% occurred in 2011, as TPES fell in times of growing GDP. Over the decade to 2011, energy intensity contracted at an annualised rate of 2.2%.

Figure 7. **Energy intensity in Germany and in other selected IEA member countries, 1973-2011**



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and *National Accounts of OECD Countries*, OECD Paris, 2012.

INSTITUTIONS

Several federal ministries share responsibility for the development and implementation of energy efficiency policies while some responsibility also rests at Länder level. The lead responsibility lies with the **Federal Ministry of Economics and Technology** (BMWi).

Other ministries have responsibility for specific areas, such as the **Federal Ministry of Transport, Building and Urban Development** (BMVBS) for buildings and transport, and the **Federal Ministry of Finance** (BMF) for energy taxation.

In 2009, the **Federal Energy Efficiency Centre** (BfEE) was created within the **Federal Office of Economics and Export Control** (BAFA). This body is tasked with verifying the indicative energy savings target, as required under articles 4 and 5 of the Energy Services Directive, as well as preparing the National Energy Efficiency Action Plans (NEEAPs). In addition, since the implementation of the Act on Energy Services and Other Energy Efficiency Measures (EDL-G) in November 2010, a large number of tasks and duties were added to its responsibilities. A fundamental focus of the work of the BfEE is monitoring and developing the market for energy services, energy audits, and other energy efficiency measures.

The **German Energy Agency** (DENA), in which the federal government has a share of 50%, works with a large number of agents in political community, industry and society in

order to promote energy efficiency throughout the country. A network of important institutional promoters has emerged over the course of many years, and each of these makes a significant contribution to increasing energy efficiency.

The **German Federation of Energy Conservation and Climate Protection Agencies** (EAD) includes 32 energy and climate protection agencies. These agencies make an important contribution to the development of markets for energy services and energy efficiency measures.

As a result of the federal system, the **Länder and municipalities** are largely independent and often formulate their energy efficiency policy separately.

POLICIES AND MEASURES

EUROPEAN UNION POLICIES

The European Union has a primary energy reduction target of 20% below the 2007 projected energy demand target of 2020. Several European Union directives relating to energy efficiency guide German energy efficiency policy and this is likely to increase with the advent of the new Energy Efficiency Directive in 2013.

The Directive on Energy End-Use Efficiency and Energy Services (2006/32/EC) required member states to develop national energy efficiency action plans and to meet an indicative target to reduce final energy use in the sectors not covered by the EU Emissions Trading Scheme (EU-ETS) by 9% by 2016.

On 25 October 2012, the EU adopted the Directive on Energy Efficiency (2012/27/EU) which repealed Directive 2006/32/EC. The new directive establishes a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union's 2020 headline target of 20% on energy efficiency and to pave the way for further energy efficiency improvements beyond that date. It lays down rules designed to remove barriers in the energy market and overcome market failures that impede efficiency in the supply and use of energy, and provides for the establishment of indicative national energy efficiency targets for 2020.

The Directive on the Energy Performance of Buildings (EPBD, 2002/91/EC) and its 2010 successor (EPBD, 2010/31/EU) established requirements for building codes. These codes include minimum energy performance requirements (MEPs) and energy certificates. The 2010 recast requires new buildings to be at "nearly-zero energy" performance by the end of 2020.

The Ecodesign Directive (2009/125/EC) sets minimum energy performance standards (MEPS) for energy-related products. Fifteen product groups have been regulated so far by product-specific implementing regulations so (additional products will be added in 2013).

Energy labelling of energy-related products is required under the Energy Labelling Directive (2010/30/EU); product-specific labelling standards are set up in delegated regulations under this directive.

Since May 2009, new passenger cars manufactured in the European Union fall under the CO_2 emissions regulation (Regulation 443/2009), which effectively limits the fuel efficiency of vehicles. By 2015, CO_2 emissions of new passenger cars must be at, or below, 130 grams CO_2 per kilometre (CO_2/km). Complementary measures are being introduced to reduce the CO_2 emissions of non-engine components by a further 10 g CO_2/km through

efficiency improvements in non-engine components, such as tyres and transmission technology. The CO_2 emissions limit is expected to be reduced to 95 g CO_2/km by 2020. A similar regulation for new vans was introduced in May 2011. The CO_2 emissions of heavy-duty vehicles are not regulated at present; however, the future introduction of regulations is planned.

Box 1. **EU energy efficiency regulations**

On 25 October 2012, the EU adopted the Directive 2012/27/EU on Energy Efficiency, which establishes a common framework of measures for the promotion of energy efficiency within the European Union in order to achieve the Union's 2020 20% target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date. It lays down rules designed to remove barriers in the energy market and overcome market failures that impede efficiency in the supply and use of energy, and provides for the establishment of indicative national energy efficiency targets for 2020.

Overall, the directive is considered an important milestone for EU-wide co-operation on energy efficiency. It calls for binding measures rather than binding targets. Each member state should set its own target and present a national efficiency action plan every three years, beginning in 2014. The new directive requires each member state to:

- Set a national energy savings target in line with the EU-wide 20/20/20 target.
- Establish a long-term strategy for renovating the building stock, including a renovation rate of 3% for buildings occupied and used by central government.
- Develop public procurement rules ensuring that central governments purchase only high-efficiency products.
- Oblige energy providers to achieve cumulative end-use energy savings by 2020 equivalent to 1.5% of annual energy sales over the period 2014-20. Member states can pursue alternative ways to achieve equivalent energy savings.
- Require all large enterprises to undergo quadrennial energy audits.
- Facilitate development of national financing facilities for energy efficiency measures.
- Ensure that individual meters of energy consumption are installed at the end-user level, if technically possible and economically feasible.

The directive may fall short (by 3% to 5%) of the 2020 target. It requires a review in mid-2014; a shortfall in energy savings may result in a shift from binding measures to binding targets.

DOMESTIC POLICIES

Germany published a second NEEAP in 2011, with a target to improve energy efficiency by 9% between 2007 and 2016, incorporating an energy savings target of 748 petajoules (PJ) by 2016 and an interim target of 456 PJ for 2010. The plan includes measures to target energy efficiency improvements in all sectors, with most of the projected energy savings coming from the residential sector, where the bulk of potential cost-effective improvements can be found. Federal government initiatives and measures relating to energy efficiency on the demand side focus on the following areas:

- *buildings*: accelerated exploitation of the potential for energy savings in the buildings sector, especially involving residential buildings;
- *public sector*: increased measures involving delivery of the "extensive economic energy potential" in public buildings and in public-sector procurement;
- *industry*: support for measures designed to increase energy efficiency in the trade, retail, services, agricultural and industrial sectors, in particular in small and medium-sized enterprises (SMEs);
- *transport*: improving the technical fuel efficiency of passenger cars and heavy-duty vehicles, with support for greater market penetration of fuel-efficient vehicles and non-engine components such as low-resistance tyres and oils;
- *public awareness*: increasing information and motivation of consumers on energy efficiency and training and education for professionals.

The second NEEAP outlines 89 measures to increase energy efficiency and it estimates the energy savings that can be delivered by each. Results of the second NEEAP indicated that Germany will significantly exceed a 9% reduction in energy end-use by 2016. As expected, most (60%) of the energy savings will be achieved in the buildings sector.

CROSS-SECTORAL POLICIES

The multi-phased implementation of the Ecological Tax Reform Law of 1999 introduced important changes to energy prices. The first stage increased tax rates on petroleum and implemented an electricity tax. Four further petroleum tax increases were implemented between 2000 and 2003 and tax rates for heavy fuel oil for heat and power production were consolidated into one rate. The fifth stage of environmental tax was implemented in 2003 and it increased tax rates on natural gas, liquid petroleum and heavy fuel oil. These tax reforms can be interpreted as being supportive of improvements in energy efficiency.

For economic, environmental and socio-political reasons, there are several tax reliefs available for energy use. For example, energy-producing and energy-consuming industries are granted tax reliefs on energy in order to take account of the insufficient harmonisation of the tax regulations in the EU for companies in international competition. From 2013 on, important tax reliefs for these industries (tax cap or *Spitzenausgleich*) are linked to energy efficiency measures such as implementation of energy management systems and achieving energy efficiency targets.

The Energy Efficiency Fund, supported by revenues from the Energy and Climate Fund, was established in 2011. (The Energy and Climate Fund is funded by revenues from the EU-ETS.)

As a result of the low trading price of carbon during 2011 and 2012, EUR 89 million was raised in 2012. While this is less than expected, it is likely to be sufficient as many measures likely to be supported by the scheme remain under development. In future, the fund will support the provision of energy advice to households and low-income families will be exempt from payment for energy advice.

Other uses will include supporting measures to increase energy efficiency in SMEs and municipalities, for example by a support scheme of energy-efficient technologies and production lines as well as energy management systems, and innovative municipal energy efficiency measures.

Since 1978, consumer advice centres have been available to provide specialist consultations on matters relating to energy. This service is offered to consumers in return for a small fee at information points in local consumer advice centres. Supporting information campaigns have also been implemented to raise consumer awareness (such as the initiative on Energy Efficiency by the German Energy Agency).

BUILDINGS

Germany is a among the world leaders in terms of energy-efficient buildings. The 2010 Energy Concept includes several aims for the building sector to be achieved by 2020 and 2050:

- reduction of the heat demand by 20% by 2020;
- from 2020, all new buildings should be "climate-neutral" in compliance with primary energy-specific values;
- around 80% reduction of the primary energy demand in the buildings sector by 2050, which will require doubling the renovation rate of buildings from less than 1% of the total building stock per year at present to a new target of 2%.

A first evaluation of progress made is planned for 2020. Energy requirements in German building codes are determined at national level by means of the Energy Saving Act (*Energieeinsparungsgesetz*, EnEG) and the Energy Saving Ordinance (*Energieeinsparverordnung*, EnEV). Following the most recent amendment to the Energy Saving Ordinance in 2009, minimum energy performance requirements for new and existing buildings were raised by 30% on average. At present, Germany is evaluating whether it is economically feasible to strengthen those requirements further in an amendment planned for 2013.

Germany applies strict energy requirements in building codes (EnEV) compared to other countries. The average energy consumption for heating of individual residential buildings is 135 kWh/m² in 2011 (temperature adjusted) and since 2009 the building code sets an average limit of about 50 kWh/m² to 70 kWh/m² for the primary energy demand of new buildings.

Furthermore, Germany has a range of policies in place for the energy-efficient refurbishment of existing buildings, including a high target to increase the refurbishment rate to 2% annually of the existing building stock; however, refurbishment of existing buildings is not mandatory.

The KfW, a non-profit public banking group, manages a loans and grants programme for the refurbishment of old buildings and ecological construction, that exceed the minimum energy performance requirements of the Energy Savings Ordinance. The goal of this programme is to help customers meet the increased upfront costs of energy efficiency refurbishment. This is one of the most significant programmes worldwide in terms of ambition and amounts of finance available. In the view of the responsible ministry, the Federal Ministry of Transport, Building and Urban Development (BMVBS), it represents one of the most important instruments of the federal government for saving energy and protecting the climate. Between 2012 and 2014, EUR 1.5 billion is expected to be disbursed annually for the construction and renovation of low-energy buildings; however, the rate of renovation of the building stock has remained below 1%. In addition, the federal government has – as part of its decisions adopted in 2011 on the accelerated implementation of the Energy Concept – decided to review whether a market-based and budget-neutral solution (such as white certificates) can be applied from 2015.

Box 2. **The EnEV and financing the refurbishment of buildings**

The EnEV is a code that specifies minimum energy performance requirements for buildings as well as for heating, ventilation, air conditioning (HVAC) and water boilers. The EnEV was first introduced in 2002 and applies to all buildings that need either heating or cooling. Germany is one of the few countries to have specific minimum energy performance requirements for the refurbishment of existing buildings. They apply when 10% or more of the existing building component surface is changed or when more than 15 m² of floor space is added.

The EnEV replaced in 2002 two separate ordinances on thermal insulation and heating systems. Thus for the first time building shells and technical appliances for heating, cooling and ventilation were conceived as an entity. Small changes to the ordinance were introduced in 2003/2004 and 2007 owing to changes in standards set by the German Standardisation Institute DIN and in order to implement the EU Directive on the Energy Performance of Buildings.

In 2009, however, the EnEV was substantially changed and requirements were tightened. New aspects included the adoption of reference buildings in the residential area and measures to strengthen enforcement. Requirements for annual primary energy demand for new buildings were tightened by 30% on average and thermal insulation (U-value) requirements were tightened on average by 15%. Minimum energy performance requirements for existing buildings were strengthened in the same order of magnitude.

A financing programme to promote energy-efficient retrofits for private homes was introduced in 2001 as the "CO_2 refurbishment of buildings" programme and superseded in 2009 by the "Energy-efficient refurbishment programme". Both programmes provide preferential loans and grants to investors in energy efficiency measures in buildings. Since 2009 eligibility criteria for loans are based on the Bank for Reconstruction's (Kreditanstalt für Wiederaufbau, KfW) Efficiency House which uses EnEV energy performance requirements. This provides investors with comprehensive energy performance targets for building that are aligned with the German building codes.

Since 1995, all new buildings are obliged to be issued with an energy certificate. In addition, since 2009, the seller, landlord or lessor is obliged to make an energy performance certificate available to interested parties in the event of sale, letting or leasing. Among other things, the energy performance certificate contains information on the year of construction, use of the building, usable surface area, and type of heating, water heating, and type and percentage of renewable energies. In addition, the energy certificate contains recommendations for modernisation, where it is estimated that economically viable energy savings exist.

From 2012, the federal government will construct only ultra-low energy buildings for public-sector use as an example of good practice. The government has also called on the construction industry to commit to continued training of craftsmen in energy performance improvements and may if necessary improve the training regulations. A long-term roadmap is being drawn up to meet future targets which will focus on harnessing market forces to upgrade the building stock. Owners and investors will be encouraged to refurbish buildings on a voluntary basis.

Table 2. **Summary of main features of "CO_2 refurbishment of buildings" and "energy-efficient refurbishment"**

Characteristics	CO_2 refurbishment of buildings	Energy-efficient refurbishment
Duration	August 2001 – March 2009	April 2009 – present
Type	Preferential loans, and since 2007 also grants. No possibility to apply for both a loan and a grant.	Preferential loans and grants. No possibility to apply for both. Loans for very ambitious retrofitting measures include a loan repayment allowance.
Target	Refurbishment of existing residential buildings.	Refurbishment of existing residential buildings.
Eligible measures	Thermal insulation, HVAC, renewable energy (for warm water and heating).	Thermal insulation, HVAC, renewable energy (for warm water and heating).
Efficiency requirements	Choice of predefined packages of measures or since October 2008 also measures leading to compliance with EnEV standards for new houses.	Introduction of the KfW Efficiency House as a benchmark using the EnEV standard for new houses. Size of grants and loans depends on the efficiency level reached with regard to this benchmark. Also single measures become eligible.

Note: HVAC = heating, ventilation, and air conditioning.

Source*: Mobilising investment in energy efficiency: economic instruments for low-energy buildings*, IEA Insights Paper, Paris 2012.

TRANSPORT

The automobile industry in Germany plays a leading role in developing fuel-efficient technologies for the European and global automobile markets. German energy efficiency policy in the transport sector largely targets improving the technical efficiency of light and heavy-duty road vehicles rather than switching to more fuel-efficient modes of transport.

The European regulation on CO_2 emissions for new passenger cars was introduced in 2009 (Regulation No 443/2009) and sets emissions standards for new passenger cars that limit the fuel economy of the vehicles. German manufacturers and cars sold in Germany will have to comply with the limits as they are introduced, requiring 65% of new cars to meet the 130 g/km target in 2012, 75% in 2013, 80% in 2014, and 100% in 2015. The regulation will be complemented by additional measures corresponding to a reduction of 10 g CO_2/km. A similar regulation for new light commercial vehicles was introduced in 2011 (Regulation No 519/2011).

In compliance with the European Union Directive 1999/94/EC, passenger car labelling covers fuel economy and CO_2 emissions. The methodology used in Germany to rate cars is weight-based and therefore in some cases, larger, heavier vehicles may be rated with a better CO_2 efficiency grade than a smaller vehicle. This methodology allows consumers to compare passenger vehicles within the same vehicle class. Heavy goods vehicles are subject to a mileage-based road toll on federal motorways and some heavily-used trunk roads, the rate is dependent on the emission category of the vehicle but not the CO_2 efficiency label.

The Deutsche Bahn (German National Railways) has committed to reducing CO_2 emissions from trains. The passenger transport, rail freight transport and logistics business areas have separate energy and CO_2 reduction targets. Each business is responsible for the definition and control of its individual measures.

The 2010 Energy Concept outlines a specific target for energy reduction in the transport sector. Several initiatives are addressed.

The Federal Ministry for Transport, Building and Urban Development has initiated a Mobility and Fuel Strategy which includes all modes of transport. The outcome of this

process is to be a strategy for the transport sector which will provide solutions to energy and climate challenges.

Great hopes seem to be pinned on electric and hydrogen vehicles delivering significant potential to reduce fossil fuel energy consumption in the near and long-term future. The German government has committed to the objective of one million electric vehicles in Germany by 2020 and six million vehicles by 2030. A number of policy measures are being implemented in order to reach this objective. The government programme for electric mobility contains number of policies for the promotion of electric mobility. For the development of fuel cell vehicles, powered by hydrogen, the National Programme of Innovation for Hydrogen and Fuel Cell Technology will have provided around EUR 1.4 billion of public and private capital by the year 2016 to academia and industry for research in hydrogen and fuel cell projects.

Mobility measures are in place and funding is provided to public transport in municipalities from federal petroleum fuel tax revenues. Since 2008, a national cycling plan and a Mobility Management Action Programme have been piloted by the German Energy Agency in 15 regions. Since 1999, eco-driving has been included in driving licence training, also supported by a web portal providing information and advice to drivers.

INDUSTRY AND SERVICES

GHG emissions from energy-intensive industries and the electricity sector are covered by the European Union Emissions Trading Scheme (EU-ETS) which encourages improvements in energy efficiency.

A voluntary agreement between German industry and the federal government to reduce CO_2 emissions has been in place since 1995. The objective was to reduce CO_2 emissions by 20% between 1987 and 2005. This agreement was updated to achieve a reduction of emissions by 35% between 1990 and 2012.

The KfW provides financing, under the European Recovering Programme (ERP) Environmental Protection and Energy Efficiency Programmes, for SMEs to invest in energy efficiency technologies. The energy performance of technologies must be 15% better than the sectoral average for new investments, and 30% greater than average energy consumption for the previous three years for replacement investments. Additional KfW financing, the Special Fund for Energy Efficiency in SMEs, is available to support energy advice for trained independent energy efficiency counsellors to SMEs and proposals for measures for energy and cost-saving measures.

Tax relief is currently provided to all energy and electricity consumed for industrial use, in order to take account of the insufficient harmonisation of the tax regulations in the EU for companies in international competition. From 2013 on, important tax reliefs for industries (*Spitzenausgleich*) are linked to energy efficiency measures such as implementation of energy management systems and achieving energy efficiency targets.

APPLIANCES

European Union law, in particular the Ecodesign Directive 2009/125/EC and Directive 2010/30/EU on Energy Labelling (as well as related product-specific regulations based on both directives), regulates the energy performance of appliances in Germany. The Energy-related Products Act (EVPG) in 2011 implemented the first of these directives.

Energy labelling requirements are set under the Energy Labelling Act and Ordinance (EnVKG, EnVKV) in compliance with Directive 2010/30/EU.

Supporting measures include a law on public procurement (Ordinance on Public Procurement of August 2011) which named energy efficiency as an important criterion in public procurement. In addition, other voluntary eco-labels such as Energy Star are in place. Market surveillance of electrical equipment has been introduced under an adaptation of Regulation (EC) No. 765/2008 on market surveillance. This provides for:

- consistent provisions on enforcement on the federal level;
- continuous development of market surveillance concepts and programmes;
- better coordination between the federal administration and the Länder by means of the Federal Institute for Material Research and Testing as a coordinating body.

ASSESSMENT

Energy efficiency is an important pillar of the 2010 Energy Concept and the country has set a target of 20% reduction in primary energy consumption by 2020 and 50% by 2050. It has also plans to reduce electricity consumption by 10% by 2020 and by 25% by 2050. The IEA welcomes the adoption of these ambitious targets. The buildings sector has been identified as the key sector in meeting these energy savings. Nonetheless, greater detail is required on the measures likely to achieve the targets set in each sector.

As a next step, the IEA encourages the federal government to implement consistent and cost-effective instruments to achieve its targets across all sectors. There is still much to be done if Germany wishes to reduce its TPES by 20% by 2020 and a comprehensive assessment of the energy-saving potentials and targets for the individual sectors appears is urgently needed.

The national action plan provides some information regarding the instruments with which energy savings could be achieved but a consistent package of instruments and funding mechanisms to achieve the overall targets set in the Energy Concept for 2020 and 2050, and interim targets along this path, remains unfinished. In particular, broad strategies for energy efficiency in industry and transport appear to be lacking. The target to reduce energy consumption by 10% by 2020 and by 50% by 2050 in the transport sector has no firm basis. In the buildings sector, it is difficult to understand how the targets will be reached by using only current measures. Monitoring and evaluation of progress can further strengthen this process.

In the buildings sector, Germany has developed and implemented stringent, long-term targets for the existing building stock and new buildings. It will be very important to ensure that the correct mix of measures is in place to achieve these goals.

The KfW provides preferential loans and grants for refurbishments but the annual funding of the programme is dependent on the federal budget and it has suffered from unstable funding levels in the past. In this regard, the IEA welcomes the move to finance the refurbishment programme from the Energy and Climate Fund; however, the level of funding must remain stable regardless of fluctuations in the carbon market. The IEA also welcomes plans to link the eligibility criteria for the financing of buildings through the refurbishment programmes to the building codes set by the Energy Savings Directive, a policy that will encourage comprehensive improvements in the energy performance in

buildings. Grants for single component-based measures are also available and Germany should remain vigilant that there are more attractive incentives available for whole building approaches. Single energy efficiency measures should remain a precursor to deeper building retrofits rather than an opportunity for lost energy savings locked-in to the building.

Building refurbishment programmes are evaluated regularly and Germany is encouraged to continue assessing the technical and economic efficiency of these programmes. Germany has adopted a refurbishment rate target of 2% per year but additional incentives or regulations will be needed. According to the 2010 Energy Concept, scientific analysis suggests that up to EUR 10 billion of savings are available to German industry each year through investment in energy efficiency. While energy-intensive industry is part of the European Union Emissions Trading Scheme, and some support measures have been put in place for SMEs, more could be done to co-ordinate and promote energy efficiency in industry.

From 2013 on, energy efficiency measures such as introducing energy or environmental management systems in industry are required for companies which are granted the tax cap (*Spitzenausgleich*). In addition, from 2013 on, energy efficiency targets have to be achieved for this tax relief; energy efficiency improvements will be monitored and the results will be made public. Greater incentives are needed and government-led energy management programmes are a good first step to encourage companies to put in place energy management systems.

At the moment, significant tax relief applies to heating fuels and electricity used by companies in the manufacturing and agricultural sectors. This is a result of insufficient harmonisation of tax regulation in the EU for trade-exposed industries. From 2013 onwards, important tax reliefs for industries (*Spitzenausgleich*) are linked to energy efficiency measures such as implementation of energy management systems and achieving energy efficiency targets. In general, energy taxes are an efficient way to internalise the external costs of using energy, and this is an important cross-sectoral instrument to achieve energy efficiency targets, especially in the industry sector. Moreover, with energy taxes, the non EU-ETS sector (less energy-intensive industries and the services sector) could be better priced for the use of energy, without which effective instruments are missing otherwise. Utilities could also be better involved in delivering energy efficiency improvements to their customers.

At present, EUR 89 million is provided from the Energy and Climate Fund in the form of grants for energy-efficiency projects in industry and SMEs and advice programmes for households and municipalities. This funding is used predominantly for grants for energy efficiency investment where pay back periods are deemed too long and also for consulting, energy checks and management (so-called voluntary schemes). Germany should continue this programme in a cost-effective way, evaluate it after four to five years, and assess if market barriers are lowered through the programme.

Carbon emissions from the transport sector have fallen over the past decade, mainly as a result of technological progress. With EU-wide emissions standards for automobiles, Germany will achieve further energy savings in this sector. This should be complemented by further investment in measures to increase modal shift, such as strengthening the public transport systems in urban centres.

Further measures are needed to improve the efficiency of freight transport. Germany should support the introduction of emission standards for heavy-duty vehicles (HDVs) in Europe. The toll system for HDVs could also be enhanced in order to encourage more freight transport by rail and support should be provided for the development of more

efficient freight logistics where appropriate. Consideration should be given to extending the toll system to light-duty commercial vehicles and eventually to passenger cars.

Tax relief for commuting by car sends a negative price signal in terms of encouraging car use rather than public transport. Instead, Germany should take steps to encourage the use of public transportation and consider road pricing in congested areas. A sustainability plan for transport infrastructure should also be developed. The vehicle labelling system should better align absolute vehicle fuel consumption and CO_2 emissions with vehicle taxes.

Notwithstanding Germany's strong progress, the government should continue efforts to fully implement, where appropriate, the IEA recommendations for improving energy efficiency (see Box 3).

Box 3. **IEA 25 energy efficiency recommendations**

In 2011, in order to reflect emerging priorities, the IEA, in consultation with international experts and member countries, streamlined and updated the 25 recommendations. The updated 25 recommendations cover a robust portfolio of policies that member and non-member countries should consider in the context of their energy economies.

This portfolio of recommendations includes policies to cost-effectively increase energy efficiency by establishing market signals to motivate effective action, accelerate the introduction of new technologies, and strengthen and enforce MEPS for appliances, lighting, equipment and building energy codes.

1. To improve *energy efficiency* across all sectors, the IEA recommends action in the following areas:

- energy efficiency data collection and indicators;
- strategies and action plans;
- competitive energy markets, with appropriate regulation;
- private investment in energy efficiency;
- monitoring, enforcement and evaluation of policies and measures.

2. To achieve savings in the *buildings sector*, the IEA recommends:

- mandatory building energy codes and minimum energy performance requirements;
- aiming for net zero energy consumption in new buildings;
- improving energy efficiency of existing buildings;
- building energy labels and certificates;
- energy performance of building components and systems.

3. To achieve significant energy savings in the *appliances and equipment* sector the IEA recommends:

- mandatory energy performance standards and labels for appliances and equipment;
- test standards and measurement protocols for appliances and equipment.

Box 3. **IEA 25 energy efficiency recommendations** *(continued)*

4. To achieve significant energy savings in the *lighting sector*, the IEA recommends:

- phase-out of inefficient lighting products and systems;
- energy-efficient lighting systems.

5. To achieve significant energy savings in the *transport sector,* the IEA recommends:

- mandatory vehicle fuel efficiency standards;
- measures to improve vehicle fuel efficiency;
- fuel-efficient non-engine components;
- improving operational efficiency through eco-driving and other measures;
- improve transport system efficiency.

6. To achieve significant energy savings in the *industrial sector*, the IEA recommends:

- energy management in industry;
- high-efficiency industrial equipment and systems;
- energy efficiency services for SMEs;
- complementary policies to support industrial energy efficiency.

7. To achieve significant *energy savings* in energy utilities and end use efficiency, the IEA recommends:

- governments should establish regulatory and other policies to ensure that energy utilities support cost-effective, verifiable end-use energy efficiency improvements.

RECOMMENDATIONS

The government of Germany should:

- ☐ *Secure stable and long-term funding for the building refurbishment programme. Further measures may be needed to achieve the annual 2% target. Any incentives should be tied to ambitious energy performance standards and include economic indicators in annual evaluation mechanisms.*
- ☐ *Continue to move away from tax reliefs in the industrial sector and instead focus on requirements for energy management and reporting of energy savings opportunities identified; reward the best in class companies and provide support for capacity - building in SMEs with grants from the Energy and Climate Fund.*
- ☐ *Increase efforts to improve energy efficiency in the transport sector by encouraging modal shift for passenger and freight transport; consider aligning vehicle labels with the motor taxation system, and consider road pricing for the passenger cars.*

4. CLIMATE CHANGE

Key data (2011)

Total GHG emissions (excluding LULUCF)*: 916.8 Mt CO_2-eq, -26.4% since 1990

2008-12 target: -21% from 1990

CO_2 emissions from fuel combustion: 747.6 Mt, -21.3% since 1990

Emissions by fuel: coal 41.6%, oil 34.2%, natural gas 21.8%, other 2.4%

Emissions by sector: electricity and heat generation 43.4%, transport 19.9%, manufacturing and construction 15.3%, residential 11.9%, services and other 9.5%

* Source: Federal Environment Agency.

OVERVIEW

Germany is the largest GHG emitter in the European Union, and the third-largest in the IEA, after the United States and Japan. It has successfully decoupled GHG emissions from economic growth. Emissions from all sectors of the economy have declined since 2000 and in the Energy Concept, the country has established ambitious targets for GHG emissions cuts: by 40% by 2020, a 55% reduction by 2030, a 70% reduction by 2040 and an 80% to 95% reduction by 2050.

TARGETS AND OBJECTIVES

Germany is among the few Annex I parties to the United Nations Framework Convention on Climate Change that will comply with its commitments under the Kyoto Protocol exclusively through GHG emissions reductions. Domestic GHG emissions declined by 11.8% between 2000 and 2011, and in 2011 they were 26.4% below the Kyoto Protocol base year level, 936.5 million tonnes CO_2-equivalent (Mt CO_2-eq) compared to 1 246.1 Mt CO_2-eq. According to the first preliminary calculations and estimations of the Federal Environment Agency (UBA), GHG emissions in 2012 rose by 1.6% to 931 Mt CO_2-eq compared to 916.8 Mt CO_2-eq in 2011.[6]

Under the Kyoto Protocol, Germany is committed to an average reduction of GHG emissions of 21% below the base year level over the period 2008-12. According to the latest official inventory, GHG emissions were 2.8% lower in 2011 (916.8 Mt CO_2-eq) compared to 2010 (943.8 Mt CO_2-eq) but 27% below base year.[7] The fall in emissions from the energy sector was the major driver of the decrease, accounting for 28.6 Mt CO_2-eq.

6. Press Release No. 09/2013, The Federal Environment Agency, 25 Feb. 2013.

7. *Berichterstattung unter der Klimarahmenkonvention der Vereinten Nationen und dem Kyoto-Protokoll 2013, Nationaler Inventarbericht Zum Deutschen Treibhausgasinventar 1990-2011*, Federal Environment Agency, January 2013.

Germany has also committed to GHG reductions by 2020 as part of the EU Climate and Energy Package. The Effort Sharing Decision established binding annual GHG emission targets for EU member states for the period 2013-20. These targets concern emissions from most sectors not included in the EU Emissions Trading Scheme (EU-ETS), such as transport (except aviation), buildings, agriculture and waste. The Effort Sharing Decision sets national emission targets for 2020, expressed as percentage changes from 2005 levels. It also lays down how national limits in tonnes for each year from 2013 to 2020 are to be calculated.

Germany is committed under the Effort Sharing Decision to a 14% reduction of its emissions in the non-trading sector by 2020 relative to 2005 levels. According to the latest report published by the European Environment Agency, Germany is projected to meet its 2020 targets in the sectors not covered by the EU-ETS with the current set of domestic policies and measures.[8] Free certificates will no longer be issued to power plant operators for electricity production in the third trading period (2013-20). This announcement comes from the Federal Environment Agency (UBA), where the German Emissions Trading Authority (DEHSt) is also located. Between 2013 and 2020, around 1.4 billion emission certificates distributed to about 1 700 installations will be allocated free of charge.

On 28 September 2010, the German government adopted the Energy Concept and established strategic targets for Germany's energy and climate policy for the long term. The Energy Concept was updated in 2011 following the Fukushima Daiichi nuclear accident earlier that year. The Energy Concept set out a GHG reduction target of 40% below 1990 levels by 2020 and set additional reduction targets of 55% by 2030, 70% by 2040 and 80% to 95% by 2050 each relative to 1990. The latest projections suggest that Germany will achieve a significant reduction of its domestic GHG emissions by 2020 on the basis of existing measures but additional measures will be required to fully comply with the 40% reduction target.

ENERGY-RELATED CO_2 EMISSIONS

SOURCES OF CO_2 EMISSIONS

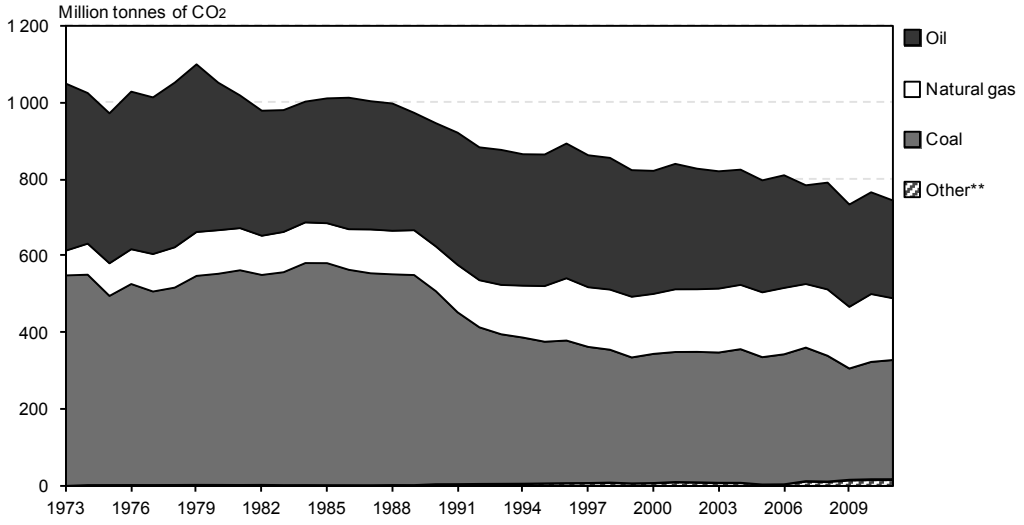
In 2011, CO_2 emissions from fuel combustion accounted for the largest share (81.5%) of GHG emissions in Germany. Since 1990, the share of emissions from fuel combustion has increased from 76.2% of total GHG to 81.5%, indicating that CO_2 emissions from fuel combustion have declined at a slower rate compared to total emissions. Germany has reduced its CO_2 emissions from fuel combustion by 21.3% since 1990, from 949.7 million tonnes (Mt) in 1990 to 747.6 Mt in 2011.

More than 75% of CO_2 emissions from fuel combustion are from coal and oil usage: 41.6% and 34.2% respectively in 2011 (Figure 8). CO_2 emissions from these fuels have declined since 1990, with emissions from coal down by 38.4% and emissions from oil reduced by 20.6%. Overall, the share of coal and oil in emissions from fuel combustion has decreased from 87.1% in 1990. The reduction in emissions from coal and oil coincides with a fall in total energy sourced from these fossil fuels over the past two decades, from 249.9 Mtoe in 1990 to 179.3 Mtoe in 2011.

8. EEA Report No 6/2012, *Greenhouse gas emission trends and projections in Europe 2012 – Tracking progress towards Kyoto and 2020 targets*, European Environment Agency, October 2012.

Natural gas consumption was responsible for approximately 163 Mt CO_2 in 2011, representing 21.8% of energy-related emissions. This is 38% higher than in 1990 (118 Mt CO_2), when natural gas accounted for 12.4% of the total. Natural gas applications and usage have developed and broadened over the years, resulting in higher emissions from this source. A similar trend is exhibited by the usage of waste for energy, with total emission from this source up from 4.5 Mt CO_2 in 1990 to 17.6 Mt CO_2 in 2011 reflecting greater use of this energy source.

Figure 8. **CO_2 emissions by fuel*, 1973-2011**

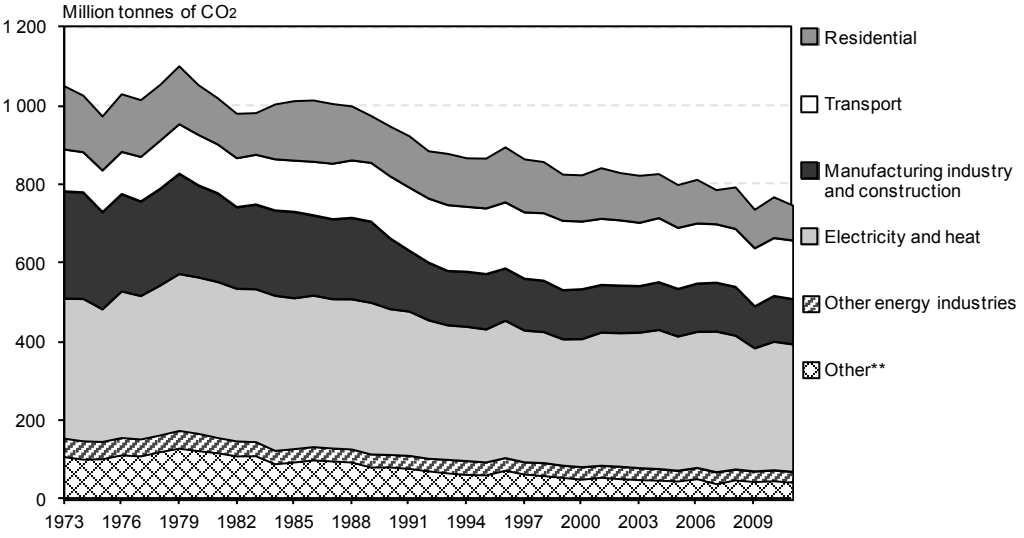


* Estimated using the IPCC Sectoral Approach.

** *Other* includes industrial waste and non-renewable municipal waste.

Sources: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2012 and country submission.

Figure 9. **CO_2 emissions by sector*, 1973-2011**



* Estimated using the IPCC Sectoral Approach.

** *Other* includes emissions from commercial and public services, agriculture/forestry and fishing.

Sources: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2012 and country submission.

The power generation sector accounted for 43.4% of energy-related emissions in 2011 (Figure 9). Electricity and heat generation in Germany is moderately CO_2-intensive as coal, natural gas, and oil represent more than 50% of energy sources used in generation.

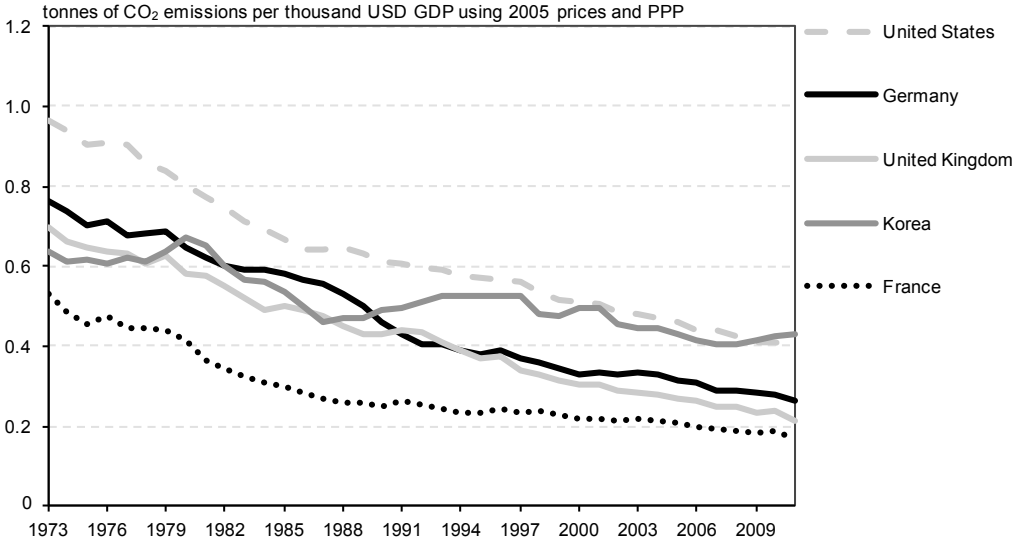
Over the past two decades, the share of power generation in CO_2 emissions from fuel combustion has increased slightly from 39.1% in 1990, indicating that the electricity and heat generation sector has reduced emissions at a somewhat slower rate compared to a reduction in total GHG. A similar trend was exhibited by the transport sector, which accounted for 19.9% of energy-related emissions in 2011, up from 16.6% in 1990. Emissions from the transport sector decreased by 5.6% since 1990 and total CO_2 emissions from fuel combustion fell by 21.3% over the same period.

The manufacturing industry and construction sectors accounted for 15.3% of CO_2 emissions from fuel combustion in 2011, down from 18.9% in 1990. Commercial and other services also reduced their share of energy-related emissions over the past two decades, from 12% in 1990 to 9.5% in 2011. The residential sector was the source of 11.9% of energy emissions in 2011, which is slightly lower than 13.4% in 1990.

CO_2 INTENSITY

Germany emitted 0.26 tonnes of CO_2 per USD 1 000 of GDP on a PPP basis in 2011 (Figure 10). This is 19.2% lower than the average for IEA member countries, yet 8% higher than the average for European IEA member countries.

Figure 10. **Energy-related CO_2 emissions per GDP in Germany and in other selected IEA member countries, 1973-2011**



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and *National Accounts of OECD Countries*, OECD Paris, 2012.

Since 1990, Germany has reduced the CO_2 intensity of its economy by nearly 40%, at a consistent rate. As a comparison, carbon intensity of the IEA average declined by 30.3% over the same period. As such, Germany's rank among IEA members has changed from tenth most carbon-intensive in 1990 down to seventeenth in 2011.

CO_2 intensity of electricity and heat generation has also contracted over the past two decades. In 2011, the power generation sector emitted 443 grams of CO_2 per kilowatt hour (g/kWh) of electricity and heat, decreasing by 19.8% since 1990.

TRENDS AND PROJECTIONS

GHG EMISSIONS

The Fifth National Report of the Government of the Federal Republic of Germany (Fifth National Communication) prepared under the Kyoto Protocol to the United Nations Framework Convention on Climate Change contains a number of projections for GHG emissions based on “with-measures” scenarios. The "with-measures" scenario includes the measures that have already been implemented or for which implementation has been approved or will take place in the near future. Such measures include a politically determined decreasing role for nuclear power and a clear reduction in dependence on coal-fired electricity production but do not take into account changes to the Energy Concept in 2011.

Table 3. **Break-down of total GHG emissions, in the “with-measures” scenario, by gases, 2000-20**

	Million tonnes CO_2-equivalent				
	2000	**2005**	**2010**	**2015**	**2020**
Carbon dioxide (CO_2)	883.4	876.9	829.4	800.5	754.6
Methane (CH_4)	64.7	47.7	40.6	35.8	31.2
Nitrous oxide (N_2O)	59.1	65.5	59.5	50.6	49.8
Hydrofluorocarbons (HFC)	6.5	9.9	12.3	11.2	10.1
Perfluorocarbons (PFC)	0.8	0.7	0.4	0.4	0.4
Sulphur hexafluoride (SF6)	5.1	3.4	2.4	2.9	3.5
Total	1 019.5	1 004	944.7	901.5	849.6
With respect to 2005	*1.5%*	*-*	*-5.9%*	*-10.2%*	*-15.4%*
With respect to 1990	*-17%*	*-18.2%*	*-23.1%*	*-26.6%*	*-30.8%*
With respect to base year	*-17.3%*	*-18.5%*	*-23.3%*	*-26.9%*	*-31.1%*
International air transport and maritime bunkering	24.8	29.3	33.2	37.7	42.8

Note: base year for carbon dioxide, methane and nitrous oxide is 1990. For HFC, PFC and SF_6 the base year is 1995.

Source: Fifth German submission to the UNFCCC.

Accordingly, the Fifth National Communication forecasts that GHG emissions will decrease by about 15.4% in 2020 below the 2005 level. Compared to 1990, the base year of the Kyoto Protocol, that decrease amounts to an emissions reduction of 31.1%. The largest contribution to the reduction comes from CO_2 emissions, which account for over 80% of the total emissions reduction.

In terms of sectoral changes, almost half of the emissions reductions come from the energy sectors, especially the electricity generation sector. The transport sector provides the second-largest contribution, while the third-largest group of emissions reductions is achieved in the area of process-related GHG emissions. Emissions reductions of about 18% are achieved in final consumption sectors, with the exception of industry, and in the area of energy transformation.

INSTITUTIONS

Responsibility for climate policy lies with the federal government. The **Federal Ministry for the Environment, Nature Conservation and Nuclear Safety** (Federal Ministry for the Environment or BMU) is the lead ministry with responsibility for coordinating climate policy. The ministry is primarily concerned with fundamental environmental policy including climate protection, the interaction between environment policy and energy policy, efficient use of resources and energy, as well as protecting people's health from environmental pressures and international co-operation. It oversees emissions trading, the National and International Climate Initiative, CCS, waste and resource efficiency, biodiversity and international forest sinks protection, adaptation to climate change, EU climate policy and international climate negotiations. It is also responsible for renewable energy policy.

Other ministries have responsibility for related sectors: The **Federal Ministry of Economics and Technology** (BMWi) is responsible for energy policy (except renewable energy) and energy efficiency; the **Federal Ministry for Transport, Building and Urban Development** (BMVBS) oversees policies on transport and buildings; the **Federal Ministry of Education and Research (BMBF) is responsible for basic research on resource and energy efficiency; the Ministry of Finance** (BMF) is responsible for climate-related fiscal issue, *e.g.* taxation, while the **Federal Ministry for Food, Agriculture and Consumer Protection** (BMELV) is responsible for land use, agriculture and forestry policy.

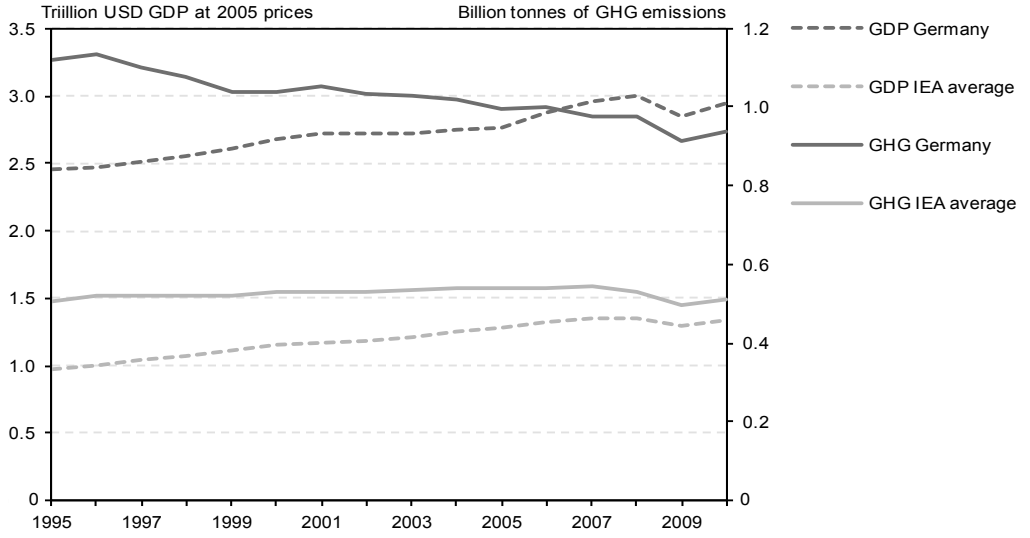
The **Federal Environment Agency**, established in 1974, is Germany's central federal authority on environmental matters. Its key statutory mandates are: to provide scientific support to the federal government; to implement environmental laws; and to inform the public about environmental matters.

There are no regional emissions trading schemes in Germany. Regional governments are, however, implementing additional climate policies or support programmes in some cases. Some of the Länder have, however, established regional GHG reduction targets as have some large cities.

POLICIES AND MEASURES

Germany is one of the few OECD countries that have (has) successfully decoupled economic growth and GHG emissions over the past decade. The policies and measures used to achieve this are largely based on greater use of renewable energy and improved energy efficiency. The EU-ETS has also played a part alongside a number of market-based instruments such as ecological taxes, the use of which Germany pioneered (see Chapter 2 for more details).

Figure 11. **Greenhouse gas emissions and GDP growth in Germany and the IEA, 1995-2010**



Sources: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2012 and country submission.

INTEGRATED ENERGY AND CLIMATE PROGRAMME

In August 2007, the Federal Cabinet adopted an ambitious energy and climate programme, consisting of 29 key elements aimed at higher levels of energy efficiency and greater use of renewable energy. On 5 December 2007, the cabinet submitted a comprehensive package of 14 acts and ordinances. Another smaller package containing further legislative proposals followed in May 2008. The programme combined changes in the legal framework with investments in R&D.

Table 4. **Components of the Integrated Energy and Climate Programme and GHG emissions reduction targets**

Policy	**Emissions reduction per year by 2020**
Reduce electricity consumption	40 Mt CO_2-eq
Modernisation of fossil-fired power stations	30 Mt CO_2-eq
Promotion of electricity generation from renewable energies	55 Mt CO_2-eq
Promotion of combined heat and power generation	20 Mt CO_2-eq
Modernisation of buildings and heating systems	41 Mt CO_2-eq
Heat saving in production processes	n/a
Use of renewable energies in heat production	14 Mt CO_2-eq
Energy saving measures in the transport sector	30 Mt CO_2-eq
Other GHG emissions reduction measures	40 Mt CO_2-eq
Total reductions	**270 Mt CO_2-eq**

Source: Fifth National Report of the Government of the Federal Republic of Germany (Fifth National Communication) to the UNFCCC, Federal Government of Germany, 2012.

The aim of the programme was to reduce GHG emissions in Germany by 40% by 2020, compared to 1990 levels. While the programme excluded a long-term development path up to 2050, it proposed a reduction of German GHG emissions by 40% compared with 1990 as a contribution towards global emissions reductions or an increase in the proportion of electricity generated from renewable sources to at least 30% by 2020. The programme was based on the conviction that energy must be used with much greater efficiency than was the case at the time, and a much higher priority must be placed on the use of low-carbon energy.

The adopted measures aimed to prove that climate protection is both affordable and compatible with economic growth. For this reason, the German government pursued policies that deliver favourable results in keeping CO_2 emissions low, but in as cost-effective manner as possible. A key role of the Integrated Energy and Climate Programme was to promote research and innovation, both on the supply side and on the demand side, in innovative energy technologies. In May 2008, the Federal Cabinet adopted the second package implementing the Integrated Energy and Climate Programme. The seven acts and ordinances of the second package focused on increasing energy efficiency.

THE ENERGY CONCEPT

In September 2010, the federal government adopted the Energy Concept, prepared jointly by the Federal Ministry for the Environment and the Federal Ministry of Economics, which established Germany's energy policy until 2050. In June 2011, against the backdrop of the Fukushima Daiichi nuclear accident in Japan, the Energy Concept was revised following a decision to accelerate the phase-out of nuclear power in Germany. Taking into account this revision, the federal government adopted additional measures to speed up its implementation. The updated Energy Concept endorsed the main strategic targets of Germany's energy and climate policy for the long term.

The Energy Concept builds on the government commitment to reduce GHG emissions by 40% by 2020 and by at least 80% by 2050. It indicates that reaching the 2050 target will imply a 55% reduction by 2030 and a 70% reduction by 2040. The intention of the Energy Concept is to set specific strategic goals to provide long-term orientation while preserving the flexibility required for new technical and economic developments. It established the following goals:

- GHG emissions are to be reduced by 40% by 2020, 55% by 2030, 70% by 2040 and by 80% to 95% by 2050, compared to 1990, the reference year;
- primary energy consumption is to fall by 20% by 2020 and by 50% by 2050;
- energy productivity is to rise by 2.1% per year based on final energy consumption;
- electricity consumption is to fall by 10% by 2020 and by 25% by 2050, compared to 2008;
- compared to 2008, heat demand in buildings is to be reduced by 20% by 2020, while primary energy demand is to fall by 80% by 2050;
- renewable energies are to achieve an 18% share of gross final energy consumption by 2020, a 30% share by 2030, 45% by 2040 and 60% by 2050;
- by 2020, renewables are to have a share of at least 35% in gross electricity consumption, a 50% share by 2030, 65% by 2040 and 80% by 2050.

EU EMISSIONS TRADING SCHEME (EU-ETS)

The EU-ETS established in 2003 by Directive 2003/87/EC, is a mandatory cap-and-trade system covering CO_2 emissions from installations in ten energy-intensive sectors: combustion installations (power and heat generation), refinery processes, coke ovens, metal ores, steel, cement, glass, lime, ceramics, and cellulose and paper. The EU-ETS was launched in 2005 and its first commitment period ran until the end of 2007. The second phase covered the period 2008-12. Installations in the EU-ETS can meet their obligations either by implementing emissions reduction measures of their own, or by purchasing allowances from other installations covered by the EU-ETS, or by purchasing credits from the Kyoto Protocol's flexible mechanisms (Joint Implementation or the Clean Development Mechanism).

The EU-ETS recently commenced its third phase, which will run from 2013 to 2020. The third phase is significantly different from previous phases including the introduction of single EU-wide ETS Cap. The ETS Cap will be calculated on the basis of a 1.74% reduction per year from 2010 onwards, resulting in a total reduction of 21% until 2020 based on the 2005 emissions levels. Auctioning, rather than free allocation is the default mechanism for allocating allowances. In 2013, more than 40% of allowances will be auctioned, and this share will rise progressively each year. The electricity production sector will no longer receive free allocation of credits from 2013 onwards. A separate cap applies to the aviation sector. For those sectors where allowances will still be given away for free, such as the industry and heat sectors, harmonised allocation rules apply, based on EU-wide benchmarks of emissions performance

According to Germany's National Allocation Plan for the second phase of the EU-ETS (2008-12), the country's total annual allocation was about 453 million allowances per year. Of these, around 9% are to be auctioned annually.

On 24 August 2011, the Federal Cabinet introduced a regulation, Allocation Ordinance 2020, which transposed EU provisions governing the allocation of allowances for GHG emissions in the 2013 to 2020 trading period into German law. The regulation allowed the federal government to allocate allowances free of charge to energy-intensive industry and heat facilities in the trading period between 2013 and 2020. The number of free allocations in this period will be less than in previous trading periods as a result of the exclusion of electricity from the free allocation of allowances. Many facilities will receive allocations based on product-related emission levels: "product benchmarks" have been fixed for the whole of Europe and are based on the most efficient 10% of European facilities. Accordingly, inefficient plants will have to buy an increased number of emission allowances in the future. Facilities exposed to possible carbon leakage will receive most of their allowances for free. At the same time, free allocation to other facilities will be gradually reduced from 80% to 30% of the benchmark-based allocation between 2013 and 2020.

MEASURES IN THE TRANSPORT SECTOR

Eco-tax reform

Germany was one of the first IEA member countries to successfully implement ecological tax reforms. Reform commenced in April 1999, with the enactment of the Act on the Introduction of the Ecological Tax Reform of 24 March 1999 (Ecological Tax Reform Act), which gradually increased the excise duties applied to fossil fuels, and implemented a

tax on electricity consumption. The objectives of the tax were twofold: to mitigate CO_2 emissions and to boost job creation and boost innovation.

The Ecological Tax Act provided for increases in four further steps from 1 January 2000 to 1 January 2003 but tax rates have remained unchanged since then. A defining feature of the tax was the use of a large portion, up to 90%, of the revenue derived from the tax to offset payroll contributions from employers and employees. An additional feature of the tax was the provision of special exemptions for trade-exposed energy-intensive manufacturers. The current statutory tax rates for the most important energy products are presented in Table 5.

Table 5. **Statutory tax rates on energy products**

Taxable item	Tax rate
Fuels	
Petrol	EUR 654.5 per 1 000 litres
Diesel	EUR 470.4 per 1 000 litres
Heating fuels	
Fuel oil	EUR 61.35 per 1 000 litres
Liquid petroleum gas	EUR 60.6 per 1 000 kg
Natural gas	EUR 5.5 per 1 000 MWh
Electricity	20.50 per MWh

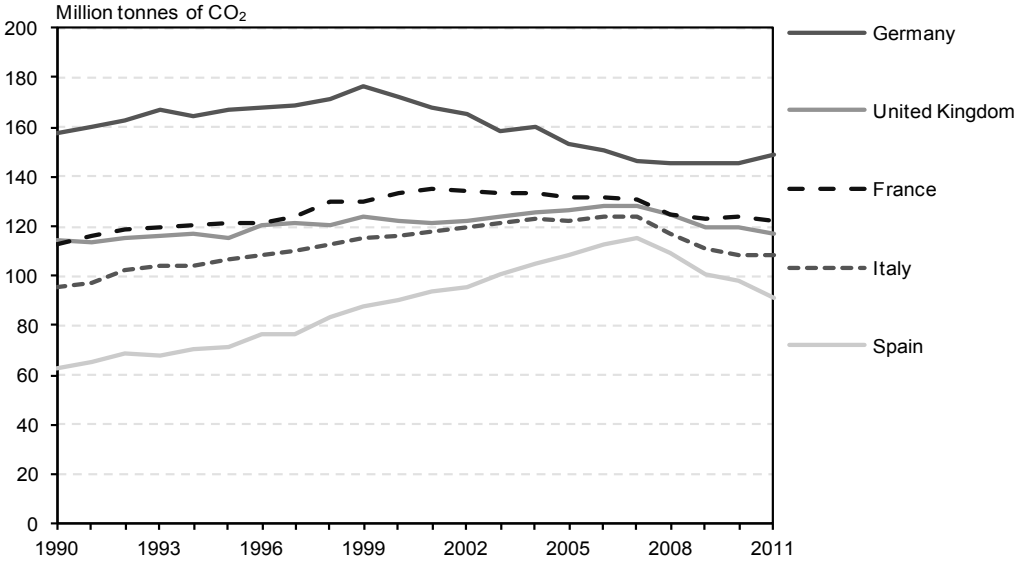
Source: BMWi.

The eco-tax reform programme has contributed to reducing energy consumption and GHG emissions most notably in the transport sector, where emissions have decreased significantly despite greater use of road transport. Between 2000 and 2010, the amount of goods hauled by the German heavy good fleet increased by almost 12% while the number of passenger miles driven increased by 7%.[9] Environmental taxes on transport (fuel and other taxes) as a percentage of total taxation were 4% in 2010 compared to 5.2% in 2005. From 2013 onwards, in order to create a further incentive for increasing energy efficiency in the manufacturing sector, important tax reliefs for industries (*Spitzenausgleich*) are linked to energy efficiency measures such as implementation of energy management systems and achieving energy efficiency targets.

Nonetheless, and despite the benefits of the ecological taxes there are inherent weaknesses in the mechanism that lessened their potential impact. Their application appears arbitrary at times; there is no correlation between the level of emissions and the amount of tax levied. In Germany the diesel rate is applicable on commercial and non-commercial use. To compensate this tax advantage for private car owners the motor vehicle tax on privately owned diesel-powered cars doubles the tax on gasoline-powered cars. For most people who drive an average number of kilometres per year this eats up the tax advantage on diesel. A further problem is that the rates have remained static since 2003 although there have been some amendments most recently in 2011.

9. *EU Transport in Figures; Statistical Pocketbook 2012*, European Union, 2012.

Figure 12. **CO_2 emissions in the transport sector in Germany and in other selected IEA member countries, 1990-2011**



Sources: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2012 and country submission.

Vehicle taxes

The Motor Vehicle Tax Act (KraftStG) was amended in 2009 to take into account the volume of CO_2 emissions. In order to encourage the purchase of passenger vehicles with low CO_2 emissions, output of 120 g/km or less, no CO_2-based motor vehicle tax is payable. The limit was reduced to 110 g/km for cars newly registered in 2012 and 2013 and will be lowered to 95 g/km for cars newly registered from 2014.

Owners of diesel passenger vehicles of emissions standard Euro 6, which were first registered between 2011 and 2013, receive a maximum motor vehicle tax exemption of EUR 150. To create an incentive to purchase electric passenger cars, there was a tax exemption for these vehicles which was limited to five years. This tax exemption is now extended up to ten years for all electric vehicles newly registered as from 18 May 2011 up to the end of 2015.

In 2009, CO_2 emissions of motor vehicles fell by 6.4%. In July 2009, the number of new passenger vehicle registrations with a CO_2 figure in the tax-exempted range increased by 175.2% compared to the same month in the previous year. By contrast, there was a fall in the number of new registrations of passenger vehicles with high CO_2 emissions.

In 2005, mileage-based road toll for heavy commercial vehicles on federal motorways and some heavily-used trunk roads was amended to account for pollutant class.

In order to promote the use of natural gas-driven motors for environmental and climate policy reasons, the Energy Tax Act provides for reduced tax rates for natural gas and liquefied petroleum gas (LPG) used as a motor fuel until 31 December 2018. For natural gas, these are EUR 13.90/MWh instead of EUR 31.80/MWh, and for LPG EUR 180.32/1 000 kg instead of EUR 409/1 000 kg.

2009 Vehicle Scrapping Programme

In January 2009, within the framework of the Second Economic Programme, the federal government adopted a funding programme for the award of an environmental bonus to the value of EUR 2 500. This was granted as a once-off subsidy on application to the Federal Office of Economics and Export Control (BAFA) where a private car owner bought a new or one-year-old car and at the same time could prove that he or she had had a car scrapped that was at least nine years old. The objective of this bonus was to replace old passenger vehicles with high emissions of classical pollutants with new, more efficient vehicles. The funding amount was increased to EUR 5 billion owing to the very high level of demand.

Other tax-related measures in the transport sector

In order to improve the competitive position of local public transport, tax concessions are granted to fuels (gasoline, diesel, LPG, natural gas) used in road and rail vehicles for local public transport. The tax concession for natural gas is EUR 1.0/MWh on the natural gas rate quoted previously. The total value of subsidies for 2011 is estimated to be EUR 71 million.

Passenger Vehicle Energy Consumption Labelling Ordinance

Introduced in 2004 – under European Directive 99/94/EC – and amended in 2011, the Passenger Vehicle Energy Consumption Labelling Ordinance (Pkw-EnVKV) obliges vendors of new passenger vehicles to provide information on their fuel consumption and CO_2 emissions. A 2011 amendment to the Ordinance added a coloured CO_2 efficiency scale to the existing numerical CO_2 figures. In addition to consumption and efficiency information, the label must in future also include information on the annual tax and the average annual cost of energy sources (fuel and electricity) in order to provide consumers with additional information when taking purchasing decisions.

OTHER MEASURES AND INITIATIVES

International measures

Germany is on track to achieve its Kyoto target of -21% over the period 2008-12 compared to base year level through domestic measures. For its GHG reduction targets beyond 2012, Germany is currently not planning to rely on international flexible mechanisms.

The Energy and Climate Fund

In 2010, to support the implementation of the Energy Concept, the German government established a separate budget structure, the Special Energy and Climate Fund, to finance national and international climate-related expenditures. At the time of establishment, it was understood that approximately 20% of the new fund's revenue should be provided by the nuclear power sector with the remaining 80% coming from the proceeds generated by the auction of CO_2 certificates. Following the 2011 decision to phase-out nuclear power, the funding arrangements were revised in order to address the shortfall

of revenue from the nuclear power sector. Today, all auctioning revenues from the EU Emissions Trading System in Germany are fed into the energy and climate fund.

In March 2012, the Federal Ministry of Finance allocated EUR 452 million to government departments and increased the budgetary framework for making commitments on new measures to around EUR 3.9 billion.

The key spending areas identified were:

- building refurbishment for lower carbon emissions;
- advancement of electric mobility;
- international climate and environment protection;
- energy efficiency.

A total of EUR 9.7 billion were estimated to be available to the Energy and Climate Fund from 2013 to 2016 which supplements the energy and climate policy funding provided in the federal budget.

International Climate Finance

High levels of investment are needed to help developing countries reduce their emissions of GHGs and adapt to climate change. Germany is shouldering its responsibilities as regards helping to finance the necessary measures and has long been one of the largest donors for climate action in developing countries and emerging economies. In recent years, the German government has systematically expanded its involvement in this sector: in 2009, German investments for climate change mitigation and adaptation in developing countries amounted to EUR 989 million. This amount has grown within the last years and reached a total of about EUR 1.4 billion in 2012. The major share (almost 90%) of funding stems from the Federal Ministry for Economic Cooperation and Development (BMZ); the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) contributes more than 10% to Germany's International Climate Finance.

Germany is providing funding for climate measures involving both bilateral and multilateral co-operation. The major share of BMZ funding goes to bilateral programmes in countries where Germany is engaged in development co-operation.

Alongside the bilateral programmes, which Germany is implementing together with its partners, multilateral mechanisms also play a major role in the financing of climate projects in developing countries. The BMZ's contributions to international funds and facilities in 2010 amounted to 20% to 30% of the overall climate finance.

Other measures

The federal government has put in place a number of other regulations to reduce GHG emissions in a number of sectors.

Table 6. **Other measures to reduce GHG emissions**

Measure	Purpose
Greenhouse Gas Emissions Trading Act (*Treibhausgasemissionshandelsgesetz*)	The Greenhouse Gas Emissions Trading Act obliges the energy sector, energy-intensive industries and airlines to submit emission certificates for their CO_2 emissions. A substantial proportion of the certificates are auctioned to the companies and revenue from the auction is channelled into climate funding programmes.
Income Tax Act (*Einkommensteuergesetz*)	Governs tax deductibility of craftsmen's services for energy upgrading.
Energy Tax and Electricity Tax Act (*Energiesteuergesetz und Stromsteuergesetz*)	Regulates the taxation of motor fuels, heating fuels and electricity. From 2013 on, industries shall only be eligible for the tax cap (*Spitzenausgleich*) if they provide evidence of energy efficiency measures.
Renewable Energy Sources Act (*Erneuerbare-Energien-Gesetz* – EEG)	Establishes the feed-in priority of renewable energies over other energies and guarantees fixed payments for renewable electricity.
Renewable Energies Heat Act (*Erneuerbare-Energien-Wärmegesetz* – EEWärmeG)	Stipulates that in newbuilds, a certain percentage of energy must come from renewable sources.
Energy Conservation Act (*Energieeinsparungsgesetz* – EnEG) Energy Saving Ordinance (*Energieeinsparverordnung* – EnEV)	Regulate energy standards for newbuilds and comprehensive modernisation of existing buildings.
EU regulation on CO_2 standards for new cars	Establishes emissions limits for cars and light duty vehicles: maximum emissions limit for new cars = 130 g CO_2/km.
Motor-vehicle tax	Taxation of motor vehicles according to their CO_2 emissions. In motor-vehicle tax, use of an emissions-oriented and engine displacement-oriented calculation basis as of 1 July 2009. That change will apply to passenger cars newly registered as of 1 July 2009. Introduced in 2004 – under European Directive 99/94/EC – and amended in 2011, adding a coloured CO_2 efficiency scale to the existing numerical CO_2 figures. In addition to consumption and efficiency information, the label must in future also include information on the annual tax and the average annual cost of energy sources (fuel and electricity) in order to provide consumers with additional information when taking purchasing decisions.
Federal Trunk Road Toll Act (*Bundesfernstraßenmautgesetz*)	Requirement for goods vehicles above 12 tonnes to pay tolls on motorways and four-lane federal trunk roads. Progressive toll according to emission class. Spreading of truck road-use toll rates on the charged road network, for trucks with more than 12 tonnes permissible total weight, (for three-axle vehicles: EUR 0.141/km, EUR 0.169/km, EUR 0.190/km and EUR 0.274/km, depending on emissions class; for vehicles with four or more axles: EUR 0.155/km, EUR 0.183/km, EUR 0.204/km and EUR 0.288/km, depending on emissions class).
Regulatory framework for CCS (in preparation)	The framework established the regulatory regime for carbon capture, transport and storage.
Waste Shipment Ordinance (*Verordnung zur Verbringung von Abfällen*)	Prohibits use of untreated waste in landfill since July 2005 in order to reduce methane emissions.
EU regulation on fluorinated GHG (review underway at present)	Aims to reduce the use and leakage of climate-damaging fluorinated greenhouse gases in air conditioning.

Sources: BMWi, BMU.

Other initiatives

In addition to the federal government, many of Germany's Länder have developed and implemented climate change strategies of their own. Such activities include:

- implementing federal and EU regulations and support programmes;
- enacting their own projects, efforts and measures;
- carrying out their own support programmes and enacting their own relevant legal provisions.

In recent years, municipalities have made large contribution towards national climate objectives. One of currently six support programmes within the National Climate Initiative is specifically designed for municipalities and social and cultural establishments. Municipalities are encouraged to prepare, as a broad group, to implement their own climate protection measures. Federal government funding is available, for instance, for both long-term climate protection concepts covering the whole of the local authority area, and individual projects such as the installation of high-efficiency lighting systems in public buildings, or the CO_2-neutral modernisation of an entire school. Box 4 summarises such activities in the city of Hamburg.

Box 4. **Climate Action Plan of Hamburg**

The Free and Hanseatic City of Hamburg implemented its climate action plan in 2007. The aim was to help to reduce Hamburg's CO_2 emissions in 2012 by 2 million tonnes compared to 2007 (a reduction from 17.6 Mt CO_2-eq to 15.6 Mt CO_2-eq). The city has set ambitious targets for future development: reducing CO_2 emissions by 40% by 2020 and 80% by 2050, compared with the EU target of 20% by 2020. This target is to be achieved by municipal actions, federal and European Union policies, efforts of the industrial sector to reduce its CO_2 emissions, raising awareness and technological progress.

The city has been proactive in its efforts to reduce CO_2 emissions, with a Municipal Climate Protection Act, adaptation and research programmes. The climate protection programme, approved by the local government in 2007, identifies ten areas of action covering over 450 individual measures. The city invests up to EUR 22.5 million a year in these measures.

An example of a successful scheme is the Enterprise for Resource Protection partnership programme, which has resulted in the completion of about 1 000 projects to date. The aim of the programme is to encourage voluntary investment in increasing energy and resource efficiency in enterprises. For each euro invested by local government, participating companies contribute EUR 10. This has generated total private investment of EUR 146 million matched by municipal support of EUR 15 million. In total, the enterprises participating are estimated to currently save 134 000 tonnes of CO_2 emissions each year.

In recognition of its achievements to date, and on its intentions for further action, the European Commission awarded its European Green Capital Award 2011 to the city.

Sources: European Commission, Hamburg Parliament.

ASSESSMENT

Germany is one of the few IEA member countries to have successfully decoupled GHG emissions from economic growth over the last two decades. The country is on track to meeting its Kyoto 2008-2012 period commitment of 21% resulting from the internal EU

burden-sharing agreement and is likely to exceed this target by using domestic measures only. Germany has also committed to the EU climate and energy package to reduce GHG emissions, increase its renewable energy share and improve energy efficiency by 2020. Under this strategy, Germany is part of the EU-ETS with an EU-wide cap on emissions of 21% less than 2005 emissions. The German target for reduction of emissions from the non-traded sectors has been set to 14% below 2005 emissions.

Securing energy supply and protecting the climate are among the energy policy goals of the Energy Concept and Germany's aim is to become a world leader in the fields of energy efficiency and environmental protection while simultaneously maintaining competitive energy prices and a high level of prosperity. The Energy Concept contains four strands of domestic measures to reduce GHG emissions: the expansion of renewable energies, improving energy efficiency, increasing the number of electric vehicles, and increasing energy technology R&D.

In 2010, Germany introduced a comprehensive set of targets set out in the Energy Concept to reduce GHG emissions: a 40% reduction by 2020, 55% reduction by 2030, 70% reduction by 2040 and 80% to 95% by 2050 compared with 1990. The objective is to reduce GHG emissions, simultaneously improve energy security and economic efficiency in a long-term strategy. Nonetheless, transforming Germany into a low-carbon economy over the next three decades will require a sustained effort. For the near term, recent modelling shows that existing policy measures on their own will not be enough to achieve the 40% target by 2020 and additional measures will be needed in all sectors.

Energy-related CO_2 emissions in Germany are split between the energy, industrial, transport, household and tertiary sectors, in order of significance. The non-traded sectors in Germany include transport, buildings (residential and non-residential), and less energy-intensive industry. There are significant measures already in place to reduce GHG emissions by using energy efficiency, fuel switching, and renewable energy in these sectors, yet there is no quantification of the measures.

There appears to be no cross-sectoral energy price and taxation strategy, which favours low-energy consumption and production, and low-carbon emissions. The move to link tax relief originally provided for industry, agriculture and forestry enterprises as part of the ecological tax reform to improved energy performance is welcomed. Energy taxes are set at federal level and tax reliefs are available for industry.

The IEA welcomes federal government plans to assess, for energy and climate policy and also for all other sectors of the economy, whether subsidies that make short-run sense can be replaced in the medium term with market-based solutions that do not rely on public funds (in the case of climate policy objectives, for example, by introducing tradable "white certificates" on the heating energy market).[10]

The EU-ETS caps CO_2 emissions in the energy-using industrial and power generation sectors, and plays a central role in Germany's plans to move to a low-carbon economy. Approximately 9% of German permits have been auctioned to date and all permits for power generation will be auctioned from 2013. The revenue from these will be placed in the Energy and Climate Fund and were estimated to reach EUR 2 billion in 2013. The federal government plans to provide up to EUR 500 million per year from the Energy and Climate Fund to energy-intensive industries to compensate for electricity price rises

10. The Twenty-Third Subsidy Report of the Federal Government, Federal Ministry of Finance, 2012.

resulting from the EU-ETS, complementing, as necessary, a support volume of up to EUR 300 million from the Federal budget. The precise amount depends on the relevant future CO_2 price and the EU state aid guidelines, which are currently being drafted by the European Commission.

There could be significant interactions between the German unilateral targets and the EU-ETS in both directions. The current EU-ETS price is relatively low (less than EUR 5.0 as of February 2013) and this may have implications for the achievement of the German 40% reduction target in 2020 owing to switching from gas to greater coal use. Similarly, longer-term climate goals may be jeopardised if the low carbon price deters investment in new low-carbon infrastructure, instead locking in higher emissions for decades to come. Conversely, the increased share of renewable energy in Germany under the 2020 unilateral renewable energy targets should reduce the emissions from power generation in Germany. Greater co-ordination between national and European level policy making could help ensure that policies set at these levels do not end up undermining one another.

Although Germany's record in reducing GHG emissions from the transport sector is among the best in Europe, the rate of reduction has been slower than in other sectors. A number of robust instruments are already in place including a suite of tax measures and plans to roll out one million electric vehicles by 2020. Nonetheless, further measures are needed to reduce emissions in the transport sector most notably by reforming the ecological tax and motor taxation regimes. Germany is one of the few European countries that place no tax on vehicle purchases. Instead, motorists pay an annual vehicle tax. The absolute amount of vehicle tax paid by German consumers is relatively small compared to the total cost of vehicle ownership, somewhere in the range of 1% to 5%. Furthermore, the CO_2-related component introduced in 2009 is among the lowest in IEA Europe and fails to provide an adequate signal to switch towards smaller, more efficient vehicles.[11]

RECOMMENDATIONS

The government of Germany should:

- ☐ *Review the detailed and ambitious policy measures which have already been introduced in the non-ETS sectors with a view to identifying untapped cost-efficient potentials to further deliver the attainment of the targets contained in the Energy Concept.*
- ☐ *Extend energy (or carbon taxes) in the economy, but especially in the non-ETS sectors, to provide a consistent price signal across all sectors of the economy. The tax cap (*Spitzenausgleich*) should only be awarded when there is a link to significantly improved energy efficiency, which is the case in Germany from 2013 onwards.*
- ☐ *Monitor the impact of low carbon prices on operational and investment decisions in sectors covered by the EU-ETS, and whether these are consistent with short- and long-term climate objectives.*
- ☐ *Encourage more co-ordination between German and European-level policy mechanisms to ensure that the EU-ETS is not affected by stronger German policies.*

11. *OECD Environmental Performance Reviews: Germany 2012*, OECD, 2012.

PART II
SECTOR ANALYSIS

5. NATURAL GAS

Key data (2011)

Production: 10.9 Mtoe, -31.1% since 2000

Share of natural gas: 22.3% of TPES and 13.9% of electricity generation

Imports: 75.1 Mtoe, +23% since 2000

Exports: 14.7 Mtoe, +249.6% since 2000

Inland consumption: 69.6 Mtoe (industry 30.6%, residential 28.9%, power generation 26.4%, commercial services and other 13.2%, transport 0.9%)

OVERVIEW

Germany is the second largest natural gas market in IEA Europe, with robust import and export infrastructure, large storage capacity and a domestic production industry. The country is at the heart of Europe's natural gas supply industry.

SUPPLY AND DEMAND

SUPPLY

At the geographical centre of Europe, Germany has good access to natural gas supplies from the North Sea, the Netherlands and Russia. It also produces about a sixth of its gas supplies, with nearly all reserves located in Lower Saxony, between the Dutch border and the Elbe River. Germany's gas reserves are the fourth-largest in the European Union, behind Norway, the Netherlands and the United Kingdom. According to the *Oil & Gas Journal* (OGJ), natural gas reserves in Germany were 175 billion cubic metres (bcm) in 2011, down from 351 bcm in 1990.

Natural gas supply amounted to 69.6 Mtoe (86 bcm) in 2011, representing 22.3% of total primary energy supply (TPES). Over 11 years since 2000, supply of gas has fallen by 3.1%, which is lower than the 7.4% decline in TPES over the same period.

Indigenous production was 14.8 bcm in 2011, which is relatively unchanged compared to 2010 and 32.7% lower than in 2000. Production accounted for 17.2% of total gas demand in 2011, also down from 25.1% of total consumption in 2000. Natural gas production has been on a steady decline since the beginning of the century, owing to a natural fall-off in extraction from gas fields and declining gas reserves. Government forecasts indicate that indigenous production will continue to decline over the next 20 years, as resources are further depleted. To date, unconventional gas extraction in Germany has been limited to exploratory drilling.

IMPORTS AND EXPORTS

Germany relies on gas imports for the majority of its supply. In 2011, total imports of natural gas were 89.6 bcm, largely sourced from other major European gas producers, with 36.7% coming from Russia, 30.6% from Norway and 25.5% from the Netherlands. These three countries have been the major source of Germany's gas imports for decades, thanks to plentiful resources, long-term contracts and a well-established pipeline infrastructure. With the commissioning of the Nord Stream twin pipeline system in 2012, imports from Russia could be boosted in the future.

Natural gas trade is also high as Germany is an important natural gas transit hub, with significant amounts of natural gas from Russia and Norway transiting the country for delivery to other markets. Exports of natural gas totalled 17.6 bcm in 2011, which is 18.7% higher than total production in the same year. Total exports have increased more than threefold since 2000, when only 24.3% of production was sold abroad. This trend highlights the significance of Germany's geographical position in Europe, pipeline utilisation pressures and the existence of a well-functioning market for gas.

DEMAND

Natural gas demand in Germany is robust, the highest level within the European Union in 2011, and fourth after the United States, Japan and Canada. Demand totalled 86 bcm in 2011, a decrease of 8.8% compared to 2010 and 2% lower than in 2000. Demand fell significantly during 2011 owing to milder winter weather conditions on average, and rising gas prices. Gas consumption has averaged around 90 bcm over the past decade, peaking at 94.3 bcm in 2010.

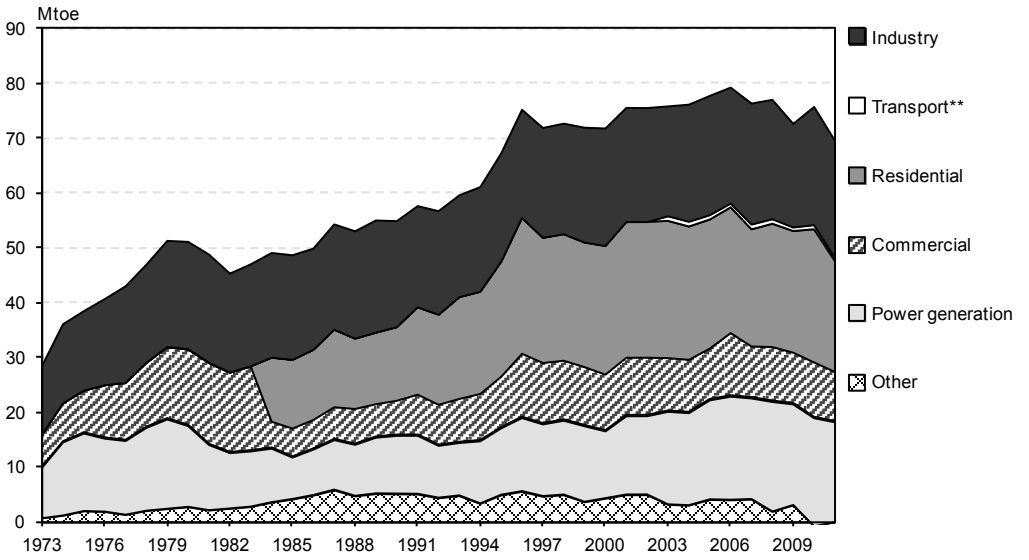
The use of natural gas is spread relatively evenly between residential, power generation and industry consumption. Industry consumption amounted to 30.6% of total supply in 2011 and despite the cold winter in 2011/12, gas used mainly for heating in households accounted for 28.9%, followed closely by power generation at 26.4%. Commercial and services sector accounted for 13.2% of supply, with minor usage of 0.9% by transport. Residential and industry have dominated gas usage for the past decade, while consumption for power generation has increased from 17.1% of total supply in 2000.

According to government projections, Germany will continue to curb its use of gas, with a further decline in consumption expected by 2020 and 2030. The projected decline in total natural gas consumption is largely due to energy efficiency improvements and savings in various areas such as district heating. The government is expecting this decline to more than offset a likely increase in natural gas use for electricity generation.

Projections for the next 20 years indicate that power generation will increase to 33.7% of total supply, industry will continue to be strong at 30.6%, while residential and commercial usage will fall to 24% and 6.9% respectively. The increase in natural gas use for electricity generation is due to the likely need for more CCGTs to provide baseload generating capacity following the decision to phase out nuclear power, and to provide back-up for renewable electricity generation. CCGT capacity is expected to more than double from 20 gigawatts (GW) at present to 50 GW in 2030. Since 2012, however, gas-fired plants struggle to find room in the power mix because of competition from both renewables and coal-fired plants. Despite the decommissioning of nuclear power plants in 2011, the impact on gas in the power sector has been barely noticeable.

Natural gas use in transport will increase to 3.6%, with gas replacing petrol as a more efficient fuel regarding greenhouse gas emissions.

Figure 13. **Natural gas supply by sector*, 1973-2011**



* TPES by consuming sector.

** Negligible.

Note: *Industry* includes non-energy use; *Commercial* includes commercial, public services, agriculture/ forestry, fishing and other final consumption; *Other* includes other transformation and energy sector consumption.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and country submission.

NATURAL GAS INFRASTRUCTURE

TRANSMISSION AND DISTRIBUTION

Germany's natural gas pipeline network is 475 000 km in length and services about 19.5 million customers.[12] The high-pressure transmission pipelines transport gas from gas fields or import points to major centres of population as well as to some large users, such as gas-fired power plants. The distribution networks distribute gas at lower pressure to local gas suppliers (municipal companies) and in some cases to larger final customers. Municipal companies deliver gas to households and businesses.

The high-pressure transmission network is more than 30 000 km-long and is owned and operated by 12 TSOs compared to 22 in 2006. These companies operate in two market areas, namely NetConnect Germany (NCG) and Gaspool. Six TSOs operate in each market area. Open Grid Europe is the largest transmission pipeline operator in Germany, with 12 000 km network length in the NCG market area, and supplies approximately half of Germany's gas demand. Other significant TSOs are Gascade (formerly Wingas), Gasunie, Ontras, and Thyssengas. In 2011, there were 743 DSOs. The structure and ownership of the 12 TSOs in Germany has changed significantly over the past few years, owing to gas market changes and unbundling of production and supply activities and certification for most TSOs in under way.

12. *Statistical Report*, Eurogas, 2012.

Cross-border connections

Germany has an extensive network of pipelines transporting gas from Norway, Russia, and the Netherlands and to a lesser extent from Denmark and the United Kingdom (through Belgium).

Gas deliveries from Norway reach Germany via three pipelines - Norpipe, Europipe I and Europipe II – with total capacity of 54 bcm. Gas deliveries from Russia reach Germany via three pipeline networks – Nord Stream with a capacity of 55 bcm, Yamal with a 33 bcm capacity, and the Ukraine pipeline system with total capacity of 120 bcm. Natural gas from the Netherlands is also transported to Germany via four main pipelines.

The Nord Stream pipeline system is the newest capacity addition to the cross-border connections between Germany and its gas trade partners, fully commissioned in 2012. The system comprises of two parallel offshore natural gas pipelines from Vyborg in Russia to Greifswald in Germany, running through the Baltic Sea. The two pipelines run at 1 224 km each, with a combined capacity of 55 bcm.

There are also two gas further pipeline projects underway and, unlike the previous ones bringing foreign supplies to Germany, they will bring gas from Nord Stream to the wider German market as well as to neighbouring countries. The first of these is the North European Gas pipeline (NEL) going from Germany close to the border with the Netherlands which is in operation since November 2012 with a capacity of 20 bcm. It connects with the Nord Stream pipeline to bring gas to Germany and the Netherlands. Second is the OPAL Gas pipeline which runs inside Germany from the Baltic Sea coast to Olbernhau on the German-Czech border. The pipeline is in operation and has a capacity of approximately 35 bcm and links with the Nord Stream pipeline to bring additional Russian gas to Germany and Europe.

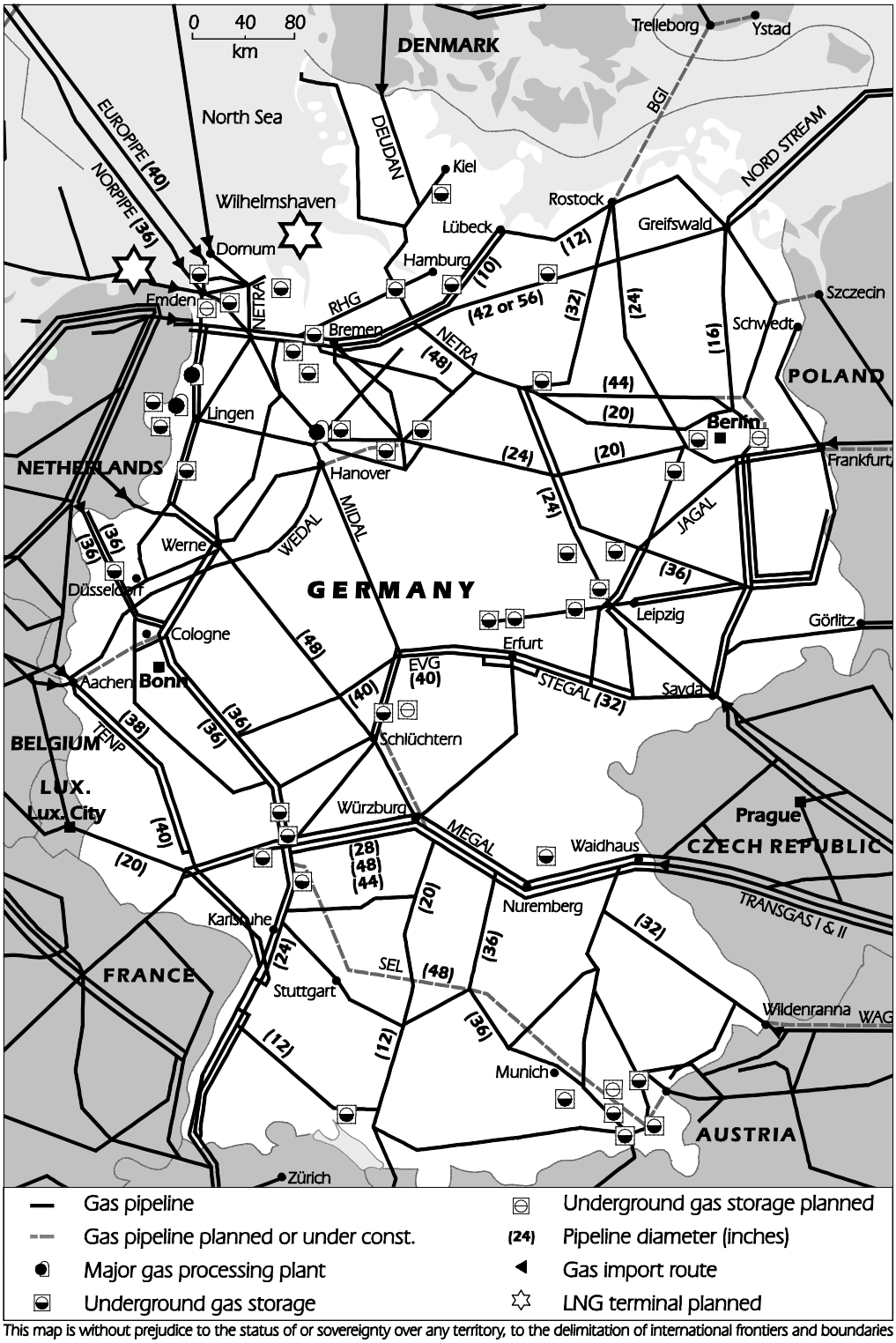
The Nord Stream system was developed to increase accessibility of gas from plentiful Russian fields to markets all across Europe. Germany already acts as a central transit hub for gas from large suppliers to other markets; the commissioning of these pipelines highlights the significance of well-functioning hubs and puts additional strain on the existing infrastructure. With an increase in imports and gas transportation domestically and across borders, as well as concerns over security of supply when dependence on gas is likely to increase because of the planned nuclear phase-out, infrastructure planning has been a strong focus of the government and the industry for a number of years.

Gas grid development plan 2013

The German Energy Act obliges the German gas TSOs to prepare a joint national gas grid development plan every year and submit it to BNetzA, the Federal Network Agency. The ten-year development plan has to contain all measures and steps necessary for optimisation, enhancement and expansion of the gas grids to satisfy forecast demand, and ensure security of supply.

In April 2012, the TSOs published the Gas Grid Development Plan 2012 (NEP Gas 2012), determining the long-term capacity requirements to 2022. NEP Gas 2012 outlined 32 projects with an investment value of EUR 2.2 billion, mainly focusing on new pipelines and compressors, and additional 15 projects worth EUR 1 billion, already in planning at the time of drafting.

Figure 14. **Gas infrastructure in Germany**



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: country submission.

In December 2012, the German Federal Network Agency (BNetzA) requested certain amendments to NEP Gas 2012, however without structural modelling changes to the plan. The grid operators have to incorporate the specific changes and submit the Gas Grid Development Plan 2013 by 1 April 2013.

Liquefied natural gas

Germany has no LNG infrastructure, as gas is sufficiently supplied through the existing pipeline network but it is expected to become of increasing importance as an alternative method of gas deliveries. Plans for LNG terminals in Germany exist, and the federal government encourages market participants to purchase regasification capacities in LNG terminals in neighbouring countries. At present, there is also the possibility to use LNG terminals in neighbouring countries: both E.ON and RWE have access capacity at the Dutch Gate terminal.

STORAGE

Underground gas storage facilities play a significant role in the suppleness of gas supply, providing flexibility and reliability at times of high or fluctuating gas demand. As at 1 January 2012, Germany had 48 gas storage facilities with a total capacity of 20.4 bcm.[13] This is the highest storage capacity within the EU, followed by France and Italy at around 15 bcm. Gas is stored in caverns or in porous rock storage facilities and there is potential for an expansion in resources due to favourable geological conditions. Germany's natural gas storage facilities are owned and operated by approximately 25 private companies (E.ON Gas Storage GmbH is the largest), and are well dispersed geographically. In addition to this storage capacity, German firms also have access to natural gas storage in Haidach (Austria) which has a capacity of 2.6 bcm.

More cavern storage facilities are in the planning stage or under construction (total additional volume of around 13.9 bcm). A porous rock storage facility owned by Storengy is also being planned in Behringen, with a storage volume of 2.3 bcm and a working gas capacity of 1 bcm. Demand for storage facilities is growing with the expansions in pipeline capacity, as well as the volume of gas transiting through Germany and trading.

There are no compulsory natural gas storage requirements in Germany, and no state-owned storage facilities. Operators of gas storage facilities must grant other companies access to their facilities and auxiliary services at a fair market price.

MARKET STRUCTURE

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. Approximately 700 gas grid operators and 800 gas suppliers, which operate a gas grid, are active in the market. The market is organised around a three-tier structure:

- The first market tier consists of five supra-regional wholesaling companies (E.ON Ruhrgas AG, Verbundnetz Gas AG, Wingas GmbH, RWE Gas AG, Gasunie) plus a number of new arrivals such as GDF Suez, DONG Energy, EconGas, NatGas, Trianel, Nuon, ENI Gas & Power GmbH., each of which imports gas or supplies domestically produced

13. *Statistical Report*, Eurogas, 2012.

gas via the transmission system to companies, which in turn distribute the gas at regional level. In recent years, companies such as Novogate, a joint venture between German gas distributors Bayerngas and Dutch Essent, and Centrica from the United Kingdom, have tried to break into this tier.

- At the second tier, approximately 30 regional gas utilities and long-distance gas-transport companies (*e.g.* Gas Union, Saar Ferngas AG) distribute the gas to the local gas suppliers (municipal companies) and in some cases to final consumers.
- The third tier is made up of approximately 725 regional or municipal utilities (*Stadtwerke*) that sell gas to other distribution companies and to final consumers.

Gazprom has set up a subsidiary to supply consumers with both natural gas and electricity and plans to invest in storage. GDF Suez has also entered the storage sector substantially through the acquisition of five natural gas underground storage facilities and a 19.7% stake in another one from Shell and ExxonMobil, making it the largest gas storage operator in Germany and Europe.

Following a revision of the Energy Industry Act, operators of the transport system must now also be indirect or direct owners of the grid they operate. To the extent that the grid companies are not sold by the integrated energy utilities to third parties, they are generally operated by a grid operator which forms a separate, independent company in the group. Furthermore – particularly at the distribution grid tier – co-operation is feasible between distribution companies, with two or three companies setting up a joint grid company.

Regulation of the gas sector has been overseen by the Federal Network Agency (*Bundesnetzagentur* or BNetzA) since its creation in 2005, although the *Stadtwerke* are overseen by Länder authorities if the respective grids do not cross Länder borders and if less than 100 000 customers are connected to the relevant grid.

WHOLESALE MARKET AND NATURAL GAS TRADING

Since 2006, Germany has implemented an entry-exit system, reformed the balancing rules and reduced the number of market areas from more than 20 to 6 in 2009 and only two market areas today. Today, Germany has two dual-quality market areas (the L-gas and H-gas networks based on their methane content requiring separate operation for technical reasons) with all customers included in one large balancing area (see Box 5). A functioning entry-exit system, based on the two-contract model, has been in place since 2007. Under this system, only one entry and one exit contract is required per market area for transportation of gas.

Natural gas trading at the two hubs, Gaspool and NCG, has grown significantly since 2007 and between 2009 and 2012; the volumes traded have increased fourfold. Almost 90% of volumes traded in Germany are H-gas, a trend which has continued from 2009. The low liquidity on the L-gas markets makes evaluation and creation of a market-oriented reference price more difficult. Because of the low level of liquidity and demand, trading of L-gas products is not offered on the European Energy Exchange (EEX).

As a result of the mergers of market areas, Germany has for the first time a dual-quality market area. Technically, the L-gas and the H-gas networks must continue to be operated separately but all customers are incorporated in one large balancing area. Shippers and traders are now able to book entry and exit capacity and supply their customers with gas, regardless of the quality, something that was impossible before the creation of the

new market areas. Nonetheless, technical restrictions remain between the different quality networks but these are managed by the network operators. Shippers and traders are required to pay a conversion charge when they supply customers with H-gas in the L-gas area or with L-gas in the H-gas area.

Box 5**. Gas quality in Germany**

Natural gas in Germany can be divided into two distinct categories, H-gas and L-gas, based on their methane content. Depending on its source and region of production, distinction can made between different natural gas qualities and their chemical compositions. Nonetheless, the main component of both is methane. Belgium, France, Luxembourg, the Netherlands and Germany distribute both H-gas and L-gas but in each of these countries the H-gas and L-gas are transported in physically separate networks.

High-calorific gas (also called H-gas) is of higher quality because of its greater methane content (between 87% and 99%). Low-calorific gas (L-gas) is natural gas with a lower methane content of between 80% and 87%. Often, L-gas cannot be shipped directly to the end customer without first being upgraded unless it meets the quality standard (11.1 KWh/m^3). Gas quality in northern Germany, where much of Germany's natural gas deposits are located, varies strongly; however, L-gas is predominant. Natural gas imported from the Netherlands is also mainly L-gas.

If gas quantities are to be transferred from an H-gas balancing group to an L-gas balancing group (or vice versa), then it must first be converted to make it compatible for the target balancing group.

THE GAS HUBS

NetConnect Germany (NCG)

In October 2008, E.ON Gas Transportation and Bayernets merged their respective H-gas market areas to create the first Germany-wide market area, NCG. The following year, Eni Gas Transport Deutschland, GRTgaz Deutschland and GVS Netz agreed to merge their H-gas market areas with NCG. Following the merger of the six market areas, the transmission networks of the partners had a combined total length of 14 800 km and included more than 400 gas grids. The new market area expanded further in April 2011 when Open Grid Europe L-Gas, Thyssengas H-Gas and Thyssengas L-Gas market areas agreed to merge, thereby creating the first German cross-quality market area and extending the length of the network in NCG to 20 000 km and almost 500 gas distribution networks.

NCG is responsible for the operative handling of the market area and provides balancing services and a virtual trading point, which includes a market area platform, and the procurement of control energy on behalf of the co-operation partners.

Gaspool

In March 2009, the trans-regional gas-transport companies Gasunie Deutschland, Ontras, Wingas Transport, DONG Energy Pipelines and StatoilHydro Deutschland initiated a process leading to the creation of a single market area. Following approval from the Federal Network Agency and the Federal Cartel Office (*Bundeskartellamt*), the new market area, containing

more than half of German the H-gas volumes, became operational in October 2009. The new market area incorporated approximately 350 downstream natural gas transport networks and provides services similar to those provided by NCG. In October 2011, Gaspool extended its reach to approximately 400 networks when it merged with the L-gas market Aequamus.

Proposals for a single gas hub

In early 2012, Gaspool and NCG announced plans to merge their markets. This was followed in October 2012 by an announcement that the two market area managers – in close co-operation with the TSOs and the Federal Network Agency and following consultation with the market – had commended work on a common target model to harmonise the procedures for procuring balancing gas throughout Germany.

Table 7. **Volumes of natural gas traded in the German market areas**

	NCG		Gaspool	
TWh	**Physically delivered**	**Net traded**	**Physically delivered**	**Net traded**
2009	277	622	143	318
2010	348	934	329	723
2011	395	1 205	329	842
2012	470	1 479	388	981

Source: IEA.

A market area statement (*Marktgebietsbericht*) published by the TSOs in October 2012 came to the conclusion that the costs of a merger between Gaspool and NCG would exceed the expected benefits. According to a study conducted by the companies, the financial benefit for the market would amount to a maximum of EUR 57.3 million per year, while the additional minimum costs would amount to EUR 395 million in the first year after the merger. In total, the TSOs estimate that the gas grid would need investments of EUR 3 billion should the two market zones merge. The Federal Network Agency is also conducting a market consultation on the matter, the results of which are expected to be published in the first half of 2013.

EUROPEAN ENERGY EXCHANGE

The European Energy Exchange (EEX), based in Leipzig, was founded in 2002 following the merger of power exchanges in Frankfurt and Leipzig. It operates a spot and derivatives market for the German market areas Gaspool and NCG as well as a spot market for the neighbouring Dutch TTF market area. In 2009, greater volumes of gas changed hands on EEX markets than in the Dutch TTF market – previously mainland Europe's largest gas market – and growth continued strongly into 2010, 2011 and 2012. In 2012, the volume of gas traded on the derivatives market rose by 11% to 39.5 TWh compared to 35.5 TWh. Spot trading increased by 56% to 35.9 TWh compared to 23.1 TWh.

COMPETITION CONCERNS

Historically, a major obstacle to the emergence of a liquid, competitive market was the hoarding of pipeline entry- and exit-point capacity. Germany has since introduced new rules on congestion management procedures. According to these rules capacity not needed must be offered on the secondary market (a single platform) or be returned to the network operator. This has significantly reduced the aspect of hoarding.

A study conducted by the Federal Cartel Office between February 2009 and December 2009 found that between half and three quarters of technically available firm capacity was tied up in long-term contracts. A large portion of these contracts, often on cross-border and market area interconnection points, was found to have been made between the network operator and companies which were affiliates of the respective network operator.[14]

The inquiry was triggered by signs of restraints of competition and the aim of the inquiry was to gain a detailed insight into the competition conditions and to identify any possible competition law violations. The enquiry focused on the extent and effect of the long-term booking of firm entry and exit capacities. The principal findings of the enquiry were that many cross-border interconnection points were operating in the long term (*i.e.* contract durations of more than two years) at full capacity and were being used largely by affiliated distributors, thereby making market foreclosure likely on the downstream gas supply markets. Demand for capacity, often from new suppliers, was sometimes refused. The authority came to the view that such long-term bookings can only be justified on grounds of security of supply if they do not exceed the minimum take obligation in the gas supply contracts.

Also in 2009, the European Commission launched an investigation into E.ON's dominant market position within the German natural gas market. The European Commission had concerns that, by foreclosing access to entry capacity into its gas transmission grid, E.ON may have abused its dominant position on the gas transport markets in its L-gas network and in the H-gas market area NCG. E.ON booked large parts of the firm, freely allocable entry capacities available in its own gas network, which, according to the preliminary assessment, may have prevented competitors to transport gas in E.ON's network and to the customers connected to this grid. Thereby, E.ON may have restricted competition on the downstream gas supply markets.[15]

An initial European Commission assessment (which E.ON rejected) found that E.ON had booked large parts of the available firm and freely allocable entry capacities on its gas transmission grid, restricting competition.

In response, E.ON proposed to release by October 2010 a volume of 17.8 GWh per hour of firm, freely allocable entry capacities into its gas transmission network.

As a second step, E.ON agreed to further reduce its overall share in the bookings of firm and freely allocable entry capacity in the NCG H-gas market area to 50% by October 2015 and for the BCG L-gas network to 64% by October 2015. E.ON committed not to exceed these thresholds until 2025. In response to the E.ON offer the European Commission ended proceedings in the case.

14. *Sektoruntersuchung Kapazitätssituation in den deutschen Gasfernleitungsnetzen*, Bundeskartellamt, 2009.

15. Summary of Commission Decision of 4 May 2010 relating to a proceeding under Article 102 of the Treaty on the Functioning of the European Union and Article 54 of the EEA Agreement (Case COMP/39.317 — E.ON Gas) (notified under document C(2010) 2863 final) Text with EEA relevance, European Commission, 2010.

Following the publication of the Federal Cartel Agency inquiry and the European Commission's E.ON investigation, the long-term contract arrangements that were previously the norm and which allowed the incumbents to retain their market dominance came under pressure. Often, these contracts contained take-or-pay clauses, which obliged the buyer to receive a minimum level of gas or pay the difference. They also contained pricing mechanisms strongly linked to oil prices.

As a result of the economic slow down in 2009, some long-term contract holders found themselves left with excess volumes, which were off-loaded on the spot markets often to smaller players eager to get their hands on cheaper gas. Prices recovered in 2010 but a glut of LNG in Europe kept gas prices low, often to the benefit of smaller market participants. In mid-2010, the Federal Cartel Agency published a report on the evaluation of its decisions on long-term gas supply contracts and found that the market had evolved significantly as a result of its previous actions and is now found to be characterised by different types of contracts, product diversity, a wider selection of suppliers and greater bargaining power on the demand side.[16]

The European Commission also opened antitrust proceedings against RWE in May 2007 based on concerns that RWE may have abused the dominant position on its gas transmission network to restrict its competitors' access to the network, thereby violating Article 82 of the EC Treaty. In reaction to the Commission's concerns, RWE offered to divest its entire Western German high-pressure gas transmission network. In response to the RWE offer, the Commission closed its investigation.[17]

The new Gas Ordinance dealing with this aspect entered into force on 8 September 2010. In the meantime the Federal Network Agency further concretised the capacity management rules by a decision in 2011.

RETAIL MARKET AND PRICES

The natural gas market was fully liberalised in April 1998; however, technical and commercial difficulties, limited access to transport, distribution capacities, long-term supply contracts in the wholesale market and access to liquidity seriously impeded the development of competition until 2007 when the Energy Industry Act was amended. Today, there are seven major suppliers active in the market, the largest of which has a market share of approximately 9%, and a further 800 suppliers servicing consumers at local level.

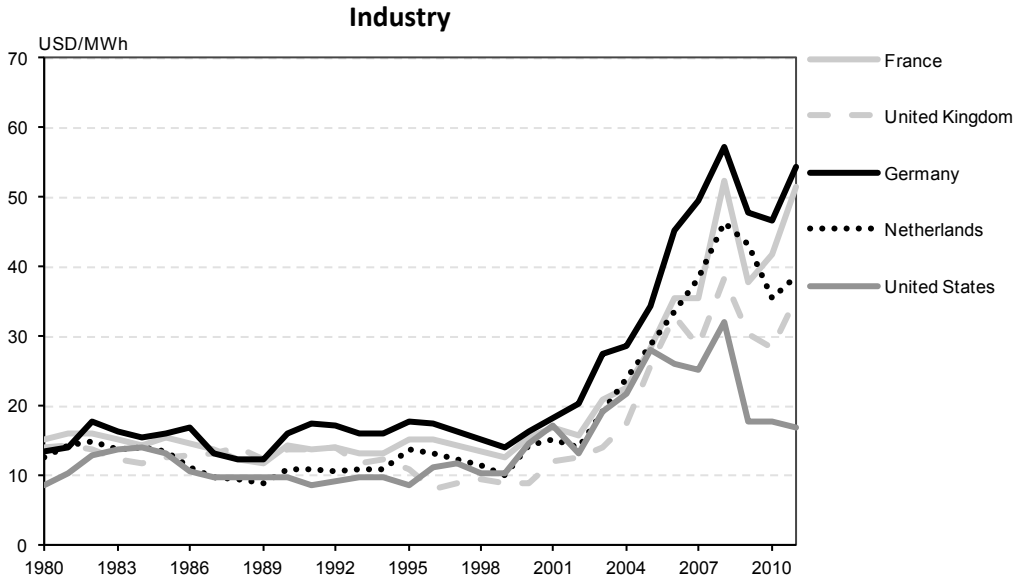
End-user gas prices in Germany remain some of the highest in the IEA Europe owing to both relatively high wholesale prices, but also to a larger tax component compared to other IEA countries. Despite the progress in the wholesale market over the previous decade and the rationalisation of the hubs, gas prices for importers, distributors, and deliveries to large consumers are often linked to the prices of related energy substitutes and are established automatically via contractually binding formulas.

Domestic customers can be supplied with gas in three different ways. Besides standard service from the basic supplier, customers can also be supplied on special terms. With this option, the customer stays with his current supplier but signs a new contract with special terms (change of contract). Almost 25% of the gas volume delivered to household customers comes from basic supply.

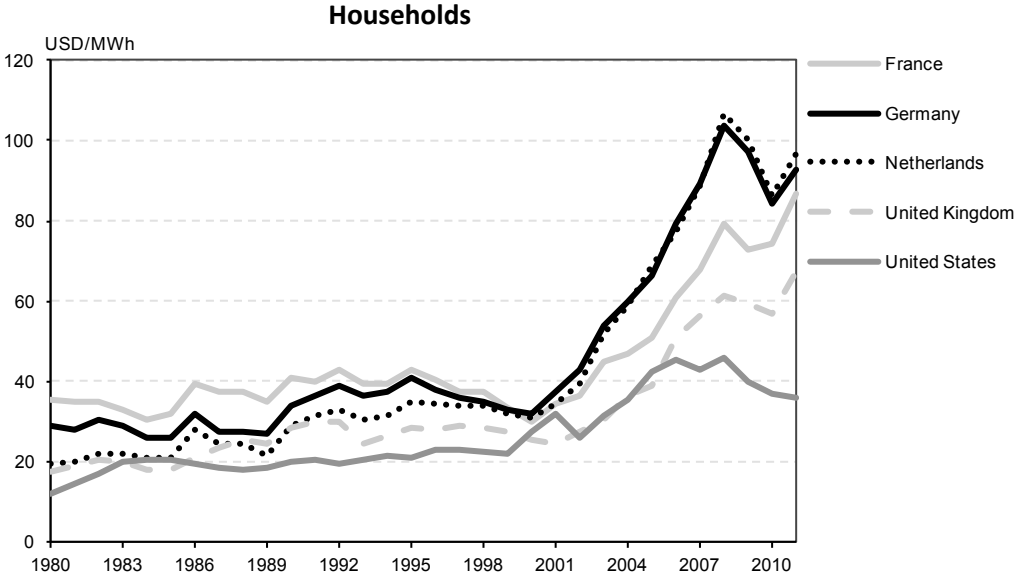
16. *Bericht über die Evaluierung der Beschlüsse zu langfristigen Gasliefererverträgen*, Federal Cartel Agency, 2010.

17. Final report of the Hearing Officer in Case COMP/39.402 — RWE Gas Foreclosure, European Commission, 2009.

Figure 15. **Gas prices in Germany and in other selected IEA member countries, 1980-2011**



Note: data not available for the Netherlands from 2004 to 2006.



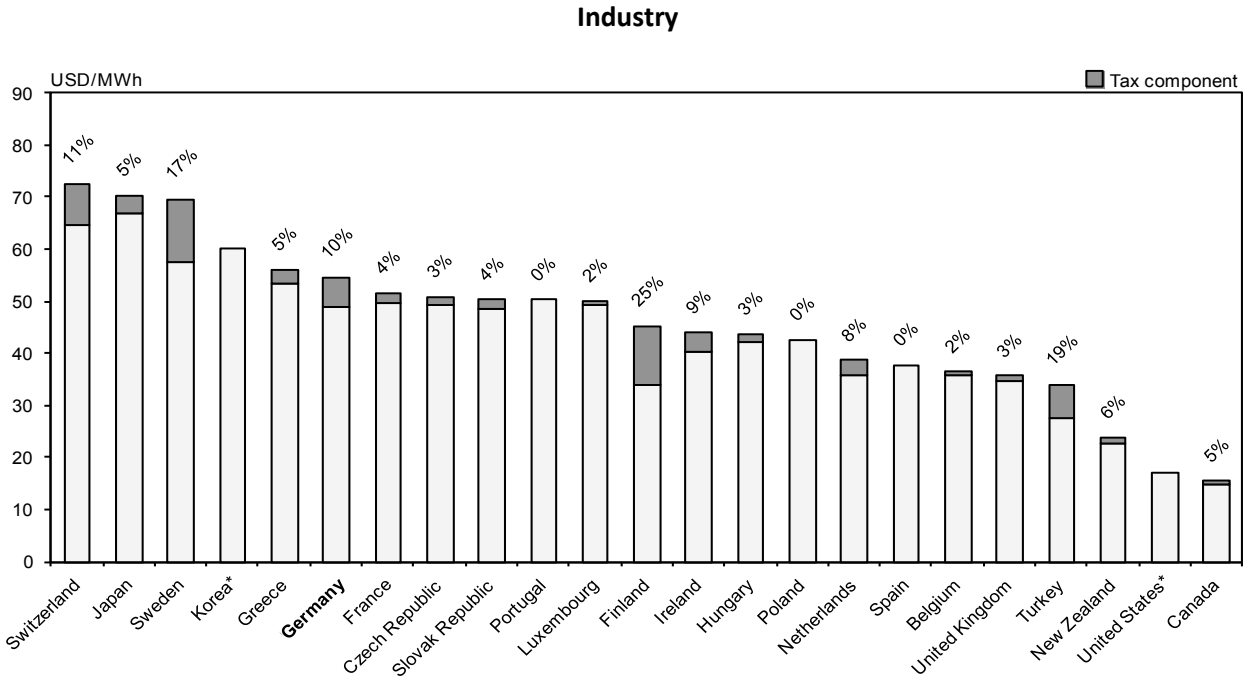
Note: data not available for Germany for 2001.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2012.

In 2010, approximately 720 000 household customers switched supplier and most household customers had a choice of between 11 and 20 gas suppliers. In 36 network areas, a household customer could choose from over 50 suppliers. The number of suppliers active in just one network area continues to decline and in 2010 they were 277. Conversely, the number of suppliers operating in several networks has grown, as has the number of gas suppliers active in over 100 networks simultaneously. Nevertheless, most gas suppliers continue to have a regional focus and limit themselves to supplying customers in their home region.[18]

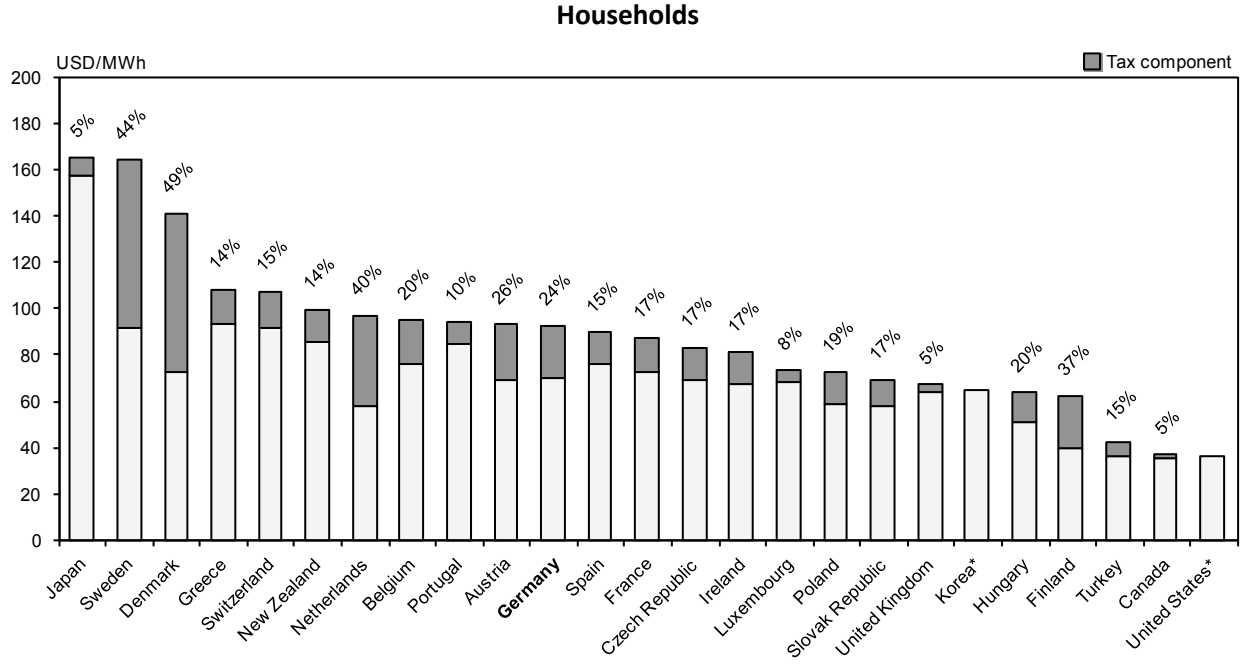
18. *Monitoring Benchmark Report 2011*, Federal Network Agency, 2012.

Figure 16. **Gas prices in IEA member countries, 2011**



* Tax information not available for Korea and the United States.

Note: data not available for Australia, Austria, Denmark, Italy and Norway.



* Tax information not available for Korea and the United States.

Note: data not available for Australia, Italy and Norway.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2012.

In accordance with the Energy Industry Act, the provider of gas to household customers is obliged to supply household customers even in extreme temperatures, in times of unusually high gas demand and in the case of disruption of the largest gas infrastructure.

NATURAL GAS SECURITY OF SUPPLY

In December 2010, EU Regulation no. 994/2010 was adopted on measures to safeguard security of gas supply (and repealed Directive 2004/67/EC). The regulation includes a requirement that EU member states meet the N-1 standard. Germany has made significant progress on implementing this regulation. Germany is compliant with the N-1 standard owing to its high degree of infrastructure reliability, including the diversification of supply routes and substantial storage capacity. Germany's N-1 compliance is further enhanced by a requirement to have "reverse flow" capacity at border-crossing points, when needed, but in reality the existing and planned reverse flow capacities rather serve s security of supply interests in the neighbouring countries.

There are no compulsory natural gas storage requirements in Germany, and no state-owned storage facilities. All natural gas stocks in Germany are maintained for commercial reasons. Germany has 48 natural gas storage facilities with a total capacity 20.4 bcm.

In an emergency, the federal government has the responsibility of triggering Germany's natural gas emergency response measures by declaring a state of emergency. The lead agency for natural gas security in Germany is the Ministry of Economics and Technology (BMWi). BMWi is responsible for natural gas legislation and for emergency response co-ordination at the national and EU levels. The regulatory authority, with responsibility for implementation of non-market based emergency response measures during a natural gas supply emergency, is the Federal Network Agency.

Regional-level aspects of natural gas emergency policy also involve the Länder (regional governments) and municipal energy suppliers. The Länder have responsibility for implementing some aspects of non-market based emergency measures in conjunction with the Federal Network Agency.

There are several legal tools available to German authorities for natural gas emergency response:

- The main legislation governing the responsibilities of the gas undertakings and network operators is the Energy Industry Act. It allows for system responsibility to be transferred to TSOs and DSOs. According to this Act, all gas undertakings are tasked with ensuring a supply of gas to the general public which is as secure, low-cost, consumer-friendly, efficient and environmentally compatible as possible.
- The 1975 Energy Security of Supply Act applies in an emergency**.** The non-market based measures outlined in the 1975 Energy Security of Supply Act can only be enforced if the federal government establishes by means of an ordinance that a danger or disruption of supplies exists. This permits the enactment of ordinances to ensure that vital energy needs are met. Ordinances can restrict the sale, purchase or use of goods, both in terms of quantity and time, or permit them only for certain priority purposes.
- On the basis of the 1975 Energy Security of Supply Act, *i.e.* only in an emergency, the Ordinance to Ensure the Supply of Gas in a Supply Crisis regulates the responsibilities for load distribution. It permits the bodies responsible for load distribution – the Federal Network Agency and the Länder – to issue instructions to companies and consumers.

In the case of a natural gas emergency, some groups of customers have been given precedence over other consumers and will hence be supplied with priority. These "protected customers" represent 50% to 60% of demand. Protected customers are defined as households and district heating installations delivering heating to households.

Interruptible contracts

Interruptible contracts are available to industrial consumers, especially with those who have fuels switching capacity. In terms of the quantity of gas sold, a maximum of approximately 10% to 20% of contracts with clients are interruptible contracts.

Fuel switching

Fuel-switching capacities are not included in German security of supply policy measures. Although some generators and larger industrial customers are equipped with fuel-switching facilities, there is only limited information available on the overall volumetric potential of substitution effects in the case of an emergency. There are no regulations in place promoting, restricting or monitoring fuel-switching capabilities. The government expects companies to assume individual responsibility for back-up solutions where necessary and possible in order to obtain a higher level of security of supply for their plant. Companies equipped with fuel-switching capability would consider utilising this capacity in the event of a gas supply emergency. There would be no restrictions to switching from natural gas to other fuels.

With the amendment of the Energy Industry Act, it is possible to offer interruptible contracts also on a DSO level in order to avoid congestions. There is no ability to surge gas production.

RISK ASSESSMENT

An important development with regard to gas emergency policy in Germany has been the implementation (ongoing) of EU Regulation 994/2010. As the first step towards full implementation of the regulation, the federal government completed a natural gas security Risk Assessment. The key finding of the Risk Assessment is that the security of supply situation in Germany is reliable and safe. Other results of the Risk Assessment were that the standards required by the EU regulation have been fulfilled and that the available market-based instruments are generally sufficient for securing supply. The assessment was based on a risk assumption that there will be substantial reductions of gas imports at the main network entry points during extremely cold winters.

The major step towards implementation of the regulation was the development of Emergency and Preventive Action Plans:

- The Preventive Action Plan takes into account the results of the Risk Assessment the national network development plan, and the need for Reverse Flows on some pipelines.
- The main elements of the Emergency Plan are the delineation of crisis levels: *i)* confirmation by the competent authorities for emergency management; *ii)* delineation of the responsibilities of authorities, TSOs, gas undertakings and the identification of non-discriminatory measures; a crisis team consisting of permanent and non-permanent

members; *iii)* processes for co-operation and information-sharing between industry and national authorities and at the national and EU levels; the need for emergency response training.

The Emergency Plan was published in December 2012 following intense consultations with industry, business and consumer associations and other authorities and neighbouring countries. Similar consultations on the Preventive Action Plan are under way.

DATA QUALITY

The legal authority for the collection of natural gas data in Germany is the Energy Statistics Act. Companies submit the required monthly data (regarding extraction, production or grid-based distribution of natural gas) to the Federal Statistical Office. Gas industry operators also provide data on gas purchases, the gas storage balance, and consumption.

In addition to the Energy Statistics Act, the Energy Industry Act regulates the transmission of data from the gas industry to the Federal Network Agency as the regulatory authority. Additional requirements to supply data to the Federal Network Agency derive from EU Regulation 2004/67/EC. Finally, according to EC Regulation 638/2004, companies are obliged to submit Intrastat reports to the Federal Statistical Office. The purpose of the Intrastat reports is to record the actual trade in goods between the member states of the European Union.

Natural gas data for imports from third countries (non-EU member states) are determined on the basis of import control notices which are submitted in compliance with the Foreign Trade and Payments Ordinance. Data for exports and imports to and from EU member states are derived from the Intrastat notices which companies provide to the Federal Office of Economics and Export Control (BAFA).

Determining the imports from Norway is an exception. The quantities imported from Norway and intended for domestic consumption are determined on the basis of the notices given by the operators of the infrastructure for the transport and the distribution of Norwegian natural gas in Germany. Germany does not participate in Joint Organisations Data Initiative (JODI) Gas, but this is expected to change in 2013 when new natural gas data reporting requirements come into effect.

Since 2012, the Federal Statistical Office has surveyed the natural gas data directly rather than via the Länder, as was done previously. This has resulted in more timely data. From October 2012, network operators are obliged to report daily data on physical gas flows (imports exports, stock levels, stock changes, etc.) to the Federal Network Agency. After appropriate checking and quality control, these data could also be used for Germany's Gas Flow Map and JODI Gas.

The Energy Statistics Act is in the process of being amended to allow for more flexible use of available data, monthly short-term statistics based on physical flows (network operators), and annual statistics based on data from trading companies. German companies are not required to report site-based natural gas storage levels – only the total change in the amount of gas stored. According to the federal government, a mandatory reporting allocation for gas stock holding companies is not necessary because it already collects total (*i.e.* nationally aggregated) natural gas figures.

ASSESSMENT

Despite falling consumption levels, Germany is one of the largest markets for natural gas in Europe. The country remains a natural gas producer and is at the heart of European natural gas trade with robust supply and storage infrastructure and strong domestic utilities. The natural gas market has seen a number of positive developments, which have resulted in greater competition over the five years since the previous review. The Federal Network Agency has implemented an entry-exit system, reformed the balancing rules and rationalised the number of market areas, from more than 20 in 2006 to six in 2009 and only two market areas today. Today, Germany has two dual-quality market areas (for technical reasons the L-gas and H-gas networks are operated separately) with all customers included in one large balancing area.

Two antitrust decisions by the European Commission went a large way towards addressing the problem of insufficient access to network capacity. As a result of these interventions, RWE divested its gas-transport network and E.ON released significant volumes of gas at the entry points to its gas networks. Nonetheless, congestion at the main import-export points remains a problem owing to long-term bookings thereby impeding greater levels of cross-border trade and competition and ultimately resulting in higher prices for German consumers.

Diversification of gas supply routes into Germany has also improved, notably with the opening of the Nord Stream pipeline, which added 55 bcm to import capacity. Interconnection with other European countries is also improving with the opening of the OPAL pipeline, and the forthcoming commissioning of the North European pipeline. Germany has the largest gas storage capacity in Europe and 43% of this storage is fast-response salt caverns, important for supporting the emergence of a more flexible electricity system as renewable energy capacity expands in coming years. A further 13.9 bcm of storage capacity is under development.

German natural gas prices (excluding taxes) in 2010 were USD 40 per MWh, higher than in the more integrated and liquid markets elsewhere such as the Netherlands and the United Kingdom. More work is needed to minimise these price differentials if economic growth, especially in the industrial sector, is to be maintained, particularly with the market changes happening in North America.

Despite Germany having one of the largest gas sectors in Europe, the strength of its domestic economy, an increasingly diverse array of supply sources and robust supply infrastructure, there is limited clarity in the Energy Concept on the role of natural gas. Implementation of the Energy Concept over the coming decade will lead to significant changes to, and uncertainty about, the role of natural gas in the domestic energy mix. The Energy Concept notes that there will be a call for investment in reserve and balancing capacities, in particular in more flexible coal- and gas-fired power stations, and a greater role for natural gas in transport, but it is slow to position natural gas in as an active part of the future.

Increasing gas use could result from a likely need for more flexible capacity from CCGTs which can provide secure generating capacity following the decision to phase out nuclear power. Gas plants may also be needed to replace coal generation if Germany is to meet its 55% emissions reductions targets by 2030. CCGT capacity is expected to rise from 20 GW at present to 50 GW in 2030. Increased use as a flexibility tool will drive much greater volatility of gas demand. At 19 GW, gas-fired generating plants account for less than 19% of total installed generating capacity in Germany, although this is set to expand modestly by 2015 with the addition of some 3.9 GW from new plants.

The complexity of the ownership structure of the German market still remains an issue with numerous cross-cutting share holdings involving large players, regional transporters and the *Stadtwerke*. Most *Stadtwerke* are owned by municipalities who are also involved in electricity generation and distribution, heat and water supply and public transport. Concentration of ownership in the sector is still an important concern. Nonetheless, since the creation of the regulator, the Federal Network Agency in 2005 its competencies have been strengthened. The implementation of the EU's Third Package also bolstered the independence of transmission network operators from other gas market activities and the required certification process of TSOs to assess their independence is under way. The recent Energy Industry Act has obliged storage operation to be legally unbundled from others parts of energy utilities. The proposed creation of the new Market Transparency Office is welcome.

The transmission industry has developed a national gas grid development plan and TSOs are currently seeking final approval for a ten-year investment plan with the Federal Network Agency. The plan comprises 32 projects, requiring an investment of EUR 2.2 billion in total, each of which has to be built by the gas TSOs over the next ten years. It is unclear, however, if the planning and processes of the distribution networks are sufficiently flexible to cope with the changes the Energy Concept will introduce, and whether they are entirely and to the fullest possible extent aligned with the TSOs' plans. An effective and flexible German gas network and market with appropriate gas storage facilities will be essential to ensure the German energy system is robust enough to cope with these changes.

Despite the large volumes of gas that are physically being delivered at the two German hubs, liquidity remains relatively low, especially when compared to the hubs of the United Kingdom (NBP) and the Netherlands (TTF). Nonetheless, evidence from the markets suggests that natural gas pricing in Germany is increasingly moving away from oil-indexed pricing to the use of traded prices. Given the scale of Germany's natural gas market, its location at the centre of Europe and its strong interconnections with neighbouring countries, the preconditions to become the primary trading point for gas in continental Europe are in place. So far however, the Dutch TTF is still the leading gas hub in continental Europe. Without the full support of the German TSOs, who own the two existing hubs, this is unlikely to change.

Germany's gas data have become a source of uncertainty for gas analysts looking at the European gas markets. Indeed, no data set seems to match either on a volume or growth rate basis. A comparison of data from the Federal Ministry of Economics and Technology (BMWI), the Federal Office of Economics and Export Control (BAFA), the Federal Statistical Office (Destatis) and the Federal Network Agency (BNA) shows significant differences, in spite of these bodies being all governmental agencies. They also differ from industry's data (*AG Energiebilanzen*), although the Federal Ministry of Economics and Technology has tended to align with the IEA recently. This is further illustrated by the gap between monthly submissions and final annual submissions to the IEA. As Germany represents roughly one-fifth of European gas demand, this makes any analysis of European gas trends almost redundant. Not only the absolute volumes but also the sectoral splits pose problems. The annual data reported in the IEA *Natural Gas Information 2012* publication shows a drop by almost one quarter in residential gas demand in 2010, one of the coldest years this past decade.

This uncertainty could potentially create issues in terms of security of gas supply, Germany being also a major transit country; the unreliability of import-export data can transfer a risk to other countries. Data represented and analysed in the in-depth review are drawn from *Natural Gas Information 2012* and IEA databases.

RECOMMENDATIONS

The government of Germany should:

- *Develop detailed scenarios for the role of gas in the German energy mix over the next 20 years, consistent with the Energy Concept, taking into account the greater flexibility natural gas offers.*
- *Continue to ensure that gas grid infrastructure can be further integrated, markets can become more liquid, import sources can become more diverse and storage is adequate to cope with a range of gas use scenarios and more volatile demand.*
- *Encourage greater access to global gas markets through either improving access to LNG terminals in neighbouring countries through reinforcement of interconnection and transmission network grid capacity, and transparent trading arrangements or, if needed, facilitating the construction of one or more LNG terminals in Germany by improving investment conditions and the diversity of the supply .*
- *Establish a coherent data-base, analysis and publication of German gas market information.*
- *Extend the capability of the regulator to monitor the wholesale and retail markets for gas (and electricity) for over-concentration or manipulation of prices, and maintain the Federal Cartel Office powers under the section 29 of the Act Against Restraints of Competition to investigate abuses of market power in energy suppliers.*
- *Intensify the dialogue with countries of present and potential future origin of gas supply to increase flexibility and encourage pricing that reflect market fundamentals.*

6. OIL

Key data (2011)

Crude oil production: 2.6 Mt, -17% from 2000

Net oil imports: 96.9 Mt, -18% from 2000

TFC: 92 Mt, -19.3% from 2000

Share of oil: 32.7% of TPES and 1.1% of electricity generation

OVERVIEW

Oil is the main source of energy in Germany although it has declined markedly since the early 1970s. The country has limited domestic oil resources and relies largely on imports to meet demand and the large amount of refined products it produces and exports. It has well-diversified and flexible oil supply infrastructure, which consists of pipelines and import terminals. The domestic market is liberalised and characterised by a large number of market participants. In 2011, oil represented approximately 33% of TPES. Oil stock levels are generally well above the 90 days required by the IEA: total oil stock levels were equivalent to 140 days net imports in April 2012.

SUPPLY AND DEMAND

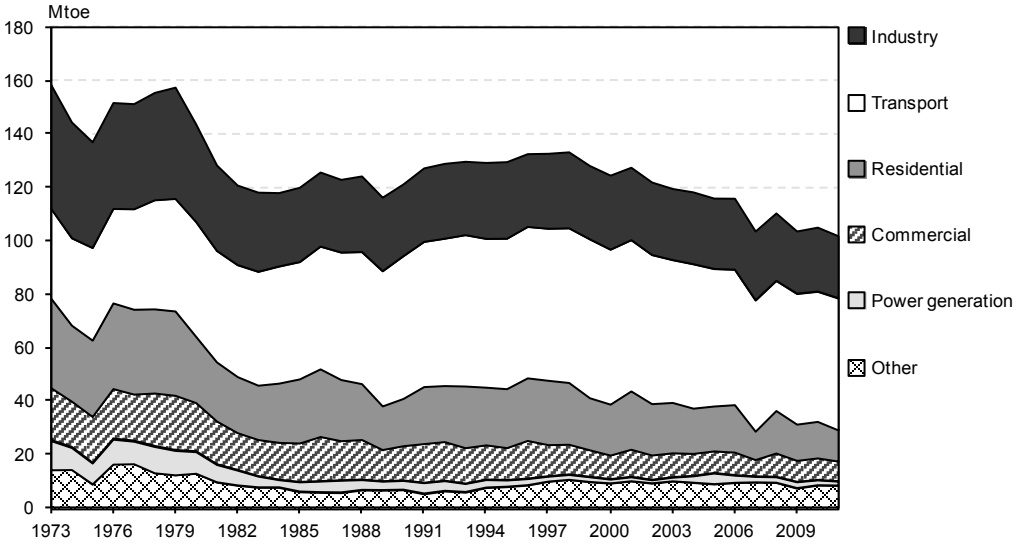
PRODUCTION, IMPORTS AND EXPORTS

Oil remains the most significant (although declining) energy source in Germany, accounting for 32.7% of TPES in 2011, up slightly from 31.9% in 2010. Over the past decade, the share of oil in total energy supply has fallen from around 37%, offset partly by a growing use of biofuels. Oil supply totalled 101.9 million tonnes (Mt) in 2011, which is a decline of 3.1% compared to 2010 and 18.3% lower than in 2000. Total consumption of oil has also experienced a declining trend, falling from 114 Mt in 2000 to 92 Mt in 2011. Net imports account for approximately 95.1% of total oil supply; Germany imported 125.7 Mt of oil in 2011, while 18.3 Mt was exported (10.5 Mt was accounted for by international bunkers).

Germany has limited domestic oil production – 2.6 Mt in 2011, which is equivalent to around 3% of consumption. This is higher than 2.5 Mt in 2010 and 17% lower compared to 3.2 Mt in 2000. In general, oil production has been on a downward trend for decades, and the government expects that production will continue to decline at a rate of around 5% annually. Proven and probable oil reserves are estimated to be less that 36 Mt. Production is located in the Länder of Schleswig-Holstein and Lower Saxony. There is also some production in the Rhineland-Palatinate from the Römerberg field. Companies active in domestic exploration and production include Wintershall Holding, RWE DEA, GDF Suez E&P Deutschland, and BEB Erdgas und Erdöl.

Total oil imports were 2 515 thousand barrels per day (kb/d) in 2011 – equivalent to approximately 98% of domestic oil consumption. Imports included 1 826 kb/d of crude oil and 648 kb/d of products (279 kb/d of which is gas/diesel oil). Germany also exported 372 kb/d of crude and products). Its imports of crude oil are relatively well diversified, with the countries of the former Soviet Union accounting for 50.8% of imports, another 25% coming from OECD countries (mostly European), and a further 18.2% from a range of member countries from the Organization of the Petroleum Exporting Countries (OPEC), notably Nigeria, Algeria, Angola and Libya. Almost 88% of refined oil product imports came from OECD countries (95% of this from Europe, notably the Netherlands, Belgium and the United Kingdom), with most of the remainder coming from countries of the former Soviet Union.

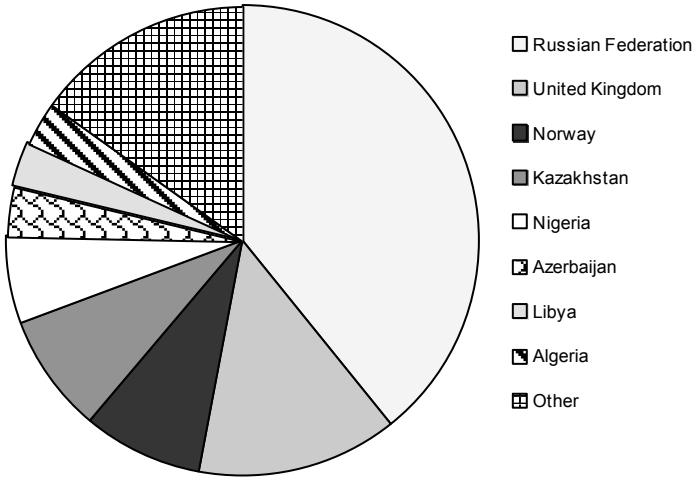
Figure 17. **Oil supply by sector*, 1973-2011**



* TPES by consuming sector. *Industry* includes non-energy use. *Commercial* includes commercial, public services, agriculture/ forestry, fishing and other final consumption. *Other* includes other transformation and energy sector consumption.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012, and country submission.

Figure 18. **Crude oil imports by country of origin, 2011**



Source*: Oil, Gas, Coal and Electricity Quarterly Statistics*, Second Quarter 2012, IEA/OECD 2012.

Crude oil can be imported through four cross-border pipelines and four main sea ports. The four cross-border pipelines, which transport oil from Russia, the Netherlands, France and Italy, had a combined throughput in 2010 of 1 298 kb/d or 64.3 Mt). There are three importing sea ports on the North Sea (Wilhelmshaven, Brunsbüttel and Hamburg) and one other (Rostock) on the Baltic Sea. After unloading, the oil is processed in refineries near these ports or by inland refineries connected to the ports by pipelines. Four domestic pipelines (with a combined throughput of 497 kb or 24.6 Mt in 2010) connect Wilhelmshaven, Brunsbüttel and Rostock to several refineries.

Refined oil products are also imported into Germany by sea (ports in Bremen plus three of those also used for crude imports) and one oil product pipeline. The product pipeline comes from Rotterdam and has an annual import capacity of approximately 261 kb/d or 12.8 Mt.

REFINING

Germany has one of the largest refining capacities in Europe and is among the largest oil refiners in the world. At of end 2011, Germany had 13 operating refineries with a total crude oil refining capacity of 2 090 kb/d (103.5 Mt/year).

The refining sector is undergoing a process of rationalisation, driven partly by changing local market conditions, which have resulted in a decline in demand for gasoline and domestic heating oil. Other factors include higher crude oil prices and the changing structure of global refining, both of which have created pressure on refining margins. It is unclear what impact, if any, environmental regulations (such as emissions ceilings) may be having on German refining-sector margins relative to those in other EU countries. According to the German government, refining margins in 2011 were better than in 2009 and 2010, but significantly lower than in the period from 2004 to 2008, similar to experience elsewhere in Europe.

The most significant recent development in the refining sector was the decommissioning of the ConocoPhillips-owned Wilhelmshaven refinery at the end of 2010 (the refinery had been largely inactive since November 2009). With a capacity of 272 kb/d (13.5 Mt/yr), the refinery was the third-largest in Germany and exported most of its output. The site remains in use for storage of refined products.

The future of another refinery was called into question when production at the 100 kb/d (5 Mt/yr) Ingolstadt refinery was temporarily halted in February 2012 as a result of financial difficulties at Petroplus-Holding and its subsidiary Petroplus Raffinerie Ingolstadt GmbH. Since then, the Ingolstadt refinery was bought by the Gunvor Group and came on stream again at the end of August 2012.

Elsewhere, Shell Deutschland plans to sell its Hamburg-Harburg refinery, which has a capacity of 105 kb/d (5.2 Mt/yr). Nynas agreed to take over the refinery in 2012 with a view to expanding the production of special lubricants. Shell Deutschland also sold its refinery at Heide (72.7 kb/d or 3.6 Mt/yr capacity) in late 2010 to the Swiss-based Klesch and Company.

Also, in late 2010, Rosneft purchased 50% of Ruhr Oel from Petroleos de Venezuela (BP has retained the other 50%). Ruhr Oel operates the Gelsenkirchen refinery (256 kb/d or 12.7 Mt/yr capacity) and has stakes in the MiRO Oberrhein refinery in Karlsruhe (301 kb/d or 14.9 Mt/yr capacity), in the Bayernoil refinery in Neustadt (208 kb/d or 10.3 Mt/yr capacity) and in the PCK refinery in Schwedt (228 kb/d or 11.3 Mt/yr capacity).

Although total refinery output is only slightly lower than domestic oil product demand, there are a number of imbalances which require significant imports of some products and exports of others. For example, Germany has been a net importer of diesel since 2010: by the end of 2011, Germany had a 138.6 kb/d gas/diesel oil deficit and an overall middle distillates deficit of 315.6 kb/d. There is also a naphtha shortfall of 183 kb/d. Conversely, the industry had a gasoline production surplus of 67 kb/d in 2011 and has been a net exporter of gasoline fuels and gasoline components since 2004. Germany's net product imports stood at 327 kb/d in 2011. Demand for diesel increased by around 16% between 2001 and 2011 while demand for gasoline dropped by nearly 30% during the same period. Naphtha demand has also declined by 8.8% since 2001.

Table 8. **German refining capacity**

Refinery	Location	Land	Capacity (Mt/yr)
Mineraloelraffinerie Oberrhein (MiRO) in Karlsruhe	Karlsruhe	Baden-Württemberg	14.9
BAYERNOIL Raffineriegesellschaft mbH	Neustadt/Vohburg	Bavaria	10.3
Petroplus Raffinerie Ingolstadt	Ingolstadt	Bavaria	5.0
OMV Deutschland GmbH	Burghausen	Bavaria	3.48
PCK Raffinerie Schwedt GmbH	Schwedt	Brandenburg	11.2
Elbe Mineralölwerke Raffineriezentrum Hamburg Harburg	Hamburg	Hamburg	5.2
Holborn Europa Raffinerie GmbH	Hamburg	Hamburg	4.65
Erdöl-Raffinerie Emsland	Lingen	Lower Saxony	4.5
Wilhelmshavener Raffineriegesellschaft mbH	Wilhelmshaven	Lower Saxony	13.5
Rheinland-Raffinerie Werk Godorf	Köln-Godorf	North Rhine-Westphalia	8.9
Rheinland-Raffinerie Werk Wesseling	Köln-Wesseling	North Rhine-Westphalia	7.0
Ruhr Oel GmbH	Gelsenkirchen	North Rhine-Westphalia	12.8
Total Raffinerie Mitteldeutschland GmbH	Leuna-Spergau	Saxony-Anhalt	12.0
Raffinerie Heide	Heide	Schleswig-Holstein	4.2
Total (Mt)			**117.63**

Source: Petroleum Industry Association – Annual Report 2010.

DEMAND

In 2011, demand for oil in Germany was 2 400 kb/d, less than in 2010 (2 470 kb/d), continuing a downward trend observed since 1998. The road transport sector is the largest consumer of oil and it consumed 49.7% of total oil supply in 2011, with diesel accounting for 27.5% of oil product demand. The industry sector was a distant second, consuming 22.4% of total oil product demand in 2011. Its share has remained relatively constant over the past decade.

Oil consumption is expected to continue to decline in the medium term: the German Petroleum Industry Association has forecast a 14% decrease in oil consumption for the period between 2010 and 2025. Key factors influencing the demand outlook include the promotion of biofuels and alternative fuels, energy taxation levels, and efficiency standards for buildings and cars.

The government has a target to reduce final energy consumption in the transport sector by 10% during the period 2005-20, and by 40% in the period 2005-50. According to the Energy Concept, the government aims to have one million electric vehicles on the roads by 2020 and six million by 2030. The federal government is also developing a "mobility and fuel" strategy that will focus on the development of new and alternative fuels and propulsion systems with the aim of establishing renewable energy in the transport sector and reducing the dependence of transportation modes on oil. A draft of the strategy is scheduled for completion the first half of 2013.

INDUSTRY STRUCTURE

The oil market in Germany is largely deregulated and competitive. There are a large number of companies operating in the sector, including many independents in the refining and retail sectors. The German government does not have an ownership stake in any of the companies operating in the oil sector.

In the upstream sector, there are only a few companies conducting exploration activities or producing oil. The companies with the largest shares of indigenous output are Wintershall Holding, RWE Dea, GDF Suez, E&P Deutschland, and BEB Erdgas und Erdöl.

In the refining sector, there are numerous international oil companies with an ownership stake in German refining capacity. In 2010, the largest refining operator in Germany was Shell Deutschland Oil with a 25.6% share of overall German refining capacity. The next largest were BP Europa (14.5%), ConocoPhillips Germany (13.9%) and Total Deutschland (11.8%). Rosneft had 9.8% share in the sector via its joint venture Ruhr Oel (with BP). Four of Germany's 14 refineries are owned as joint ventures each of which, in turn, has up to five shareholders.

In the downstream, retail fuel sector there are approximately 14 400 roadside filling stations, and another 350 filling stations on the *autobahns*. The number of filling stations in Germany is declining, with 475 fewer filling stations than at the beginning of 2006 and approximately 1 600 fewer than at the beginning of 2001.

Aral (BP) and Shell have the highest market shares (22.5% and 21% of fuel sales respectively), followed by Jet (Conoco-Phillips) with 10.5% and Total and Esso with 7.5% each. In addition, many other refinery companies and independent medium-sized oil companies are active on the fuel market, including Avia, Westfalen and Freie Tankstellen (bft). Approximately 280 filling stations are owned and operated by supermarkets and another 275 filling stations, located at supermarket sites, are owned by Jet, Total, Orlen and Shell.

COMPETITION CONCERNS

Market shares in the German retail fuel sector have remained relatively steady over the past few years, and there is an ongoing debate as to whether the five largest fuel retailers constitute a dominant oligopoly. On 26 May 2011, the Federal Cartel Office (*Bundeskartellamt*) presented the results of its inquiry into the retail fuel sector. This

enquiry was initiated in response to numerous complaints from independent petrol stations and consumers in relation to competition in the service station market. The report supported the assumption that a dominant oligopoly exists in the market.

The report found that five oil companies BP (Aral), ConocoPhillips (Jet), ExxonMobil (Esso), Shell and Total, formed a dominant oligopoly, whose members jointly accounted for 65% of fuel sales. This oligopolistic market structure resulted in a uniform petrol process at service stations. The outcome of the inquiry was the adoption of a strict approach to merger control in order to prevent a further concentration of the market.

REFINING

Germany has one of the largest refining capacities in Europe and is among the largest oil refiners in the world. Nonetheless, the sector has undergone some rationalisation in recent years. As the end of 2011, Germany had 13 operating refineries with a total crude oil refining capacity of 2 090 kb/d (103.5 Mt/yr). The largest refinery operator in Germany (as of end 2011) is Shell Deutschland Oil with a 25.6% share of German refining capacities. The next largest operator is BP Europa SE with a 14.5% share of refining capacity, followed by Total Deutschland with 11.8%. Conoco-Phillips Germany had a 13.9% share before deciding to put its refinery in Wilhelmshaven out of operation.

The largest refinery, in terms of atmospheric distillation (the separation of crude oil components at atmospheric pressure in the distillation tower) capacity, is the Shell Deutschland's Rheinland (Godorf, Wesseling) refinery, which consists of two parts, the one in Godorf and another in Wesseling, 6 kilometres south, with a capacity of 321 kb/d (15.9 Mt/yr). The next largest refinery is the MiRO Mineraloelraffinerie Oberrhein in Karlsruhe with a capacity of 301 kb/d (14.9 Mt/yr), followed by Ruhroil's Gelsenkirchen refinery with 256 kb/d (12.8 Mt/yr) capacity and Total's Spergau refinery with 242 kb/d (12 Mt/yr) capacity.

OIL SUPPLY INFRASTRUCTURE

PORTS

Three of Germany's four major oil-importing ports are located on the North Sea (Wilhelmshaven, Brunsbüttel and Hamburg). The other major port, located in Rostock, is on the Baltic Sea. The most important of these is Wilhelmshaven, which has three unloading facilities: two with a maximum capacity of 12 000 cubic metres per hour (m^3/h) and one with a maximum capacity of 16 000 m^3/h.

Rostock has maximum crude capacity of 6 000 m^3/h, Brunsbüttel a maximum crude capacity of 1 000 m^3/h, and Hamburg is structured around several firms that run their own port equipment in separate inner harbours.

Germany also has four cargo ports with infrastructure for product imports. One of these, Bremen, is used solely for product imports. Several firms have anchoring births at Bremen. Brunsbüttel has a product import capacity of 240 to 800 m^3/h, Rostock has product capacity of 250 to 1 200 m^3/h, and the arrangements at Hamburg are the same as those for crude oil.

Besides the oil ports noted above, there are a number of storage sites with an anchoring berth in German coastal and riverside towns.

PIPELINES

Germany has four cross-border crude oil pipelines, and four domestic pipelines connecting, all of which connect the oil ports of Wilhelmshaven, Brunsbüttel and Rostock to domestic refineries. All crude oil pipelines are privately owned and operated by oil companies. (Table 9 shows the quantities of crude oil transported in 2010.)

Table 9. **German cross-border crude oil pipelines, 2010**

Pipeline	Abbreviations	Throughput 2010 (Mt)
Brunsbüttel – Heide		2.9
Wilhelmshaven – Hamburg	NDO	4.2
Wilhelmshaven – Ruhr and Rhine district	NWO	15.6
Rotterdam, Netherlands – Ruhr and Rhine district	RRP	13.9
Lavera, France – Karlsruhe	SPSE	6.0
Triest, Italy – Bavaria and Karlsruhe	TAL	24.6
Russia – Schwedt and Spergau	Druzba	19.8
Rostock – Schwedt	MVL	1.9

Source: Bundesamt für Wirtschaft und Ausfuhrkontrolle (BAFA).

STORAGE CAPACITY

Germany has oil-tank storage capacity of around 65.7 mcm, 27.3 mcm of which is stored in caverns (as of end 2010). This is a small reduction from 68.2 mcm (27.2 mcm in caverns) at the end of 2005. Of this capacity, 30.2 mcm of storage is for crude and 35.5 mcm is for intermediate and finished products. Refineries account for around a third of total capacity. Oil storage facilities are relatively well distributed throughout the country.

The German stockholding agency EBV is responsible for holding compulsory stocks. The Oil Stockholding Act stipulates that the EBV shall constantly maintain stocks of oil and petroleum products at a level which corresponds at least to the net imports for 90 days. EBV's storage infrastructure is included in the totals above. The agency owns four cavern facilities consisting of 58 caverns in total and it also holds contracts for storage in third-party caverns. It also stores stocks in 130 above-ground storage facilities. The caverns mainly contain crude oil and the above-ground facilities mainly contain oil products.

The EBV has begun work on expanding the cavern storage facility at Wilhelmshaven-Rüstringen. It is not clear if this will have any effects on the use of other sites by the EBV.

EMERGENCY PREPAREDNESS AND ORGANISATION

Germany's oil emergency response policies are based on three key pieces of legislation.

The German Stockpiling Agency (*Erdölbevorratungsverband* or EBV) was established in 1978 under the Oil Stockholding Act (*Erdölbevorratungsgesetz*). The Act regulates the stockholding of oil and petroleum products for the purpose of responding to national and international crises. It also establishes the 90-day stockholding obligation of the EBV,

stipulates which products are subject to stockholding obligations, sets the rules on stockholding/storage/delegations, establishes stock release criteria, and sets out reporting and information requirements. In order to implement European Directive 2009/119/EC, imposing an obligation on member states to maintain minimum stocks of crude oil and/or petroleum products, the Oil Stockholding Act has been revised and the Oil Data Act amended. Neither has any effect on the implementation of the Agreement on an International Energy Program (IEP), the founding document of the IEA or the established the Co-ordinated Emergency Response Measures (CERM).

The 1975 Energy Security of Supply Act (*Energiesicherungsgesetz 1975*) is the basis for demand restraint measures and other regulatory interventions in the oil market.

The Oil Data Act (*Mineralöldatengesetz*) is the legal basis by which data are collected for the implementation of the IEP and European Union rules on information systems and emergency measures in the field of oil. It is also the basis for data collection for the implementation of the 1975 Energy Security of Supply Act, including the ordinances based on it.

The German National Emergency Sharing Organisation (NESO) is a joint body comprising representatives from government, the stockpiling agency EBV and industry. Rather than being established by legislation, the co-operative structure of the German NESO is based on a voluntary agreement between the parties. Legal reference to this co-operative approach to crisis management is made in the 1975 Energy Security of Supply Act which, in Article 8, states that government authorities can rely on associations (*e.g.* industry associations) for individual tasks if they agree to participate. The KGV (the NESO's Supply Coordination Group), with its tasks as a mediator and adviser in the national fair sharing process, is explicitly mentioned in Article 10 of the Ordinance of 13 December 1985 on fair sharing.

NATIONAL EMERGENCY SHARING ORGANISATION (NESO)

The German NESO is based on close co-operation between government, EBV and industry for the purposes of crisis management. Key players include the Federal Ministry of Economics and Technology (BMWi), the Federal Office of Economics and Export Control (BAFA), EBV and supply experts from the oil industry and trade enterprises.

The oil industry collaborates within two NESO bodies: the Supply Coordination Group (KGV); and the Crisis Supply Council (KVR). The KGV consists of seven permanent members and their deputies. Its main task is to undertake a detailed analysis of the domestic supply situation during a crisis and to propose solutions on how to cope with the situation. The KVR consists of the Chairman of the Supervisory Board of the EBV, his deputy and the chairman of the KGV. Core tasks of the KVR include advising BMWi on political decisions regarding the release of stocks and/or demand restraint measures. KVR also serves as a key interface with companies and business associations.

In the event of a crisis the NESO is activated by the Ministry of Economics. The chair of the KVR then convenes the KVR and if necessary the KGV.

In the absence of a crisis the NESO office coordinates regular emergency response exercises with the participation of the Ministry of Economics, the Federal Office of Economics and Export Control BAFA, EBV and KGV. Both national and international supply disruption scenarios are considered.

EMERGENCY OIL RESERVES

Since 1998, the stockholding agency EBV has had sole responsibility for fulfilling Germany's 90-day stockholding obligation. The Oil Stockholding Act 2012 (Section 3) stipulates that the EBV shall constantly maintain stocks of oil and petroleum products at a level which corresponds to a minimum of 90 days of net imports. In Germany, industry has no statutory obligation to hold stocks for emergency purposes.

The Federal Office of Economics and Export Control (BAFA), a federal agency of the BMWi, monitors the fulfilment of the stockholding obligation. The Oil Stockholding Act stipulates that the EBV must regularly provide the BAFA with the necessary data on stocks and must provide other information as required.

The EBV is tasked with maintaining emergency stocks to cover at least 90 days of net imports and its operations are funded by member contributions. The members of the EBV are those companies which import or produce products subject to stockholding obligations in Germany. From 1 April 2012, the products subject to this obligation are: gasoline, diesel fuel, light heating oil and kerosene-type jet fuel.

Irrespective of the 90-day stockholding obligation, a convention of regionalisation also exists. To meet this so-called regionalisation rule, the EBV holds stocks of finished products in each of Germany's five supply regions to ensure that it is capable of meeting a minimum of 15 days demand for each region if required. The rationale for this is to prevent logistical bottlenecks which could occur if all emergency stocks were stored centrally.

Germany consistently meets its 90-day IEA obligation, and generally holds storage well in excess of the obligated amount. In 2011, the amount of stock held in excess of the 90-day obligation was 11 128 kt crude oil equivalent (coe) or the equivalent of 50 days.

OIL DEMAND RESTRAINT

Germany has both light-handed and heavy-handed demand restraint measures that it can deploy in an emergency. The legal basis for demand restraint measures and for various other interventions in the oil market is the Energy Security of Supply Act 1975. A declaration by the federal government that the energy supply is endangered or has been disrupted is normally required before demand restraint measures can be implemented. For the purposes of ensuring that demand restraint measures can be implemented as quickly as possible if needed, a draft ordinance establishing a danger or disruption to Germany's energy supply has been prepared in advance. However, if the measures are being implemented to meet Germany's obligations under the IEP, a government declaration is not required.

In the case of a risk to, or disruption of, Germany's energy supply which cannot be properly addressed with market measures, the Energy Security of Supply Act permits a variety of far-reaching regulatory interventions. Such intervention must be proportionate to the disruption to supply, and be as light-handed as possible. Statutory ordinances can be enacted with rules on production, transport, storage, distribution, use and maximum prices of oil and oil products.

Any decision to implement demand restraint measures in Germany must take the supply situation and the impact of the proposed measures on economic activity into account. There is a strong preference in Germany for some of the emergency oil stocks to be

released before considering demand restraint measures. When these measures are used, light-handed measures (such as appeals by the federal government to consumers, or savings in the federal government administration) will be implemented in the first instance.

Specific demand restraint measures are implemented by Federal Government Ordinance. Draft texts have been prepared for ordinances on: vehicle speed limits; prohibitions on the use of vehicles, aircraft and ships and boats; a ban on Sunday driving; and the prohibition of motor sports events. Implementation of an ordinance, including the necessary Federal Cabinet decision, takes two to three weeks (although the timeline can be shortened in the event of an emergency).

In the event of the activation of any of Germany's demand restraint measures, monitoring of energy savings will be carried out via the monthly statistical reports of the oil industry, and by *ad hoc* reviews if necessary. In the case of the ordinances which are ready to be enacted if necessary, administrative offences would be punished by the police and, if appropriate, by other relevant authorities.

OTHER OIL EMERGENCY RESPONSE MEASURES

There is no meaningful potential to surge oil production in Germany. Oil production is equivalent to only a tiny fraction of its consumption. Consequently, the government does not have any policies in place to surge oil production by, for instance, changing or relaxing mining or environmental regulations.

With regard to fuel switching, this too has limited application in Germany. In the case of electricity, only 1.1% of gross electricity generation was based on oil products in 2010.

In the transport sector, almost all of the sector's energy requirements are met with gasoline and diesel fuel. In principle, there is some limited potential for substituting fossil diesel with biodiesel in the short term. The production capacity of Germany's biodiesel manufacturers is roughly 4.9 Mt per year, which is well above current domestic consumption of 2.58 Mt per year.

Overall, Germany has only very limited possibilities for reducing oil consumption in the short term by fuel switching. Consequently, there are no policies or legislation available to promote short-term fuel switching in place at this time.

ASSESSMENT

Oil remains the main source of energy in Germany providing almost 33% of primary energy consumption in 2011. Germany has only a very small amount of indigenous production (2.6 Mt in 2011) and it remains one of the three largest net oil-importing countries of the IEA. It has built substantial oil infrastructure and maintains considerable oil trade links with neighbouring IEA countries, as well as with Russia. Crude imports are largely sourced from the countries of the former Soviet Union (Russia, Kazakhstan, Azerbaijan) Norway, the United Kingdom and Nigeria, and in the past, Libya. Germany has a number of crude import pipelines connecting it to international supply points. Alternatively, imports are moved by sea to ports along its northern coastline ports and transported by pipeline to the refineries.

Germany has the largest refining capacity in Europe and is among the largest oil refiners in the world. Present crude oil refining capacity is around 2.1 million b/d or 103.5 Mt/yr, which

is distributed among 13 major facilities, the largest being the Karlsruhe refinery with a 300 000 b/d capacity or 14.9 Mt. Domestic demand accounts all in all for approximately the total refinery output, while at the same time there are considerable imports and exports of products. The sector is undergoing a process of rationalisation at the moment, driven partly in response to changing local market conditions resulting in a decline in demand for gasoline and domestic heating oil but also high crude oil prices, the changing structure of global refining, which is resulting in high pressure on margins.

Retail fuel is sold via almost 14 400 roadside filling stations, 10% less than ten years ago. While there are a number of independents (many selling branded products) and supermarkets operating in the retail sector, vertical integration remains and there is a strong correlation between the retail market and the refining industry, with Shell and BP the main players in both sectors. There is much domestic debate whether the biggest five retailers form a dominant oligopoly and further amendments to competition law may be required.

Germany is Europe's largest biofuels producer, and the country experienced rapid growth in production capacity between 2000 and 2007, driven by a government tax exemption. With the adoption of a 6.25% biofuels quota, these exemptions, which were short term, resulted in redundancy of some production capacity.

Germany has maintained a stockholding agency, the *Erdölbevorratungsverband* (EBV), since the late 1970s. In an emergency situation, Germany is expected to draw on these agency stocks, which meet both the IEA and EU stockholding obligations. Legislation to transpose the EU Stockpiling Directive 2009/119/EC of 14 September 2009 is in place and became effective in April 2012.

The road transport sector is the largest consumer of oil in Germany. IEA understands that the government is currently drawing up a Mobility and Fuel Strategy, which will focus on all conventional, new and alternative fuels and the use of renewable energy in the transport sector. The domestic biofuels target has been revised and now stands at 6.25% minimum share of the fuels sold. It may be argued that while the present regulations can deliver Germany towards meeting its 10% renewables target in transport fuels by 2020; it does so by adding cost to consumers, even though the use of biofuels is the most cost-efficient way to fulfil the target. From 2015, the biofuels quota will change to a minimum GHG reduction quota which increases from 3% in 2015 to 7% in 2020. Assuming an average GHG reduction of 60% in 2020 this will yield a biofuels share of around 12% by energy content. Furthermore, some of the biofuels on the German market today may not qualify to count towards the 10% target as they do not meet the minimum GHG thresholds (35% today, 50% for plants built after 2017 and 60% for those built after 2018), these biofuels will not be allowed to count toward the quota from April 2013. In any case, it is important to have solid sustainability certification in place to ensure that the biofuels used meet the sustainability criteria set out in the EU Renewable Energy Directive.

RECOMMENDATION

The government of Germany should:

- ☐ *Continue to monitor activity in the retail fuel market and ensure that the present dominant oligopoly is not impacting negatively on consumers or other market participants.*

7. COAL AND CARBON CAPTURE AND STORAGE

Key data (2011)

Production: 46.5 Mtoe (65.9 Mtce), -23.2% since 2000

Imports: 32.7 Mtoe (42 Mtce), +47% since 2000

Exports: negligible

Share of coal: 24.8% of TPES and 45.1% of electricity generation

Consumption: 77.4 Mtoe (power generation 81.8%, industry 8.5%, other energy 7.6%, residential 1.6%, commercial and other services 0.5%)

OVERVIEW

Germany has considerable resources of hard coal and lignite making these the country's most important indigenous source of conventional energy. The government has committed to phasing out subsidised hard coal production by 2018. On the other hand, lignite, the least-cost fossil fuel source, will continue to play a major role in German energy supply for the foreseeable future.

SUPPLY AND DEMAND

SUPPLY

Coal, hard coal and lignite contributed 77.4 million tonnes of oil equivalent (106.5 million tonnes of coal equivalent) to Germany's TPES in 2011. This represents about a quarter of TPES and a decline of 8.8% since 2000, with the largest dip during the 2009 recession. Since 2009, coal supply has recovered to just below 2008 levels.

The overall trend in hard-coal production and consumption in Germany is a declining one; conversely, lignite production is thriving and continues to provide a major source of energy. A study prepared by Prognos, the Institute of Energy Economics of the University of Cologne (EWI) and Institute of Economic Structures Research (GWS) indicates that total supply of hard coal will be a third of what it was in 2011 by 2030, as demand for hard coal falls.

In 2011, Germany produced 176.5 Mt of lignite, making it the largest producer of lignite in the world. Production of lignite accounted for 94% of all coal produced while the remainder was hard coal. Production of lignite has increased by 5% since 2000. The Federal Institute for Geosciences and Natural Resources (BGR) estimates that lignite resources in Germany total approximately 36.5 billion tonnes.[19]

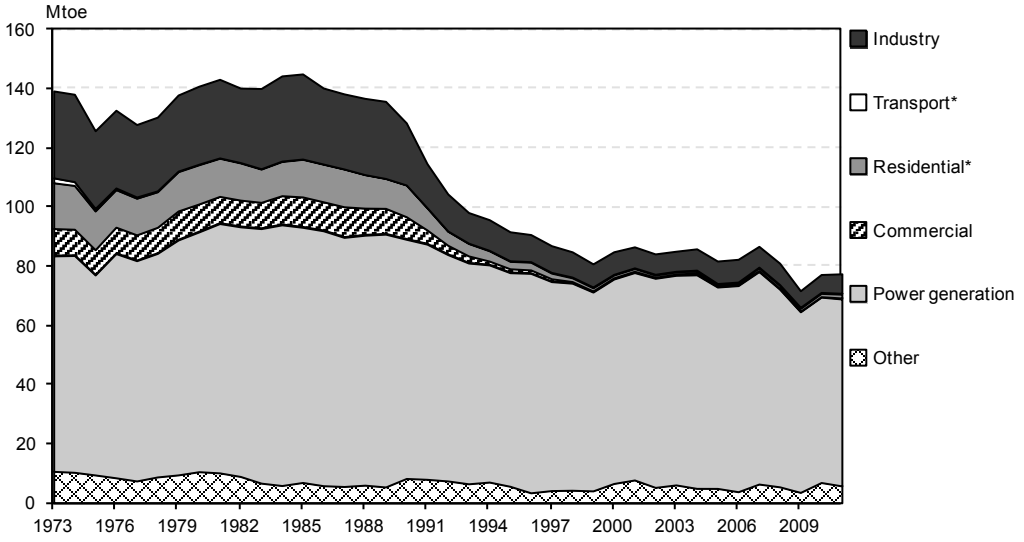
19. *Energiestudie 2012*, Federal Institute for Geosciences and Natural Resources, 2012.

Hard coal production in 2011 was a little less that 12.1 Mt, of which 4.8 Mt was coking coal and 7.3 Mt was steam coal. This represented a significant decline compared to 2000, when hard coal production was 37.4 Mt or 18% of coal produced.

The Federal Institute for Geosciences and Natural Resources (BGR) estimates that hard-coal resources in Germany total approximately 83 billion tonnes.[20] Hard coal reserves, however, *i.e.* commercially usable deposits, total only 48 Mt for 2011. This is the amount that the BGR expects to be extracted with subsidies until the termination of hard coal production in 2018.

There have been six hard-coal mine closures since 2005: Lohberg/Osterfeld, Walsum, Lippe, Ost, Saar and West. At present, three hard-coal mines remain in operation – two in the Ruhr District and one near Ibbenbüren. The remaining mines are planned to be closed in 2015 and 2018.

Figure 19. **Coal supply by sector*, 1973-2011**



* TPES by consuming sector. *Industry* includes non-energy use. *Commercial* includes residential, commercial, public services, agriculture/forestry, fishing and other final consumption. *Other* includes other transformation and energy sector consumption. *Residential* is negligible. *Transport* ceased in 2003.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and country submission.

IMPORTS AND EXPORTS

Germany imported 47.8 Mt of hard coal in 2011, 4.6% more than the preceding year and 71.2% more than in 2000. Germany has the third-highest level of coal imports within IEA member countries, behind Japan and Korea. Coking coal, 8.8 Mt, represented 18.3% of imports while imports of steam coal made up the remainder. Hard-coal imports have nearly tripled since 1995, the last year in which there were import quotas.

The United States and Australia, 2 815 Mt and 2 551 Mt respectively, were the main sources of coking coal while the main sources of steam coal were with Colombia (9 919 Mt), Russia (8 700 Mt), the United States (4 865 Mt) and Poland (3 229 Mt). Imports from Colombia, Russia and the United States have grown at a rapid rate since 2005, while

20. Ibid.

imports from Australia, Poland and South Africa have declined over the same period. Germany exports hard coal to a small extent, with only 0.2 Mt of exports in 2011.

With regards to lignite, imports and exports do not play an important role. Because of the high water content in crude lignite (approximately 50%) and its low energy density transportation over long distances is uneconomical.

DEMAND

The power generation sector is the main end-user of lignite. In 2011, 160.2 Mt of lignite, or 90.7% of lignite supply, was consumed by electricity and heat generation plants. The use of lignite in power generation has been relatively flat over the past decade.

The power and heat sector is also the largest consumer of steam coal, accounting for 86.9% of consumption or 36.1 Mt in 2011. Most of the remaining steam coal was consumed in blast furnaces and by industry. Coke ovens accounted for 10.4 Mt of coking coal use, with the electricity and heat sector accounting for most of the remainder (6.1 Mt).

INDUSTRY STRUCTURE

HARD COAL

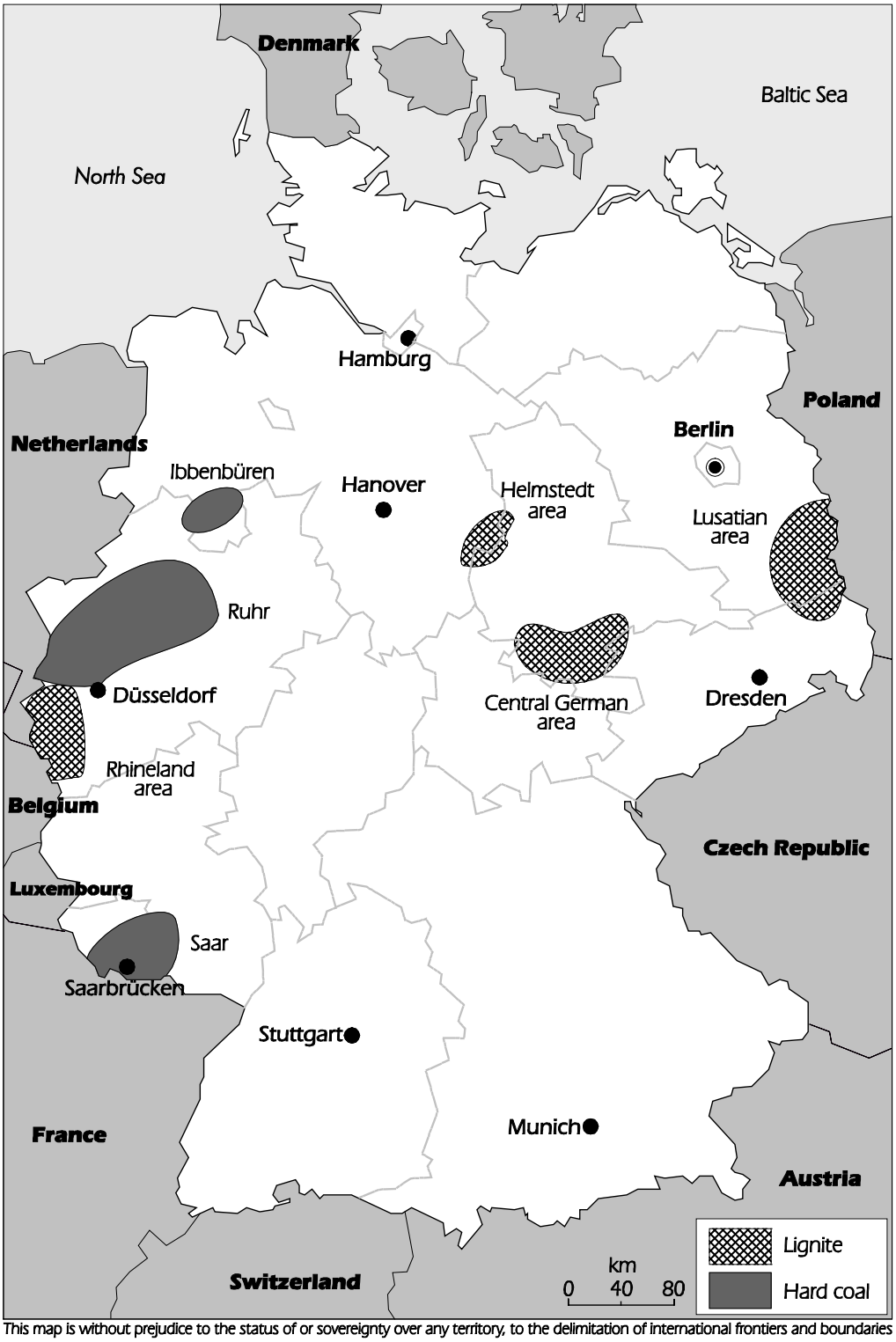
The structure of the hard coal industry has undergone significant changes since the last in-depth review in 2007. RAG AG remains the only hard coal producer but the structure of the company has changed following the 2007 decision to phase-out the subsidised mining of hard coal. Before 2007, RAG AG was composed of two distinct divisions: a hard coal mining unit and a chemicals, energy and property business. In September 2006, the latter division was restructured to become RAG Beteiligungs-AG, which was renamed Evonik Industries AG in 2007.

Taking effect on 1 December 2007, the shareholders at the time, E.ON, RWE, ThyssenKrupp and ArcelorMittal, transferred their RAG AG shares at the symbolic price of EUR 1.0 to the RAG Foundation, which was established in July 2007. On 31 December 2007, RAG Foundation purchased Evonik Industries, 25.01% of which was sold to British investor CVC in 2008.

RAG Foundation also became the sole owner of RAG AG and is responsible for the management of the phase-out process. It will finance the inherited liabilities of RAG AG following termination of the industry. For this purpose, it will use its shares in Evonik Industries AG. According to current calculations, the RAG Foundation will require approximately EUR 13 billion as of 2019 in order to use the corresponding interest return to finance the long-term responsibilities. Previously, this amount was estimated at EUR 8.4 billion. The increased amount results from lower interest rates and price developments. Should the Foundation's funds be insufficient, the mining states of North Rhine-Westphalia and Saarland as well as the federal government will, according to their commitment, provide the funds required to finance and permanently cover the long-term responsibilities.

At the end of 2012, RAG AG employed 17 600 people. It had group sales of approximately EUR 3.1 billion in 2011. The company operates three mines, all of which are located in North Rhine-Westphalia (Auguste Victoria, Prosper-Haniel and RAG Anthrazit Ibbenbüren mines).

Figure 20. **Coal reserves in Germany**



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: country submission.

LIGNITE

Lignite is extracted from 12 open-cast mines in four coal-mining areas: Rhineland, Helmstedt, central Germany and Lausitz. Its primary use is as a feedstock for power generation; it makes an important contribution to secure and inexpensive power generation in base-load supply. In addition, lignite is being used for upgrading coal for the production of briquettes, pulverised coal, coal for fluidised-bed combustion and coke. Briquettes are sold mainly in the household heating market. By the end of 2012 the number of persons employed in the lignite-mining industry totalled 22 424. A slight reduction took place over the previous five years.

Table 10. **Lignite mines in Germany**

Region	Number of mines	Owner/operator
Rhineland	Three	RWE Power
Helmstedt	One	Braunschweigische Kohlen-Bergwerke AG (BKB), a subsidiary 100% owned by E.ON Kraftwerke GmbH
Lausitz	Five	Vattenfall Europe Mining AG
Central Germany	Two	Mitteldeutsche Braunkohlengesellschaft mbH (MIBRAG)
	One	Romonta GmbH

Source: DEBRIV.

Table 11. **Lignite production in Germany, 2005-12**

Coal-mining area	2005	2012	Change
	Thousand tonnes		
Rhineland	97 228	101 739	4.64%
Lausitz	59 737	62 441	4.53%
Central Germany	19 085	19 225	0.73%
Helmstedt	2 129	2 027	-4.79%
Bavaria	32	0	-100%
Total	178 211	185 432	4.23%

Source: DEBRIV.

In Rhineland, RWE Power AG operates the three opencast mines Hambach, Garzweiler and Inden. Almost 90% of the lignite is consumed by the company's own power stations. The generation capacity of RWE Power consists of five lignite-fired power plants with a total capacity of 10 800 MW. At Neurath, a new lignite-fired power plant with optimised plant technology was commissioned in 2011, boasting a gross capacity of 2 200 MW.

In the Helmstedt mining area, E.ON Kraftwerke extracts lignite from the Schöningen opencast mine. The lignite produced there feeds a 390 MW power plant at Buschhaus.

In the Lusatian mining region, where Vattenfall Europe Mining AG is the sole producer, lignite is extracted in the opencast mines Jänschwalde, Cottbus Nord and Welzow Süd in

Brandenburg, as well as in the opencast mines Nochten and Reichwalde in Saxony. Vattenfall Europe Generation AG is the main operator of lignite-fired power plants in the Lusatian area with a gross rated capacity of 6 500 MW.

Mitteldeutsche Braunkohlengesellschaft (MIBRAG) is the owner of two opencast mines Profen (Saxony-Anhalt) and Vereinigtes Schleenhain (Saxony). In 2012, MIBRAG produced 18.7 Mt of lignite, serving the three company-owned power plants, with a combined capacity of 208 MW at Deuben, Mumsdorf and Wählitz.

Romonta operates an open-cast mine located near Amsdorf (Saxony-Anhalt), in the Central German mining area. In 2012, 0.5 Mt of lignite were mined there, processed to extract raw lignite wax, which is employed for power generation at Amsdorf.

SUBSIDIES FOR THE COAL INDUSTRY

Unable to compete with cheaper non-EU imports, the federal government and North Rhine-Westphalia traditionally provided subsidies to the domestic hard coal industry, a major source of employment in some regions and a form of operational aid permitted by European Council Regulation. A proposal by the European Commission in July 2010 suggested imposition of a time limit on aid to the hard coal industry to 2014, a measure that met widespread resistance in Germany and other coal-producing EU member states. According to the Council Decision which entered into force on 1 January 2011, operational aid will continue until the end of 2018.

On 7 February 2007, a coal policy agreement was reached between the federal government, the coal-mining Länder of North Rhine-Westphalia and Saarland, RAG AG and the Mining, Chemical and Energy Industrial Union (*Industriegewerkschaft Bergbau, Chemie, Energie,* IG BCE). According to the agreement, subsidised hard coal production in Germany will be terminated in a socially-acceptable manner by the end of 2018.

The fundamental decision of February 2007 was transposed into specific rules during the course of 2007. Details of the phase-out process were laid down in the framework agreement entitled "Terminating subsidised hard coal production in Germany in a socially acceptable manner" concluded between the federal government, the coal-mining Länder and RAG AG on 14 August 2007, and in the Act to Finance the Termination of Subsidised Hard Coal Production by the Year 2018 (Hard Coal Financing Act, *Steinkohlefinanzierungsgesetz*). The Hard Coal Financing Act entered into force on 28 December 2007. It stipulates the financial obligations of the federal government in the phase-out process.

The framework agreement stipulates the financial burden sharing among the federal government, the coal-mining Länder and RAG AG. Pursuant to the agreement, the federal government and the coal-mining Länder grant the financial support for sales, closures and inherited liabilities needed in the period 2009-19. In the period 2009-19 North Rhine-Westphalia accounts for a total of EUR 3.9 billion of the financing, while the federal government provides financial assistance totalling EUR 15.6 billion. Pursuant to the agreement, RAG AG makes contributions after 2012. These contributions total EUR 965 million in the period 2009-19.

CARBON CAPTURE AND STORAGE

POLICY OVERVIEW

The Energy Concept 2010 explicitly recognises the role of CCS in the future energy supply mix. The Energy Concept relies greatly on energy efficiency polices and the expansion of renewable energies to meet its 2050 GHG emissions targets while recognising the potential role of CCS not only in the power sector but also in the energy-intensive, high-emitting industrial sectors. Development of CCS technologies has also the potential to present export opportunities for Germany. Accordingly, the Energy Concept supports the demonstration and, where appropriate, the deployment of CCS technology. It proposed that the following measures actively accompany the further development of CCS:

- Establishment of a legal and regulatory framework for CCS.
- Intention to construct two of the twelve EU-wide CCS demonstration projects eligible for European Union funding which are expected to be built by 2020.
- A storage project for industrial CO_2 emissions (a joint project for CO_2 from industrial biomass) is also intended. The demonstration stage will be evaluated to aid decisions about the potential commercial use of CCS technology.
- Further research into the use of CO_2 as a raw material preferably in conjunction with renewable energies (*e.g.* synthetic methane, algae reactors).
- Commission a geothermal atlas in order to review the conflicts of use between CCS and geothermal energy.
- Engage in dialogue with the public on CCS technology.

REGULATORY FRAMEWORK

Germany has encountered significant resistance in developing and adopting a legal and regulatory framework for CCS. The CCS Act, which entered force in 2012 following a protracted legislative process, only allows for CCS on a test basis, restricts the amount of CO_2 to be stored to 1.3 Mt a year per storage site (up to a maximum of 4 Mt nationwide per year), and allows individual Länder to exclude parts of the state territory from CO_2 storage provided that the exclusion is based on objective reasons. The CCS Act thus allows for a maximum of two or three medium-sized demonstration projects to be realised. Germany is continuing CCS-related R&D but for various reasons there are no plans for demonstration projects at present.

STAKEHOLDER ENGAGEMENT

Public resistance is the major barrier to reaching the demonstration phase for CCS in Germany and the development of CCS has met with great reservations in those areas deemed suitable for CO_2 storage owing largely to ecological concerns put forward by some environmental organisations.

Applying the highest environmental and safety standards for storing CO_2 in geological formations remains one of the key aspects for public acceptance. Therefore Germany's CCS Act regulates that a permit for a storage site can be granted only after a planning

approval procedure has been carried out, requiring *inter alia* that the storage site is safe in the long term, that dangers to human health and the environment are ruled out and that precautionary measures are taken in accordance with the state of science and technology. The public has extended opportunities for participation. The operator has to provide financial security to cover all relevant risks.[21]

STORAGE POTENTIAL

In a joint project with the state geological surveys, the Federal Institute for Geosciences and Natural Resources (BGR) compiled a Storage Catalogue of Germany, which identifies potential sites for the geological storage of carbon in Germany.

The Storage Catalogue of Germany contains nationwide thematic maps of 18 reservoir and barrier rock units of Paleozoic and Mesozoic deposits.[22] These maps, plus header data on deep wells and reflection seismic measurements (including for example the data owner and contact information), have been integrated in a GIS-based map-application.

Regarding potential storage in aquifers, in terms of basin extent and sediment thickness, the North German Basin holds the largest CO_2 storage potential. According to the Storage Catalogue of Germany, the Lower Triassic *Mittlerer Buntsandstein* reservoir rock unit and the Upper Triassic-Lower Jurassic *Rhaet-Lias* reservoir rock unit show particular promise as potentially suitable storage sites over relatively vast areas of northern Germany.

In addition, during the past ten years, the BGR has performed several regional CO_2 storage capacity assessments on the German mainland (with a focus on the North German Basin) and the German North Sea sector regarding saline aquifers. That work included the identification and rough characterisation of potential CO_2 storage structures. In other studies, BGR has estimated the CO_2 storage capacity of selected hydrocarbon fields in Germany and concluded that German oil fields do not provide significant CO_2 storage capacity leaving natural gas fields as the most suitable options for CO_2 storage in Germany.

The Swedish utility Vattenfall intended to explore two saline aquifers in Neutrebbin and Beeskow (in eastern Brandenburg) as potential storage sites for the CO_2 captured in Jänschwalde but abandoned its plans in December 2011 citing "insufficient will in German federal politics to implement the European directive so that a CCS demonstration project in Germany could be possible".

CCS PROJECTS – PILOT SCALE[23]

Vattenfall operates a 30 MW pilot carbon capture plant, which uses the oxyfuel process, at the Schwarze Pumpe site in the Niederlausitz region of Land Brandenburg. The plant has been in operation since autumn 2008 and is intended to contribute to the advancement and optimisation of oxyfuel capture technology.

At Ketzin outside of Berlin, the GFZ German Research Centre for Geosciences operates Europe's longest-running on-shore CO_2 storage site. Since 2008, almost 63 000 tonnes of CO_2 have been stored via one injection well into 630 metres to 650 metres-deep sandstone units.

21. *Carbon Capture and Storage, Legal and Regulatory Review*, Edition 3, IEA, 2012.

22. *Informationssystem Speichergesteine für den Standort Deutschland – Synthese*, Bundesanstalt Für Geowissenschaften und Rohstoffe, 2011.

23. Federal Ministry of Economics and Technology.

RWE operates a pilot carbon capture plant in Hürth-Niederaussem in co-operation with BASF and Linde. The plant went into operation in 2009. It contains a smaller-scale version of all the components in a large-scale plant and can capture up to 300 kg of CO_2 per hour. Various scrubbing solvents are being tested in different test phases, with the aim of identifying an optimal solvent for flue-gas scrubbing.

A pilot plant at the Staudinger power plant in Grosskrotzenburg owned by E.ON and Siemens aims to develop a process for capturing carbon from coal-fired power plants through flue-gas scrubbing (post-combustion capture). Post-combustion capture involves the use of special cleaning agents that can remove over 90% of the CO_2 from a power plant's flue gas.

CLEAN, a collaborative project carried out in Salzwedel (in the federal state of Saxony-Anhalt) until its conclusion in 2011, studied "enhanced gas recovery" technology and geological carbon sequestration in depleted gas fields. The three-year project was led and co-ordinated by the Potsdam-based German Research Centre for Geosciences. One of the project partners, GDF Suez, made the Altensalzwedel subfield available for scientific studies. No carbon storage took place within the framework of this project.

ASSESSMENT

Germany has substantial coal resources. Domestic hard coal mining is not economically viable owing to its high production costs and depth of the resource. A political decision has been taken to phase-out hard-coal production subsidies and decommission all hard-coal mines by 2018. On the other hand, lignite resources are plentiful and economically viable. Lignite reserves amount to around 41 billion tonnes, several hundred years of current production. The production of lignite as a feedstock for electricity generation is profitable notwithstanding the low price of carbon in the European Union Emission Trading Scheme (EU-ETS). In addition, imported hard coal, around 47.8 Mt or around 10% of the primary energy mix also plays a measurable role. As coal imports are well diversified and not subject to geopolitical risks, they enhance energy security.

As in all advanced economies, power generation dominates coal use. Coal use (hard coal and lignite) accounts for 45.1% of power generation, significantly more than the average of the European Union. Substantial old-coal capacity is likely to be decommissioned with the implementation of the EU Large Combustion Plant Directive. On the other hand, currently several large new coal-fired power plants are under construction, representing one of the biggest investment waves into coal capacities since the post-war reconstruction. These new coal power plants will have a technical lifetime at least until 2050. While lignite tends to run baseload owing to the high fixed costs and vertical integration between mining and power generation, load following operation of hard-coal power plants plays a significant role in providing the flexibility for renewables in the German power system. Because of the superior technical flexibility of the new supercritical plants under development, coal capacities are likely to continue to play a role in providing flexibility.

The carbon emission target of the German energy sector will fall below the current CO_2 emissions from the economically viable lignite power plants before 2030, and the embedded carbon content in German lignite resources exceeds the future emission budget by an order of magnitude. As a result, without the application of CCS technology it can be expected that coal would play only a small role for power generation in the long term.

CCS deployment is lagging in Germany following a long drawn-out legislative process. The legislation that emerged from the process is restricted to the demonstration of CCS and thus envisages a 4 Mt per year carbon-storage limit, which would be sufficient for less than 5% of current coal-fired power generation, and there is an ongoing discussion to what extent CCS should concentrate on industrial emissions. There is no specific financial incentive for CCS apart from the EU-ETS carbon price. The Jänschwalde CCS project was cancelled, despite receiving EUR 180 million funding from the European Economic Recovery Package, because of legal uncertainty and public opposition to onshore storage. On the other hand, CCS-related R&D supported by the BMWi is continuing and German government institutions as well as companies are active in international CCS technology co-operation.

RECOMMENDATIONS

The government of Germany should:

- *Monitor the process of decommissioning the hard-coal mining industry to ensure that the process meets its agreed closure dates and in accordance with budgeted costs.*
- *Clarify the role that it intends for CCS is to play in its decarbonisation pathway and verify initiatives to increase transparency and public acceptance concerning CCS.*
- *Consider all aspects of coal-fired capacities without endangering climate change objectives while assessing new market designs.*

8. RENEWABLE ENERGY

Key data (2011)

Share of renewable energy: 11.3% of TPES and 22% of electricity generation (IEA median: 9% of TPES and 18.8% of electricity generation)

Biofuels and waste: 8.5% of TPES and 7.3% of electricity generation

Wind: 1.3% of TPES and 8.1% of electricity generation

Solar: 0.7% of TPES, 3.7% of electricity generation

Other renewable energy: 0.7% of TPES and 2.9% of electricity generation

OVERVIEW

The federal government plans to aggressively expand the use of renewable energy with the aim of renewable energies providing 60% of total final energy consumption by 2050. The share of renewable energies in total electricity consumption will be increased to at least 35% by 2020. By no later than 2050, that share is targeted to grow to at least 80%.

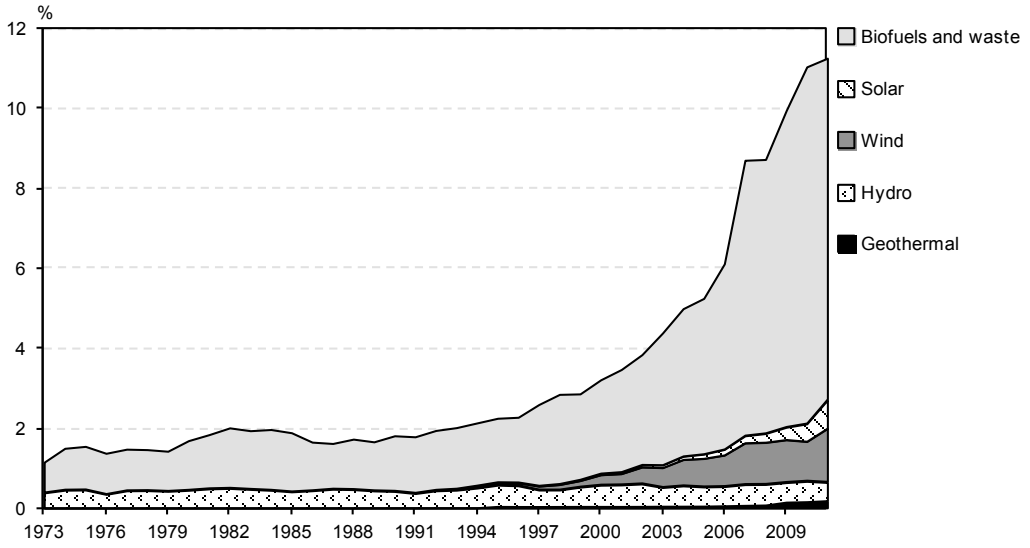
SUPPLY AND DEMAND

Renewable energy contributed 36.1 million tonnes of oil equivalent (Mtoe) or 11.3% of TPES in 2011. Biofuels and waste are the main source of renewable energy at 8.5% of TPES, followed by wind, solar, hydro and geothermal. Investment in renewable energy capacity has led to a significant increase in supply, replacing energy from coal, nuclear, natural gas and oil. Energy supply from renewables has increased by more than 200% over the past decade, up from 10.8 Mtoe or 3.2% of TPES in 2000 (Figure 21). In contrast, total TPES declined by 7.4% over the same period. Contrary to other renewable sources, supply from hydro has contracted by 20.5% since 2000, while remaining within the usual hydro output range of 0.4% to 0.6% of TPES.

By 2030, the government projects that, while TPES will fall, the contribution from renewable sources will increase substantially. Biofuels and waste are expected to provide the greatest shares of renewable energy, representing 21.6% of total TPES in 2030, with the other renewables accounting for a further 11.6%. Wind and solar will grow at a significant rate over the next two decades, while hydro and geothermal are expected to experience slower growth.

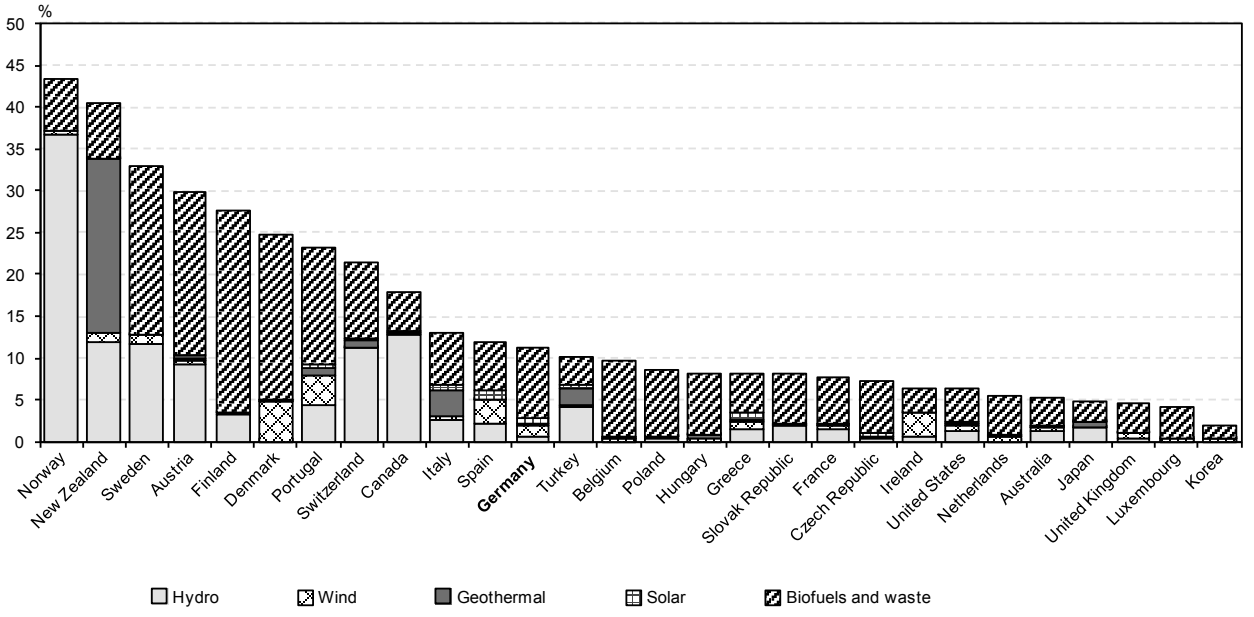
Germany ranked twelfth among IEA member countries with regards to renewables as a share of TPES (Figure 22) while it ranked sixteenth in 2005, indicating a faster rate of increase in penetration of renewable energy compared to the average IEA member country.

Figure 21. **Renewable energy as a percentage of total primary energy supply, 1973-2011**



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and country submission.

Figure 22. **Renewable energy as a percentage of total primary energy supply in IEA member countries, 2011**



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and country submission.

ELECTRICITY GENERATION

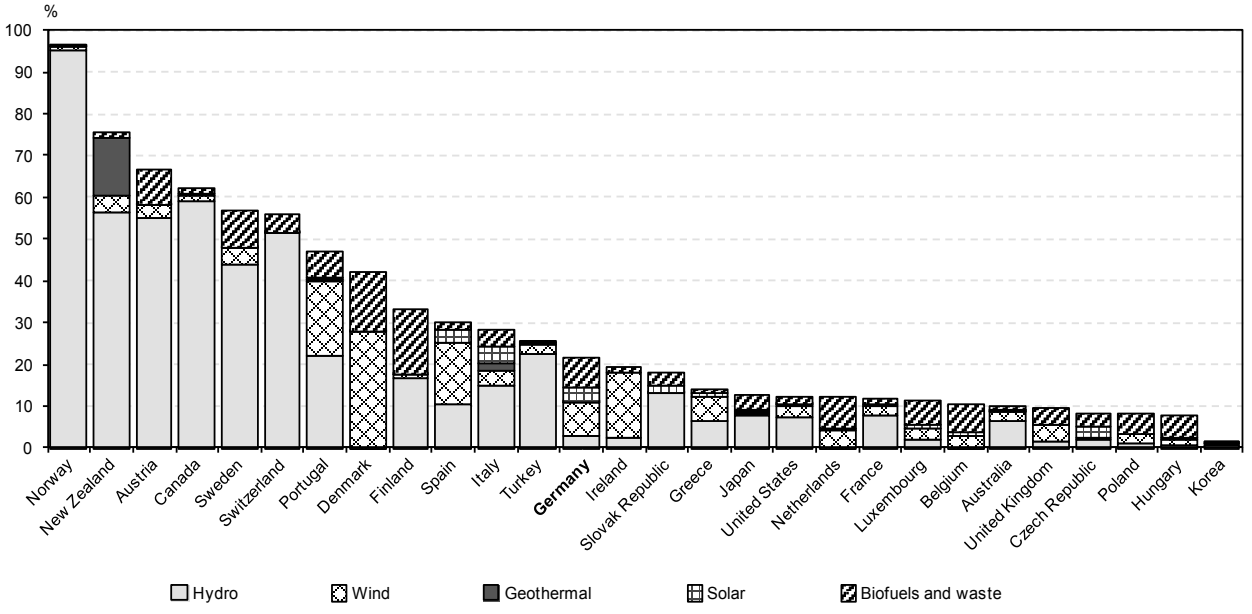
Electricity generation from renewable sources was 132.3 TWh in 2011, representing 22% of total supply, a ratio which has increased from 7.2% in 2000. Electricity from renewables was made up of 48.9 TWh of wind power (8.1% of TPES), 44 TWh of biofuels and waste (7.3%), 22.2 TWh of solar (3.7%) and 17.3 TWh of hydro-electricity (2.9%). Electricity generation from geothermal was negligible.

Despite biofuels and waste providing the highest share of TPES, wind power is the most significant renewable source in electricity generation whereas biofuels and waste have considerable usage in heat production and transport.

According to government forecasts provided to the IEA review team penetration of renewable sources in electricity generation is expected to continue to grow to 58% by 2030. This is a significant increase from just over 20% in 2011, with the greatest increase (200%) expected to come from wind power, which will account for 30.6% of total electricity in 2030, followed by biofuels at 13.3%, solar at 9% and hydro at 5.2%. Geothermal will remain at a negligible level of less than 0.5%.

Germany ranks at a median level among IEA member countries with regard to the percentage of renewable energy in electricity generation (Figure 23).

Figure 23. **Electricity generation from renewable sources as a percentage of all generation in IEA member countries, 2011**



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and country submission.

INSTITUTIONS

The Federal **Ministry for the Environment, Nature Conservation and Nuclear Safety** (BMU) is the lead ministry for renewable energy policy in Germany. It is assisted in this role by two subordinated superior federal authorities, the Federal Environment Agency and the Federal Agency for Nature Conservation. Renewable energy policy is co-ordinated within the federal government with all other relevant ministries.

The **Federal Environment Agency**, established in 1974, deals with all environmental matters. Its statutory mandates are: to provide scientific support to the federal government; to see to the implementation of environmental laws; and to inform the public about environmental matters. The **Federal Agency for Nature Conservation** (BfN) is the central scientific authority of the federal government for both national and international nature conservation.

KfW Bankengruppe, the Bank for Reconstruction, is owned by the federal government (80%) and the Länder (20%). Among other services, it provides long-term, low-interest loans for up to 100% of the investment costs of eligible renewable energy programmes.

The **Federal Office of Economics and Export Control** (BAFA) is a federal agency which reports to the Federal Ministry of Economics and Technology (BMWi). In the energy sector, among other things, BAFA implements measures to promote increasing use of renewable energies in order to conserve limited fossil fuel resources and to make a contribution to environmental and climate protection.

There is also a division of labour between federal government authorities and the **Länder**. Responsibility for policy instruments such as the Renewable Energy Sources Act, the Renewable Energies Heat Act and regulations on the biofuel quota, falls under the remit of the federal government, while the Länder authorities are tasked with regional planning, approval procedures, etc. The Länder are also responsible for implementing the Renewable Energies Heat Act.

FINANCING OF RENEWABLE ENERGY

In general, Germany's investment environment supports renewable energy deployment. A mixture of public and private entities has increasingly directed capital to renewable energy projects in recent years. In 2011, renewable energy investments in Germany totalled USD 31.9 billion (EUR 22.9 billion); only China and the United States invested more. German renewable energy projects enjoy a relatively low cost of capital compared with other countries.

As an investment location, Germany should retain several financial advantages over the medium term. First, the Bank for Reconstruction, KfW, which established a EUR 5 billion Offshore Wind Energy Programme for wind in 2011, continues to expand its offerings of low-interest direct loans for renewable energy projects. Secondly, the involvement of another state-backed fund, the European Investment Bank, has reinforced efforts in financing offshore wind.

Finally, Germany's regime of stable feed-in tariffs (*i.e.* payment is guaranteed for a period of 20 years) helps reduce project finance risks, potentially making entry attractive for other institutional investors. This effectiveness is illustrated by the fact that 88% of renewable energy investments in 2011 stemmed from power generation installations qualifying for assistance under the Renewable Energy Sources Act (EEG).

POLICIES AND SUPPORT MEASURES

RENEWABLE ENERGY SOURCES ACT

The key support instrument in the renewable electricity sector is the Renewable Energy Sources Act (*Erneuerbare-Energien-Gesetz*, EEG). The EEG promotes electricity production from renewable sources of energy on the basis of preferential grid access and a feed-in tariff scheme, differentiated by technology type, for a period of 20 years.

The electricity produced under the EEG is generally sold on the day-ahead market by the TSOs. The differential costs between the guaranteed remuneration payments made to the plant operators and the revenues made on the electricity market are passed through to the so-called privileged and non-privileged electricity consumers on the basis of different tariffs. Feed-in tariffs (FITs) vary with the generating capacity of the production source and the type

of renewable energy. They also decline annually to take into account the decrease in costs associated with the technology, such as installations and parts, and to encourage advances in technology. The EEG was amended in 2004, 2009, 2011 and, most recently, in 2012.

Box 6. **Cornerstones of the Renewable Energy Sources Act**

- Priority access for renewable energy (RE) to the power grid.
- Priority transmission and distribution.
- Fixed price for every kilowatt hour produced for 20 years for many technologies.
- Tariffs are set technology-specific and specific with regard to further provisions (such as site, system services, etc.).
- Reduction of the tariffs as a result of technical and market development.
- Equalisation of additional costs for electricity from renewable energy between all grid operators and electricity suppliers.
- Independence from public budget.
- Regular monitoring and evaluation process, comprehensive accompanying research and analysis.

Source: BMU.

A 2012 amendment to the EEG makes the targets set out in the Energy Concept legally binding, states that at least 35% by 2020, 50% by 2030 50%, 65% by 2040, and 80% by 2050, of German power supply is to be provided by renewable energy sources and the corresponding quantities of electricity fed into the power supply system.[24] EEG 2012 also provides for a number of other changes to the FIT regime:

- The introduction of an optional **market premium** offers an incentive to operators of all renewable energy installations to sell the electricity generated directly on the market and to align their offerings more closely with market requirements. Should renewable power plant operators decide not to claim the fixed FITs pursuant to the EEG, but instead sell the electricity generated themselves, they are entitled to a market premium in addition to the revenue obtained by the sale of the electricity. It is calculated as the difference between the EEG FIT and the monthly *ex-post* average price at the energy exchange and a management premium that differs with respect to the various forms of renewable energy (see Box 7).
- A new **flexibility premium**, the purpose of which is to promote investment in biogas-fired flexible power generation capacity. This premium, which will apply to both new and existing installations, facilitates investment in larger gas or heat storage and generator capacities, which, in turn, enables a demand-driven electricity generation.
- EEG 2012 also supports the development of energy storage technology by exempting storage systems from grid charges and from the EEG surcharge, and by introducing an interdepartmental research programme for storage systems, which includes demonstration plants.

24. Act Amending the Legal Framework for the Promotion of Electricity Generation from Renewable Energies (EEG 2012). The amendment was announced in the *Federal Gazette* on 4 August 2011 (2011, Part 1, No. 42), and entered into force on 1 January 2012.

- EEG 2012 also introduces a locational incentive to new generating capacity by limiting compensation payments to generators to 95% for loss of revenue due to curtailment. Investment security is retained since this regulation applies only to a maximum of 1% of annual income.

As part of its monitoring role under the EEG, the Federal Network Agency collects annual data from approximately 900 DSOs and the four TSOs, as well as approximately 1 100 electricity suppliers. According to the data gathered, at the end of 2010, the total capacity of installations eligible for payment under the EEG was approximately 50.7 GW, an increase of 9.3 GW, or 23%, compared to 2009.[25] Much of this growth was driven by an expansion in PV capacity, which increased by 7.1 GW, an increase of 72%, during 2010. This compares to a 1.7 GW increase in onshore wind capacity over the same period. In 2011, the capacity of installations eligible for payment under the EEG increased to 65.8 GW, of which 25 GW was solar PV.

Table 12. **Feed-in tariffs from renewable energy installations, 2012**

Energy source	2012 EUR/kWh	Degression
Hydropower	0.03.4-0.127	1%
Landfill gas, sewage gas, mine gas	0.0398-0.086	1.5%
Biomass	0.06-0.25	2%
Geothermal	0.25-0.30	0%
Onshore wind	0.0893*	1.5%
Offshore wind	0.15	0%
Solar energy	0.1203-0.2443	flexible up to 29% per year

* Subject to certain provisions.

Source: BMU.

EEG surcharge for 2013

In October 2012, the four electricity TSOs in Germany published the EEG surcharge for 2013.[26] The EEG surcharge, equal to the FITs paid by utilities for renewable energy, minus the revenue from sales of that energy, is added to the electricity bills of all consumers. In 2013, the EEG surcharge will amount to EUR 20.36 billion in total or EUR 0.05277/kWh. This represents a 47% increase on the previous year (EUR 0.03592/kWh). The factors influencing the increase were varied, the largest of which were: the expansion of renewable energies largely solar PV, wind and biomass (accounting for 44% of the increase, of which 15% was PV), and, forecasting errors in the previous year's calculation owing to low wholesale electricity prices (which accounted for 29% or EUR 2.6 billion of the increase).[27] For household consumers with an average consumption of 3 500 kWh per year this increase represents a rise of EUR 59 in their annual bill (excluding VAT). Energy-intensive companies are entitled to a lower EEG surcharge provided certain conditions are met. Under existing

25. *Monitoring Benchmark Report 2011*, Federal Network Agency, Berlin, 2012.

26. 50Hertz, Ampiron, TenneT and TransnetBW.

27. *Short analysis of the increase of the German EEG surcharge for 2013*, Öko-Institut, Berlin, October 2012.

arrangements, large consumers of electricity that use more than 10 gigawatt hours (GWh) of electricity per year pay a reduced surcharge (EUR 0.0005/kWh) on 90% of the electricity they consume with the full surcharge payable on the remaining 10%. Electricity-intensive industries that consume more than 100 GWh, and whose electricity bills represent more than 20% of total costs, may pay the lower surcharge on all of their consumption.

Box 7. **Market premium payments in Germany**

The 2011 changes to the Renewable Energy Sources Act (EEG) introduced the optional market premium model on 1 January 2012 (EEG). It opened the opportunity for renewable energy generators under the FIT scheme to opt for selling electricity directly into the market. This has been applied in particular for wind farms. Under the market premium model, a wind farm sells its produced output to a third party at the market price rather than selling it to the grid operator at the regulated feed-in-tariff.

The reference market price for the calculation of the market premium is determined as the monthly technology-weighted spot price at the EPEX Spot energy exchange. The premium is then set as the difference between the average wind market price and the FIT level. This represents an implicit floor price guarantee for the wind farm at the level of the regulated tariff. All wind power generators that achieve a higher price on the market have an advantage; all those who make a below average revenue get less.

In addition to the market price and the market premium, the wind farm is entitled to receive a management premium, intended to cover the administrative costs associated with the direct marketing of energy. The management premium is set at EUR 12/MWh for 2012 and steps down gradually to EUR 7/MWh in 2015, where it was scheduled to remain. However, a reform of the premium is ongoing, as some stakeholders perceive it as being too high. More than 28 500 MW of renewable energy has been transferred to new renewable market premium scheme in 2012.

Source: *Securing Power during the Transition*, IEA, 2012.

THE ENERGY CONCEPT

The federal government's objectives in relation to increasing the use of renewable energy are a cornerstone of the Energy Concept of September 2010. The Energy Concept sets out specific milestones and targets to the year 2050, including:

- an increase in the share of final energy consumption from renewable energy sources from approximately 10% in 2010 to 60% by 2050;
- an increase in the share of electricity generated from renewable energy sources from approximately 17% in 2010 to at least 80% by 2050.

Following the Fukushima Daiichi nuclear accident in March 2011, Germany returned to an earlier a decision to gradually phase-out nuclear power by 2022, augmented by greater energy efficiency and an accelerated switch to renewable energies. These decisions of June and July 2011 supplement and accelerate implementation of the measures set out in the Energy Concept of 2010. Among the key elements of the updated Energy Package were:

- Faster expansion of renewable energies based upon optimised co-ordination of conventional thermal power plants with electricity generation from renewable energy sources. This

electricity should be more flexible and be able to provide system services to ensure grid and supply security. Conversely, the development of storage facilities and greater flexibility in the conventional power plant fleet should contribute to a more stable system.

- Integration of renewable energies into the overall energy system: by accelerating grid expansion, greater market and system integration and by increased use of storage facilities.
- The Renewable Energy Sources Act was strengthened in 2012; (see previous Section for details) so as to include provisions allowing for accelerated market and system integration of renewable energies and increase the cost efficiency of their deployment.

Wind energy

The development of wind energy was indentified as a key component of the Energy Concept. The Energy Concept provided for the Offshore Wind Power Programme of the Bank for Reconstruction to support the establishment of the first ten offshore wind farms with a total of EUR 5 billion (in order to gain experience in this sector). Furthermore, an amendment to the Offshore Installations Ordinance (*Seeanlagenverordnung*) significantly simplified and accelerated the approval procedure for installations in the German Exclusive Economic Zone (EEZ).[28] This amendment improves options for replacing old wind installations with new, more efficient turbines, *i.e.* repowering.

The federal government will also co-operate closely with the Länder on the designation of suitable sites for onshore wind energy. In addition, the government and the Länder will commission an analysis of wind energy potential, which will be used as a basis to jointly develop criteria for designating suitable new sites for onshore wind farms. Limitations on proximity and height will be replaced with national criteria, developed jointly by the federal government and the Länder, for applying appropriate distance and height limits on a case-by-case basis.

NATIONAL RENEWABLE ENERGY ACTION PLAN

Prepared in 2010, The National Renewable Energy Action Plan (NREAP), prepared in accordance with Article 4 of Directive 2009/28/EC on the Promotion of the Use of Energy from Renewable Sources, presents the expected development of renewable energies in Germany in order to achieve the national target, and thus Germany's contribution to the overall EU target of 20% renewable energy in 2020. It contains existing and planned measures, with which the national target of 18% is to be achieved. At the time the NREAP was prepared, the federal government estimated the share of renewable energies in gross final energy consumption to be 19.6% in 2020: the share of renewable energies in the electricity sector will amount to 38.6%; the share in the heating/cooling sector will be 15.5%; while in the transport sector it will amount to 13.2%.

RENEWABLE ENERGIES HEAT ACT 2009

The Renewable Energies Heat Act of 1 January 2009 was amended in 2011. This amendment, which entered into force on 1 May 2011, states that owners of new buildings

28. The German waters in the North and Baltic Seas consist of the 12 nautical-mile zone (so-called territorial sea) and the Exclusive Economic Zone (EEZ). The German territorial sea is under the jurisdiction of the coastal Länder. The area seaward of the 12-mile zone, which extends maximally 200 nautical miles from the coastline, is the Exclusive Economic Zone.

must use energy from renewable sources to cover a portion of their heating and cooling requirements (use obligation). The use of solar thermal systems, biomass (solid, liquid or gas) and geothermal energy/environmental heat is permitted. This applies to both residential and non-residential buildings for which a building application or building notice was submitted after 1 January 2009.

The owner of the building is free to decide which form of renewable energy (or permitted alternative measures) to use. Since 1 May 2011, public authorities are required to play an exemplary role in this regard (implementation of Directive 2009/28/EC on Promoting the Use of Energy from Renewable Sources). According to this directive, existing buildings belonging to the public authorities are also required to use renewable energy to cover some of the heating and cooling requirements in the event of extensive renovations.

MARKET INCENTIVE PROGRAMME FOR RENEWABLE ENERGIES

The Market Incentive Programme for Renewable Energies is the main instrument used by the federal government to promote renewable energy in the heating market. This programme has been supporting investment in renewable heating technologies for more than a decade: it provides an important stimulus for innovation and the introduction of new products to the market. Guidelines are in place to regulate funding activities and funding requirements, and are usually adapted on an annual basis to take account of technological progress and current market trends. The latest guidelines became effective on 11 March 2011. The Market Incentive Programme comprises the following two components:

- Grants towards investment costs, available from Federal Office of Economics and Export Control (BAFA), for smaller installations and aimed largely at private investors in the market for single-family and two-family houses.
- Low-interest loans with repayment subsidies, available as part of the Renewable Energies (Premium variant) programme operated by the Bank for Reconstruction for larger-scale heating solutions, most of which are implemented for commercial customers or municipal authorities.

The total volume of funding allocated in 2010 under the Market Incentive Programme amounted to approximately EUR 346 million. This funding stimulated investments totalling more than EUR 2.15 billion.

Table 13. **National overall target for the share of energy from renewable sources in gross final consumption of energy, 2005 and 2020**

A	Share of energy from renewable sources in gross final consumption of energy in 2005	5.8%
B	Target for the share of energy from renewable sources in gross final consumption of energy in 2020	18%
C	Expected total energy consumption in 2020 after adjustment (ktoe)	197 178
D	Expected amount of energy from renewable sources in accordance with the target for 2020 (calculated as B x C) (ktoe)*	35 492

* The minimum volume of renewable energies required to achieve the national target, based on the expected final energy consumption in 2020.

Source: National Renewable Energy Action Plan in accordance with Directive 2009/28/EC on the Promotion of the Use of Energy from Renewable Sources, Federal Republic of Germany, 2010.

POLICIES AND MEASURES IN THE TRANSPORT SECTOR

Biofuels Quota Act

The Biofuels Quota Act sets a minimum level of biofuels that must be used in road transport in Germany. Since 2010, the total biofuels quota has been set at 6.25% based on energy content. As of 2015, this quota is to be replaced by a climate protection quota, which will specify the minimum net contribution that must be made by biofuels to the reduction of GHG emissions. This quota will be increased to 7% by 2020.

Biofuels Sustainability Law

The Biofuels Sustainability Law entered into force in Germany on 1 January 2011. This law implements European policy at national level. According to the law, the production of biofuels can only be considered sustainable if it leads to a saving of at least 35% on GHG emissions compared with fossil fuels. This minimum requirement is to be gradually increased, with biofuels saving a minimum of 50% GHG emissions by 2017. The law also stipulates that ecologically sensitive areas, such as wetlands, peat lands or rain forests, must not be used to produce biofuels. Biofuels must meet these sustainability standards to qualify for inclusion in the biofuel quota or to be eligible for tax concessions.

Government programme on electromobility

The federal government's Electromobility Programme was approved on 18 May 2011. The programme is based on the National Development Plan for Electromobility launched in August 2009, and incorporates the recommendations of the National Electromobility Platform, a panel of experts established by the federal government with representatives from science, industry and public organisations. The programme aims to advance the R&D of electric battery-powered vehicles in Germany, and to promote their commercialisation and launching on the German market. A range of fiscal and regulatory incentives is included in the package of measures. In addition, the R&D funding initiated in connection with the Stimulus Package II is to receive another boost. This programme is the joint responsibility of Federal Ministry of Economics and Technology, the Federal Environment Ministry, the Federal Ministry of Transport, Building and Urban Development (BMVBS) and the Federal Ministry of Education and Research (BMBF).

The aim is that, by 2020, there will be one million electric vehicles on the German market, with this figure increasing to six million by 2030. In addition, Germany is to become the lead market and leading provider for electromobility. Two factors are particularly essential if electromobility is to favour environmental protection and climate mitigation: the use of electricity from renewable sources and intelligent grid integration of the vehicles. These are important prerequisites of the government programme, which is steered by BMU and BMVBS.

ELECTRICTY

OVERVIEW

By 2020, the federal government targets that renewable energy will meet at least 35% of total gross electricity consumption. In addition, the federal government is also committed

to increasing the share of electricity generated from renewable energy sources to 50% of gross electricity consumption by 2030, 65% by 2040 and 80% by 2050 (in accordance with the Renewable Energy Sources Act 2012).

The growing role of renewable sources in the power generation mix is reflected by large capacity additions. In 2011, onshore wind accounted for 8% of total electricity generation and capacity rose by 1.8 GW. Solar PV installations added 7.5 GW of new capacity, bringing cumulative capacity to almost 25 GW. In 2011, Germany maintained its overall power net export position, though volumes dropped from 17 TWh in 2010 to 5 TWh.

During a Europe-wide severe cold snap in February 2012, Germany remained a net exporter, with solar PV compensating for lost nuclear during peak demand midday periods in France. In addition, wind power contributed to peak demand in the evening.

POLICY ENVIRONMENT FOR RENEWABLE ELECTRICITY

Germany's policy framework for renewable energy deployment is generally strong, underpinned by a set of stable FITs, i.e. guaranteed for a period of 20 years. Federal targets – codified in the NREAP and in the Renewable Energy Sources Act (EEG) – conform to European Union 2020 targets, but the government's renewable energy planning spans a longer time horizon, to 2050, and is integrated within its larger industry strategy.

Since 2011, the government has placed greater emphasis on rapid renewable energy deployment. On the one hand, authorities would like to speed up the process of offshore wind deployment. Germany aims to reach total capacity of 10 GW by 2020 using a set of adjusted incentives and accelerated planning procedures as well as a dynamic response to emerging issues (such as a risk-sharing mechanism for grid connection delays).

On the other hand, authorities have recognised that recent growth in solar PV was too rapid, moving out of line with both the 2020 NREAP indicative target of 52 GW and overall energy system planning. FITs were not adjusted as fast as falling system prices, leading to excess returns on solar investments and deployment. In June 2012, an amendment to the EEG – the "June PV Amendment" – made it clear that FITs for PV systems will expire when the overall target of 52 GW is reached.

ECONOMIC ATTRACTIVENESS OF RENEWABLE ELECTRICITY

Given the prevailing feed-in-tariff structure, renewable energy sources are attractive compared with conventional energy investments, as generators face no market risk and they can be sure to sell electricity even during a contraction of demand. FIT levels for hydropower, bioenergy and onshore wind new development are broadly in line with costs of new coal and gas projects. Offshore wind remains relatively less competitive.

Meanwhile, the tariffs for solar PV installations have dropped below the average electricity retail prices for households (*i.e.* retail grid parity is reached in Germany), will drop further if projects go ahead under the new tariff rates. Falling prices of solar panels and other system components, both within Germany and globally, suggests that the costs of solar PV projects will continue to decline over the medium term.

Greater levels of renewables deployment and higher renewable energy tariff spending, which is funded through electricity bills, have raised concerns over the impact on consumers. Nevertheless, the overall impact of deployment on prices remains complex, particularly with high shares of variable renewable energy decreasing wholesale market prices in periods

of high wind levels, reflecting merit-order effects. At times, high electricity production from solar PV has resulted in supply exceeding demand, resulting in downward pressure on wholesale electricity prices, savings that are not always passed on to consumers.

GRID AND SYSTEM INTEGRATION

The German very-high-voltage grid is split among four TSOs, which were unbundled from their respective generation companies in 2005. Since 2006, the Federal Network Agency (*Bundesnetzagentur*) has been charged with oversight of the sector. Grid expansions are not paid by the TSOs directly; rather, they are funded through a regulated additional tariff that is paid by all electricity consumers. The costs for grid reinforcement and development are strictly controlled through the incentive regulation (*Anreizregulierung*). Network investment budgets have to be approved by the Federal Network Agency.

So far, the German grid has not acted as a significant bottleneck to renewable energy deployment, but challenges may increase with respect to wind and solar deployment. The relative weakness of the grid in northern Germany is impacting upon wind future developments particularly in the North Sea area. Furthermore, curtailment of generation for grid stability reasons has begun to emerge as an issue for onshore wind power producers. In 2010, between 0.2% and 0.4% of total wind generation was curtailed, largely because of overloads at medium-voltage level lines and substations (110 kV, where most wind is connected to in Germany).

DSOs are obliged under the German Energy Act and the Renewable Energy Sources Act to optimise, reinforce and expand their networks to reflect latest network standards, without delay, in order to accommodate the purchase transmission and distribution of electricity from renewable sources. Accordingly, strong growth in renewable energy has posed significant challenges for the DSOs.

In 2010, the DSOs and TSOs were required to undertake a number of market-related congestion management measures, including commercial transactions needed to eliminate threats to network stability. Furthermore, and despite the continued investment in networks, not all generators were able to get their power onto the system. So-called feed-in management measures (or FMMs) are sometimes required to adjust the output levels from EEG installations in return for compensation. The Federal Network Agency estimates that approximately 129 GWh of output was unused in this way and compensation payments of EUR 10 million were required almost entirely paid to wind power generators. Moreover, timely grid connections for offshore wind power are proving particularly difficult.

Over the past year, TenneT – the TSO responsible for offshore grid installations in the North Sea – has announced connection delays for several projects due to lack of financing and labour resources, and supply bottlenecks for high-voltage direct-current (HVDC) hardware and sea cables. It has proposed measures (including the creation of a direct-current grid operator) that could facilitate planning and assist in making the large amount of capital more easily available.

Another grid and system integration issue relates to the mismatch between wind installation density in the north (Lower Saxony) – particularly for offshore – and east (Saxony-Anhalt) and the load centres in the west and south, combined with insufficient internal connection among the four supply areas in Germany. The phase-out of nuclear power will further exacerbate this mismatch as nuclear capacity has been largely located in the south of Germany. However, the ascendancy of solar power, largely situated in

the south, and good interconnections with pumped hydro storage in Austria, partly compensates for this discrepancy, although the potential to increase this form of energy storage is very limited as the economic potential of large hydro has already been developed, and the remaining potential is limited owing to environmental regulations. Nonetheless, the mismatch between supply in the north and demand in the south is a major driver of the significant investments needed in German transmissions infrastructure.

Furthermore, the European Network of Transmission System Operators for Electricity (ENTSO-E) has identified major flows in Central Europe, including loop flows in the north-south direction, among the problems driving the need for significant investments in Central Europe. Such loop flows have become more common since Germany developed large amounts of wind power in its northern Länder, but did not develop the grid infrastructure to transfer the output south to where much of the demand is located. This difficulty has been amplified by the shut down of eight nuclear plants in 2011.

In solar PV, given high deployment rates and ownership dominated by smaller, non-traditional players, (*e.g.* rooftop solar PV for households and farms), the task of grid operation is becoming more complex. According to the 2012 revision of the Renewable Energy Sources Act, all new PV plants must install the technical equipment to allow for curtailment if needed. The only exceptions are small solar PV installations (up to 30 kW), which can opt for reducing feed-in to 70% of the peak capacity of the installation instead. This value was determined to be an optimal trade-off for allowing capacity to grow, while keeping curtailment low. The technical challenges of low-voltage grid adjustment are comparably small. Aligning incentives for the different stakeholders (DSOs, generators) will be important to ensure that deployment is not hindered.

Overall, the ambitious renewable plans of the government require grid developments. The National Grid Expansion Acceleration Act (NABEG) of 2011 has been adopted to simplify and accelerate permitting procedures of national and cross-border lines while ensuring a high level of public participation. Moreover, a new grid planning process has been introduced, with a ten-year national grid development plan defining the need for new transport lines and considering new technologies to be drafted by the TSOs and adopted by the Federal Network Agency.

DENA STUDY ON THE INTEGRATION OF RENEWABLE ENERGY SOURCES

In 2012, the Germany Energy Agency (DENA) conducted its second grid study, Grid Study II, to provide a strategic plan for the further development of Germany's power grid in terms of connecting and integrating renewable energy sources in conjunction with maximally cost-efficient use of conventional power stations and higher levels of European power trading. The outcome of the study was published in November 2010.[29]

The objective of Grid Study II was to investigate suitable system solutions for the German power supply system (up to 2020 with an outlook to 2025), to fully integrate 39% renewable energy in the power supply into the German power grid while guaranteeing security of supply and taking the effects of liberalised European energy markets into account. Grid Study II investigated how Germany's power system must be expanded and optimised over the period to 2020-25 if the new challenges arising from the integration

29. DENA Grid Study II*, Integration of Renewable Energy Sources in the German Power Supply System from 2015-2020 with an Outlook to 2025*, German Energy Agency, 2010 (English-language version published in April 2011).

of renewable energy sources are to be met while simultaneously guaranteeing reliable and economically viable power supplies.

The report emphasised three principal aims: integration of 39% power generation from renewable energy sources, in particular wind power, economically optimised use of conventional power stations and taking account of increasing levels of European power trading. The study reveals the technical and economic options which are available for reconciling these aims as well as possible with one another.

The study examined a number of variants for the further development of Germany's power grid. Examination focused, on the one hand, both on those grid technologies which are available today and on those which are under development, ranging from standard 380 kV three-phase overhead lines via high temperature conductors and high-tension direct-current transmission to underground cables. Account was also taken of further relevant measures, for example increasing line capacities by temperature monitoring, controlling power demand and using power storage systems. The impact of the measures on the overall system was investigated for all variants.

SOLAR ENERGY

In 2011, 22.2 TWh (or 16.8%) of the total 132.3 TWh of energy supplied by renewable energy sources was generated by photovoltaic (PV) technology. The total PV installed capacity for 2011 was 25 039 MW. This corresponds to an increase of 23 531 MW on the figure from 2005, when the last in-depth review was conducted. Installed capacity in Germany grew by some 7.7 GW in 2011 alone and another 7.6 GW in 2012.According to the NREAP) installed PV capacity in Germany will reach 51.8 GW by 2020, generating an estimated 41.4 TWh of electricity.

The PV FIT regime has undergone several revisions and adjustments, in response to deployment considerably exceeding the indicative target corridor levels overheating. In 2008 a corridor system was introduced that ties the rate of reduction in support level to the recent rate of investments. Despite this, four non-scheduled decreases in support levels were introduced in 2010, 2011 and 2012. These revisions have helped keep the FIT levels – in terms of the net present value of all future payments – reasonably close to actual PV costs in Germany, which, thanks to market maturity, are significantly lower than in sunnier countries.

Cost control appears especially difficult in the case of PV. The technology is extremely modular, easy and fast to install and accessible to the general public: 288 000 installations of less than 100 kW were installed in Germany over 12 months in 2010 – almost three times the cumulative ambition of the initial programme. They totalled 62% of the added capacity, the remainder being provided by less than 1 200 larger installations.

As a result, the supply curve seems rather flat, reflecting considerable potential at a given cost. Controlling quantities would require a very precise price setting in an uncertain and ever-changing economic environment. At any time, the incentive level risks being either “too high”, not generating too high returns to investors but driving more investments in PV than wished, or “too low”, and much less investment than desired will take place.[30]

30. *Solar Energy Perspectives*, IEA, 2011.

Following a large spike (3 GW) in deployment of solar PV in December 2011 there has been significant debate in Germany on how to proceed. Some argued in favour of a 1 GW per year cap on additional deployment. Others opposed a hard cap on either total budget or total deployment volume and favoured more frequent tariff cuts. Subsequently, the June PV Amendment, jointly proposed by the two relevant federal government ministries, BMU and BMWi, implemented the following changes to the FIT regime:

- The cuts, advanced from July to April, will not be 15% as scheduled, but above 30%, depending on installation size (Table 15).
- Tariff reductions will occur more frequently (monthly) starting from April 2012.
- Only up to 90% of the produced electricity will be eligible under the FIT regime. The rest needs to be self-consumed, sold in the wholesale market, or compensated at the average daytime spot market price otherwise. Meanwhile, the premium for self-consumption was cancelled.

Table 14. **New feed-in-tariffs from 1 April 2012 under the Renewable Energy Sources Act**

Start of operation	Installed capacity roof-top				Free field installations	
As of 1 January 2012	Up to 30 kW	Up to 100 kW	Up to 1 000 kW	Above 1 000 kW	Conversion areas	Others
	24.43	23.23	21.98	18.33	18.76	17.94
As of 1 April 2012	Up to 10 kW	Up to 1 000 kW		Above 1 000 kW, max 10 MW	All, max 10 MW	
	19.5	16.5		13.5	13.5	
	80%	90%				

Source: BMU.

WIND ENERGY

Wind energy, at 48.9 TWh in 2011, makes the greatest contribution to electricity that is generated from renewable energy resources. This energy was produced by more than 20 000 wind power plants in operation in Germany in 2011, with a total capacity of 29.1 GW. The German wind energy market recorded further stable growth in 2012: 1 008 new wind turbines with a total capacity of 2.4 GW were installed, this compares to 895 installations or 2 GW of capacity in 2011.[31] According to the NREAP, Germany will have wind power stations with a combined capacity of 46 GW and a total output of 104 TWh by 2020.

Wind energy development in Germany is highly regionalised. During 2012; the northern Länder had the largest number of new constructions representing 40 % of newly installed capacity. Much of this new capacity is concentrated in Lower Saxony (15%), Schleswig-Holstein (14%) and Mecklenburg-West Pomerania (13%). Approximately 12% of capacity additions were in Rhineland-Palatinate in the south, followed by Brandenburg with about 10%.

31. Status of Wind Energy Development In Germany, Deutsche WindGuard GmbH on behalf of the German Wind Energy Association (BWE) and VDMA Power Systems, 2012.

Table 15. **Cumulative installed capacity and number of turbines in the Länder**

	Land	Installed capacity at 31 December 2012 (MW)	Number of turbines at 31 December 2012
North	Lower Saxony	7 338	5 479
	Schleswig-Holstein	3 588	2 926
	Mecklenburg-Western Pomerania	1 950	1 507
	Bremen	146	76
	Hamburg	53	58
Central	Brandenburg	4 814	3 135
	Saxony-Anhalt	3 813	2 413
	North Rhine-Westphalia	3 179	2 899
	Saxony	1 003	844
	Thuringia	900	641
	Hesse	802	705
	Berlin	2	1
South	Rhineland-Palatinate	1 923	1 243
	Bavaria	881	559
	Baden-Württemberg	502	383
	Saarland	158	103
Offshore	North Sea	230	46
	Baltic Sea	51	22
	Total	**31 332**	**23 040**

Source: BWE.

In 2012, 16 offshore wind turbine generators with a combined capacity of 80 MW were connected to the grid and by the end of the year a total capacity of 280.3 MW from offshore wind turbines was connected. A further 109 foundation structures were installed at sea. In the second half of 2012, construction of four additional offshore wind energy projects commenced. In total, six offshore wind energy projects are under construction, over 350 turbines with a total capacity of approximately 1 800 MW. All projects are located in the North Sea.

HYDROPOWER

Hydropower contributes 13.1% of the renewable energy sources that generate electricity to cover Germany's total final energy demand. In 2011, hydropower (including 6.8 TWh of pumped storage) provided 17.3 TWh of the 132.3 TWh of electricity that was generated from renewable energy sources. The capacity currently installed to generate this power is 11 532 MW including, 6 777 MW of pumped storage capacity.

BIOMASS

Biomass, at 33.3%, represents the second-largest share of electricity generation from renewable energy sources. Of the 132.3 TWh of electricity generated from renewable energy resources in 2011, approximately 44 TWh came from biomass, of which 19 425 GWh was biogas. The capacity installed in 2011 to generate this power is 7 324 MW including 2 997 MW of biogas capacity. Biomass includes solid and liquid biomass, biogas, landfill gas, sewage gas, and the biogenic share of waste.

In April 2009, the Federal Ministry for Food, Agriculture and Consumer Protection (BMELV) and Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) jointly produced a National Biomass Action Plan for Germany, Biomass and Sustainable Energy Supply (the Biomass Action Plan). The purpose of the Biomass Action Plan was to establish the potential for the use of biomass in Germany and identify available reserves. It also established the federal government's strategies towards promoting bioenergy use in the heating, electricity and fuel sectors, and the measures it intends to take in implementing them. The Biomass Action Plan highlights both the strategies that must be implemented to promote more efficient, sustainable bioenergy production and the actions that are needed in doing so. The Biomass Action Plan was integrated into the NREAP.

Biogas in Germany

Germany is a European leader in terms of electricity production from biogas. In 2012, around 7 600 systems with a cumulative capacity of almost 3 200 MW generated 19.4 TWh of electricity. Energy crops and agricultural manure or slurry are the substrates primarily used to generate biogas.

Table 16. **Use of biogas in Germany**

	2010	2011	2012 (est.)
Number of plants (including those feeding biomethane)	5 095 (45)	7 320 (80)	7 589 (95)
Installed capacity in MW	2 291	2 997	3 179
Net electricity production (MWh)	14.82	17.92	19.2
Homes supplied with biogas-fired electricity	4.2 million	5.4 million	6.3 million

Source: German Biogas Association, AGEE.

HEAT SUPPLY

Heat generation from renewable energy sources comprises the use of biomass as a fuel, solar thermal energy and geothermal energy. The 2020 target that has been defined in the Energy Concept and the Renewable Energies Heat Act is that 14% of the share in energy consumption for heating and cooling must come from renewable energy sources.

Biomass, geothermal energy and solar thermal energy collectively accounted for 136.1 TWh of heat generated in Germany in 2010. This corresponds to a 9.5% share in the final energy consumption for heating/cooling. The contribution made by renewable energy sources to the total heat supply has therefore increased by 3.5% since the previous in-depth review. The Renewable Energies Heat Act (which entered into force on 1 January 2009), in conjunction with the Market Incentive Programme for Renewable Energies, is an important instrument for increasing the share of renewables in the heating market.

Biomass for heat

Biomass fuels make up the greatest share of all heat supplied by renewable energy sources: 125.3 TWh, or 92%, of heat generated from renewable energy sources. Biomass includes solid and liquid biogenic fuels, biogas, sewage gas, landfill gas and the biogenic share of waste. Of these, solid biogenic fuels (100.3 TWh or 80%), is by far the greatest contributor to heat supply. The biogenic share of waste accounts for 9.5%, biogas for 6.1%, liquid biogenic fuels for 3.3%, sewage gas for 0.9% and landfill gas for 0.1%.

Solar thermal energy

In 2010, Germany had geothermal energy collector systems covering an area of approximately 14 000 m² producing an output of 5 200 GWh. This is double the amount from 2005, when the last in-depth review was conducted.

Geothermal energy

Geothermal energy, 5.585 TWh, makes up 0.4%, of the share of renewable energy in total final energy consumption, and 4.2% of the share of renewable energy of heat supply. Within this category, near-surface geothermal energy (heat pumps and pumps that use environmental heat from air and water) is by far the greatest contributor, with a share of 3.9%. Meanwhile, deep thermal energy accounts for 0.2%.

TRANSPORT SECTOR

It is planned that, by 2020, energy from renewable sources will cover at least 10% of total fuel consumption (excluding aviation fuel). In 2010, the share of renewable energy in the fuel supply was approximately 5.8%, or 35.7 TWh. Of this share, biodiesel accounted for 26 520 GWh (74.3%), bioethanol for 8 541 GWh (23.9%), and vegetable oil for 636GWh (1.8%).

ASSESSMENT

Together with energy efficiency improvements, large-scale deployment of renewable energy is at the heart of the Energy Concept or *Energiewende*. In setting long-term targets for the deployment of renewable energy, the Energy Concept sent a strong signal to all stakeholders, and demonstrates the commitment of the whole country. Implementation of the Energy Concept was stepped up in June 2011, following the accelerated phase-out of nuclear power after the Fukushima Daiichi accident in Japan.

A key element of Germany's success in developing its renewable energy has been the stable policy framework for investors over the past decade. The most important component of this policy framework has been the Renewable Energy Sources Act (EEG), which, since its inception in 2000, has proven very effective in deploying renewable energy, notable electricity generation from biomass, wind power and solar photovoltaics (PV). Electricity from biogas, wind power and solar PV, in particular, has expanded dramatically thanks to the support of FITs established by the EEG. This policy tool has also proven successful in bringing costs down, as reflected in particular in the decrease in feed-in tariffs for PV, from EUR 0.457/kWh in 2004 to EUR 0.1794/kWh in 2012 from ground-mounted installations, and from EUR 0.574/kWh to EUR 0.2443/kWh in 2012 from small roof-top systems – below the retail cost of electricity for households.

Grid parity for PV, understood as the cost of a kilowatt hour (kWh) being equal to or lower than the full retail electricity price, has been reached in Germany for households. Conversely, as the costs of renewable energy technologies have fallen, notably for solar PV, FITs failed to keep up and relative large volumes of capacity were connected to the grid. As regimes in other markets, for example in Spain, reacted and capped volumes of solar PV eligible for support, connections in Germany continued to grow in 2011.

COSTS OF PV DEPLOYMENT

In 2010, solar energy contributed 11.76 GWh (2009: 6.6 GWh) to power supply and received EUR 6 billion (2009: EUR 3.2 billion) in remuneration or 39% of Renewable Energy Sources Act (EEG) costs. Solar power systems contributed approximately 15% of the entire EEG feed-in for 2010, an amount which represents only approximately 2.4% of power sales volume to final consumers during the year. Irrespective of the way the expansion of solar power progresses in the future, the total remuneration payable to the operators of solar installations will remain at a very high level during the coming years.[32]

The present implementation of the FIT for PV, however, has so far failed to keep the volumes of instalment near the objectives that had been set of about 3 GW new-built per year, despite the various amendments made to the EEG to this end. The "breathing cap" conceived to accelerate or slow the tariff degression depending on the rhythm of instalment has not delivered. The trend of installing more than 7 GW per year has persisted. The cost schedule of installations is probably too flat, and the reality of costs too uncertain and changing too fast, to allow for a sure control of volumes through fine-tuning tariffs.

The rapid, uncontrolled deployment of PV has become a major policy concern and represents a significant cost for consumers. For example, in 2013, the largest share of the increase of the EEG surcharge to 2012 stems from the growth of electricity production from solar PV, or 29% of the increase. Nonetheless, the German government has been successful to date in reducing the difference between incentive levels and reducing costs but less successful in managing the volumes of capacity.

Together with another sharp reduction in tariffs effective from 1 January 2012, the federal government has introduced some new options to address this issue. Owners of renewable electricity generating capacities can renounce the FIT and opt alternatively for directly marketing the electricity – with several additional premiums being also financed through the EEG surcharge on electricity bills. The market premium is calculated on the basis of the difference between the average wholesale electricity price of the respective technology and the FIT. It is augmented by a management premium of EUR 0.012/kWh. A flexibility premium is also offered to biogas generators opting for direct marketing.

The intent is to drive renewable electricity generators closer to market demand – and its variations in time. In the case of electricity generated from bio-energy, the market system drives owners to deliver electricity at peak times by investing in gas storage and possibly larger generating capacities with lower capacity factors. For small-scale rooftop installations, it should encourage owners of capacity to self-consume their electricity during times of low prices, and sell it during high price times, thereby driving individual

32. *Annual Monitoring Report*, Federal Network Agency, 2012.

load management efforts. For existing wind turbines the options seem limited; it is mostly in refining their ability to forecast their production that owners can increase the value of the electricity sold on the market. For new turbines, the trend could drive a change for smaller capacity turbines with greater capacity factor, which could be an advantage with unmanageable generation. After three months, 60% of the wind power was sold on the market benefitting from too generous market and management premiums with little added value at system levels. Meanwhile, very few if any PV capacity and few biomass capacities had opted for the new system. While the FIT for biogas is usually considered generous, the premiums it could enjoy under direct marketing may be – comparatively – too low.

Other important changes entered into effect on 1 April 2012 with respect to PV, with further tariff cuts ranging from 20% to 30%. Operators will only benefit from the tariff for 90% of their production for small-scale installations, having to self-consume or sell on the market the remainder. Tariffs were cut further, by 1% per month until November 2012; at that time, the cuts became based on the volume installed in the third quarter of 2012.

The question remains, however, whether steering deployment volumes via per-kilowatt-hour remuneration will be effective at some point. If it were not, putting a cap on the total new financial commitment (rather than electrical capacity) that is added each year could be a way to guide deployment on a sustainable path and to give certainty for investment. With respect to large plants, this maximum financial commitment could take the form of tendering schemes for new capacities in substitution to the FIT, provided it is not overly technology-prescriptive, but transparent and fair.

REDUCING COSTS AND POLICY STABILITY

The debate over the social and economic impacts of the Renewable Energy Sources Act (EEG) has become more prominent as the share of renewable energy has continued to grow alongside rising retail electricity prices. Following much higher than expected deployment of renewable energy, most notably solar PV, over the past four years, driven by the falling costs of the technology and guaranteed revenues of the EEG, which are relatively high compared to the investment cost, the steep increase in the EEG surcharge, together with other cost factors, has ignited a public debate on the cost of renewable energy support mechanisms.

The transition to a low-carbon energy sector requires public support, and, therefore, retail electricity prices to remain at an affordable level. The fact that German electricity prices are among the highest in Europe, despite relatively low wholesale prices, must serve as a warning signal. At the same time, energy policy is based on long-term investment decisions and the framework conditions in Germany for a policy consensus in favour of large-scale deployment of renewables have never been better. Against this backdrop, the German government should maintain its energy policy position concerning renewables based on a predictable and stable regulatory framework while seeking means to reduce the costs.

German energy policy goals are long-term and achieving them requires a predictable political and regulatory framework. Sudden changes can undermine investor confidence and will drive up costs in the long term, because of increased risk premiums. Any form of retroactive tariff cuts – even if applied for only a short period – must be avoided. What is needed is a systematic reform of the support environment for renewables deployment. A reformed policy scheme will need to reap the benefits of competition, locate and pace new deployment in line with required infrastructure and provide sufficient certainty for

investors. A tendering scheme for larger installations, designed in the right way and in line with EU and other legislation, could meet this set of criteria.

The cost impact of the EEG needs to be assessed within the context of overall energy sector developments. Recent increases in electricity costs have placed low-income households under pressure, while large consumers who buy power on the wholesale market have been shielded from the surcharge while benefitting from the renewables-induced reduction of wholesale prices. In addition, energy poverty is equally driven by the steep increase in fossil fuel costs. The costs, but also the benefits, of renewables need to be allocated in a fair and transparent way. Exemptions for the industry have been mounting in the past years (including the exemption from grid fees for energy-intensive industries), while the cost on small consumers has risen sharply.

Also, the cost of renewables deployment may need to be put on a broader basis. The benefits of a carbon-free power system reach out into other sectors: decarbonising other sectors of the economy, such as transport and heating in households and industry is often easier to achieve through increased electrification – to the extent that the electricity is carbon-neutral. Along this line, the costs of decarbonising the power sector could be shouldered also with these sectors participating.

SYSTEM INTEGRATION

A successful energy transition calls for a fundamental redesign of the technical and regulatory framework of the electricity sector. The capacity of the German power system to absorb the very large projected amounts, in particular of solar PV and wind generation, needs to be systematically increased.

Improved operational strategies – such as the co-ordinated operation of the four TSOs and more close-to-real-time trading on power markets – have been steps in the right direction. However, synchronising renewables build-out with the evolution of other parts of the system remains a challenge. Better co-ordination and planning of PV build-out will be instrumental in allowing a more cost-effective planning and upgrading of distribution and transmission infrastructure. This point needs to be addressed better in a revised support scheme for renewables. Today, DSOs can only react to a large number of new PV installations. Ideally, the distribution grid should be developed with a clearer vision of how much PV will be present in the long term.

When considering options for increasing the flexibility of the German power system all flexible resources need to be able to participate: transmission, demand side response, flexible generation and storage. Targeted research is critical in this area – in particular for storage. While research is under way on breakthrough electricity storage technologies, it is useful to recall that pumped hydro storage is at present the only affordable large-scale available technology.

HEATING AND COOLING

Renewable heat, from geothermal, solar or bioenergy is an indispensable ingredient of a comprehensive renewable energy deployment policy. In the NREAP, the federal government estimates the share of renewables in the heating/cooling sector will be 15.5% in 2020. The Renewable Energies Heat Act focuses on buildings, where renewable heat is also likely to be promoted by the forthcoming 2020 Building Regulation. However, the deployment of efficient heat pumps does not appear as an important feature of this policy, while it is an effective means to collect ambient heat of renewable – either solar or geothermal or both – origins.

Furthermore, the potential for using renewable heat for industry and services seems to be left aside, and may only further develop in areas where it has been used for a long time, such as biomass in pulp and paper industries. Industry and services are significant customers of low-temperature heat, including low-pressure steam, which can be delivered today from various renewable energy sources, including solar (even in a country like Germany where most of the solar resource is diffuse and not direct). The costs of solar heat in industry and services is lower than for space heating, as the seasonal variability of the resource is a smaller inconvenience when the demand extends across the year. The German government should aim at investigating the possibilities and develop the incentives that would help this potential market take off.

CAPITAL COSTS

One important element of the levelised cost of energy as well as of energy savings is the cost of capital. Renewables, electricity networks and energy savings are capital-intensive investments with low running costs and in particular no or very little fuel expenses. The cost of capital is therefore of utmost importance for their competitiveness. As it already does for energy savings and, more recently, for offshore wind farms, the federal government should continue to bring cheap capital amounts into the development of electricity networks and renewables, based on the resources of the Bank for Reconstruction group but also possibly on those of the European Investment Bank. Public funds, such as those of the Climate and Energy Fund, could possibly find their best use as collateral for loans that German and/or European public finance institutions could obtain from the European Central Bank.

RECOMMENDATIONS

The government of Germany should:

- *Assess and communicate the impact of the Renewable Energy Sources Act (EEG) surcharge in the context of overall energy sector developments, taking into account the important role that renewables play in meeting German energy policy objectives.*
- *Aim at limiting the growth of the EEG surcharge attributable to the deployment of additional renewable energy capacities, while drawing all benefits from the rapid cost decrease that has occurred.*
- *Ensure that the cost but also the benefits of the German energy transition are allocated in a fair way across the different energy sectors and stakeholder groups.*
- *Refine the various premiums in the framework of direct marketing so that operators provide effective flexibility in exchange for reasonable remuneration. Regularly adjust the share of PV electricity benefitting from the FIT; controlling the growth of PV instalment should not only rest on rapid revisions of the level of FITs.*
- *Develop policies to support renewable energy heat with respect to the deployment of effective heat pumps, and the use of low-temperature heat, including low-pressure steam, in industry and services.*

9. ELECTRICITY

Key data (2011)

Installed capacity: 171.7 GW

Peak demand*: 79.8 GW

Total electricity generation: 602.4 TWh, +5.3% from 2000

Electricity generation mix: coal 45.1%, nuclear 17.9%, natural gas 13.9%, wind 8.1%, biofuels and waste 7.3%, solar 3.7%, hydro 2.9%, oil 1.1%

* Source: Bundesverband der Energie- und Wasserwirtschaft.

OVERVIEW

Germany, with over 170 GW of installed capacity, is the largest electricity market in Europe. The market is undergoing a period of substantial upheaval as it adjusts to the decision in 2011 to shut down eight of the country's oldest nuclear power plants and phase-out the remainder by 2022. Further uncertainty is created by the speed of deployment, and market effects, of renewable energy based on the ambitious renewable energy goals presented in the Energy Concept.

SUPPLY AND DEMAND

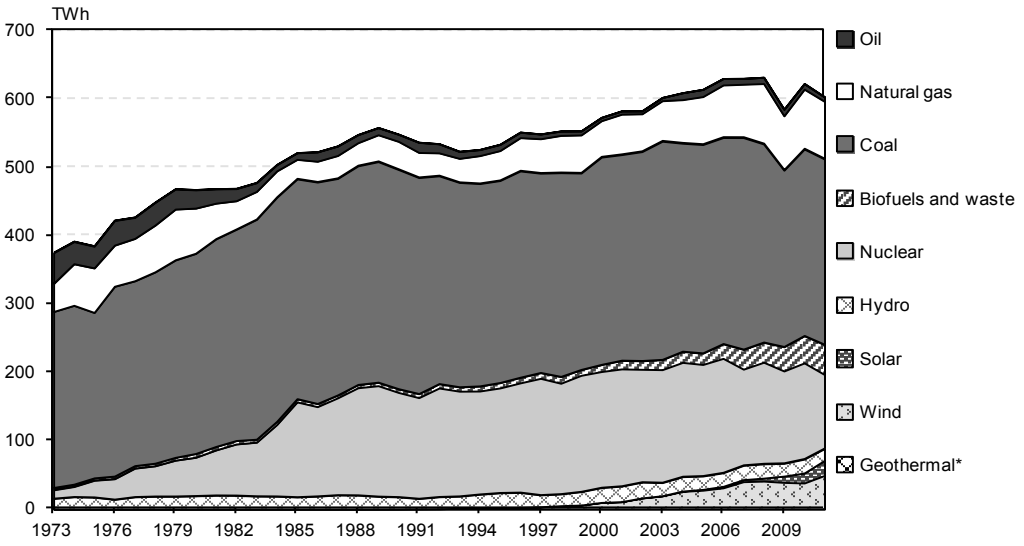
ELECTRICITY GENERATION

Electricity generation output in Germany was 602.4 terawatt-hours (TWh) in 2011, down by 3.1% compared to 2010. Since 2000, generation has increased at 0.5% per year, with some volatility during the economic recession.

Coal is the major source of fuel for electricity generation in Germany, accounting for 45.1% (271.9 TWh) of generation output in 2011. This compares to 304.2 TWh in 2000 or 53.1% of the total. Nuclear power contributed 108 TWh or 17.9%. The use of nuclear peaked in 1997, when it represented some 31% of generation, falling steadily ever since with a large drop in 2011 following the decommissioning of eight plants.

The decline in the use of nuclear energy and coal in electricity generation since 2000 has been offset to a large extent by the growing use of natural gas and renewable energy. More recently, coal use has started to increase, driven by lower market prices, and regained some market share at the expense of natural gas. Electricity generated from natural gas has increased by 59.3% since 2000, to 13.9% of generation output in 2011. Generation from wind power, solar and biofuels experienced much faster relative growth as the use of these sources for energy was negligible at the turn of the century. Wind represented 8.1% of total generation in 2011, with biofuels and solar accounting for 7.3% and 3.7%, respectively.

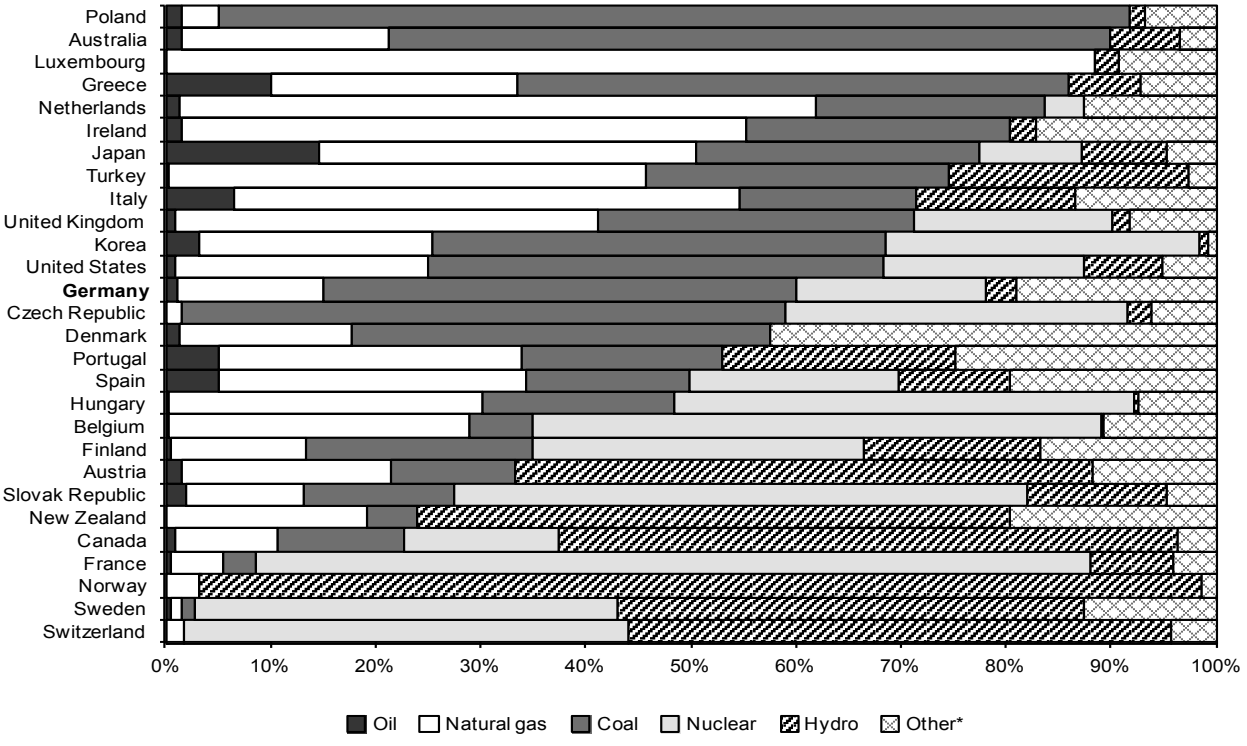
Figure 24. **Electricity generation by source, 1973-2011**



* Negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and country submission.

Figure 25. **Electricity generation by source in IEA member countries, 2011**



* *Other* includes geothermal, solar, wind, and ambient heat production.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2012 and country submission.

Renewable energy will provide the main source of electricity by 2030: the government projects that 58% of total electricity will be sourced from renewable energy, with wind being the dominant source, at 30.6%, in 2030. Electricity from wind is expected to triple over the next 19 years, while electricity from solar will double. Hydro will grow by 35.8% to account for 5.2% of generation, as will the use of biofuels, growing by 39.1% to reach 13.3% of the total. The use of natural gas in electricity generation will also increase over the period to 2030, growing to 22.6% of the total. Coal-fired generation is expected to contract to less than 20% of the total, with nuclear power use being completely phased-out by 2022. These numbers are in accordance with the "energy scenarios" of the federal government.

In comparison to other IEA member countries, Germany's share of fossil fuels in electricity generation is at the median level, similar to that of the United States and the Czech Republic (Figure 25). The contribution of renewables to power supply is also at the median level among the members.

ELECTRICITY CONSUMPTION

Electricity consumption in Germany is dominated by the industry sector which accounted for 44.2% of use in 2011. Total industry consumption reached a record of approximately 260 TWh in 2011, evidence of a second year of recovery following the 2009 recession. Commercial and services sector and the residential sector shared 26.4% and 26.2% of electricity consumption in 2011, respectively. Both sectors increased electricity use over the past decade, albeit at a slower rate compared to industry. The transport sector accounted for 3.2% of electricity consumption in 2011, a percentage which has remained relatively unchanged over the past three decades.

Total electricity consumption has increased by an average of 0.7% per year between 2000 and 2011, but it increased at a faster rate before the recession. The government projections indicate that electricity consumption will decline by 14.7% between 2012 and 2030. Forecasts indicate that the industry, residential and commercial sectors are expected to reduce their electricity use as a result of energy efficiency measures, while the transport sector will increase consumption by nearly 100% as a result of the take-up of electric vehicles and mobility measures.

IMPORTS AND EXPORTS

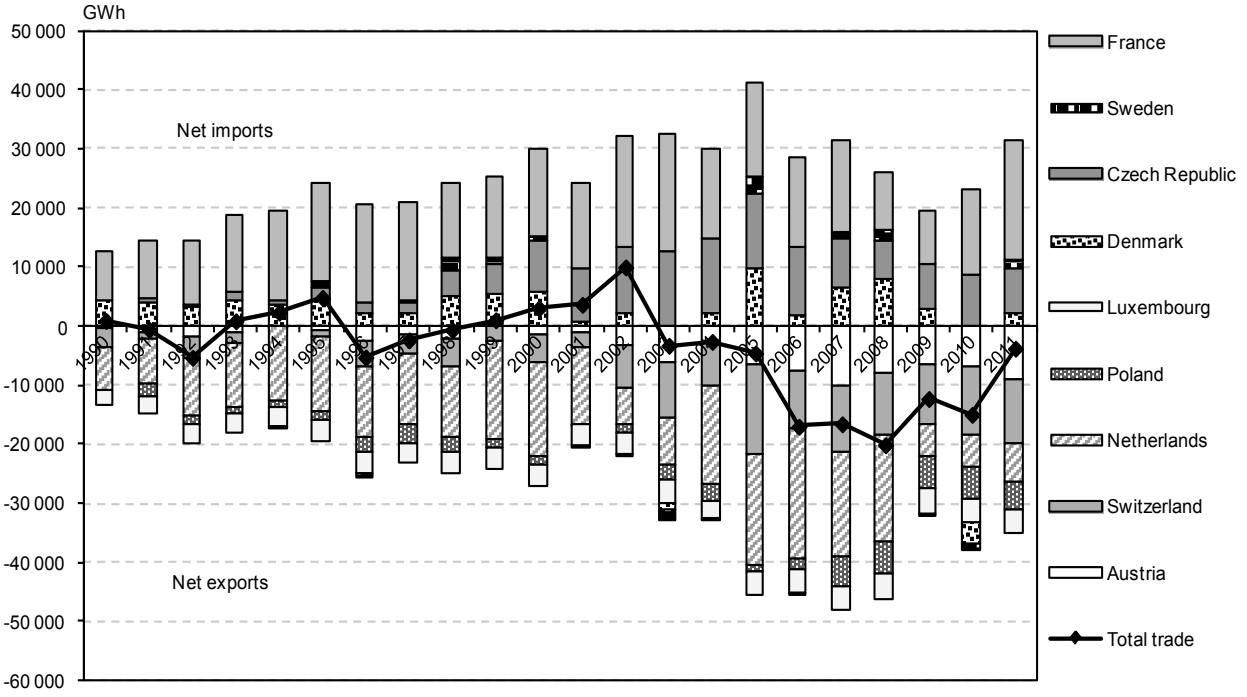
Since 2003, Germany has been a net exporter of electricity, with the trade surplus representing less than 5% of total generation. Exports range between 7% and 10% of generation, totalling 54.8 TWh in 2011. Austria was the main destination for electricity exports in 2011, accounting for 29.3%, followed by Switzerland and the Netherlands at 25.9% and 17.5%, respectively. The remainder was exported to all its other neighbouring countries.

Electricity imports amounted to 51 TWh in 2011, with 39.8% sourced from France, and a further 18.4% and 13.5% from the Czech Republic and Austria. While Germany exports to all its neighbouring countries, there are no imports from Luxembourg and Belgium. With regard to trade relationships with specific countries, Germany is generally a net exporter of electricity to Switzerland, Austria, the Netherlands, Poland and Luxembourg, while net imports are mainly from France, Denmark, Sweden and the Czech Republic (Figure 26).

Over the ten years to 2011, total exports have grown by 30% while imports experienced a slower growth of 11.4%. Exports to the Czech Republic, Poland and Austria experienced the strongest growth in that period, while imports from the Netherlands, Sweden,

France and Denmark increased notably. Following the closure of eight nuclear plants in 2011 and the growing share of renewable electricity, it can be expected that, in the absence of new investments in Central Europe, Germany will see increasing electricity imports, and network constraints will significantly aggravate the current problem of loop flows on neighbouring systems as electricity flows from the north of Germany via Poland and the Czech Republic to the industrial south.

Figure 26. **Net electricity imports to and exports from Germany, by country, 1990-2011**



Source: *Electricity Information*, IEA/OECD Paris, 2012.

INSTITUTIONS AND LEGAL FRAMEWORKS

The **Federal Ministry of Economics and Technology** (BMWi) has the lead responsibility for the formulation and implementation of energy policy, while renewable energy policies and nuclear safety fall under the remit of the **Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety** (BMU).

In Germany there are regulatory authorities at both federal and Länder levels. The federal network regulator, the *Bundesnetzagentur* or **Federal Network Agency** (BNetzA), was established in 2005 in line with EU energy market directives. Based in Bonn, the Federal Network Agency is a higher federal authority falling under the responsibility of BMWi. The role of the Federal Network Agency in the electricity sector is to facilitate, by liberalisation and deregulation, the further development of the market.

The **Federal Cartel Office** (*Bundeskartellamt*) and competition agencies in the Länder are responsible for the enforcement of competition law and overseeing mergers in the electricity sector under the Competition Act. Further to this, a **Market Transparency Office** unit at the BNetzA with the participation of the *Bundeskartellamt* will be established.

Together with the Federal Network Agency, network authorities (**Landesregulierungsbehörden**) have been established in each **Land**. Within the framework of the tasks assigned to them

under the Energy Industry Act (EnWG), the regulatory authorities in the Länder have oversight of small-scale distribution networks, which serve less than 100 000 customers and do not operate beyond their geographic boundaries. Federal and state authorities apply the same regulatory laws and ordinances and co-ordinate their general regulatory decisions in several organised gatherings throughout the year.

THE ENERGY CONCEPT (ENERGIEWENDE)

In September 2010, the federal government adopted the Energy Concept (*Energiewende*) as an elaboration of Germany's energy policy until 2050. It set out a series of measures and targets for the development of renewable energy sources, transmission and distribution grids, and energy efficiency. Following the Fukushima Daiichi nuclear disaster in March 2011, the role of nuclear power in the *Energiewende* was reassessed and a decision was taken to immediately shut down the seven oldest nuclear power plants plus one at Krümmel. The decision also extended to the closure of the remaining nine nuclear power plants on a phased basis by 2022. Accordingly, on 6 June 2011 the federal government adopted the Energy Package which supplements the measures contained in the *Energiewende* and speeds up its implementation.

MARKET DESIGN AND STRUCTURE

MARKET STRUCTURE

Although the big four utilities, E.ON, RWE, EnBW and Vattenfall Europe, remain significant players in the German market, its structure continues to evolve, both in response to the early closure of eight nuclear plants and the continued expansion of renewable energy capacity. In the first instance, the closure of eight nuclear plants has reduced the market share of the big four generators, who nonetheless still account for approximately 73% of generating capacity.[33] Furthermore, owing to the large amount of interconnection capacity available, the regulators consider that Austria and Germany comprise one electricity market, further diluting the market share of the big four, by another 10%. Concurrently, conventional generating capacity is now competing with large volumes of renewable energy, most of which lies outside the market.

In the retail market, the market share of the big four continues to fall; the regulators reported that the combined retail market share of the big four was 45% in 2011 compared to 50% in 2008. The remainder of the retail sector comprises around 900 municipal utilities (*Stadtwerke*) acting as suppliers.

GENERATING CAPACITY

As of 31 December 2011, 171.7 GW generating capacity was connected to the electricity system. This represents an increase of 14.7 GW or 8.6% compared to the previous year and an increase of 53.3 GW or 45% compared to 2000. The increase in capacity between 2010 and 2011 is largely the result of a significant increase in solar energy capacity, which expanded from 17.3 GW in 2010 to 25 GW in 2011.

33. *Monitoring Report 2012, Developments of the Electricity and Gas Markets in Germany*, Federal Network Agency and Federal Cartel Office, 2013.

Table 17. **Germany's power plants with a net nominal electricity capacity of at least 10 MW (on 1 February 2013)**

Generating technology (MW)	Renewable	Non-renewable	Total capacity
Waste	62	1 102	1 164
Biomass	5 569		5 569
Lignite		18 053	18 053
Landfill gas	262		262
Natural gas		19 253	19 253
Geothermal	12		12
Marsh gas		254	254
Nuclear energy		12 068	12 068
Sewage	90		90
Running water	3 798		3 798
Several energy sources	146	15 102	15 248
Oil		3 742	3 742
Pumped storage		9 229	9 229
Solar radiation energy	32 508		32 508
Other sources of energy		1 147	1 147
Water storage (excluding pumped storage)	1 309		1 309
Coal		20 176	20 176
Wind energy (offshore installation)	280		280
Wind energy (onshore facility)	30 016		30 016
Total	**74 052**	**100 126**	**174 179**

Source: *Kraftwerksliste der Bundesnetzagentur*, Federal Network Agency, 2013.

Renewable energy capacity accounted for 65.7 GW or 38.3% of total capacity. Before the decision to phase out nuclear power, of the conventional generating capacity, 20.5 GW (14%) was nuclear power, 11 GW (7.5%) was hydro (including 6.8 GW of pumped storage) and other combustible fuels, largely coal, 68.8 GW (47%). Owing to significant changes in the structure of generation, this increase in renewables means that more generating capacity is now connected to the distribution systems than to the transmission systems.

As of 31 December 2010, according to the Federal Cartel Office's monitoring data, the share of the four largest generators, E.ON, EnBW, RWE and Vattenfall, (excluding power stations that are not eligible for remuneration under the Renewable Energy Sources Act) was approximately 77%. At the same time the Federal Cartel Office noted that of the total number of conventional power station projects in the construction phase, 18 projects representing a total capacity of 12.3 GW have an individual minimum capacity of 100 MW.

In addition to the immediate loss of 8.4 GW of nuclear capacity decommissioned in compliance with the amended Atomic Energy Act, a further reduction of approximately 6.2 GW of conventional generating capacity is planned by the end of 2014. It is expected

that the construction of approximately 12 GW of new conventional power station capacity will compensate for this loss of capacity by 2015.

A recent list of power plants published by the Federal Network Agency, which includes power plants in Germany with a net nominal electricity capacity of at least 10 MW, indicates that the net nominal capacity of Germany was 174.2 GW on 1 February 2013. Of this, 7405 GW comes from renewable energy sources and a total of 70.6 GW is eligible for payment under the EEG. The list also includes capacities totalling 4.4 GW located in Luxembourg, France, Switzerland and Austria but feeding directly into the German electricity system.

Generation facilities under 10 MW ineligible for payment under the EEG are not included on the list. The most notable change between December 2011 and February 2013 is the growth in solar capacity, which increased by 7.7 GW or 31%, from 24.8 GW to 32.5 GW. This represents 75% of the increase in generating capacity over the same period.

TRANSMISSION AND DISTRIBUTION

The German electricity transmission system is the most important electricity-transit country and hub in the mainland European electricity market. There are interconnections with neighbours including Sweden, Denmark, Poland, the Netherlands, Luxembourg, France, the Czech Republic, Switzerland and Austria. Exports flow to the Netherlands, Switzerland and Austria while imports come mainly from France, the Czech Republic, and Denmark.

There is no single national TSO, but four TSOs, each of which was previously owned by one of the big four utilities. There have, however, been a number of changes to the ownership structure in recent years, as the big utilities divested transmission assets for a number of reasons, including regulatory pressure following initiatives taken by the European Commission and the *Bundeskartellamt*, as well as the need to strengthen company balance sheets, which have resulted in the sale of assets to independent shareholders or legal unbundling from the parent company.

With approximately 11 000 km of lines and approximately 160 transformer stations, **Amprion GmbH** operates the largest transmission system in Germany. It is an important hub for electricity trading between northern and southern Europe as well as eastern and Western Europe. The company, which was a part of RWE before 2011, is 74.9% now owned by a consortium of mainly German institutional financial investors with RWE retaining 25.1% ownership.

In order to comply with commitments offered to the EU Commission in the context of antitrust investigations, E.ON sold its transmission system to the Dutch grid operator TenneT B.V. in late 2009. The **TenneT TSO GmbH** transmission system is approximately 10 700 km in length and contains 115 transformer stations. The network covers approximately 140 000 square kilometres from the border of Denmark to the Alps.

TransnetBW GmbH (TransnetBW), part of the EnBWEnergie Baden-Württemberg group, operates the transmission system in Baden-Württemberg and consists of about 3 236 km of high-voltage lines and over 80 transformer stations.

50Hertz Transmission is responsible for the transmission grid in the northern and eastern parts of Germany, the areas previously occupied by the German Democratic Republic. It covers an area of 110 000 square kilometres, has approximately 9 840 km of lines and contains 75 transformer stations. In March 2010, Elia System Operator (the Belgian grid operator) and Industry Funds Management (an Australian investor) acquired 50Hertz Transmission from Vattenfall in a deal approved by the European Commission in May 2010.

Table 18. **German transmission and distribution system structure, 2010**

	TSO	DSO	Total
Number of network operators	4	869	873
Number of operators with less than 100 000 customers	4	794	798
Length of electric circuits (km)	**34 403**	**1 716 442**	**1 750 845**
Extra-high voltage	34 268	481	34749
High voltage	135	95 019	95 154
Medium voltage	0	497 044	497 044
Low voltage	0	1 123 898	1 123 898
Number of end users connected to the networks	**146**	**46 894 531**	**46 894 677**
Trade and industry	134	2 503 262	2 503 396
Households	12	44 391 269	44 391 281

Source: BMWi.

In 2010, there were a total of 869 DSOs in Germany. Regional or local distribution networks are operated by a large number of vertically integrated utilities, companies that own generation assets as well as supply and distribution businesses, in many of which the big four generators hold shares. The *Bundeskartellamt* has, however, in the past blocked acquisitions of interests by the big four operators in regional players, stating that such acquisitions would strengthen dominant market positions.

CROSS-BORDER TRADE AND TRANSIT

Access to the network for cross-border supply in electricity is harmonised in the European Union. Regulation (EC) No. 1228/2003 contains rules on network access charges, congestion management and an inter-transmission system operator compensation mechanism. In March 2011 Regulation (EC) No. 714/2009, which provided the basis to enhance the cross-border supply of electricity and network access in the context of the EU's internal market was enacted.[34] The new Regulation set out basic principles with regard to tariffs and capacity allocation and established the European Network of Transmission System Operators (ENTSO) for Electricity.

LOOP FLOWS IN CENTRAL EUROPE

Power loop flows, from Germany through its neighbours, appear to be causing significant difficulties in Central Europe, especially in Poland and the Czech Republic. These loop flows occur when Germany has insufficient grid infrastructure to handle power production, for example from wind, and the power is diverted through neighbouring countries' grids and then back into a different part of the country. Such loop flows have become more common since Germany developed large amounts of wind power in its northern Länder, but did not develop

34. Regulation (EC) No 714/2009 of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity.

the grid infrastructure to transfer the output south to where much of the demand is located. This difficulty has been amplified by the shutdown of eight nuclear plants in 2011.

In its Ten-Year Network Development Plan for Electricity (TYNDP), the European Network of Transmission System Operators (ENTSO-E) identified major flows in the south-east and south-central regions, including loop flows in the north-south direction, among the problems driving the need for significant investments in Central Europe.

Table 19. **Net transfer capacities (NTC) between Germany and its neighbours, winter 2010/11* (MW)**

	To Germany	From Germany
Austria	2 000	2 200
Czech Republic	2 300	800
Switzerland	3 500	1 500
France	2 700	3 200
Luxemburg	N/A	980
Netherlands	3 000	3 850
Denmark West	1 500	950
Denmark East	585	600
Poland	1 100	1 200
Sweden	610	600
Total	**17 295**	**15 880**

* The NTC values represent an ex-ante estimation of the seasonal transmission capacities of the joint interconnections on a border between neighbouring countries, assessed through security analyses based on the best estimation by TSOs of system and network conditions for the referred period.

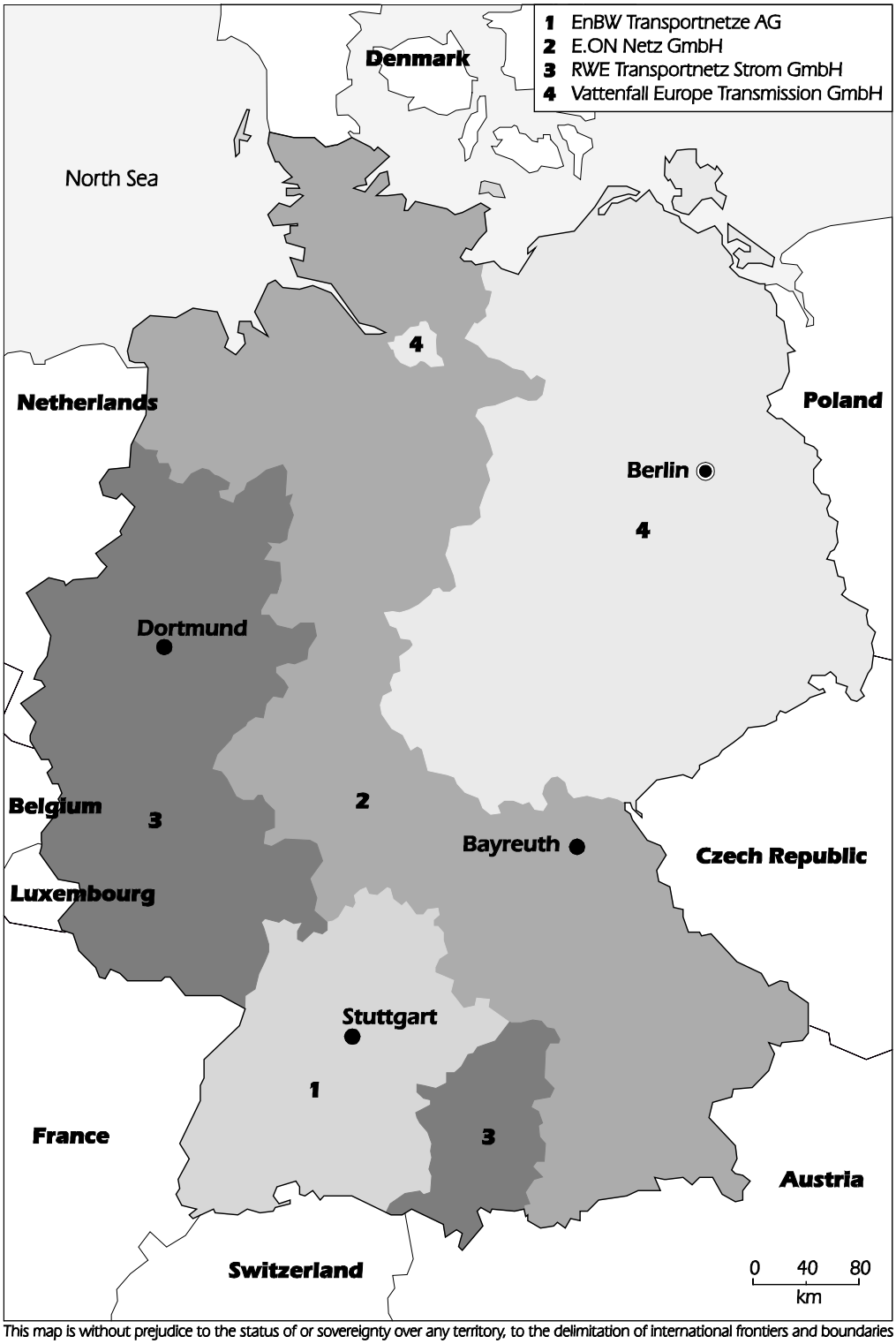
Source: Data provided by ENTSO-E.

In the case of the Czech Republic, which has the highest overall level of interconnection capacity within the Central European region, its transmission capacity is reduced because of loop flows originating mostly from Germany and flowing via Poland to the Czech Republic. Furthermore, the expansion of wind capacity in northern Germany is likely to place further constraints on its transmission grid.

In Poland, loop flows of wind-generated electricity from the north of Germany are causing considerable problems. At times, no transmission capacity is available to the market because of significant transmission reliability margin (TRM) problems resulting from, *inter alia*, substantial loop flows from Germany.[35] In December 2012, 50Hertz and PSE-Operator, the TSO in Poland, agreed on a pilot phase for a virtual phase shifter at the German-Poland border. Elsewhere, the Belgian TSO Elia installed four phase shifters to distribute and manage cross-border energy flows originating in Germany. In the Netherlands, TenneT also installed phase shifters on the border with Belgium in order to reduce loop flows and manage transit flows from northern Germany.

35. *Energy Policies of IEA Countries, Poland*, IEA, 2011.

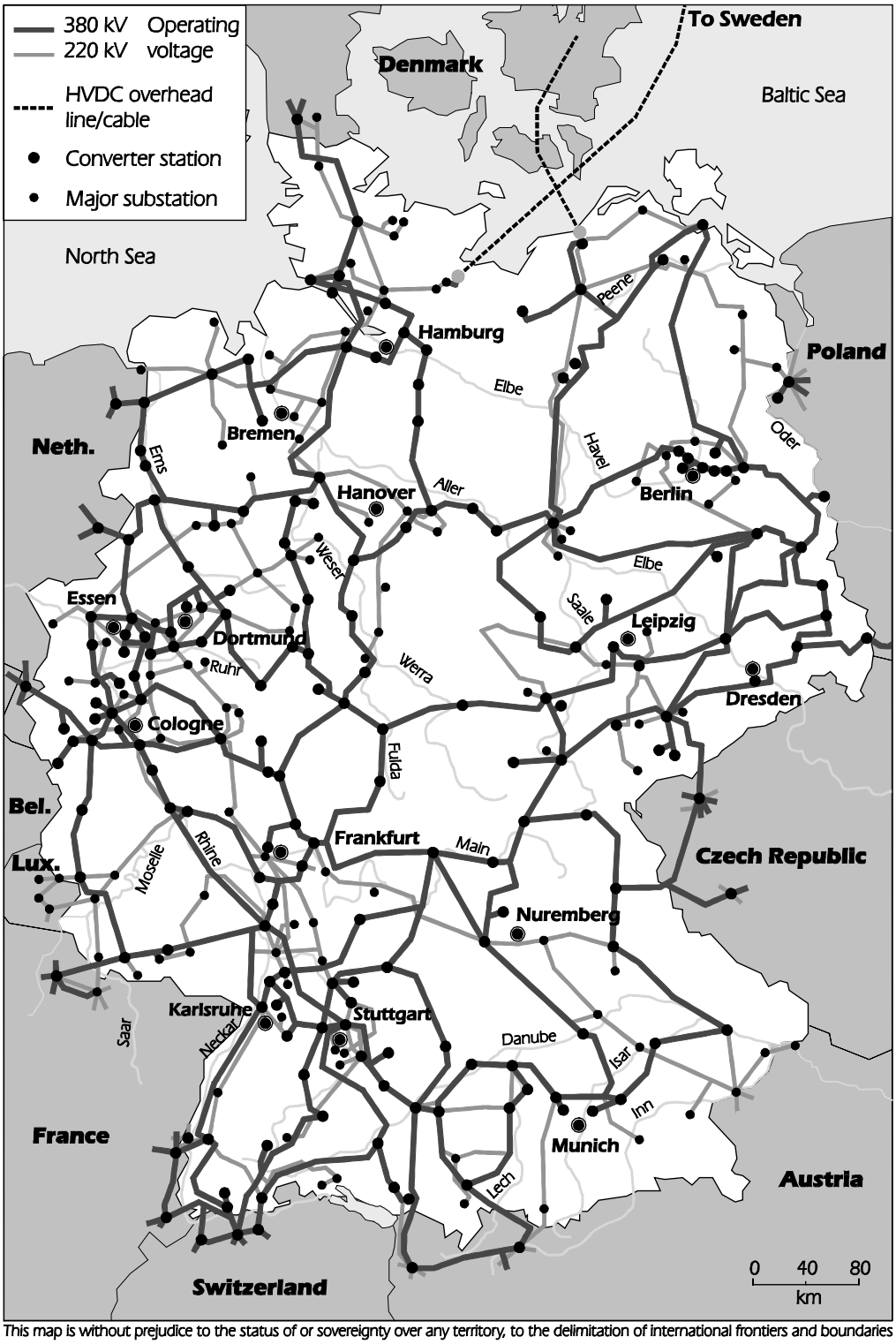
Figure 27. **Electricity transmission network areas in Germany**



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: country submission.

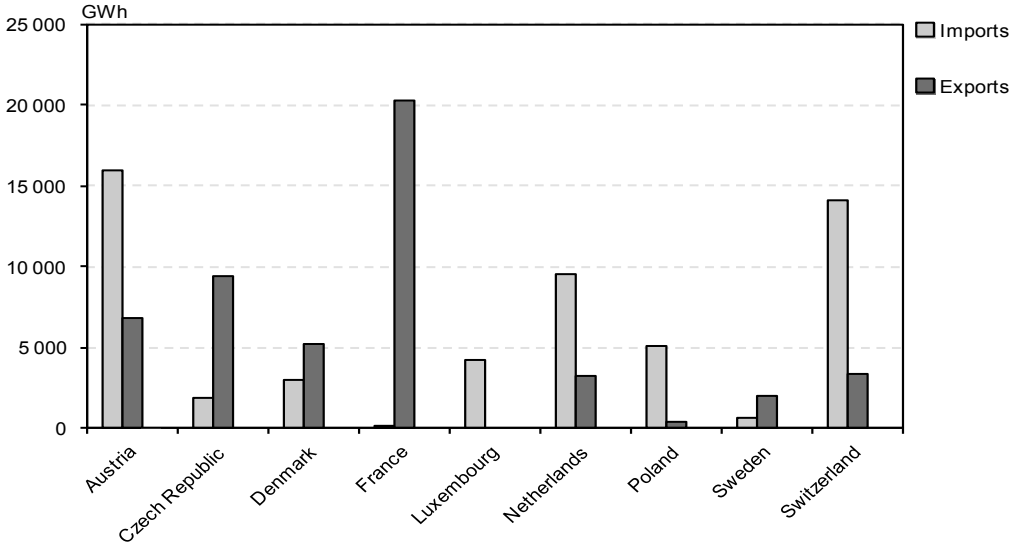
Figure 28. **Electricity network in Germany**



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: country submission.

Figure 29. **German electricity imports and exports, 2011**

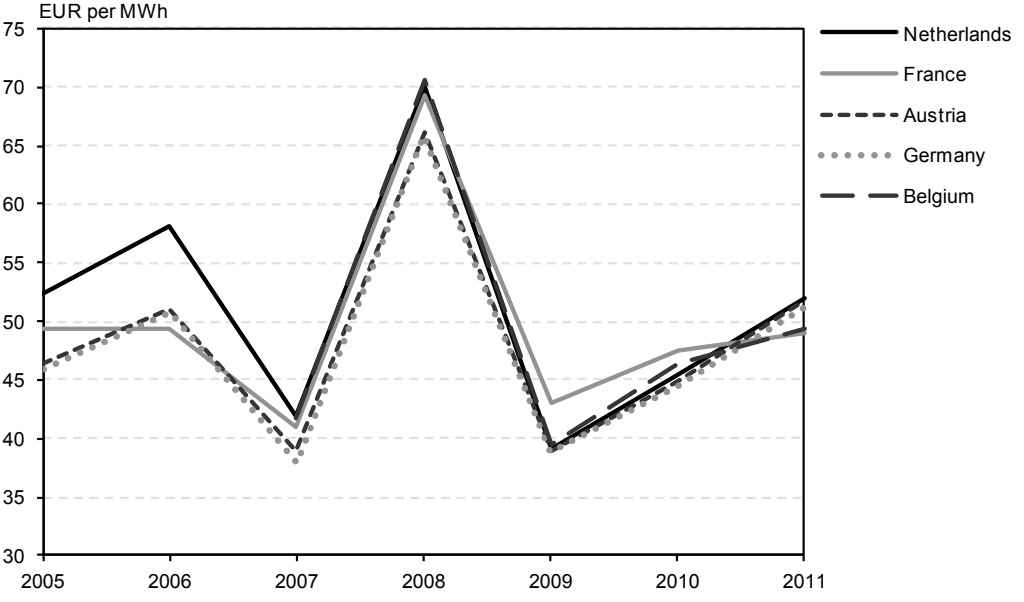


Source: data provided by ENTSO-E.

WHOLESALE MARKET

Germany has an efficient and liquid energy-only market of electricity and does not have a single designated market operator for the entire country. Instead, market participants can buy and sell electricity either on the European Energy Exchange or the European Power Exchange.

Figure 30. **Price convergence on European spot exchanges for the Central West European region, 2005-2011**



Note: data for Belgium was not available before 2007.

Source: Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2011, ACER/CEER, 2012.

The **European Energy Exchange** (EEX), based in Leipzig, was founded in 2002 as a result of the merger of the two German power exchanges in Frankfurt and Leipzig and it is the largest wholesale market for power in Germany (and Austria). The EEX operates market platforms for trading in electricity, natural gas, CO_2 emission allowances and coal. It provides a spot market, a derivatives market and an over-the-counter (OTC) market for electricity.

EEX and the French Energy Exchange, Powernext, jointly operate EPEX Spot, which is the spot market (day-ahead and intraday) for France, Germany, Austria and Switzerland. EPEX Spot operates day-ahead auctions for three market areas: Germany/Austria, France and Switzerland. EPEX Spot provides also an intraday market for Germany and France. In 2012, 339 TWh were traded on EPEX Spot markets, which corresponds to an 8% increase compared to the previous record year (314 TWh).

Much of the growth in German day-ahead market volumes since the beginning of 2010 is a result of the legal obligation on TSOs to market power from renewable energy sources on the spot exchange, in according with the *Renewable Energy Sources Act* (EEG) and the *Ausgleichsmechanismusverordnung* (AusglMechV). On the other hand, new schemes of direct marketing introduced in January 2012 have been increasingly used by producers of renewable energy. In both cases, the spot market has proven to be a suitable instrument for the marketing of those energy sources.[36]

Market coupling in Central-Western Europe

In 2006, the European Commission, together with European Energy Regulators, launched the regional initiatives in gas and electricity. The aim of the European electricity regional initiatives is to speed up the integration of Europe's national electricity markets. Market coupling forms a fundamental part of this process and the overall objective is to implement an intraday target model on all borders in Europe by the end of 2014. A key role of market coupling is to make more efficient use of available cross-border capacities and deliver greater price harmonisation across participating markets.

Market coupling uses implicit auctions in which participants do not receive allocations of cross-border capacity but bid for energy on the relevant power exchange. Purchase bids in one country are matched up with sales bids in another country, where the price may be lower. The purchase/sales bids made in the different markets are pooled and then matched up by financial merit order.

As a result, less expensive energy produced in one country can be used to meet high demand in another country. If there are no cross-border capacity constraints, the market-coupling mechanism will promote the emergence of a single price for all markets.[37] The coupling mechanism therefore makes a significant contribution to improving energy market liquidity, and the ability to acquire the necessary transmission capacity for cross-border trades is greatly enhanced.

In November 2010, the power markets of Central-Western Europe (CWE), including Germany, France, Austria and the Benelux countries, were coupled. This move facilitated the optimal use of cross-border capacities and price convergence.

36. *2012 Volumes on European Power Exchange EPEX Spot Hit New Record*, European Power Exchange press release, 8 January 2013.

37. *Day-Ahead Market Coupling Ensuring Better Market Liquidity*, Elia, 2010.

Box 8. **Sector inquiry into wholesale electricity trading by the Federal Cartel Office**

In March 2009, the *Bundeskartellamt* launched a sector inquiry into electricity generation and wholesale markets. The purpose of the inquiry was to assess the situation regarding competition and the price-forming mechanism in the German electricity generation and electricity wholesale markets in 2007 and 2008. The inquiry was launched in spite of the fact that there had been numerous complaints about the development of electricity prices and a market structure prone to abusive conduct, but there was insufficient evidence of abuse by individual undertakings to initiate specific proceedings against particular players. No evidence was found to support the case that substantial production capacities had been systematically withheld; however, the analysis found that generators have the incentive and possibilities to considerably influence the electricity price by holding back capacities.

In the course of its extensive investigations comprehensive data were collected from 80 market participants for 2007 and 2008 on all their electricity generating units with a capacity of more than 25 MW. An analysis was carried out of a total of 340 electricity generating units for 2007 and 2008, accounting for approximately 93.6% of the total amount of electricity generated in 2007 and 92.9% of the total amount generated in 2008.

The inquiry found that the level of competition in the market for the first-time sale of electricity remains unsatisfactory. Although E.ON recently divested capacity and shareholdings in municipal utilities to a not inconsiderable extent, more than 80% of the first-time sales market rests with four market players. The enquiry found no evidence to support the claim that generating capacity was withheld to any significant extent. Nonetheless, the market structure was found to provide scope, and an incentive, to influence pricing through the unjustified withholding of capacity.

Despite the inconclusive findings the *Bundeskartellamt* made a number of suggestions as to how the market could be improved and these may be summarised as follows:

- A market transparency scheme (*Markttransparenzstelle*) should be launched as soon as possible in order to rebuild or increase consumer confidence in the efficiency of energy markets.
- The sometimes lengthy approval proceedings to set up conventional power plants should be accelerated in order to facilitate access for new competitors to the electricity generation markets.
- Exempting generators, for example *Stadwerke*, from public procurement law could make it easier for public contractors and for municipal utilities in particular, to enter these markets and to reduce their structural disadvantages vis-à-vis the large utilities.
- The development of a functioning market for reserve power agreements would enable smaller electricity generators to more effectively contribute to competition.
- On account of the increasing importance of EEG electricity, the market integration of EEG electricity should be pursued as soon as possible. The focus of market integration should be an increasingly demand-oriented generation of EEG electricity and a sale mechanism that is guided by market mechanisms.

Source: *Sector Inquiry into Electricity Generation and Wholesale Markets*, Bundeskartellamt, 2011.

The convergence of wholesale prices can be regarded as a good indicator of market integration: during the period between 2005 and 2011, there was clear evidence the Dutch, Belgian, French and German spot prices were converging (see Figure 30). In 2011, the Dutch-German border showed full price convergence 87% of the time, while on other borders convergence ranged from 63% to 71% except in the case of Belgium-France, which was as high as 95%. Furthermore, a price convergence of 64% of the time was observed on EPEX German and French markets in 2012.

In addition, the CWE region is connected with the Nordic market via interconnectors between Germany, Denmark and Sweden respectively. North western European (NWE) market coupling between the Nordic region, the United Kingdom and the CWE region is planned for late 2013.

GENERATION ADEQUACY IN GERMANY

CONTEXT

The sudden shut down of 8.4 GW of nuclear capacity in 2011 reduced Germany's electricity generating fleet to approximately 174.4 GW. This converts to reliable available generation matching rather precisely the peak load on the system which is assumed to be in the region of 83 GW. A further 12 GW of nuclear power will be decommissioned by 2022 and the same amount of fossil fuel-fired capacity is likely to be built over the same period. This would suggest that the system is relatively secure over the coming decade. This is unlikely to be the case, however, as many other variables must be taken into account such as the evolution of demand over the period, the timing of new capacity additions, the scale and location of new renewable energy capacity and the rate at which investments in network infrastructure proceed.

Furthermore, studies commissioned by the Federal Network Agency concluded that there are network-related local reliability problems with congested lines and voltage level deviations in northern and southern Germany. This is largely the result of the nuclear phase-out, which has significantly increased the need for regulatory interventions such as generator re-dispatch and curtailment of renewables. Such administrative interventions have been limited so far, but system reliability tolerance levels against unexpected deviations (generator or line tripping, forecast errors) are reduced. One report notes that it is worth keeping at least one of the phased-out nuclear plants in reserve for phase-shift operations.[38] The report also noted that rapid contracting by TSOs of reserve capacities and planning approval of transmission lines is needed without delay.

As a result, the TSO contracted 2 GW of reserve capacity plus Biblis Nuclear Power Plant Unit A for phase-shift operations to contribute to network stability. The Federal Network Agency has also started continuous monitoring on generating capacity developments and recommended the urgent commissioning of specific transmission lines.

As an additional measure, in November 2012, the *Bundestag* approved an amendment to the German Energy Industry Act (EnWG), which provided for new provisions relating to offshore wind power, notably for an offshore planning and an offshore liability regime. The amendment provides the Federal Network Agency the power to order operators of plants

38. *Report on The Impact of the Nuclear Power Exit on Transmission Networks and Security of Supply and Report on the Need for a Back-Up Nuclear Power Plant Under the amended Atomic Energy Act*, Federal Network Agency, 2011.

generating or storing electricity with a rated power of 10 MW to inform the responsible transmission operator and the regulator at least 12 months before a preliminary or permanent closure of power plants or generating units with the plant. Preliminary or permanent shut-downs without notification or prior to the end of the twelve-month period are prohibited.

A regulation (*Reservekraftwerksverordnung*) specifying new rules established with the amendment concerning the contracting of capacity by TSOs as a short-term measure for maintaining network reliability is under preparation and is expected to come into force in mid 2013.

THE CAPACITY SITUATION

The Federal Network Agency publishes monthly updates on the capacity situation in Germany. In February 2013, the installed capacity of dispatchable conventional power plants (including nuclear, gas, coal and oil) was approximately 100 GW. Imports from Austria and Switzerland can add a further 0.5 GW in case of emergency. There is approximately 74.6 GW of installed renewable capacity, of which 10.9 GW is dispatchable (biomass, waste to gas, run of river and water storage) and onshore wind is 30 GW. If it is assumed that total installed onshore wind capacities can contribute by 2% to meeting peak demand in Germany, this leads to another 0.5 GW of generating capacity being available during Germany's peak demand.

Between now and 2015, the Federal Network Agency expects net growth of 5 GW of conventional capacity (1 GW of gas-fired capacity and 4 GW coal-fired capacity). The remaining nuclear plant representing capacity of 13 GW will retire incrementally between 2015 and 2022: 1.4 GW in 2015; 1.4 GW in 2017; 1.5 GW in 2019; 4.3 GW in 2021; 4.3 GW in 2022. At present, the reserve margin is 10 GW or 12% of peak demand.[39]

Table 20. **Available capacity and reserve margins in Germany, 2013-15**

All figures in GW	**Today**	**2015**
Peak demand	83	84.079
Available dispatchable conventional generation	100	98.6
Available import capacity	0.5	0.5
Availability onshore wind capacity at peak	0.5	0.5
Unavailable capacity due to maintenance, etc.	8	8
Net capacity growth		6.4
Reserve margin in GW	10	13.921
Reserve margin	12%	17%

Source: Federal Network Agency.

The IEA electricity demand forecast model projects an annual demand growth of 0.42% per year during the outlook period. Assuming that this translates directly into higher peak demand, the model anticipates peak demand of 84 GW in 2015 and a reserve margin of 13 GW or 17% (other parameters may be subject to change).

39. Dispatchable domestic capacity plus dispatchable import capacity plus onshore wind contribution less peak demand and unavailable dispatchable generation capacity during peak.

Table 21. **Available capacity and reserve margins in Germany, 2022**

All figures in GW	2022
Peak demand	85.49
Available dispatchable conventional generation	87
Available import capacity	0.5
Available onshore wind capacity at peak	0.5
Unavailable capacity due to maintenance, etc.	8
Net capacity growth	0
Reserve margin GW	-5.49
Reserve margin	-6%

Source: Federal Network Agency.

Beyond 2015, developments are more difficult to forecast but certain assumptions can be made: growth in peak demand comparable to recent trends; the nuclear phase will continue as expected; no growth in onshore wind; stable imports at peak; no growth or decline in dispatchable generating capacity. On this basis, Table 21 summarises the outlook for 2022.

Under these conditions, Germany could incur a shortage of supply capacity at peak. The market has always delivered investments into new generating capacity in the energy-only market. On the assumption that these investments continue, 6 GW of added generating capacity is needed between 2015 and 2022 to reach a 10% reserve margin.

These figures do not include any developments in demand response, which can reduce investment requirements into new capacity such as energy efficiency gains, re-scheduling of maintenance cycles, further regional co-operations to share peak supply units or improvement of wind availability during peak.

DOES GERMANY NEED A CAPACITY MARKET?

Demand response is used by utilities and TSOs in many electricity markets as a means of improving reliability, increasing economic efficiency, and to a growing extent, integrating larger volumes of renewable generation capacity into their systems. Commonly used mechanisms tend to fall under three major headings: capacity markets, price-responsive markets, and ancillary services markets. Most of the present discussion in Germany focuses on the role of capacity markets.

In the case of Germany, as the *Energiewende* gets under way, some stakeholders argue that the present energy-only market model may no longer be sufficient to ensure system adequacy. Indeed, the Federal Network Agency has suggested that the continued expansion of power generation based on variable renewable energy sources is likely to lead to a reduction in the number of operating hours of flexible, conventional power plants in the future.[40]

40. *Monitoring Benchmark Report 2011, published under Sections 63 (4) and (5) in conjunction with Section 35 of the Energy Act*, Federal Network Agency, 2012.

The German electricity market is in the midst of a significant transition as the volume of renewable energy grows while at the same time large volumes of nuclear capacity are being decommissioned. Conventional power plants remain necessary in order to balance the variable output of renewable sources but the number of operating hours of conventional power plants is likely to decrease, forcing them to either earn higher margins in fewer hours or to shut down.

Over the next decade, Germany will decommission approximately 12 GW of nuclear power plant capacity, and more than 10 GW of capacity from incumbent power plants are at acute risk of being decommissioned. In addition, the building of approximately 17 GW of new power plant capacity up to 2022 and at least an additional 10 GW up to 2030 may be needed to complement the planned expansion of renewable energy to ensure adequate generating capacity.

Within this context, there is some debate in Germany as to whether or not the market arrangements will continue to provide sufficient signals for the investment in conventional power plants. This has triggered a discussion on the possible introduction of so-called capacity markets, a topic that notably the Federal Ministry of Economics and Technology in the context of the BMWi-Kraftwerksforum is continuing to explore.

Capacity markets are a feature of markets elsewhere, such as the PJM market in North America, and in others, most notably France, they are likely to be introduced in the near future.[41] There is also considerable debate in the United Kingdom. These capacity markets provide an additional incentive to make capacity available during periods when system conditions are tight, often during peak hours. Capacity providers are paid on a megawatt per-year basis for the available capacity or, in the case of demand response, the capacity of power that can be reduced.

Many market participants have argued that the German power market is the example of one of the better functioning power markets in continental Europe: it is a liquid wholesale market with many active traders; it is well integrated into European markets with interconnections with nine other countries. Generally, energy-only markets (*e.g.* in Australia and the Netherlands) have worked well and generators have continued to invest heavily in new capacity when needed.

An increasingly important element of generation adequacy in Germany is the need to ensure that flexible resources are delivered to complement variable wind and solar power generation. Furthermore, there is a need to ensure that sufficient capacity is available to meet demand on the system at times of highest system stress, as was experienced in February 2012.[42]

The opinions of market players on the next steps differ and range from keeping the energy-only market but strengthening its robustness, activating demand-response mechanisms and improving the design of renewables schemes to facilitate better market integration towards the development and integration of a variety of capacity mechanisms into the market.

41. PJM Interconnection is a regional transmission organisation that coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

42. Consultation Paper on Generation Adequacy, Capacity Mechanisms and the Internal Market in Electricity, European Commission, November 2012.

Stratkraft, the Norwegian utility operating in the German market, has argued that there is no need at present to intervene in the German wholesale power market and to introduce capacity markets or stimulate investments with direct subsidies. According to the company, energy-only markets are most suited to provide the right price signals for both optimal dispatching of power plants as well as to attract investments in the right mix of technologies, including demand flexibility. Further improvements in the functioning of the power market in the longer term can be achieved by calibrating the existing arrangements towards a market-based support scheme for renewables (to allow for a market-based dispatch and a reduction of generation in times of over-supply and security problems). The implementation of smart meters with real-time pricing can further stimulate demand-side response.[43]

Similarly, a study commissioned by the German Association of Energy and Water Industries (BDEW) concluded that energy-only markets work and no far-reaching regulatory interference is necessary. The study also highlights elements of the energy-only market which influence its future robustness and should therefore be refined.[44]

Nonetheless, the BDEW study notes that the increase in the share of renewable energies and the integration of the internal EU market have resulted in a state of transition. As a consequence, there are temporarily lower prices and a reluctance to invest in conventional generating capacity. It may be reasonable, therefore, to safeguard security of supply through an appropriate mechanism, one which will not distort power market operation nor lead to increasing regulatory risk such as a strategic reserve. To avoid a reluctance to invest, potential investors will need a regulatory framework for their activities. A political commitment to the energy-only market, complemented by a strategic reserve with pre-defined deployment prices, would serve as a safeguard.

Meanwhile, the Öko-Institut argues in favour of a German capacity market implemented within the scope of the integrated electricity market in continental Europe.[45] A co-ordinated initiative between Germany, France, Belgium, the Netherlands, Luxembourg and Austria is put forward, an approach complicated by the fact that several of these countries are already advanced in their discussion and implementation of capacity markets, which renders harmonisation difficult. Although capacity mechanisms may initially be introduced separately in individual countries in the face of rising pressure to act, they should be flexible enough to be able to be incorporated into integrated models at a later date.

An earlier study, commissioned by RWE, concludes that the present, and previously forecast, reserve situation in Germany is not critical. Even the accelerated nuclear phase-out following the Fukushima accident is unlikely to change that. In case of a less favourable development, however, Germany may need to rely on to a greater extent on some degree of imports in extreme situations.[46] There may be alternative policy measures that may similarly help to address some of the concerns raised in the context of introducing capacity markets: a reliable and predictable policy environment, promoting demand response, facilitating market entry and setting locational incentives, and improving energy and balancing markets.

43. *The Statkraft Position on Capacity Markets for the German Power Market*, Stratkraft, 2012.

44. The Necessity of Capacity Mechanisms, Ecofys commissioned by the German Association of Energy and Water Industries, September 2012.

45. Focused capacity markets: A new market design for the transition to a new energy system, a study for the WWF Germany Environmental Foundation, Öko-Institut, October 2012.

46. *Practical considerations of capacity mechanisms – German situation and international experience*, a Frontier Economics report prepared for RWE, Frontier Economics, July 2011.

TRANSMISSION AND DISTRIBUTION ACCESS

NETWORK ACCESS

Network operators are required to grant non-discriminatory third-party access to their infrastructure. Access can be denied only where granting it would be impossible or unreasonable for operational, capacity, technical or commercial reasons. An amendment to the Energy Industry Act (EnWG), which entered into force on 4 August 2011, strengthened requirements for fair network access and thus for competition in the electricity and gas markets.

TRANSMISSION CHARGING

The Federal Decree on Network Access Fees determines how a TSO may calculate charges for transmission services. Rather than identifying specific tariffs, the Federal Network Agency has developed an incentive mechanism for network operators as a means to increase their efficiency.

To this end, the German government has adopted the Federal Decree on Incentive Regulation. According to this instrument, the prices or revenues of a transmission or distribution network operator do not solely depend on its cost base (as was the case under the former regulatory framework), but allow higher returns for efficient companies.

To enable the Federal Network Agency to determine which TSOs are more efficient than others, each network operator needs to provide the regulator with detailed information about its cost base and various parameters which can explain certain costs. Having audited these costs by using statistical benchmarking methodologies, the Federal Network Agency determines which operators are relatively efficient and those which are not. On the basis of, *inter alia*, the audited costs and the relative efficiency of each TSO, the Federal Network Agency determines an overall annual level of revenues which the network operator will be allowed to receive via its tariffs for its transmission services during a defined regulatory period.

DISTRIBUTION ACCESS AND CHARGING

Generally, the same access and charging principles apply to the 869 DSOs as is the case with transmission networks. Differences exist, however, in the way investments or expansions of the network are assessed in the context of tariff regulation. In addition, in the case of a DSO of less than 100 000 customers, the network access fees are determined by the regulatory authority of the Land in which the network operator conducts its operations. Furthermore, several of the Länder have conferred this responsibility to the Federal Network Agency.

NETWORK DEVELOPMENT AND EXPANSION

In August 2011, the Grid Expansion Acceleration Act for Transmission Networks (NABEG) and the Law on the Revision of Energy Sector Regulations came into effect. The purpose of the NABEG is to streamline the planning and permitting procedures for supra-regional transmission lines to be carried out, subject to certain conditions, by the Federal Network

Agency. This ensures permitting procedures from a single source and according to harmonised rules. The core component of this is comprehensive and timely participation by the general public in the planning process. Furthermore, the general framework for the construction of cross-border power cables and for the use of underground cables at 110 kV level was optimised. Connection to the grid of offshore facilities was eased, as efficient joint grid connection of wind farms (cluster connection) is made possible, to replace individual connections. In future, municipalities crossed by power lines can negotiate with the network operators in the framework of the Incentive Regulation Ordinance (ARegV) to agree on financial settlement. The NABEG and amendments to the Energy Industry Act should bring about significant improvements in terms of public involvement as well as greater planning security for investors at all procedural levels of network expansion. On 19 December 2012, the federal government adopted the draft of the *Bundesbedarfsplangesetz* in the cabinet.

TEN-YEAR NETWORK DEVELOPMENT PLANS

The Energy Industry Act makes provision for the preparation of a binding and co-ordinated ten-year network development plans for major electricity transmission (and gas pipeline) networks. These network development plans will determine the extent of required network expansion and form the basis for extensive consultations with parties affected by the construction of transmission lines.

Accordingly, in May 2012, the four TSOs presented the first national ten-year grid development plan, the Electricity Grid Development Plan 2012 (NEP 2012). The plan contained measures to modernise, enhance and extend the electricity networks that the TSOs consider necessary over the next ten years. The plan was available for public consultation until 10 July 2012. Subsequently, the Federal Network Agency commenced a public consultation on NEP 2012.

NEP 2012 highlights the obvious need to extend and optimise the transmission network, notably the lines that will transport power from the north to southern Germany. The TSOs propose to build new direct-current (DC) transmission lines, arguing that they are best suited to transmit power over long distances. These lines will augment the existing 380 kV alternating-current (AC) lines, which will also have to be extended and optimised. They estimate that costs for the expansion of the transmission grid will amount to roughly EUR 20 billion over the next ten years. In November 2012, the Federal Network Agency approved 51 of the 74 projects proposed by the four TSOs. This includes approval for reinforcement measures for existing power lines with a length of approximately 2 900 km and 2 800 km of new power lines. In March 2013, the four TSOs presented the first drafts of the 2013 Electricity Grid Development Plan (NEP 2013) and the first Offshore Grid Development Plan (O-NEP 2013) to the Federal Network Agency. This package of proposals contains plans to manage loop flows with neighbouring countries.

Under amended national law following the EU third directive, TSOs are required to obtain licences from the Federal Network Agency (certification). For certification, TSOs must show that, from a legal, organisational and personnel point of view, system operation is conducted separately from the energy supply and generation business. This provides the structural framework for ensuring that the systems constitute a neutral platform ensuring a competitive environment in the energy market. A TSO must also prove that it has adequate financial resources. In its first licensing round, the regulator did not certify one of the four TSOs. According to the regulator, TenneT TSO GmbH was

not certified as the company had been unable to provide the necessary proof of having the requisite financial means to fulfil its statutory system operation and expansion obligations. This does not imply, however, that TenneT TSO GmbH is no longer entitled to operate its own system. If TenneT can continue to operate, under these conditions it may be subject to further procedures: certification as such does not correspond to an operating permit. If a company operates its system without having been certified, this constitutes an administrative offence which must be established in separate proceedings.[47]

ENTSO-E Ten-Year Network Development Plan[48]

The Third Legislative Package for the Internal Market in Electricity (Third Package), which entered into force on 3 March 2011, imposed a number of requirements on the European electricity industry in terms of regional co-operation to promote the development of electricity infrastructure both within and between EU member states, while also looking at cross-border exchanges of electricity between the member states. The key element of the Third Package is the mandate to the European Network of Transmission System Operators for Electricity (ENTSO-E) to prepare and publish a biannual, non-binding, Ten-Year Network Development Plan (TYNDP). The main objectives of the TYNDP are:

- to identify investment gaps, notably with respect to cross-border capacities;
- to contribute to a sufficient level of cross-border interconnection and to contribute to non-discrimination, effective competition and the efficient functioning of the market;
- to ensure greater transparency regarding the entire electricity transmission network in the European community.

In July 2012, ENTSO-E published its first Ten-Year Network Development Plan (TYNDP 2012) package and submitted it to the Agency for the Cooperation of Energy Regulators (ACER) for opinion. The TYNDP 2012 package comprises eight documents and identifies the need to invest EUR 104 billion in the refurbishment or construction of roughly 52 300 km of extra-high voltage power lines clustered into 100 investment projects throughout Europe. Approximately 80% of the 100 bottlenecks identified are related to the direct or indirect integration of renewable energy sources (RES) such as wind and solar power. The north-south internal corridors in Germany are typical example of the latter. The massive development of RES is the main driver behind larger, more volatile power flows, over longer distances across Europe.

The scenario analysis upon which the TYNDP 2012 is based has taken into account the decision to phase out nuclear power in Germany and the first National Ten-Year Grid Development Plan prepared jointly by the German TSOs Amprion GmbH, 50Hertz Transmission GmbH, Tennet TSO GmbH and Transnet BW GmbH. Of the EUR 104 billion investments required over the forecast period, TYNDP 2012 notes that over 25% or EUR 30.1 billion of the investment is likely to be needed in Germany.

47. *Bundesnetzagentur takes its first decisions on certification*, Federal network Agency press release, November 2012.

48. *Ten-Year Network Development Plan 2012*, European Network of Transmission System Operators for Electricity, July 2012 (updated September 2012).

DISTRIBUTION NETWORK EXPANSION

As a result of the large volume of renewable energy being connected to the distribution system, the volume of generation connection to the distribution system now exceeds that connected to the transmission system. The expansion of renewable energy and the increasingly decentralised power generation have become growing challenges not only for the transmission grids, but also for the distribution grids, to which most of the plants are connected. To accommodate the growing the volumes of renewable energy substantial investments have already been made to the distribution system, and will have to be made over the coming decades if Germany is to meet its targets. In many regions, the electricity purchased by the grid operator in accordance with the Renewable Energy Sources Act (EEG) often exceeds local demand.

A study from the German Energy Agency (DENA) provided estimates of the scale of the investment required both in terms of costs and size of the infrastructure.[49] The study estimates that by 2030, the electricity distribution grids in Germany will require expansions of between 135 000 km and 193 000 km while approximately 21 000 km to 25 000 km will need to be converted. The study estimates that this level of expansion will require capital investments of between EUR 27.5 billion and EUR 42.5 billion. As the share of renewable energy entering the distribution system continues to grow, the present capacity of the distribution grids will no longer be sufficient to transport electricity from RES to consumers.

The study also points to the need for further research on how renewable power generation plants will in the future be able to participate in the provision of ancillary services. It also points to the need for new management concepts for the electricity networks based on greater co-operation between TSOs and DSOs to maintain system stability and security as well as greater levels of co-operation between Germany and its neighbours.

DISTRIBUTED AND VARIABLE RENEWABLE POWER INTEGRATION

The present regulatory framework provides favourable conditions for the connection of electricity from RES. While barriers exist, Germany has been very successful in connecting many renewable electricity plants over the past decade without serious problems; the market design contains a number of features which are favourable for renewable integration such as the relatively short gate-closure time and priority access to the grid.

Electricity purchased under the Renewable Energy Sources Act (EEG) is has to be marketed on the electricity exchange spot market by the TSOs. The feed-in volume of EEG electricity forecast as per the day-ahead forecast is marketed on the day-ahead market on a price-independent basis. Where the intraday forecasts throw up discrepancies, additional volumes are sold or bought on the intraday market. EEG electricity thus has an impact on pricing on the exchange and hence on development of the so-called merit order. Assuming inelastic demand, conventional production within the scope of EEG production is displaced from the merit order.

As the EEG compensation rates are always above the exchange price, additional costs apply to the EEG electricity compared to the conventionally produced electricity. The EEG surcharge imposed on consumers is determined *ex ante* for the following year. The

49. *Ausbau- und Innovationsbedarf der Stromverteilnetze in Deutschland bis 2030*, German Energy Agency, 2012.

fee is determined from the expected difference between the marketing revenues on the one hand and the indemnities, forecast costs and additional transaction costs paid, on the other. At the end of the year, any difference between the surcharge and the actual costs incurred during the year will be carried over to the next year. The reallocation fee for 2013 is EUR 0.05277 per kWh, compared to EUR 0.0353 per kWh in 2011, EUR 0.0205 per kWh in 2010 and EUR 0.012 per kWh in 2008 and 2009.

The sale of almost all the EEG energy volumes (fluctuating and constant feed-in) on the electricity exchange since 2010 has improved the liquidity of the spot markets (day-ahead and intraday markets). A trend is observable in both the futures and the spot market: price volatility, or the band of fluctuation within which prices move, has fallen significantly compared to recent years. The high level of new solar energy capacity in particular has resulted in the differential between peak and off-peak prices becoming much smaller. Thus on low-load days, with a high level of solar power feed-in, the relationship can be negative.

Furthermore, in 2009 there were significant individual events which resulted in sharply negative electricity exchange prices, because of high wind power feed-in and low residual load. Comparable events were for the most part absent in 2010 and in 2011, as market participants reacted flexibly and were also able to exploit potential flexibility. It is anticipated that the potential flexibility available in the system (including load gradients of conventional power plants), needs-oriented direct marketing of suitable renewable energy plants, elimination of bottlenecks in the electricity networks, and use of electricity storage units and switchable loads) will for a few years until 2020 be able to compensate for rapid additional capacity construction, in particular of fluctuating renewable energy production facilities.[50] How this can subsequently be guaranteed with falling shares of conventional thermal power plants (also in view of the required system services) is the subject of intensive debate.

The Renewable Energy Sources Act amendment of 2011 (EEG 2012) makes provision for a key innovation in the introduction at the beginning of 2012 of an optional market premium, which is planned to drive forward market integration in terms of more needs-oriented feed-in of renewable energies. On a monthly basis, plant operators can decide whether they prefer to continue to receive the guaranteed FIT or alternatively to sell the EEG energy volume directly in the market (through supply contracts or on the electricity exchange). Besides the proceeds from sale, in the latter case they receive a market premium which equalises the difference between the respective EEG FIT and the average monthly energy exchange price (including a management premium for the direct marketing transaction costs and taking into account forecast deviations as well as a flexibility premium limited to the biogas sector). For the generator there may be a revenue optimisation incentive, through market needs-oriented marketing, to control the output of wind and solar PV during times of excess generation to avoid negative prices.

SMART GRID DEVELOPMENTS

A key element of the *Energiewende* is the concept of smart grids. Smart distribution grids are vital for the expansion and system integration of renewable energies. The focus in Germany is on gradually creating conditions for the market-driven development of these grids complemented by the development and use of new storage technologies to

50. The load gradient determines by how much the power output of a power plant can be varied.

stabilise fluctuating energy generation. An amendment to the Energy Industry Act (EnWG) strengthened the foundations for smart grids and storage facilities. The latter are essential for integrating fluctuating renewable energies. Accordingly, new storage facilities are exempt from the usual grid charges.

With the support of the federal government smart grids are being tested in six pilot regions in Germany. The Federal Ministry of Economics and Technology is providing EUR 40 million, the Federal Environment Ministry EUR 20 million, and companies involved in the model projects contribute another EUR 80 million. The six projects are:

- the E-DeMa project is investigating options for intelligent management of consumption, including real-time demand data and their availability for consumers;
- the eTelligence project in Cuxhaven, Lower Saxony tested a control system for balancing intermittent wind power and integrating the electricity in the local grids and the regional market;
- the MeRegio project involves 1 000 electricity consumers in Freiamt and Göppingen (Baden-Württemberg) who are testing smart home solutions;
- the MoMa (model city Mannheim) project involves 200 households, which have been supplied with new control devices, to assist them in managing their demand and benefit from time-of-use energy prices;
- the RegModHarz project in the Harz Mountains in Lower Saxony explores ways to pool renewable locally generated energy and ways to market this energy on different markets;
- the SmartWatt project is an information and management system for energy systems that complies with unbundling regulation and provides market participants with real-time data on supply and demand.

DEMAND-SIDE MEASURES

There are a limited number of demand-side management programmes in Germany. The principal mechanism is an indirect incentive to avoid power peaks and to curb peak demand with the network charging system (*Netzentgeltsystematik)*. There is therefore a wide range of energy services available in the market (such as energy management consulting).

For standard load-profile customers, a combination of peak and off-peak tariffs are available. In some cases, there are field tests in which more tariff time zones are offered or a number of specific days in the year are offered at a flat rate. For customers consuming more than 30 000 kWh (industry and groupings of several consumers), billing is annual or monthly according to power peak and corresponding annual or monthly total consumption; there are various models available which allow different tariffs within a single day.

COMBINED HEAT AND POWER

In the period from 2002 to 2010 the share of net power production accounted for by combined heat and power (CHP) increased by 1.5% to just under 16% at present. The federal government has set itself the target of increasing the share of CHP to 25% by 2020.

Legislation to protect and modernise existing CHP installations and provide incentives to build smaller CHP plants (up to 50 kW) was introduced in 2002 (Combined Heat and Power Act). Under this Act, CHP generators receive payments for each kilowatt-hour of

electricity they export to the grid, depending on the age of the plant, its size and its efficiency. The Act was amended in 2008 to extend support to large new power stations for industrial CHP and district heating, if commissioned by 2016.

In July 2006, the law on taxation of fuel inputs for electricity production was amended to exempt natural gas used for electricity generation in stationary CHP installations with a monthly or annual usage efficiency of at least 70%. The elimination of the natural gas tax for condensing power stations increases the attractiveness of natural gas-fired CHP production, with its relatively low emissions.

The Law on Preservation, Modernisation and Development of Combined Heat and Power Generation (KWK-G) introduced additional incentives in the form of legally applicable surcharges on CHP power production graduated according to size categories. Under this law CHP plants of the system operators are to be given priority for connection to the grid and the CHP electricity generated is to be bought from them. Pursuant to the KWK-G amendment of 2008, investments in heating networks which contribute to increased use of CHP are now also funded by means of a once-off state investment subsidy to a maximum of 20% of the eligible costs.

ELECTRICITY SECURITY

In accordance with section 13(1) of the Energy Industry Act (EnWG), the four TSOs are both authorised and obliged to remedy any threat to or malfunction in the electricity supply network through the adoption of system-related and market-related measures. To the extent electricity DSOs are responsible for the security and reliability of the electricity supply in their networks, they are also authorised and obliged to implement such measures under section 14(1) of the Act.[51] This is very important for the functioning of electricity markets. Market operations in Germany are bilateral contracts with specific plants that have the effect to depress electricity prices and undermine incentives to invest. A clear definition of the reliability criteria and the malfunction in the electricity network is essential.

The Federal Network Agency has prepared three reports on the implications of the decommissioning of nuclear capacities for the transmission systems and the security of supply. Generally, these reports have shown that although the present network situation is manageable, it requires network operators to intervene with increasing frequency in market settlement. Nonetheless, network operations in the electricity sector remains stable and secure. In the event of any threat to, or malfunction in, the electricity supply network, TSOs are both authorised and obliged to remedy the associated problems through the adoption of network and market-related measures.

Network-related measures, in particular with network switching, were implemented each day during 2010, before the nuclear shut-down. Market-related measures, in particular those relating to congestion management, were taken on 129 days during the same year. In addition, the TSOs undertook commercial transactions on 157 days of the year in order to eliminate threats to, or malfunctioning in, the network. In future, continuous high-level security of electricity supply will be ensured if large-scale investments are made throughout the voltage levels of the electricity network in addition to new generating capacity.

51. *Monitoring Benchmark Report 2011*, published under Sections 63 (4) and (5) in conjunction with Section 35 of the Energy Act, Federal Network Agency, 2012.

The Power Grid Expansion Act (EnLAG) of 2009 is intended to greatly simplify the implementation of the necessary expansion measures. The Act identifies 24 projects for immediate, prioritised implementation. So far, two of these projects have been completed. There are clear delays to the approval and implementation plans of 12 of the 24 EnLAG projects, with the result that the intended commissioning dates have been exceeded by several years in some cases.

The reports submitted by the TSOs to the Federal Network Agency regarding the state of implementation of their planned network expansions also document these delays. In the second quarter of 2011, a total of 149 expansion projects were planned throughout 2014. Of the total volume of expansion measures, 73 were behind schedule or had postponed completion dates at the end of the second quarter of 2011. Accordingly, the investment data reported within the framework of the 2011 monitoring activities provide further evidence of the fact that the new building and expansion projects planned for the transmission systems are significantly behind schedule.

In accordance with the Energy Industry Act (EnWG) the Federal Ministry of Economics carries out monitoring of security of supply with respect to network-based supply of electricity and natural gas. A monitoring report on security of supply in the electricity sector is to be drawn up every two years and, in accordance with Article 4 of Directive 2003/54/EC, it is provided to the European Commission. The monitoring report is required to address the relationship between supply and demand in the domestic market, expected growth in demand and available supply, additional capacities, both projected and under construction, the quality and the extent of network maintenance, and an analysis of network failures together with measures for meeting peaks in demand and overcoming the failure of one or more utilities.[52]

Pursuant to Section 23 of the Incentive Regulation Ordinance (ARegV), investment budgets are to be authorised by the Federal Network Agency. In addition, the incentive regulations include mechanisms designed to increase the efficiency and the quality of supply of the energy supply networks.

TSO security co-operation

The Transmission System Operator Security Co-operation (TSC) was established in December 2008 as an initiative to improve the security of the transmission grids throughout Central Europe. It is a cooperative mechanism of 11 European TSOs, including all four German TSOs, whose purpose is to improve overall electricity system security through more intensive co-operation by creating a permanent network of operational experts and developing co-ordinated procedures and remedial actions. The goals of the TSC include, avoiding electricity system risks in Central Europe and securing operation of interconnected grids.

The initiative encompasses a permanent TSO Security Panel, uses a Real-time Awareness and Alarm System (RAAS) and implements a shared information technology platform for exchanging data and assessing common security calculations. In effect, TSC helps TSOs to better manage in real time their expanding operations, especially with respect to integrating wind energy and handling increasing cross-border trading and electricity transmission.

52. *Monitoring-Bericht des Bundesministeriums für Wirtschaft und Technologie nach § 51 EnWG zur Versorgungssicherheit im Bereich der leitungsgebundenen Versorgung mit Elektrizität*, BMWi, July 2012.

RETAIL MARKET AND PRICES

Approximately 1 100 electricity suppliers are active in Germany. Besides a series of large companies, a host of small and medium-sized energy utilities are in operation, the majority owned by municipalities which account for more than two-thirds of all suppliers. Many of them offer their product in more than one network areas and consumers can choose from a growing number of alternative suppliers and are therefore no longer tied to their regional basic supplier. In 2011, more than three-quarters of network areas had more than 50 suppliers active. This compares well to less than one-quarter in 2007. Switching supplier is also becoming more popular: in 2011 54% of industrial and business customers and 17% of household customers had chosen a supplier other than the incumbent. In the same year, approximately 3.8 million customers switched supplier, an increase of 27% on the previous year.[53]

ACER defines post-tax total prices (POTP) as the sum of the commodity price, regulated transmission and distribution charges, and retail components (billing, metering, customer services, and a fair margin on such services) plus value-added tax, levies (as applicable: local, national, environmental) and any surcharges (as applicable). Under this approach, Germany records the highest POTP of all those 11 European countries without any price regulation in place in 2011.[54] The total price for German household consumers was EUR 0.253 per kWh in 2011, which is for example 80%, 68% and 25% higher than the price charged to households in France, the United Kingdom and Italy. This can be explained by the fact that energy taxes tend to be higher in Germany. Generally speaking, and as is expected, the highest retail prices can be observed in countries with higher taxes and those having limited or even non-existent interconnections to neighbouring countries (so-called "electricity islands" such as the Baltic region, Malta and Cyprus).[55]

Early in 2013, electricity prices rose on average by 11% with 728 of the 854 utilities which supply standard customers without special supply arrangements increasing prices by an average of 12%.

THE COMPOSITION OF END-USER PRICES

Electricity prices in Germany, especially those for household consumers, are among the highest in Europe. The most recent Quarterly Report on European Electricity Markets observed that Denmark and Germany were the EU member states where household consumers paid the highest electricity prices, EUR 0.331 per kWh and EUR 0.284 per kWh respectively, in consumption band Db (between 1 000 kWh and 2 500 kWh per year).[56] The average price of electricity for household consumers in the EU-27 (the prices for each member state are weighted according to their consumption by the household sector in 2010) was EUR 0.184 per kWh in the second half of 2011.

53. *Development in Electricity and Natural Gas Markets in Germany, Monitoring Report 2012 Summary*, Federal Network Agency, Federal Cartel Agency, 2013.

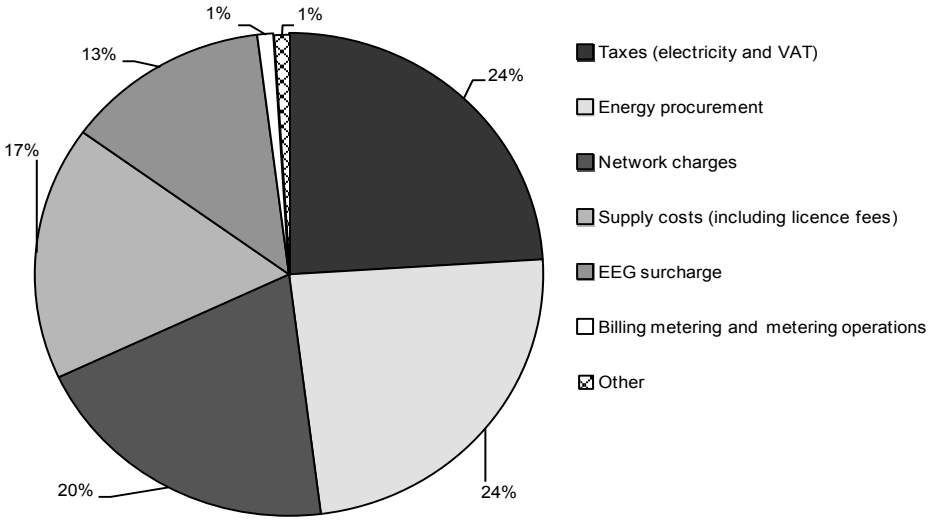
54. Annual non-weighted average per country, based on half-yearly data, using Eurostat consumption band DC (2 500 kWh to 5 000 kWh) for households and consumption band ID (2 000 MWh to 20 000 MWh) for non-households.

55. The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

56. *Quarterly Report on European Electricity Markets*, Directorate-General for Energy Market Observatory for Energy, Volume 5, ISSUE 2: April 2012 – June 2012 European Commission, 2012.

Furthermore, a European Commission study on electricity retail prices in the European Union published in 2012 observed that, while the energy and transportation (transmission and distribution) component of the electricity bill for median households in Germany remained stable between 2007 and 2011, the taxation and surcharge component increased more than threefold. The overall result was a 40% increase in constant prices and a 60% increase in nominal prices.[57] Eurostat reported that the proportion of taxes and levies in the final price of electricity for consumers is Germany was 44.9%, the second-highest among the countries surveyed.[58]

Figure 31. **Household customer price break-down as of 1 April 2012***



* Volume-weighted average across household tariff categories.

Source: *Monitoringbericht 2012*, Federal Network Agency, 2013.

A large driver of the cost of electricity in Germany is the EEG surcharge, which in 2012 represented 14% of the household price. The EEG surcharge for 2013 is EUR 0.523 per kWh or 47% higher than the previous year. This represents an increase of almost EUR 60 in the average annual bill for households or a rise in the share of households' spending on electricity from around 2.4% in 2012 to almost 2.5% in 2013. These proportions are significantly higher for low-income than for high-income households.[59]

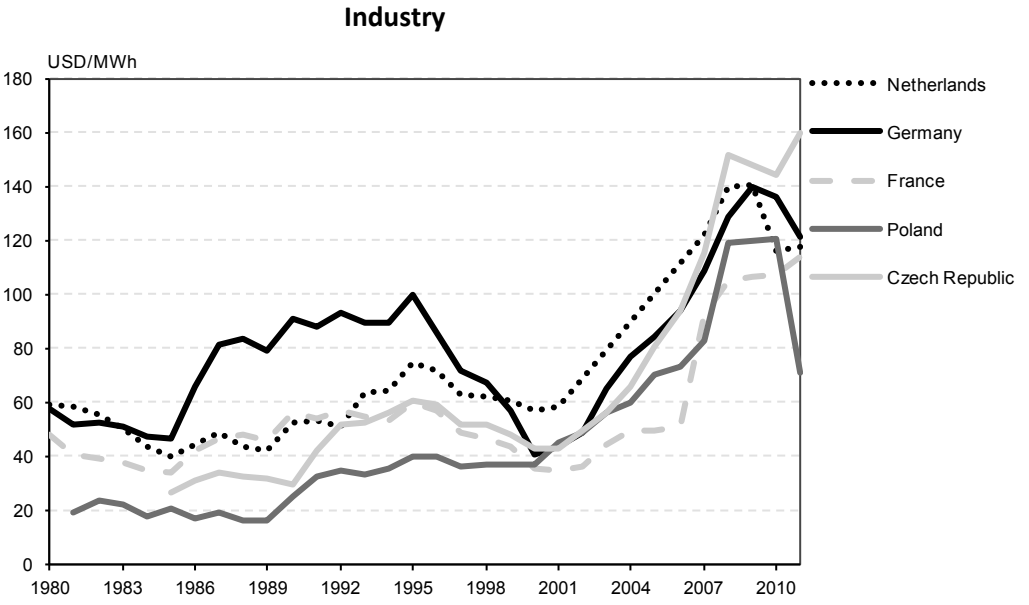
The German Institute of Economic Research recommends that to compensate for the social hardship of rising electricity prices for low-income households, existing benefit systems could be adapted to anticipate price increases. At the same time, low-income households could be supported with tailored advice and financial assistance to enhance the efficiency of their electricity use and to ensure a lasting reduction of electricity expenditure. Alternatively, the electricity tax for a basic volume of power consumption could be reduced.

57. *Price developments on the EU retail markets for electricity and gas 1998 – 2011*, Directorate-General for Energy, European Commission, 2012.

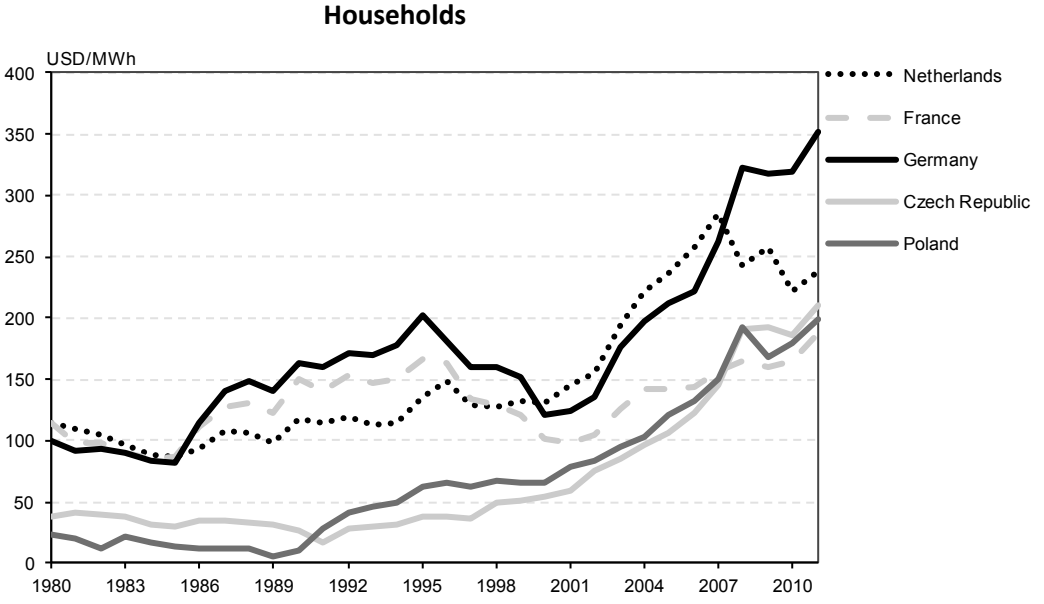
58. http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Energy_price_statistics, last accessed on 1 March 2013.

59. "German Electricity Prices: Only Modest Increase Due to Renewable Energy Expected", *DIW Weekly Report*, German Institute for Economic Research, 2011.

Figure 32. **Electricity prices in Germany and in other selected IEA member countries, 1980-2011**

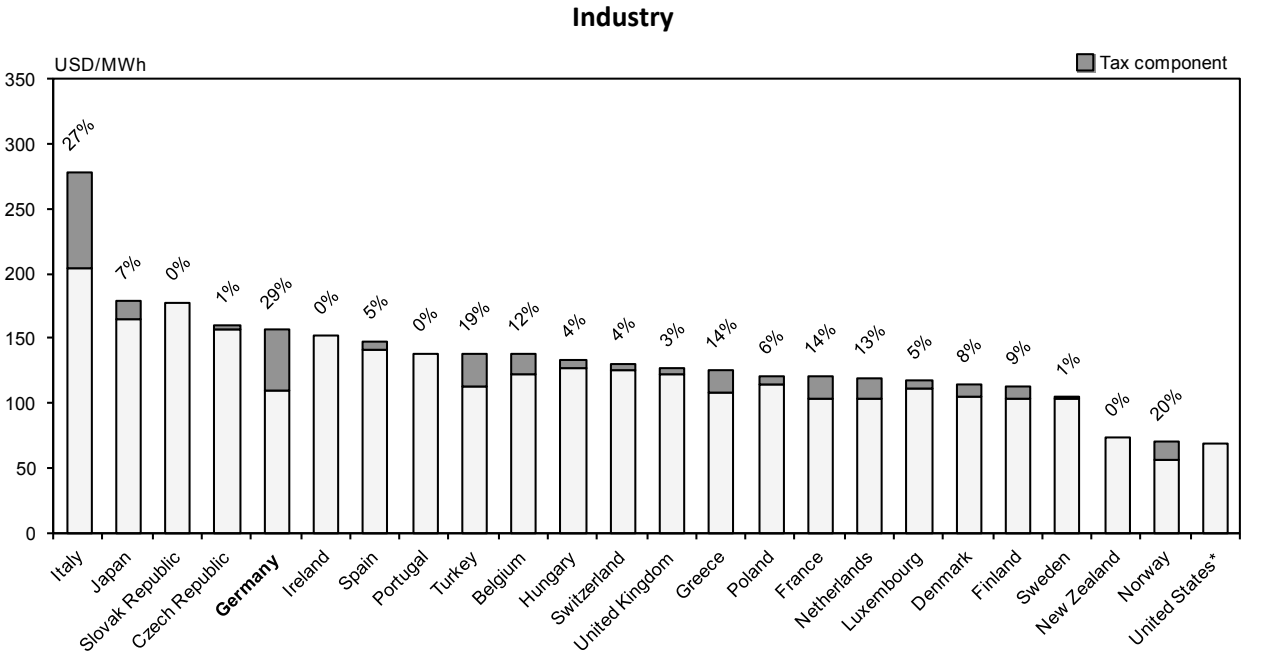


Note: data is not available for Poland for 1980. Data is not available for the Czech Republic between 1980 and 1984. Data is not available for the Netherlands between 2002 and 2006.



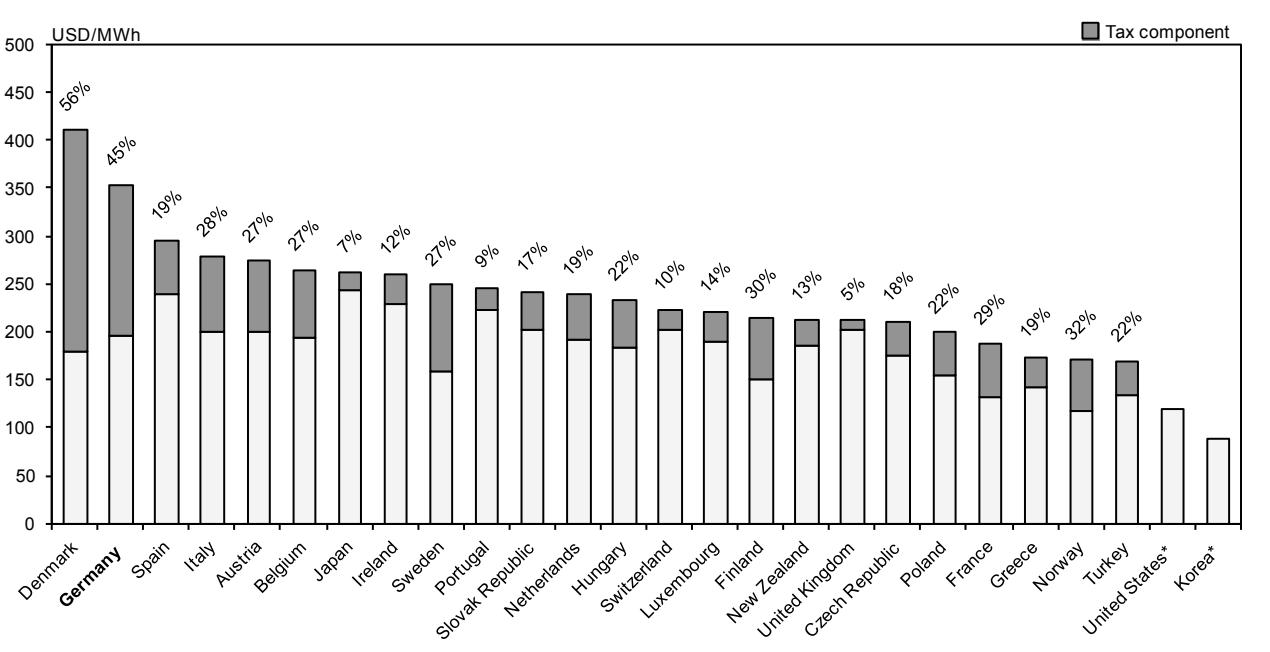
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2012.

Figure 33. **Electricity prices in IEA member countries, 2011**



* Tax information not available for the United States.

Note: data not available for Australia, Austria, Canada and Korea.



* Tax information not available for Korea and the United States.

Note: data not available for Australia and Canada.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2012.

A major concern regarding the cost of the Renewable Energy Sources Act is the allocation of those costs. BAFA stated that in 2012, only 734 industrial consumers (85 TWh) were largely (but not completely) relieved from paying the EEG surcharge by special compensation mechanism (*besondere Ausgleichsregelung*). For 2013, there are requests from 2057 industrial consumers (107 TWh) awaiting a decision, which is expected in the first half of the year. Furthermore, since 2011 there are also medium-sized electricity-intensive companies, accounting for 9 300 GWh of electricity purchases, that can benefit from the reduction of the EEG surcharge.[60]

ASSESSMENT

Germany has a large diversified electricity system which benefits from interconnections with neighbouring countries. Owing to its sufficient thermal power generation capacities and strong interconnections the system has coped to date with the shut-down of 8.4 GW in nuclear capacity without major energy security concerns, although the situation in winter 2011/12 was severely strained. The nuclear phase-out and the growth of renewable generation, however, are placing existing network infrastructure in Germany and elsewhere under stress. Renewable energy production has been growing at around 12 TWh per year, while there are approximately 10 GW conventional power generation capacities under development. Projections suggest that Germany has a high capacity balance until at least 2015, although it is too early to judge whether the balance may become tighter with the second stage of the nuclear phase-out from 2018.

Electricity is at the core of the *Energiewende*, which aims to phase-out nuclear power while keeping the economy on a decarbonisation path and maintaining supply security. This will require continuously strong deployment of renewable energy, large-scale electricity transmission developments as well as changes to the market design that ensure that the German power system continues to have adequate capacities of dispatchable power plants, electricity storage as well as demand response capability.

A robust German electricity market, fully integrated in the EU internal market for energy, is a key instrument, one which should provide for the most cost-effective solutions to achieve the ambitious energy transformation set out in the *Energiewende*. Efficient wholesale and retail markets can provide German households and industries with secure, competitive and environment friendly supply of energy while providing adequate investment signals to the market.

WHOLESALE MARKETS

Germany has developed a wholesale market for electricity, which is considered among the best in Europe. High liquidity, detailed and transparent information and a large number of participants contribute to price formation which is used as a benchmark in continental Europe. In addition, Germany fully co-operates in the regional initiatives involving the TSOs, the European Union and ACER. The establishment of market-coupling mechanisms has significantly reduced the occurrence of adverse flows and has resulted in increased price convergence in CWE. Recent measures to increase the market exposure of renewable energy also enhance efficiency.

60. *Hintergrundinformationen zur Besonderen Ausgleichsregelung für die Jahre 2012/2013*, BMU, 2012.

Maintaining and further developing liquidity and transparency on the market should remain a priority. Additional efforts are needed regarding the balancing market which is growing in importance owing to the intra-day volatility of renewable production. Strengthening and integrating balancing markets is an important task since interconnections with neighbouring systems is an important source of flexibility supporting the integration of renewable energy in Germany.

Balancing is the responsibility of the four TSOs. Historically, the capacity balance is calculated on a static basis by looking at the annual peak demand and comparing it with the minimum available supply. Forecasts show that, after full phase-out of the remaining nine nuclear plants by 2022, the capacity balance will be tight and substantial changes to the way the system is operated will be required.

At present, only a very limited part of the generation from RES is included in the capacity balance calculations. PV is not included and wind capacity is accounted for but to a very small extent (1% for the time being). It may be more efficient to increase their contribution to peak demand in close co-ordination with other technologies, such as flexible gas-fired generation, storage technologies, or demand response to name a few. To activate their contribution and determine a right set of technologies at the right time and location, Germany should identify and implement a system-wide policy, regulatory and market-based approaches which optimise these dimensions between market participants and regulated networks.

Concerning system integration and flexibility of existing generation, many measures directed at the district heating system are about to enter into force. In this context, support to construction of heat storage facilities is considered important as this will enable CHP plants to provide flexibility in the electricity market.

GENERATION ADEQUACY

The German electricity system is regarded as a secure system; an average of 19.27 minutes lost in 2010 placed it among the most secure electricity systems in the Europe.[61] Over the past 20 years, Germany has enjoyed plenty of reserve capacity, both in generation and transportation networks, most notably in the distribution grid.

Generating capacities are sufficient to cover peak demand under existing market conditions. Notwithstanding, the nuclear phase-out, reserve margins remain above peak demand until 2015 at least. Between 2015 and 2022, new investments are required but other means exist to reduce the need for new generating capacity. Despite the efficiency of power markets, concerns remain as to the extent to which the current market arrangements can deliver the necessary investments to maintain secure and reliable electricity services. For the moment, owing to an unprecedented increase in generation from renewable sources, and also to lower electricity demand as a result of the economic crises, investments in some power plants were ill-timed. For the time being, with weak carbon prices and high gas prices, existing gas-fired plants have lost competitiveness and some are being taken off line. The average load factor of combined-CCGTs in Germany is around 3 000 hours, and is likely to be depressed further. At the same time, these gas-fired plants cannot fully build on revenues from more volatile operational requirements, even if these plants can show techno-economical advantages against existing coal plants.

61. Fifth CEER Benchmarking Report on the Quality of Electricity Supply 2011, Council of European Energy Regulators, 2012.

In addition, the large-scale entry of low marginal cost generation is likely to compress wholesale markets and make it more difficult for conventional generation to recover fixed capital costs. This has led to a discussion of capacity mechanisms and other investment incentives.

While present reserve margins suggest that there is no urgent need to develop some form of capacity mechanism, there is a need to adapt existing markets arrangements. Such adaptations can help defer or potentially avoid the implementation of further regulations and maintain efficient energy-only markets. For example, only a harmonised reserve margin requirement at EU level can lead to harmonised market price reactions during hours of scarcity. At international level, therefore, Germany should utilise existing mechanisms to seek to harmonise security of supply rules, procedures and reserves similar to, for example, arrangements in the Nordic power exchange, Nord Pool.

Activated demand response, undistorted wholesale and retail market prices and political credibility can improve investment certainty into potentially required future power plants. Further changes to the Renewable Energy Sources Act may also be required, in order to avoid the present situation in which renewable generation cannot react to market prices. Assessments should continue, with reference to international developments (such as the North American Electric Reliability Council of Texas (ERCOT) and PJM market, or experience in Alberta, Canada and in Australia) in parallel with close monitoring of the German market. To the extent that the federal government must contract for capacity as a short-term measure for maintaining network reliability, as already happens, such contracting should be done on a transparent and open basis, for example by public tender. Such measures should be supported by network-based incentives on generators to optimise their location decisions from a system-wide reliability and cost perspective.

Furthermore, there is a need for transparent and widely understood triggers, which are linked to the fundamentals of demand and supply rather than price, in order minimise the risk of crowding out incremental capacity. These triggers should be seen as a transitional measure to assist with the potentially difficult medium-term adjustment.

Market arrangements including the efficient deployment of smart metering are essential to mobilise demand response that may become a cost-effective flexibility source, while supporting more efficient and least-cost network development.

Germany has time to adjust its energy-only market design; it runs a sufficiently high reserve margin and is well interconnected with neighbouring countries. Close monitoring is required and should continue in the medium term. Germany should strengthen its energy-only market by improving demand elasticity, establishing targets for reserve margins, introducing cost-reflective reimbursement for network services, market price-sensitive renewables. It should introduce price caps, and enhance EU co-ordination. Examples from other regions exist, such as ERCOT in North America or the National Electricity Market (NEM) in Australia, and Germany should take advantage of this collective experience.

In unexpected cases, the reserve margins could fall below what is desired; when this happens, Germany should start looking into options to complement its liquid and efficient energy-only market with market-based instruments. A targeted and temporary capacity mechanism, with the phase-out timed around managing the peak period of uncertainty while the nuclear capacity is being replaced, should be the aim. Germany should also monitor network-related aspects of reliability to better balance the overall electricity system.

INVESTMENT IN TRANSMISSION AND DISTRIBUTION INFRASTRUCTURE

The transmission grid has been designed to accommodate transport of power from large-scale thermal and nuclear power plants. In 2011, electricity generated from renewable sources, mostly variable generation, accounted for 20% of total generation. The Energy Concept forecasts this share will increase to 35% by 2020. At the same time, the decision to phase-out nuclear power will result in the loss of a large share of base-load generating capacity. There will be a substantial difference in the spatial distribution of production, with nuclear capacities decommissioned in the south and central regions and large-scale wind power production coming from the north. These fundamental changes are magnifying power system management and security challenges.

With the change in the electricity generation fleet, to accommodate large numbers of PV and wind turbines connected to the distribution grid, the function of the transmission network is undergoing a substantial change. Over the next ten years, the transmission system will have to transport significant amounts of variable renewable energy, large-scale offshore wind from the producing regions in the north to consumers in the south. This will require the removal of north-south bottlenecks by reinforcing and expanding the network.

The expansion of renewable energy and the increasingly decentralised power generation has become a growing challenge not only for the transmission grids, but also for the distribution grids, to which most of the plants are connected. Large-scale investment in the distribution networks is needed in order to accommodate the growing volume of renewable energy and to move it to where the electricity is needed. The German Energy Agency estimated the cost of this investment at between EUR 27.5 billion and EUR 42.5 billion over the life of the *Energiewende*. DENA has also indicated the need for further studies on the costs and scale of the investment required as well as the need for greater co-operation between transmission and distribution network operators and between Germany and its neighbours.

The magnitude of the investment requirement will be affected by the capability and effectiveness of system operation at the distribution level. There is a need for more effective system operation at distribution level and the potential benefits this could deliver in terms of more efficient use of existing infrastructure (potentially necessitating less network investment), in terms of system security, reliability and the system's capacity to integrate renewable generation at least cost. This will be accompanied by regulatory risks and, therefore, a need for regulators to make appropriate allowances for investments in related smart-grid technologies.

Planning is also a problem: in the past, permitting procedures were lengthy and complicated often because of strong local and political opposition to new overhead lines. By passing the Network Expansion Acceleration Act, the federal government has streamlined the planning process, which is likely to speed up approval of the most important investments and subsequent construction in the transmission system.

Deployment of a smart grid has the potential to reduce the need for conventional transmission development and to enhance flexibility. Smart grid is essentially a system integration issue. It opens up alternatives to classic grid expansion by introducing new approaches to the operation of the electricity system. Historically, load follows demand, but with a large share of variable generation flexibility of demand response has the potential to become cost-effective compared to alternative to grid investments in many cases. Grid investments, however, will not become obsolete.

ELECTRICITY PRICES

Household electricity prices in Germany have increased significantly over the past ten years and are now among the highest in IEA Europe. Early in 2013, households saw prices increase on average by 11%, and 728 of the 854 utilities, which supply standard customers without special supply arrangements, increased prices by an average of 12%.

Much of this increase has been driven by the increased costs of the EEG. The Ministry for the Environment has estimated that, in the absence of cuts, total feed-in tariff costs of the EEG could be as high as EUR 680 billion by 2022, not including the costs for grid expansion, reserve capacity, R&D, electro-mobility and the energy-efficient renovation of buildings. In November 2012, the four TSOs published their forecasts for the 2014 EEG surcharge and their five-year medium-term forecast. The TSOs expect the surcharge for 2014 to be somewhere between EUR 0.0489 per kWh and EUR 0.0574 per kWh, or a slight increase on the 2013 surcharge. By 2017, the TSOs expect that the installed capacity of RES will be 111 GW, compared to the expected 80.6 GW at the end of 2013. Solar power and wind power are projected to account for 91% of supply in 2017 (solar: 54.8 GW, onshore wind: 38.97 GW, offshore wind: 7.9 GW).

If the credibility of the *Energiewende* is to be maintained, the cost of these elements and their apportionment among customer categories must be examined. The obligations upon government are threefold: to reduce the costs of the EEG, to allocate the remaining costs in an equitable manner and to ensure that grid investments deliver the most efficient outcome for consumers. In this regard the announcement in February 2013 from the Federal Minister of Economics and the Federal Minister for the Environment that they are actively seeking ways to restrain EEG-related electricity costs is welcome. A systematic reform of the support mechanism for renewables deployment should be considered. A reformed policy scheme that will reap the benefits of competition, locate and pace new deployment in line with required infrastructure and provide sufficient certainty for investors in necessary over the longer term given the large volumes of renewable energy that will be connected over the next five years. A tendering scheme for larger installations, designed in the right way and in line with EU and other legislation, could meet this set of criteria.

In addition, the approval of the 2012 National Grid Development Plan (NEP 2012) is a further measure to manage costs by prioritising certain key infrastructures. The decision to reduce the total number of major projects proposed by the TSOs from 74 to 51 is important as is the decision to approve only three of four proposed extra-high-voltage DC power lines to transmit incremental wind power generated in the north of Germany to elsewhere. Further analysis is expected in NEP 2013, which was presented to the Federal Network Agency in March 2013.

The proposal from the German Institute for Economic Research to compensate low-income households for the hardship created by increasing electricity costs is important. The welfare benefit systems should be able to anticipate price increases and complemented by energy advice and financial assistance to enhance the efficiency of electricity use to reduce electricity expenditure. Alternatively, there may be scope to reduce the electricity tax on a basic bloc of consumption.

RECOMMENDATIONS

The government of Germany should:

- *Ensure that the large-scale transmission and distribution developments including investments that are necessary if the* Energiewende *is to succeed are put in place in a timely and cost-efficient manner.*
- *Maintain a regulatory system that provides sufficient financial incentives and investment security for mobilising the necessary investments in distribution.*
- *Facilitate R&D efforts to enhance the capacity of the transmission system.*
- *Emphasise cost-effective measures to balance the increasing share of variable generation by using a market-based approach, including the participation of variable generation on those markets.*
- *Encourage demand response with the deployment of load management, including deployment of smart technologies to improve system reliability, resilience and flexibility, and to deploy variable renewable generation, especially at the distribution level.*
- *Assess in co-ordination with all relevant stakeholders whether the current market arrangements enable the financing of investments in new dispatchable generation, prevent the retirement or closure of the generating capacity needed to ensure reliability and cost-effective electricity production that will maintain capacity balance while maintaining a competitive framework. In this context, assess the suitability of capacity markets as a transitional measure to support the adjustment to a post-nuclear power system.*
- *Where feasible, co-operate with neighbouring electricity systems to develop international markets for balancing services and to tap the cross-border netting potential.*
- *Continue the integration of electricity wholesale markets with neighbouring countries and increase co-operation to harmonise security of energy supply mechanisms.*
- *Take strong measures to ensure that the costs of the* Energiewende *are minimised and allocated fairly and equitably across customer categories.*

10. NUCLEAR ENERGY

Key data (2011)

Number of plants in operation (2012): 9 plants in operation, 8 plants taken off-line in 2011

Installed capacity (2012): 12.1 GW

Electricity generation: 108 TWh, -36.3% since 2000

Share of nuclear: 9% of TPES and 17.9% of electricity generation

OVERVIEW

Germany's phase-out of the use of nuclear power was transposed into law through the April 2002 adoption of the Act on the Structured Phase-out of Nuclear Power for the Commercial Production of Electricity. The legislation established rules to end the use of existing German nuclear power plants (NPP) for the commercial production of electricity. To this end, a decision was taken regarding the remaining amount of power that each nuclear power plant could produce.

This amount corresponded to the total amount of power that would be produced during an average operational lifespan of 32 years. Power plants were to be switched off once they had generated the quantity of power stipulated in the law.

In autumn 2010, the federal government adopted an Energy Concept, which determined that nuclear power is to play a bridging function, but only until renewables are able to make a greater contribution to electricity supply, and the infrastructure needed to achieve this has been put in place. The 11th Act Amending the Atomic Energy Act, which took effect in December 2010 and is based on the Energy Concept, raised the limit of the remaining power amounts that NPPs would be permitted to produce, thereby extending the life spans of Germany's 17 nuclear plants by an average of 12 years (the seven power plants that had gone into operation before 1980 were allowed to produce additional power corresponding to eight additional years of operation; for the other ten power plants, the amount corresponded to 14 additional years).

Following the Fukushima Daiichi nuclear accident in March 2011, the federal government decided to reassess the risks associated with the use of nuclear power. It decided, in co-ordination with the Minister-Presidents of the Länder where nuclear power plants are in operation, to subject all German NPPs to a comprehensive safety review. As part of this safety review, eight NPPs – seven older plants together with the Krümmel plant – were either taken off-line or, for those plants not in operation at the time, not switched on. The eight plants affected by this temporary three-month discontinuation of operation are Neckarwestheim 1, Phillipsburg 1, Biblis A and Biblis B, Isar 1, Unterweser, Brunsbüttel and Krümmel. The safety review of all German NPPs was conducted by the Reactor Security Commission in close collaboration with the competent nuclear regulatory authorities. In May 2011, the Reactor Safety Commission submitted a comprehensive analysis of the risks associated with German NPPs. In addition, the federal government set up an

independent ethics commission, the Ethics Commission for a Safe Energy Supply, which in May 2011 submitted a comprehensive opinion on issues relating to Germany's future energy supply. The findings of these commissions served as guidelines for the energy policy decisions that needed to be taken.

On 30 June 2011, the *Bundestag* decided by a large majority that, no later than the end of 2022, Germany will fully terminate the generation of power by German NPPs. This 13th Act amending the Atomic Energy Act took effect on 6 August 2011.

Table 22. **German nuclear power plants***

Nuclear power plant	Type	Year taken online	Maximum output capacity	Operator	Owner	Gross power generation 2010	Shut-off date under amended Atomic Energy Act
Biblis A	PWR	1975	1 167 MW	RWE	RWE	5 042 GWh	2011
Neckarwestheim 1	PWR	1976	785 MW	EnBW	EnBW	2 208 GWh	2011
Biblis B	PWR	1977	1 240 MW	RWE	RWE	10 306 GWh	2011
Brunsbüttel	BWR	1977	771 MW	Vattenfall	67% Vattenfall, 33% E.ON		2011
Isar 1	BWR	1979	878 MW	E.ON	E.ON	6 543 GWh	2011
Unterweser	PWR	1979	1 345 MW	E.ON	E.ON	11 239 GWh	2011
Philippsburg 1	BWR	1980	890 MW	EnBW	EnBW	6 791 GWh	2011
Krümmel	BWR	1984	1 346 MW	Vattenfall	50% Vattenfall, 50% E.ON		2011
Grafenrheinfeld	PWR	1982	1 275 MW	E.ON	E.ON	7 938 GWh	2015
Gundremmingen B	PWR	1984	1 284 MW	RWE	75% RWE, 25% E.ON	9 954 GWh	2017
Philippsburg 2	PWR	1985	1 402 MW	EnBW	83.3% E.ON, 16.7% SWB	11 797 GWh	2019
Gundremmingen C	BWR	1985	1 288 MW	RWE	75% RWE, 25% E.ON	10 936 GWh	2021
Grohnde	PWR	1985	1 360 MW	E.ON	75% RWE, 25% E.ON	11 417 GWh	2021
Brokdorf	PWR	1986	1 410 MW	E.ON	EnBW	11 945 GWh	2021
Isar 2	PWR	1988	1 410 MW	E.ON	80% E.ON, 20% Vattenfall	12 007 GWh	2022
Emsland	PWR	1988	1 329 MW	RWE	75% E.ON, 25% SWM	11 560 GWh	2022
Neckarwestheim 2	PWR	1989	1 310 MW	EnBW	87.5% RWE, 12.5% E.ON	10 874 GWh	2022

* Nuclear power plants taken off-line are shaded in grey; BWR = boiling water reactor; PWR = pressurised water reactor.

Source: BMWi.

In a step-by-step process to be completed no later than the end of 2022, Germany will fully terminate the generation of nuclear power. For the eight NPPs taken off-line during

the nuclear safety review, the authorisation to generate power expired when the 13th Act amending the Atomic Energy Act took effect on 6 August 2011. Other NPPs are to be taken offline as follows: the Grafenrheinfeld plant by end 2015, Gundremmingen B by end 2017, Philippsburg 2 by end 2019 and Grohnde, Gundremmingen C and Brokdorf by end 2021. The three newest facilities – Isar 2, Emsland and Neckarwestheim 2 – are to be taken off-line by end 2022 at the latest. Taken together, the eight power plants taken permanently off-line as a result of the entry into effect of the amended Atomic Energy Act had a net maximum output capacity of 8.4 GW. This corresponds to 41% of the power generation capacity of the plants remaining in operation.

Germany also introduced a nuclear fuel rod tax that came into effect on 1 January 2011. The tax obligation arises when a fuel element or individual fuel rod is inserted into a nuclear reactor and a self-sustaining chain reaction is triggered. Revenues from the nuclear fuel rod tax will contribute to the consolidation of government finances. The tax is set to expire on 31 December 2016.

NUCLEAR INDUSTRY STRUCTURE

Germany has been using nuclear power since 1960, when the first nuclear power plant went critical. However, following the Chernobyl accident, scepticism began to grow and the government concluded the first agreement on a nuclear phase-out in 2000.

All NPPs currently in operation in Germany were constructed by Kraftwerk-Union (KWU, founded by Siemens and AEG) in the 1970s and 1980s. KWU, a 100% subsidiary of Siemens AG for a long time, was transferred to a French-German joint venture in 2001, in which the French AREVA had a shareholding of approximately two-thirds and Siemens AG of one-third. Since April 2006, the joint venture has operated under the name of AREVA NP. In March 2011, AREVA NP became a 100%-owned subsidiary of AREVA.

The company Babcock-Brown Boveri Reaktor GmbH (BBR, a joint venture of Brown, Boveri & Cie and Babcock & Wilcox from the United States, later ABB, respectively sold to BNFL/UK in December 1999, now renamed Westinghouse) supplied the PWR plant Mülheim-Kärlich, which was shut down in 1988.

Currently nine NPPs remain in operation following the entry into force of the 13th Act amending the Atomic Energy Act. Altogether, these nine plants have a power generating capacity of 12.1 GW and all are privately owned. In 2012 they generated 100 billion kWh of electricity or nearly 18% of electricity production. The unit and energy availability of the NPPs reached 90%.

The individual power utilities or their subsidiaries are the licensees of the NPPs. They are obliged by law to build up financial reserves to be prepared for the follow-up costs connected with the operation of a nuclear power plant, such as the decommissioning and dismantling of the installations, and the treatment and disposal of radioactive material, including spent fuel. The financial reserves are adjusted on an annual basis. The valuation of these reserves is regularly reviewed by independent accountants and the financial authorities.

In addition to NPPs, 46 research reactors were built and operated in Germany. At present, most research reactors are shut down and being decommissioned. Eight research facilities – three with a capacity of more than 50 kW thermal power and five small training reactors – are still in operation.

As of December 2010, 19 NPPs have been permanently shut down. Of these, 15 are currently being dismantled with "green-field conditions" being the planned target, two are in safe enclosure and two have already been completely dismantled to green-field conditions. Six other NPPs never commenced operations as the projects were abandoned during the construction phase. For the eight NPPs shut down in August 2011 after the nuclear accident in Fukushima Daiichi, no application for decommissioning has been filed as yet.

NUCLEAR FUEL SOURCES

Uranium extraction no longer takes place in Germany. The process of decommissioning and rehabilitating the Wismut GmbH's uranium mine, however, sometimes gives rise to minor amounts of uranium. This means that German NPPs purchase the nuclear fuel they need on world markets. The URENCO Group – an international enrichment services company – operates an enrichment facility in Gronau, Germany. ANF GmbH, a subsidiary of AREVA NP GmbH based in the city of Lingen, produces fuel elements for pressurised water reactors and boiling water reactors.

RADIOACTIVE WASTE MANAGEMENT: LOW- AND INTERMEDIATE-LEVEL

Germany's plans are for all types of radioactive waste to be permanently stored in deep geological repositories, consistent with the policies adopted in other European countries. Radioactive waste derived from the operation and decommissioning of NPPs is to be stored in interim storage facilities until it is placed in a final repository. Interim storage facilities for this waste are currently located on-site at power plant sites as well as at off-site storage facilities (the Unterweser external storage facility; the Biblis decentralised interim storage facility; the waste storage facilities in Gorleben and Ahaus; the Mitterteich interim storage facility; an interim storage facility in Hanau operated by Nuclear & Cargo Service GmbH; the Interim Storage North facility near Greifswald; and the interim storage facility at the central decontamination operations department of Karlsruhe Institute of Technology.)

Radioactive waste that is generated at large-scale research centres is normally placed in interim storage at the place of origin. Radioactive waste generated for research, industrial and medical purposes can be deposited at 11 collection centres run by the Länder. The Konrad mine is the planned final repository for low- and intermediate-level waste (waste that generates negligible amounts of heat). The planning approval notice for the Konrad final depository was issued in 2002 and has been legally binding since 2007. Storage operations are not expected to begin before 2019.

RADIOACTIVE WASTE MANAGEMENT: HIGH-LEVEL

As stipulated by the Atomic Energy Act, the management of spent fuel elements from nuclear power reactors occurs via interim storage, followed – contingent on the availability of a final repository in deep geological formations – by direct final disposal. Nuclear power plant operators at Germany's power plant sites have built on-site interim storage facilities for storing the spent fuel elements that are produced by these plants until they cease operating. Interim storage facilities for spent fuel elements are located at a total of 12 nuclear power plant sites in Germany.

In the past, spent fuel elements from German NPPs were reprocessed in France and the United Kingdom. However, the shipment of spent fuel elements to reprocessing facilities has been prohibited since 1 July 2005.

The exploration of the Gorleben salt dome as a potential final repository for high-level radioactive waste resumed in November 2010 after a ten-year moratorium on exploration expired. At the same time, a preliminary safety analysis was launched in June 2010 and will be completed in the second quarter of 2013. In a protocol statement issued in conjunction with the 13th Act amending the Atomic Energy Act on 8 July 2011, the federal government affirmed its position that generation using nuclear energy must also take responsibility for storing the radioactive waste that is produced. This includes the further open-ended exploration of the Gorleben salt dome, as well as procedures to determine general geological suitability criteria and other possible disposal options. The further exploration of the Gorleben site was suspended until further notice in December 2012 so as not to affect the negotiations of the federal government with the Länder about the future Radioactive Waste Management Programme in Germany.

REGULATION

As Germany is organised as a federal state, the execution of federal laws lies in principle within the responsibility of the federal states, the Länder, unless otherwise specified. The "regulatory body" is therefore composed of federal government and Länder government authorities. The Länder perform their nuclear regulatory activities on behalf of the federal government (Section 24 of the Atomic Energy Act in conjunction with articles 85 and 87c of the Basic Law). By organisational decree, the federal government names the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit*, BMU) as the supreme regulatory authority in charge of nuclear safety and radiation protection. The BMU is responsible for federal oversight of the lawfulness and expediency of the actions of the Länder, including the right to issue binding directives. The subordinate authority to the BMU is the Federal Office for Radiation Protection (*Bundesamt für Strahlenschutz*, BfS). This supports the BMU technically and scientifically, especially in the execution of federal oversight, the preparation of legal and administrative procedures, and in intergovernmental co-operation.

According to the Atomic Energy Act, the respective Länder governments determine their own supreme authorities in charge of the licensing and supervision of NPPs. For technical matters in the licensing procedure and the supervision of nuclear facilities, the regulatory authorities of the Länder are supported by independent technical support organisations, in general the nuclear departments of the technical support organisations.

In 2010, adoption of the 12th Act amending the Atomic Energy Act, not only implemented the EU Directive 2009/71/EURATOM establishing a community framework for the nuclear safety of nuclear installations, but also added new provisions introducing “additional safety precautions”. The aim of these new provisions is to implement additional security precautions that serve to increase safety margins and to ensure that NPPs achieve the highest possible levels of safety.

PUBLIC AWARENESS

The BMU conducts public outreach, particularly with regard to nuclear safety concerns, through a wide variety of media and activities, including: ongoing public relations work (press releases, press conferences, and the organisation of public and media visits to certain facilities); information campaigns; events; informational brochures and printed material; extensive online information services; audio-visual media; activities associated with the

implementation of the Environmental Information Act; responses to individual inquiries; and public lectures upon request. In addition, similar measures are conducted by the nuclear licensing and regulatory authorities of the Länder on their own initiative.

ASSESSMENT

On 14 March 2011, following the Fukushima Daiichi accident, the federal government introduced a moratorium that shut down all German NPPS that had been commissioned before 1980. This affected the NPPs Biblis A, Neckarwestheim 1, Biblis B, Brunsbüttel, Isar 1, Unterweser and Philippsburg 1. The Krümmel NPP was already shut down at that time.

On 30 June 2011, the *Bundestag* confirmed that Germany will stop the generation of power by German NPPs by the end of 2022. This 13th Act amending the Atomic Energy Act took effect on 6 August 2011. The further authorisation for power operation for the eight plants shut down was considered to be expired from that date.

The extension of operating times laid down in December 2010 was withdrawn by the decision of August 2011 and the additional electricity volumes were cancelled. The Federal Network Agency decided on 31 August 2011 that none of the NPPs shut down on 6 August 2011 will be used as reserve to guarantee electricity supply.

The phase-out policy has wide support but was decided very quickly and requires re-adjustment of the previously planned rate of introduction of renewables and causes pecuniary impacts on both the utilities and the grid operator. Certainly the decision has affected the profitability of the electricity generating companies, as reported in their annual reports, and a recent estimate of the costs of replacement capacity was given as EUR 45.8 billion.

The government has decided that no compensation will be paid to the utilities for their loss of revenues, but that the nuclear tax will still apply and that the utilities will remain fully responsible for all decommissioning and waste management costs.

The immediate impact of the closure of the eight plants was that Germany moved from being a net exporter to a net importer for half a year and this affected electricity availability in other parts of Europe. The closure of the nuclear plants will add extra pressure to the other sectors to compensate for the loss of nuclear as a low-carbon source of electricity.

RADIOACTIVE WASTE MANAGEMENT

Radioactive waste (RW) is currently held in interim storage either at the utility site or at the storage facilities at Mitterteich, Karlsruhe Institute of Technology, and at Hanau. No final disposal facilities exist for low-, intermediate- or high-level waste. Actions are being taken to move towards final disposal, and funding for this process is proportionately held by the private companies or the government as relevant.

Deep geological disposal is planned for both low- and intermediate-level waste (LIW) (at Schacht Konrad, near Salzgitter in Lower Saxony) and there are ongoing discussions on a new process for the high-level waste disposal site. For the Konrad site, a legally binding planning approval has been underway since 2007, with storage operations expected to start not earlier than in 2019. This facility will be capable of holding 303 000 m³ of LIW.

High-level waste (HLW) is currently held at 12 on-site and three off-site interim storage facilities, while the final disposal process is restarted. Discussions are ongoing between

the BMU and the Länder, with a proposal to establish some criteria for a comparative process between possible sites. The Gorleben site is still a possibility but the difficulty of proceeding at this site will be great, given the strong and well-informed opposition groups that have been established over the years. The stated intention is to have the site chosen by 2029 and operating 12 to 15 years after that date.

Progress on a disposal site for LIW is a noteworthy achievement given the difficulty of gaining public support for such repositories. However the restart of the process for a HLW repository raises many issues about the certainty of achieving an acceptable result. The current time scales are long and there are many possible causes of delay.

The lack of a final disposal site or time scale makes the determination of the funds for final waste disposal more difficult. In addition, the continued use of interim storage accrues costs, and the timetable for closure of these facilities is unknown. Disposal sites will be state-owned.

DECOMMISSIONING

Germany has 19 reactors in various stages of decommissioning, excluding the eight shut down in 2011 or the research reactors permanently shutdown. Thus, the need to maintain and develop expertise is very important in ensuring a safe and environmentally benign decommissioning process.

The responsibility for decommissioning rests with the utilities and this has not changed despite the earlier closure of the NPPs. Responsibility for other facilities (research and prototype) rests with either the federal government or the Länder, as appropriate. The management of the funds for decommissioning is also held by the utilities. It is not a separate fund.

Germany has already completed, or is completing, the decommissioning of the majority of its nuclear research facilities although there are still the URENCO plant and ANF in operation as major fuel cycle facilities. This represents a very significant international experience in decommissioning. There are some remaining power and research reactors in operation but the number of decommissioned facilities puts increasing pressure on the need to manage RW.

HUMAN RESOURCE DEVELOPMENT

The German government has recognised the need to ensure adequately skilled resources for the remaining life of its existing nuclear fleet, waste management and decommissioning, as well as the importance of maintaining its high-quality work in applications of nuclear energy in the non-power sphere. A R&D budget has been set up to ensure that these capabilities remain. The goals of this programme are:

- to ensure safe operation of the remaining NPPs;
- to maintain knowledge for future tasks;
- to contribute to international nuclear safety issues.

The Federal budget has allocated around EUR 75 million per year for nuclear safety research and around EUR 150 million per year for fusion research. This includes around EUR 10 million for funding of young researchers. This is a noteworthy programme and will be important in ensuring adequate human resources.

A number of other countries are in a similar position, either phasing-out or maintaining small nuclear programmes. To cope with this declining attractiveness of the industry to young people and the associated decline in educational and training programmes, international collaboration and sharing facilities are important to maintain the necessary expertise.

RECOMMENDATIONS

The government of Germany should:

- ☐ *Maintain efforts to achieve a good balance between the need to press ahead with the process for determining a repository site and the need to involve the public in a meaningful and effective manner. Good lessons can be learned from the experience of other countries on long-term engagement and funding for potential host communities.*
- ☐ *Ensure that funds remain sufficient as reactors close and are no longer producing revenues. Also ensure that funds are adequate for final disposal when a site is decided.*
- ☐ *Ensure the best use of the resources being allocated by pursuing dedicated education and training programmes; enhance involvement in international educational and training networks and collaborative research agreements, such as those proposed or in operation in the European Union.*

PART III
ENERGY TECHNOLOGY

11. ENERGY RESEARCH, DEVELOPMENT AND DEPLOYMENT

Key data (2011)

Government energy RD&D spending (2012 estimated): EUR 764 million

Share in GDP: 0.31 per 1 000 units of GDP (IEA median: 0.39)

RD&D per capita: USD 10.9 (IEA median: 14)

OVERVIEW

On 3 August 2011, the federal government unveiled Research for an Environmentally Sound, Reliable and Affordable Energy Supply, the Sixth Energy Research Programme of the federal government. The purpose of this programme is to implement a key measure outlined in the Energy Concept. The programme also includes the adjustments to the Energy Concept, which resulted from the June 2011 Energy Package. The federal government believes that supporting a high level of R&D that is broadly conceived and tightly co-ordinated – from basic research right through to industrial applications and demonstrations – is one of the key prerequisites for testing new designs, accelerating innovation and bringing forward-looking technologies to market.

The programme was compiled under the lead responsibility of the Federal Ministry of Economics and Technology (BMWi), in co-operation with the other government departments responsible for energy research matters: the Federal Ministry of Environment, Nature Conservation and Nuclear Safety (BMU); the Federal Ministry for Food, Agriculture and Consumer Protection (BMELV); and the Federal Ministry of Education and Research (BMBF) and in co-ordination with other departments. The Sixth Energy Research Programme focuses on three primary goals:

- to contribute to the achievement of federal government targets related to the energy industry and climate protection;
- to support companies in the area of modern energy technologies, including efforts to commercialise these technologies on global markets;
- to open up, consolidate and expand technological options and thereby to prevent risks to the general economy.

To achieve these goals, the federal government intends to promote the research, development and demonstration of modern energy technologies. To this end, for the period 2011 to 2014, a total of approximately EUR 3.5 billion will be allocated for purposes of project funding as well as institutional funding for the Energy Research Department at the Helmholtz Association. This represents an increase of over 75% in funding compared to the period 2006-09.

INSTITUTIONS

The federal government maintains a platform for energy research policy that serves as the main instrument for coordinating the energy research activities of the various government departments.

The new Energy Research Programme expands the role of the coordinating platform; the plan is to include the co-ordination of energy research activities at Land level also. Given the increasing number of research initiatives in the energy sector, the federal government plans to establish a centralised information system, located at the Federal Ministry of Economics and Technology, in order to enhance the transparency of government funding policy and to enable the more effective assessment and analysis of developments in the field of energy technology. Using this information system, the ministry will collaborate with other government departments to produce a Federal Report on Energy Research, which will provide the public and policy makers with available information on energy research. The findings of the report feed into the federal government's official process of monitoring the progress that has been made in implementing the Energy Concept. In the future, the work of the co-ordinating platform will also encompass Länder activities in the field of energy research.

Four government departments are involved in the energy research programme: the Federal Ministry of Economics and Technology (BMWi); the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU); the Federal Ministry for Food, Agriculture and Consumer Protection (BMELV); and the Federal Ministry of Education and Research (BMBF).

Two instruments are used to support R&D: project funding and institutional funding. Project funding is used to support clearly defined research projects with specific time frames that are carried out by companies, research centres or universities. A key trait shared by these projects is that they are application-oriented and close-to-market.

Box 9. **The Helmholtz Association**

Institutional funding for energy-related R&D is provided mostly within the framework of the Energy Department of the Helmholtz Association, an institution supported by the BMWi and BMBF.

The Helmholtz Association's research centres generally focus on questions that involve basic research or that, owing to their high level of complexity or need for large-scale equipment, are best carried out in large-scale research facilities. The Helmholtz Association brings together 18 scientific-technical and biological-medical research centres. With some 32 698 employees and an annual budget of approximately EUR 3.8 billion, it is Germany's largest scientific organisation. The Helmholtz Association supports the federal government's energy strategy and, by providing expertise and experience, assists in its implementation. In addition, it is closing research gaps and seeking to achieve more rapid progress in all relevant fields.

The work of the Helmholtz Association is divided into six strategic research fields: Energy; Earth and Environment; Health; Key Technologies; Structure of Matter; and Aeronautics, Space and Transport. In the energy sector, it organises programmes under five broad headings: Renewable Energies, Efficient Energy Conversion, Nuclear Fusion, Nuclear Safety Research and Technology, Innovation and Society.

The federal government determines how the various responsibilities in the field of energy research are divided between government departments. Interdepartmental co-ordination takes place within the framework of the co-ordinating platform for energy research. Government departments organise their project funding activities independently and in accordance with their stipulated areas of responsibility. There is also an early co-ordination instrument that enables the departments to consult with one another at an early stage about individual projects and thereby to avoid duplicate funding.

The **Federal Ministry of Economics and Technology** (BMWi) has lead responsibility for the overall programmatic orientation of energy research. The ministry's project funding targets issues involving non-nuclear technologies along the entire energy chain. These include: energy-optimised construction; energy-efficient cities; energy efficiency in industry, commerce, trade and services; energy storage units and grids, including key power supply-related aspects of electric mobility, power plant technologies and carbon capture; fuel cells/hydrogen; and system analysis. Nuclear safety and final storage constitute another priority research field, and the main focus here is on the retention and advancement of scientific expertise.

As part of the institutional funding it provides to the Helmholtz Association, the BMWi supports research by the German Aerospace Center in the areas of combustion technology, solar energy and system analysis. Project executing agencies for the BMWi include the Forschungszentrum Jülich (40.5 full-time positions), the Karlsruhe Institute of Technology (four full-time positions), and the nuclear safety agency Gesellschaft für Anlagen- und Reaktorsicherheit (six full-time positions).

The **Federal Ministry for the Environment, Nature Conservation and Nuclear Safety** (BMU) is responsible for project funding in the areas of wind energy, photovoltaics, geothermal energy, solar thermal energy, solar thermal power plants, hydropower, and ocean energy. Another priority area involves projects that contribute to the shift toward an energy system based on renewable sources. The Forschungszentrum Jülich serves as a project-executing agency for the BMU (49 full-time positions).

The **Federal Ministry of Food, Agriculture and Consumer Protection** (BMELV) project funding focuses on technologies for the use of bioenergy. This includes solid, liquid and gaseous biofuels. One of the BMELV's priority areas involves institutional funding to the German Biomass Research Centre (DBFZ). The Agency of Renewable Resources (based in the town of Gülzow in Mecklenburg-Western Pomerania) executes research, development and demonstration projects for the BMELV in the area of bioenergy (29 full-time positions).

The **Federal Ministry of Education and Research (BMBF)** is responsible for activities in the area of basic research. Its project funding focuses on photovoltaics, organic photovoltaics, bioenergy, wind energy and energy efficiency. To preserve long-term options for action, the ministry also provides funding for nuclear fusion projects. The BMBF also promotes young scientists as part of its support for research in the fields of nuclear safety, nuclear waste disposal and radiation, in order to ensure that Germany maintains the necessary level of expertise in these areas. The BMBF is also responsible for the general research activities conducted by the Helmholtz Association's Energy Department, which play a key role in ensuring Germany's position as a hub for research excellence. The BMBF's project execution agencies are located at the Forschungszentrum Jülich (16.5 full-time positions) and the Karlsruhe Institute of Technology (two full-time positions).

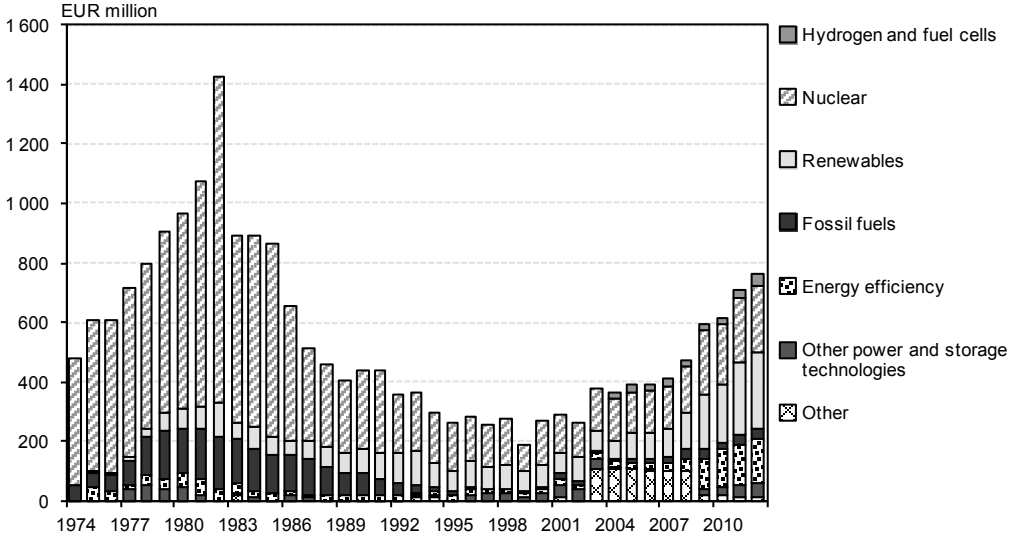
ENERGY RESEARCH PRIORITIES AND FUNDING

The priorities of the Energy Research Programme are geared towards the parameters laid down in the federal government's Energy Concept. These include, in particular:

- renewable energy;
- energy efficiency;
- storage and grid technology;
- the integration of renewable sources into the energy supply;
- interactions between the types of technology relevant to these fields.

Grid technology is a new research priority that will be expanded together with research on energy storage. Because of the multi-sectoral nature of these research areas, the federal government plans to carry out interdepartmental funding activities to target these priorities. A joint call for projects focusing on the issue of energy storage has already been issued by three government departments; this call encompasses total funding of up to EUR 200 million.

Figure 34. **Government RD&D spending on energy, 1974-2012***



* Estimated for 2012.

Note: nuclear includes spending on nuclear fusion.

Source: BMWi.

FUNDING

The federal government's funding policy is based on the following guiding principles:

- strategic focus;
- interdepartmental co-operation;
- international perspective;
- co-operation and co-ordination;

- transparency;
- flexibility;
- quality assurance.

Table 23. **BMWi budgetary funds for energy-related R&D** (EUR million)

	Actual 2010	Planned 2011	Projected data		
			2012	2013	2014
Efficient energy use	118.3	119.3	120.9	115.1	122.5
Electric mobility	16.8	21.2	0	0	0
Energy and climate fund	0	22.0	28.5	103.2	113.5
Nuclear safety and repository research	33.0	33.3	33.7	34.1	34.1
(1) Total	168.1	195.8	183.1	252.5	270.1
Institutional funding (DLR in Helmholtz Association)					
Efficient energy use	12.7	14.2	14.6	15.3	16.0
Renewable energy	3.5	3.6	4.2	4.5	4.7
Technology, innovation and society	1.2	1.2	1.2	1.2	1.2
(2) Total	17.4	19.0	20.0	21.0	21.9
(1+2) Overall total	185.5	214.8	203.1	273.5	292.0
	Actual 2010	**Planned 2011**	**Projected data**		
			2012	**2013**	**2014**
Efficient energy use	118.3	119.3	120.9	115.1	122.5
Electric mobility	16.8	21.2	0	0	0
Energy and climate fund	0	22.0	28.5	103.2	113.5
Nuclear safety and repository research	33.0	33.3	33.7	34.1	34.1
(1) Total	168.1	195.8	183.1	252.5	270.1
Institutional funding (DLR in Helmholtz Association)					
Efficient energy use	12.7	14.2	14.6	15.3	16.0
Renewable energy	3.5	3.6	4.2	4.5	4.7
Technology, innovation & society	1.2	1.2	1.2	1.2	1.2
(2) Total	17.4	19.0	20.0	21.0	21.9
(1+2) Overall total	185.5	214.8	203.1	273.5	292.0

Source: Research for an Environmentally Sound, Reliable and Affordable Energy Supply, Sixth Energy Research Programme, BMWi.

Germany has been implementing energy research programmes since 1974. The programmes are geared towards the respective current parameters of Germany's energy policy. The Sixth Energy Research Programme, Research for an Environmentally Sound, Reliable and

Affordable Energy Supply, was adopted by the federal government on 3 August 2011. The programme lays down the guidelines and priorities for energy research funding in the coming years.

This programme constitutes a key step in the implementation of the federal government's Energy Concept, which was adopted on 28 September 2010 as a strategic roadmap toward the age of renewable energy.

Table 24. **Other ministries' budgetary funds for energy-related R&D** (EUR million)

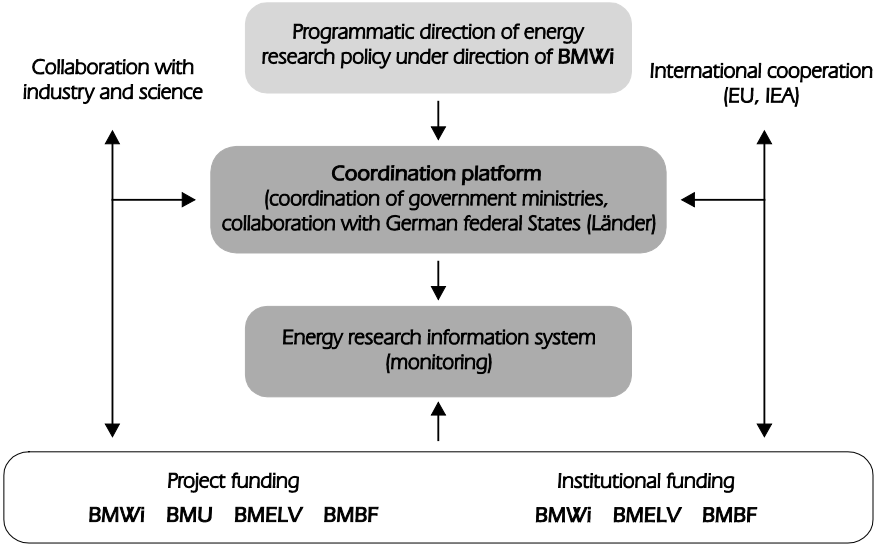
	Actual 2010	Planned 2011	Projected data		
			2012	2013	2014
Project funding provided by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety					
Renewable energy	120.2	128.9	148.9	158.4	158.4
Energy and Climate Fund	0	22.0	16.0	71.4	91.0
(1) Total	120.2	150.9	164.9	229.8	249.4
Project funding provided by the Federal Ministry for Food, Agriculture and Consumer Protection					
Bioenergy	23.2	25.0	25.0	25.0	25.0
Energy and Climate Fund	0	9.0	6.5	29.3	37.0
(**2) Total**	23.2	34.0	31.5	54.3	62.0
Project funding provided by the Federal Ministry of Education and Research					
Energy efficiency	12.1	15.3	15.8	16.3	12.3
Renewable energy	16.3	18.7	18.2	17.7	18.6
Nuclear safety and final disposal research	9.1	10.0	10.0	10.0	10.0
Fusion research	8.3	11.0	14.0	14.0	11.0
Energy and Climate Fund	0	15.0	11.5	47.9	61.0
(3) Total	45.8	70.0	69.5	105.9	112.9
Institutional funding provided by the Federal Ministry of Education and Research: Helmholtz Association					
Energy efficiency conversion and usage	46.1	41.1	41.8	42.7	43.5
Renewable energy	37.7	42.4	43.3	44.3	45.3
Nuclear safety research	29.5	29.7	30.2	30.8	31.5
Fusion research	122.7	137.1	138.7	140.6	142.6
Technology, innovation and society	7.3	7.7	7.8	7.9	8.0
Other measures	0	5.2	23.7	34.3	19.5
(4) Total	243.3	263.2	285.5	300.6	290.4
(1+2+3+4) Overall total	432.5	518.1	551.4	690.6	714.7

Source: Research for an Environmentally Sound, Reliable and Affordable Energy Supply, Sixth Energy Research Programme, BMWi.

The Energy Research Programme has been allocated approximately EUR 3.5 billion drawn largely from the special Energy and Climate Fund established by the federal government on 1 January 2011. An additional EUR 685 million from this source is being allocated to the programme for the period 2011-14. These funds will be used exclusively for R&D projects in the areas of renewable energy and energy efficiency.

A detailed breakdown of the funding is provided in Tables 23 and 24.

Figure 35. **The federal government's Energy Research Programme**



Source: Research for an Environmentally Sound, Reliable and Affordable Energy Supply, Sixth Energy Research Programme, BMWi.

Evaluation

As a rule, within the framework of project funding, the project-executing agency conducts a thorough assessment of each individual project (*e.g.* progress reports, final reports, utilisation of findings/results and price audits). In addition, research findings are frequently presented at expert meetings. In some cases, advisory boards are established that make recommendations with regard to funding activities. The responsible ministries also subject their funding activities to *ex ante* evaluations at regular intervals.

INTERMINISTERIAL RESEARCH INITIATIVES

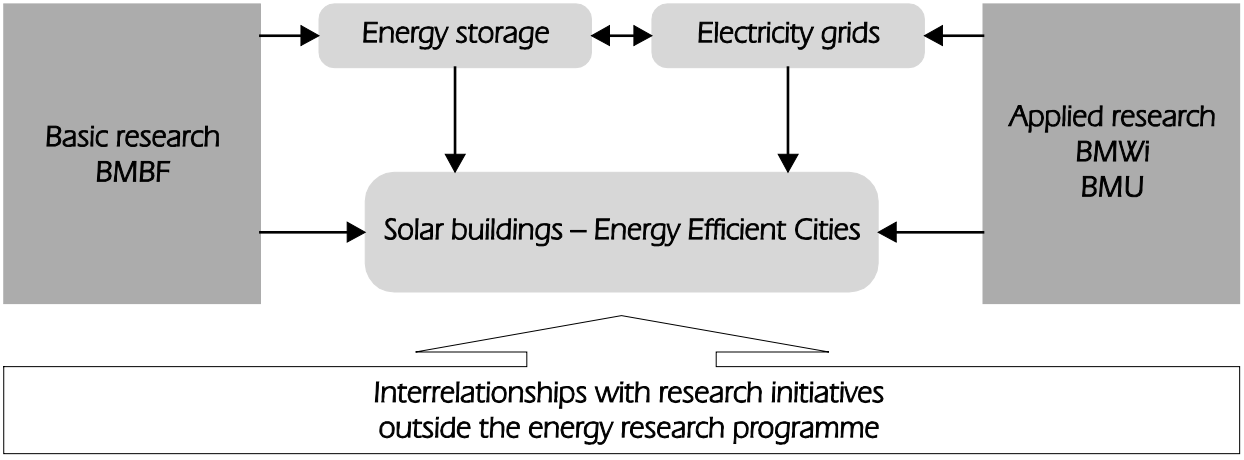
State funding for technology must accommodate these new developments. Interministerial funding strategies thus have an important role to play. Co-operation between different ministries is the best way of using the available expertise, realising synergies and combining forces to achieve the necessary technological breakthroughs in the areas that are vital for Germany's future energy supply.

Joint funding strategies are especially appropriate when the following factors apply:

- the technology is highly complex and system interdependencies must be taken into consideration;
- dovetailing of basic research, applied research, initial testing and marketing is important;
- policy makers want to achieve successful results as quickly as possible.

The federal government has resolved to develop and implement inter-ministerial funding initiatives in three areas initially: Energy Storage; Electricity Grids; and Solar Powered Buildings – Energy-Efficient Cities. These initiatives are framed within a technical and political context and must be co-ordinated appropriately with related or comparable initiatives in Germany (in the individual Länder, for example) and Europe.

Figure 36. **Interministerial research initiatives**



Source: Research for an Environmentally Sound, Reliable and Affordable Energy Supply, Sixth Energy Research Programme, BMWi.

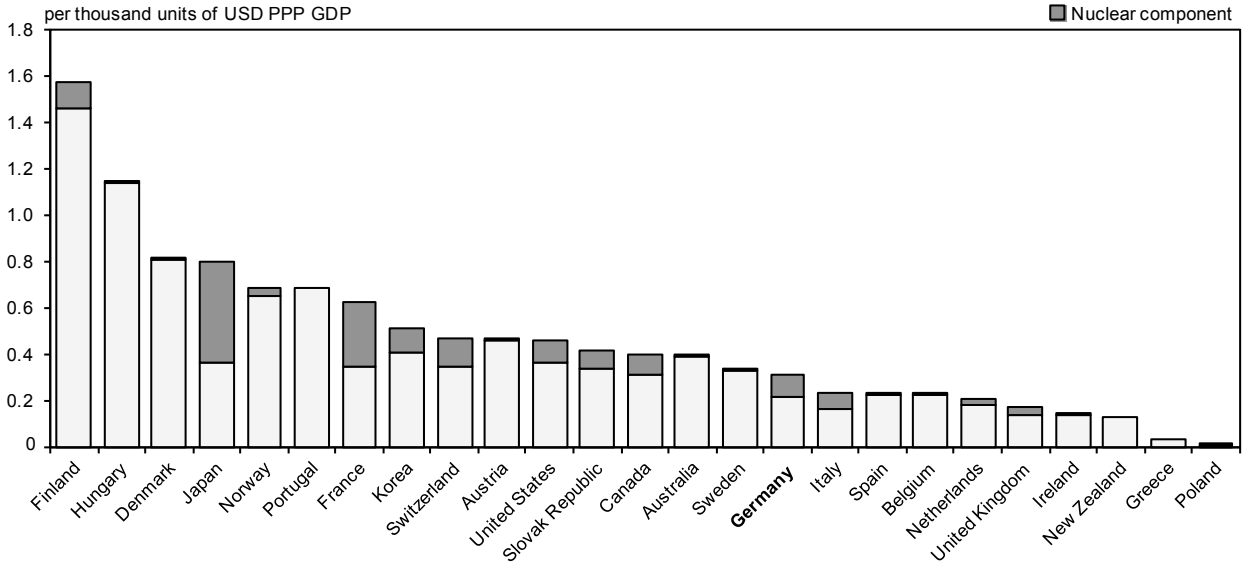
The Federal Ministry of Economics and Technology, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the Federal Ministry of Education and Research, are funding R&D in storage technologies with different priorities. They are thus laying the groundwork for a high-efficiency energy supply that is based predominantly on RES.

Since the three federal government ministries (Economics and Technology, Environment, Nature Conservation and Nuclear Safety and Education and Research) fund R&D on different aspects of the grid, close inter-ministerial co-operation can both maximise synergies and expedite urgently needed technological developments. There is an urgent need to invest now in expanding the electricity grids and adapt these to cope with a high proportion of renewable energy: intensive and co-ordinated co-operation between all stakeholders in this area is therefore vital. Given the pan-European nature of electricity grids in general, this will necessitate more intensive EU co-operation within the framework of the Strategic Energy Technology (SET) plan. The "Solar-Powered Buildings – Energy-Efficient Cities" joint funding initiative is focused on expanding and consolidating efforts in strategic areas.

Within the federal government's High-tech Strategy, these inter-ministerial funding initiatives play a major part in the implementation of the projects "Intelligent restructuring of energy supply" and "Carbon-neutral, energy-efficient and climate-adapted cities", which are aiming at the future of energy production, distribution and usage.

These projects will be executed in line with the particular technical responsibilities and competences of the relevant federal ministries. Implementation of the projects will require close co-ordination, sound co-operation and joint management of the research programme.

Figure 37. **Government RD&D budgets in IEA member countries, 2011**



Note: data not available for the Czech Republic, Luxemburg and Turkey.

Sources: *OECD Economic Outlook*, OECD Paris, 2012 and country submission.

INTERNATIONAL COLLABORATION

Within the European context, the federal government will support the efforts of German applicants to participate in and successfully implement the EU's Strategic Energy Technology (SET) plan. Germany places a priority on projects that have a clear European dimension, especially when it comes to research in the following areas: power grids, renewable energy, storage technology, energy efficiency, and CCS. Germany participates in 24 of the IEA multilateral technology initiatives (Implementing Agreements).

PRIVATE-SECTOR PARTICIPATION

Industry is a key actor notably in the area of application-oriented research funding. In many cases, industry is involved in collaborative projects with universities and research centres; in addition, it often provides private-sector funding for R&D activities. The government provides a maximum of 50% funding for projects run by commercial enterprises (a bonus can be granted to small- and medium-sized companies). Funding rates are determined in accordance with development risks and can, as a result, turn out to be lower than 50%.

According to data published in November 2010 by the *Stifterverband für die Deutsche Wissenschaft*, a business community-owned innovation agency for the German science system, the private sector spent roughly EUR 300 million on energy-related research in 2009. The *Stifterverband*'s figures are based on surveys by the Federal Statistical Office.

ASSESSMENT

In order to achieve its energy policy target, the possibilities provided by effective RD&D policy need to be fully explored. In this context, the federal government published the

new Energy Research Programme in August 2011 which promotes RD&D activities to achieve the policy targets in the Energy Concept 2010, with some adjustments enacted as part of the Energy Package in June 2011.

The main funding sources include the federal budget and the Energy and Climate Fund. The federal government has been increasing the budget to promote RD&D activities for energy technologies in the past decade and plans to increase it from EUR 1.9 billion over the period 2006 to 2009 to EUR 3.5 billion for the period 2011 to 2014 to achieve the goals set in the Energy Research Programme. This commitment by the federal government to further increase spending on energy RD&D is welcome.

Germany's performance in terms of energy-related RD&D expenditure expressed as a percentage of GDP is one of the lower group among the IEA member countries. This is partly because some key advanced technologies (battery, information and communications technology, solid-state material, etc.) are not grouped in the energy-related technologies in the federal government data system at present. Given the limited public resources for energy RD&D, the cost-effectiveness of the RD&D programme needs to be enhanced. The German government should improve RD&D data collection to review energy RD&D spending and ensure that they are efficiently allocated according to the energy policy priorities.

The federal government provides RD&D funding to a wide variety of technological areas while focusing on a few key priority areas. In general, Germany's energy RD&D funding is strongly linked to its overall energy policy goals. For example, renewables and energy efficiency are highly prioritised in the Energy Concept and these areas receive significant government RD&D funding.

The federal government has established a co-ordinating platform between the relevant ministries to efficiently allocate their financial resources. The new Energy Research Programme expands its role to include coordination with the Länder governments.

In 2011, the energy research information system was introduced to enhance transparency and to monitor progress in RD&D activities funded by the federal government. The first federal government's *Report on Energy Research* was published in 2012. The federal government is also actively involving the private sector by funding RD&D activities of industries to facilitate market deployment of new technologies. These measures will help improve the overall effectiveness of government funding.

Germany is making good progress in a wider range of key technological areas such as mechanical engineering, electrical and electronic engineering, chemical technologies, automobile industries etc. On the basis of these experiences, the IEA encourages the federal government to continue to have broader perspectives in various fields of technology and to expand its portfolio to meet long-term challenges. For example, fuel cell, hydrogen and alternatives to rare earth metals are possible areas that could be pursued in the future. Germany's steady and strong commitment to energy RD&D will benefit not only Germany, but the global energy sector.

Considering the increasing needs for new low-carbon technologies in future, the government, in co-operation with universities and other academic institutes, should accelerate education in the energy technology sectors. Participation in international co-operation programmes is an effective way to optimise RD&D spending. Germany is actively participating in such programmes bilaterally and multilaterally. Within the European context, the federal government supports the efforts of German applicants to participate in EU's Strategic Energy Technology plan. Germany is also strengthening its involvement in IEA activities.

RECOMMENDATIONS

The government of Germany should:

- *Continue to increase funding for RD&D to ensure that energy technology innovation will meet the challenges set out in the Energy Concept.*
- *Further strengthen the function of the co-ordination platform to effectively involve all stakeholders.*
- *Continue to assess its RD&D challenges and to adjust its RD&D portfolio as national energy policy priorities change.*
- *Continue efforts in energy education and training to meet future demands for researchers and engineers.*

PART IV
ANNEXES

ANNEX A: ORGANISATION OF THE REVIEW

REVIEW CRITERIA

The *Shared Goals,* which were adopted by the 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 presented in Annex C.

REVIEW PROCESS

The in-depth review team visited Berlin from 26 March to 30 March 2012. During the week-long visit, the review team met with government officials, representatives from ministries and government agencies, energy producers and suppliers, interest groups and various other organisations and stakeholders. This report was drafted on the basis of the information obtained in these meetings, the government response to the IEA energy policy questionnaire and other information from many sources. The team is grateful for the co-operation and hospitality of the many people it met during the visit. Thanks to their openness and candour, the review visit was highly productive.

In particular, the team wishes to express its gratitude to Mr. Stefan Kapferer, State Secretary at the Federal Ministry of Economics and Technology (BMWi), Mr. Detlef Dauke, Director General, Energy Policy, BMWi and Mr. Diethard Mager, Deputy Director General, Energy Policy, BMWi for their personal engagement with the review team and to their staff for providing the team with detailed briefing on energy policy in Germany.The IDR team also wishes to thank the Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) for their participation in the review visit and their support throughout the process. The willingness of all German participants to share information and their gracious hospitality contributed in no small way to a successful and productive visit.

The author is particularly thankful to Mr. Oliver Bornkamm, Deputy Head of Unit, (BMWi) for co-ordinating the team visit and his ongoing support throughout the drafting process and also Mr. Patrick Specht, Counsellor Energy and Trade, Permanent Mission of the Federal Republic of Germany to the OECD for his assistance and guidance throughout the process.

The members of the review team were:

- Team Leader – Ms Marie-Pierre Fauconnier, General Director, Ministry of Economic Affairs, Belgium and Chair of IEA Governing Board
- Ms Florence Tordjman, Assistant Director of Energy, General Directorate for Energy and Climate Change, Ministry of Economy, Finances and Industry, France
- Mr. Anders Højgaard Kristensen, Head of Electricity Transmission Division, Danish Energy Agency, Denmark

- Mr. Ed Stafford, Head of Gas Markets Policy, International Energy and Energy Security, Department of Energy and Climate Change, United Kingdom
- Mr. Lukas Gutzwiller, Senior Energy Policy Advisor, International Energy Affairs, Swiss Federal Office of Energy, Switzerland
- Mr. Dinko Raytchev, Economic Analyst, Energy Markets, Energy Policy & Monitoring of Electricity, Gas, Coal and Oil Markets, European Commission – DG Energy
- Mr. Ron Cameron, Head of Division, Nuclear Development, OECD Nuclear Energy Agency
- Mr. Laszlo Varro, Head of Gas, Coal & Power Markets Division, IEA
- Mr. Cedric Philibert, Senior Analyst, Renewable Energy Division, IEA
- Mr. Shinji Fujino, Head of Division, Country Studies Division, IEA
- Ms Lisa Ryan, Energy Economist, Energy Efficiency Unit, IEA
- Mr. Kieran McNamara, Desk Officer, Country Studies Division, IEA

The review was conducted under the direction of Mr. Ulrich Benterbusch, Director for Global Energy Policy, IEA. Kieran McNamara managed the review and is the author of the report with the exception of Chapter 3 on Energy Efficiency and Chapter 6 on oil, which were drafted jointly with Lisa Ryan and Andrew Robertson respectively. Sonja Lekovic prepared and drafted the sections relating to energy data contained in each chapter. Ulrich Benterbusch, Rebecca Gaghen, Kijune Kim, Paolo Frankl, Ron Cameron, Gabriele Gwinner, Douglas Cooke, Manuel Baritaud, Dennis Volk, Anne-Sophie Corbeau, Thijs van Hittersum, Carlos Fernández Alvarez, Christina Hood, Justine Garret, Sylvia Beyer, Sonja Lekovic, Simon Müeller and Cédric Philibert contributed helpful comments throughout.

Sonja Lekovic, Catherine Smith and Bertrand Sadin prepared the figures. Karen Treanton and Zakia Adam provided support on statistics. Muriel Custodio, Cheryl Haines, Astrid Dumond and Angela Gosmann managed the production process. Viviane Consoli provided editorial assistance while Catherine Smith and Sonja Lekovic helped in the final stages of preparation.

ANNEX B:
ENERGY BALANCES
AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY		1973	1990	2010	2011	2020	2030	2040
TOTAL PRODUCTION		**171.7**	**186.2**	**132.6**	**124.2**	**104.6**	**88.4**	**80.4**
Coal		141.4	121.7	45.1	46.5	33.8	14.0	4.6
Peat		-	0.1	-	-	-	-	-
Oil		6.9	4.7	3.3	3.5	1.8	0.6	-
Natural Gas		16.4	13.5	11.0	10.9	8.6	5.0	1.4
Biofuels & Waste[1]		2.5	4.8	29.6	26.7	35.5	43.7	43.7
Nuclear		3.2	39.8	36.6	28.2	8.2	-	-
Hydro		1.3	1.5	1.8	1.5	1.7	2.1	2.1
Wind		-	0.0	3.3	4.2	8.7	12.1	14.3
Geothermal		-	0.0	0.5	0.6	2.1	4.1	6.2
Solar/Other		-	0.0	1.5	2.2	4.3	6.8	8.1
TOTAL NET IMPORTS[2]		**164.1**	**160.3**	**193.8**	**188.5**	**161.9**	**128.3**	**104.7**
Coal	Exports	18.3	8.1	1.0	1.0	0.9	0.3	0.1
	Imports	15.2	11.5	32.8	32.7	23.3	12.3	10.0
	Net Imports	-3.1	3.4	31.8	31.7	22.4	12.0	9.8
Oil	Exports	9.8	10.1	18.6	18.3	13.0	7.1	3.0
	Imports	170.7	132.2	131.3	125.7	108.7	77.6	51.7
	Int'l Marine and Aviation Bunkers	-7.0	-7.0	-10.8	-10.5	-10.0	-9.9	-9.5
	Net Imports	153.9	115.1	101.8	96.9	85.6	60.6	39.3
Natural Gas	Exports	0.1	0.9	17.2	14.7	6.5	4.9	3.0
	Imports	12.4	42.7	78.8	75.1	60.3	53.6	40.4
	Net Imports	12.3	41.7	61.6	60.4	53.8	48.7	37.4
Electricity	Exports	0.7	2.6	5.0	4.7	3.3	2.0	1.4
	Imports	1.7	2.7	3.7	4.4	3.3	5.8	8.9
	Net Imports	1.0	0.1	-1.3	-0.3	0.0	3.8	7.5
TOTAL STOCK CHANGES		**-1.1**	**4.7**	**3.3**	**-1.0**	**-**	**-**	**-**
TOTAL SUPPLY (TPES)[3]		**334.7**	**351.1**	**329.8**	**311.8**	**266.5**	**216.7**	**185.1**
Coal		139.4	128.6	77.1	77.4	56.2	26.1	14.4
Peat		-	-	-	-	-	-	-
Oil		158.7	121.4	105.2	101.9	87.4	61.2	39.3
Natural Gas		28.6	55.0	75.8	69.6	62.4	53.7	38.9
Biofuels & Waste[1]		2.5	4.8	29.4	26.6	35.5	46.8	54.3
Nuclear		3.2	39.8	36.6	28.2	8.2	-	-
Hydro		1.3	1.5	1.8	1.5	1.7	2.1	2.1
Wind		-	0.0	3.3	4.2	8.7	12.1	14.3
Geothermal		-	0.0	0.5	0.6	2.1	4.1	6.2
Solar/Other[2]		-	0.0	1.4	2.2	4.3	6.8	8.1
Electricity Trade[4]		1.0	0.1	-1.3	-0.3	0.0	3.8	7.5
Shares (%)								
Coal		*41.6*	*36.6*	*23.4*	*24.8*	*21.1*	*12.0*	*7.8*
Peat		-	-	-	-	-	-	-
Oil		*47.4*	*34.6*	*31.9*	*32.7*	*32.8*	*28.2*	*21.2*
Natural Gas		*8.6*	*15.7*	*23.0*	*22.3*	*23.4*	*24.8*	*21.0*
Biofuels & Waste		*0.7*	*1.4*	*8.9*	*8.5*	*13.3*	*21.6*	*29.3*
Nuclear		*0.9*	*11.3*	*11.1*	*9.0*	*3.1*	-	-
Hydro		*0.4*	*0.4*	*0.5*	*0.5*	*0.6*	*1.0*	*1.1*
Wind		-	-	*1.0*	*1.3*	*3.3*	*5.6*	*7.7*
Geothermal		-	-	*0.2*	*0.2*	*0.8*	*1.9*	*3.3*
Solar/Other		-	-	*0.4*	*0.7*	*1.6*	*3.2*	*4.4*
Electricity Trade		*0.3*	-	*-0.4*	*-0.1*	-	*1.7*	*4.1*

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

Forecasts are based on the 2010/11 submission.

Unit: Mtoe

DEMAND							
FINAL CONSUMPTION	**1973**	**1990**	**2010**	**2011**	**2020**	**2030**	**2040**
TFC	**241.7**	**240.7**	**229.9**	**221.0**	**202.6**	**176.1**	**154.6**
Coal	55.7	39.2	7.4	8.2	7.5	4.8	3.5
Peat	-	-	-	-	-	-	-
Oil	133.3	111.2	94.7	92.0	80.2	55.7	35.1
Natural Gas	18.6	39.1	56.6	51.2	42.9	35.0	29.1
Biofuels & Waste[1]	1.7	3.0	13.5	13.7	19.3	28.5	35.4
Geothermal	-	0.0	0.5	0.6	1.0	2.0	2.7
Solar/Other	-	0.0	0.4	0.6	1.5	3.3	4.5
Electricity	26.9	39.1	45.5	44.9	40.8	39.2	38.3
Heat	5.5	9.1	11.3	10.0	9.4	7.7	6.0
Shares (%)							
Coal	*23.0*	*16.3*	*3.2*	*3.7*	*3.7*	*2.7*	*2.3*
Peat	-	-	-	-	-	-	-
Oil	*55.1*	*46.2*	*41.2*	*41.6*	*39.6*	*31.6*	*22.7*
Natural Gas	*7.7*	*16.2*	*24.6*	*23.2*	*21.2*	*19.9*	*18.8*
Biofuels & Waste	*0.7*	*1.2*	*5.9*	*6.2*	*9.5*	*16.2*	*22.9*
Geothermal	-	-	*0.2*	*0.3*	*0.5*	*1.2*	*1.8*
Solar/Other	-	-	*0.2*	*0.3*	*0.7*	*1.9*	*2.9*
Electricity	*11.1*	*16.3*	*19.8*	*20.3*	*20.1*	*22.2*	*24.8*
Heat	*2.3*	*3.8*	*4.9*	*4.5*	*4.6*	*4.4*	*3.9*
TOTAL INDUSTRY[5]	**105.5**	**89.1**	**78.8**	**78.8**	**72.6**	**63.6**	**57.9**
Coal	29.5	21.1	6.1	6.6	6.8	4.4	3.2
Peat	-	-	-	-	-	-	-
Oil	46.5	26.9	24.0	23.2	21.0	17.6	15.0
Natural Gas	12.5	19.3	21.5	21.3	18.6	16.4	16.0
Biofuels & Waste[1]	0.0	0.8	4.3	3.7	5.8	6.1	6.1
Geothermal	-	-	-	-	0.1	0.1	0.2
Solar/Other	-	-	-	-	-	-	-
Electricity	15.3	18.6	19.4	19.8	16.9	16.0	15.0
Heat	1.6	2.4	3.5	4.0	3.4	3.1	2.5
Shares (%)							
Coal	*28.0*	*23.7*	*7.7*	*8.4*	*9.4*	*6.8*	*5.5*
Peat	-	-	-	-	-	-	-
Oil	*44.1*	*30.2*	*30.4*	*29.5*	*28.8*	*27.6*	*25.8*
Natural Gas	*11.9*	*21.7*	*27.3*	*27.0*	*25.6*	*25.8*	*27.6*
Biofuels & Waste	-	*0.9*	*5.5*	*4.7*	*8.1*	*9.6*	*10.5*
Geothermal	-	-	-	-	*0.1*	*0.2*	*0.3*
Solar/Other	-	-	-	-	-	-	-
Electricity	*14.5*	*20.9*	*24.6*	*25.2*	*23.2*	*25.1*	*25.9*
Heat	*1.5*	*2.7*	*4.4*	*5.1*	*4.7*	*4.8*	*4.4*
TRANSPORT[3]	**36.1**	**54.4**	**53.7**	**54.2**	**50.3**	**44.4**	**37.6**
OTHER[6]	**100.1**	**97.2**	**97.5**	**88.1**	**79.7**	**68.1**	**59.2**
Coal	24.5	18.2	1.3	1.6	0.7	0.5	0.3
Peat	-	-	-	-	-	-	-
Oil	53.2	31.0	22.3	19.6	17.5	10.3	5.5
Natural Gas	6.1	19.8	34.3	29.2	23.2	16.6	11.2
Biofuels & Waste[1]	1.7	2.2	6.3	7.0	7.9	10.4	12.2
Geothermal	-	0.0	0.5	0.6	1.0	1.9	2.6
Solar/Other	-	0.0	0.4	0.6	1.5	3.3	4.5
Electricity	10.7	19.3	24.7	23.6	22.0	20.5	19.4
Heat	3.9	6.7	7.8	6.0	5.9	4.6	3.4
Shares (%)							
Coal	*24.4*	*18.7*	*1.3*	*1.8*	*0.9*	*0.7*	*0.6*
Peat	-	-	-	-	-	-	-
Natural Gas	*6.1*	*20.3*	*35.2*	*33.2*	*29.2*	*24.4*	*18.9*
Biofuels & Waste	*1.7*	*2.2*	*6.4*	*7.9*	*9.9*	*15.3*	*20.6*
Geothermal	-	-	*0.5*	*0.6*	*1.2*	*2.8*	*4.3*
Solar/Other	-	-	*0.5*	*0.6*	*1.9*	*4.8*	*7.7*
Electricity	*10.7*	*19.9*	*25.3*	*26.8*	*27.6*	*30.0*	*32.7*
Heat	*3.9*	*6.9*	*8.0*	*6.8*	*7.4*	*6.8*	*5.8*

Unit: Mtoe

DEMAND							
ENERGY TRANSFORMATION AND LOSSES	**1973**	**1990**	**2010**	**2011**	**2020**	**2030**	**2040**
ELECTRICITY GENERATION[7]							
INPUT (Mtoe)	**98.5**	**138.0**	**143.0**	**131.5**	**99.6**	**71.3**	**57.0**
OUTPUT (Mtoe)	**32.2**	**47.1**	**53.5**	**51.8**	**46.4**	**39.6**	**33.9**
(TWh gross)	374.4	547.7	622.0	602.4	539.9	461.0	394.3
Output Shares (%)							
Coal	*69.0*	*58.7*	*44.0*	*45.1*	*37.6*	*18.9*	*10.5*
Peat	-	-	-	-	-	-	-
Oil	*12.0*	*1.9*	*1.3*	*1.1*	..	..	..
Natural Gas	*10.9*	*7.4*	*14.0*	*13.9*	*18.1*	*22.6*	*13.6*
Biofuels & Waste	*0.8*	*0.9*	*6.4*	*7.3*	*9.9*	*13.3*	*16.1*
Nuclear	*3.2*	*27.8*	*22.6*	*17.9*	*5.8*	-	-
Hydro	*4.1*	*3.2*	*3.3*	*2.9*	*3.7*	*5.2*	*6.1*
Wind	-	-	*6.1*	*8.1*	*18.8*	*30.6*	*42.3*
Geothermal	-	-	-	-	*0.2*	*0.4*	*1.0*
Solar/Other	-	-	*2.4*	*3.7*	*5.9*	*9.0*	*10.5*
TOTAL LOSSES	**92.5**	**110.2**	**100.8**	**92.0**	**63.7**	**40.5**	**30.4**
of which:							
Electricity and Heat Generation[8]	59.9	80.2	77.2	68.5	43.0	23.3	16.5
Other Transformation	8.7	9.4	7.4	7.3	6.7	6.1	5.5
Own Use and Losses[9]	23.9	20.6	16.3	16.1	14.1	11.1	8.3
Statistical Differences	**0.5**	**0.2**	**-1.0**	**-1.2**	**0.1**	**0.1**	**0.1**
INDICATORS	**1973**	**1990**	**2010**	**2011**	**2020**	**2030**	**2040**
GDP (billion 2005 USD)	1491.80	2216.30	2959.10	3048.70	3214.46	3470.73	3769.80
Population (millions)	78.96	79.36	81.76	81.78	80.50	79.10	76.90
TPES/GDP[10]	0.22	0.16	0.11	0.10	0.08	0.06	0.05
Energy Production/TPES	0.51	0.53	0.40	0.40	0.39	0.41	0.43
Per Capita TPES[11]	4.24	4.42	4.03	3.81	3.31	2.74	2.41
Oil Supply/GDP[10]	0.11	0.06	0.04	0.03	0.03	0.02	0.01
TFC/GDP[10]	0.16	0.11	0.08	0.07	0.06	0.05	0.04
Per Capita TFC[11]	3.06	3.03	2.81	2.70	2.52	2.23	2.01
Energy-related CO_2 Emissions (Mt CO_2)[12]	1053.1	949.7	769.0	747.6	604.4	396.4	261.1
CO_2 Emissions from Bunkers (Mt CO_2)	21.4	21.1	32.7	31.7	30.3	30.0	28.7
GROWTH RATES (% per year)	**73-90**	**90-00**	**00-10**	**10-11**	**11-20**	**20-30**	**30-40**
TPES	0.3	-0.4	-0.2	-5.5	-1.7	-2.0	-1.6
Coal	-0.5	-4.1	-0.9	0.3	-3.5	-7.4	-5.7
Peat	-	-	-100.0	-	-	-	-
Oil	-1.6	0.3	-1.7	-3.1	-1.7	-3.5	-4.3
Natural Gas	3.9	2.7	0.5	-8.2	-1.2	-1.5	-3.2
Biofuels & Waste	3.9	5.1	14.1	-9.6	3.2	2.8	1.5
Nuclear	16.1	1.0	-1.9	-23.1	-12.8	-100.0	-
Hydro	0.8	2.2	-0.6	-15.5	1.6	1.8	-0.0
Wind	-	63.2	15.0	29.4	8.4	3.3	1.7
Geothermal	-	33.2	15.7	10.4	15.3	6.8	4.3
Solar/Other	-	30.2	29.2	53.0	7.6	4.8	1.7
TFC	-0.0	-0.4	-0.1	-3.9	-1.0	-1.4	-1.3
Electricity Consumption	2.2	0.6	0.9	-1.4	-1.0	-0.4	-0.2
Energy Production	0.5	-3.1	-0.2	-6.4	-1.9	-1.7	-0.9
Net Oil Imports	-1.7	0.3	-1.5	-4.9	-1.4	-3.4	-4.2
GDP	2.4	1.9	1.0	3.0	0.6	0.8	0.8
Growth in the TPES/GDP Ratio	-2.0	-2.3	-1.2	-8.1	-2.3	-2.9	-2.3
Growth in the TFC/GDP Ratio	-2.3	-2.3	-1.0	-7.7	-1.5	-2.1	-2.2

Footnotes to energy balances and key statistical data

1. Biofuels and waste comprises solid biofuels, liquid biofuels, biogases, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
2. In addition to coal, oil, natural gas and electricity, total net imports also include peat, biofuels and waste and trade of heat.
3. Excludes international marine bunkers and international aviation bunkers.
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 includes residential, commercial, public services, agriculture, forestry, fishing and other non-specified.
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 shown based on plant efficiencies of approximately 33% for nuclear, 10% for geothermal and 100% for hydro, wind and photovoltaic.
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 2005 prices and exchange rates.
11. Toe per person.
12. "Energy-related CO_2 emissions" have been estimated using the IPCC Tier I Sectoral Approach from the Revised 1996 IPCC Guidelines. 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 2010 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.

ANNEX C: INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

The member countries* of the 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 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 the meeting of 4 June 1993 Paris, France.)

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

ANNEX D: GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations and acronyms are substituted for a number of terms used within the IEA. While these terms generally have been written out on first mention, this glossary provides a quick and central reference for many of the abbreviations used.

ACER	Agency for the Cooperation of Energy Regulators
BAFA	Federal Office of Economics and Export control (*Bundesamt für Wirtschaft und Ausfuhrkontrolle*)
bcm	billion cubic metres
b/d	barrels per day
BfS	Federal Office for Radiation Protection (*Bundesamt für Strahlenschutz*)
BGR	Institute for Geosciences and Natural Resources (*Bundesamt für Geowissenschaften und Rohstoffe*)
BMBF	Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung*)
BMELV	Federal Ministry for Food, Agriculture and Consumer Protection (*Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz*)
BMF	Federal Ministry of Finance (*Bundesministerium der Finanzen*)
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit*)
BMBVS	Federal Ministry for Transport, Building and Urban Development (*Bundesministerium für Verkehr, Bau und Stadtentwicklung*)
BMWi	Federal Ministry of Economics and Technology (*Bundesministerium für Wirtschaft und Technologie*)
BNetzA	Federal Network Agency (*Bundesnetzagentur*)
BKartA	Federal Cartel Office *(Bundeskartellamt)*
CCGT	combined-cycle gas turbine
CCS	carbon capture and storage
CHP	combined heat and power production
DENA	German Energy Agency (*Deutsche Energie-Agentur*)
DSO	distribution system operator
EEG	Renewable Energy Sources Act (*Erneuerbare-Energien-Gesetz*)
EEX	European Energy Exchange

ETSO	European Transmission System Operators
EU-ETS	European Union Emissions Trading Scheme
EWI	Institute of Energy Economics (University of Cologne)
FIT	feed-in tariff
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
kb/d	thousand barrels per day
KfW	Bank for Reconstruction (*Kreditanstalt für Wiederaufbau*)
kt	thousand tonnes
Länder	regions of Germany (16 in total); singular is *Land*
LNG	liquefied natural gas
LPG	liquefied petroleum gas
LULUCF	land use, land-use change and forestry
mcm	million cubic metres
MEPS	minimum energy performance standards
Mtce	million tonnes of coal-equivalent
Mtoe	million tonnes of oil equivalent; see "toe"
NEEAP	National Energy Efficiency Action Plan
NESO	National Emergency Sharing Organisation
NREAP	National Renewable Energy Action Plan
NPP	nuclear power plant
PPP	purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies, *i.e.* estimates the differences in price levels between different countries
PV	photovoltaics
R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well
RES	renewable energy sources
SME	small and medium-sized enterprises
Stadtwerke	municipal utilities
TFC	total final consumption of energy
toe	tonne of oil-equivalent, defined as 10^7 kcal
TPES	total primary energy supply
TSO	transmission system operator
UNFCCC	United Nations Framework Convention on Climate Change

International Energy Agency

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