



Mission-oriented R&I policies: In-depth case studies

Case Study Report

Energiewende

Hanna Kuittinen, Daniela Velte
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Research and
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Mission-oriented R&I policies: In-depth case studies

European Commission
Directorate-General for Research and Innovation
Directorate A – Policy Development and coordination
Unit A6 – Open Data Policy and Science Cloud
Contact Arnold Weiszenbacher
E-mail arnold.weiszenbacher@ec.europa.eu
RTD-RISE@ec.europa.eu
RTD-PUBLICATIONS@ec.europa.eu
European Commission
B-1049 Brussels

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Case Study Report: Energiewende

Hanna Kuittinen

Daniela Velte



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1 Summary of the case study

Summary fiche	
Title:	Energiewende (Energy transition)
Country:	Germany
Thematic area:	Energy, climate change
Objective(s):	The goal of the initiative is to phase out Germany's nuclear power plants by the end of 2022, transform the energy system to become strongly reliant on renewable energy resources (min. 60% of the final energy consumption, min. 80% of the gross electricity consumption) and enhanced energy efficiency, and to reduce GHG emissions by 80-95% by the year 2050.
Main governing body:	The Federal Ministry for Economic Affairs and Energy
Timeline:	2010-ongoing
Budget:	Energiewende's total budget is not directly available. An estimation of annual budget can be made based on the annual budget outlay of the Ministry for Economic Affairs and Energy dedicated to Energy and Sustainability and specific Fund for Climate and Energy totalling EUR 5.8 billion in 2016. In addition, several other Federal Ministries (approximately EUR 800 million in 2016) and German Development Bank contribute by offering low-cost finance for investments related to renewable energy and energy-efficiency.
Brief description of the case (250 words)	The Energiewende is a national long-term strategy for the development of a low-carbon energy system based on renewable energy and energy efficiency. The national initiative is an integrated policy that addresses all sectors of the economy and is framed by two key policy documents, namely the Renewable Energy Act (EEA) in 2000 and the Energiekonzept (Energy Concept) strategy in 2010. Energiewende is driven by four objectives: fighting climate change (through a reduction of CO ₂ emissions), phasing-out nuclear power, improving energy security (through a reduction of fossil-fuel imports) and guaranteeing industrial competitiveness and growth (through industrial policies targeting technological, industrial, and employment development). The goal of the initiative is to phase out Germany's nuclear power plants by the end of 2022, and the transition of the energy system to become strongly reliant on renewable energy resources by the year 2050. The Energiewende's success depends on the technological innovations realised through research and development activities. In its 6th Energy Research Programme, the German Federal Government outlined the principles and focus of its funding policy. It envisages concentrating funding to an even greater extent on those technologies that could contribute to the objectives of Energiewende.
Implementation and organisation (a brief description of the governance and policy instruments used)	The initiative is coordinated by the Federal Ministry for Economic Affairs and Energy, in strong interactions with German regions (Länder) and other stakeholders. The initiative has established five dedicated platforms for continuous dialogue with stakeholders. The policy has two main pillars: Renewable energies and Energy efficiency, which are supported by a dedicated energy R&D policy, Market and system integration and the European energy and climate policy. The policy measures comprise large variety of legal and regulatory measures and funding programmes.
Observed / expected outputs, outcomes, and impacts	<p>Outputs:</p> <p>Energiewende has stimulated significant private investments (the latest figures available are for 2015).</p> <ul style="list-style-type: none"> • EUR 36.4 billion in residential building energy retrofits and EUR 16.8 billion in non-residential buildings. • EUR 15 billion were invested in the renewable energy installations. EUR 5.9 billion were invested in the construction of new infrastructure and in grid reinforcement. <p>Outcomes:</p> <ul style="list-style-type: none"> • Energiewende has shown important progress towards the goals set. • Today almost one third (27%) of German electricity is generated

	<p>from renewable energy sources, making it number one source of electricity.</p> <ul style="list-style-type: none"> • The nuclear phase-out plan is also progressing as planned. • The GHG emission target 2020 is not likely to be met. Simultaneous phase-out of nuclear energy and growing energy demand has led to unchanged levels (same level as 1990) of energy generation from gas, coal and lignite leading to a slower decrease in GHG emission levels. • The progress towards energy-efficiency targets has been positive but moderate.
	<p>Impacts:</p> <ul style="list-style-type: none"> • Creation of globally competitive RE research and technology capacities and industry. • Value added: Direct value added from renewables is expected to grow in Germany, and scenarios have estimated the value added to rise from EUR 18 billion in 2012 to approximately EUR 25 billion in 2030 (depending on the installation rates). • Jobs: The impact of energy transition on employment is positive, with a yearly net increase of 18 000 jobs up to 2020, when compared to a scenario without the Energiewende. Currently, the German renewable energy sector comprises 334 000 jobs. • Exports: In 2015 the export ratios reached 70% for PV; 66% for wind, 50% of biodiesel and 66% of heat pumps produced in Germany were consigned for export. • Behavioural changes: The transition is co-owned and positively assessed by the German citizens, and a large majority is in favour of Energiewende.

Assessment of the main elements of mission-oriented R&I initiative¹

Directionality (links to societal challenges, industry transformation):	Yes. Energiewende is a long-term strategy aimed at transforming the German energy sector towards low-carbon energy system based on developing renewable energy and improving energy efficiency.
Intentionality (specific, well-articulated goals):	Yes. The goals are well-structured and articulated.
Clearly set timeline and milestones:	Yes. Energiewende has a very detailed target architecture, final goal set to 2050, with intermediate milestones in 2020, 2030 and 2040.
Mobilises public and private investments:	Yes. Although the Energiewende is primarily led by public policy and supported by the corresponding public funding, private investments have a large role. The state-owned development bank KfW has played a key role providing funding and low interest loans.
Focused on new knowledge creation (basic research, TRLs 1-4):	To certain degree. The 6 th Energy Research Programme also involves funding for basic research projects. Basic research is the responsibility of the Ministry of Education and Science, but represents only a small portion of the total funding of energy research supporting the transition.
Focused on knowledge application (applied research, TRLs 5-9):	Yes. The major part of the 6th Energy Research Programme is dedicated to applied research, development and demonstration activities.
Demand articulation (involves instruments for inducing demand):	Yes. The demand articulation is among the key building blocks of the Energiewende, and many policy measures are implemented to support the uptake of renewable energies and energy efficiency.
Multi-disciplinary (inter-disciplinary and/or trans-disciplinary):	Yes. The initiative mobilises many economic sectors and involves different technologies to achieve the transition towards an energy system relying on renewable energy sources and enhanced energy efficiency.
Joint coordination (multi-level and/or horizontal governance of policies/finance):	Yes. The initiative is jointly coordinated by the German Federal State and the 16 German regions (Länder). The coordination of the Energiewende is centralised to the Ministry for Economic Affairs and Energy, but many other ministries and public administrative bodies are involved in the design and implementation of the initiative.
Reflexivity (flexible policy	Yes. The progress towards the targets set is monitored on an annual

¹ Assessment: Yes, To certain degree, No or Not known.

design, timely monitoring):	basis and the Energiewende has been a gradual process, taking into account the changing conditions. Several adjustments have been made, especially to the renewable energy targets and feed-in tariffs after positive progress was made.
Openness (connected to international agenda and networks):	Yes. Energiewende is aligned and contributing towards the Paris climate agreement, UN Sustainable Development Goals and European energy and climate policies.
Involvement of citizens:	Yes. Citizens can be considered as initiators of the Energiewende by demonstrating strong opinion against the nuclear power. Citizens are also co-owners and co-payers of the energy transition. The initially very generous feed-in tariff system encouraged citizens to become energy producers, and it has been estimated that close to half of the renewable energy installations of the country are owned by farmers, small energy cooperatives and households. The feed-in tariffs are however paid by electricity consumers (EEG surcharge) and the average electricity bill of a German household has increased 50% over the last two decades.

2 Context and objectives of the initiative

2.1 Origins of initiative and the main contextual factors

A brief history of Energiewende

There is no official starting date for the Energiewende, but rather it is a continuous and gradual process of transition of the energy system. The Energiewende can be seen as a series of federal laws that build on each other, each one adapting to current realities while maintaining the focus on the long-term vision of transforming the German energy system into one of the most energy-efficient and sustainable economies of the world.

Although the German Energiewende is commonly associated with the country's post-Fukushima national energy policy, the notion of energy transition and the term "Energiewende" (can be translated as energy transition), dates back to nuclear opponents in the 1970s aiming to demonstrate alternative energy scenarios. It can be said that the initiative relies on the public opposition to nuclear power, but is also linked to the international agenda on sustainable development and mitigation of climate change. Although the Energiekonzept (2010) can be considered the guiding strategy of Energiewende, the development has been a gradual process²:

- The German energy-mix was traditionally based on hard coal and lignite, and Germany was very dependent on gas and petroleum imports. The domestic petroleum-based fossil fuel resources are very limited, and Germany imports almost all of its oil. Over the past thirty years, the country has had an oil import dependence of between 95% and 97%³. The dependence on gas imports has increased from 65% in the 1960s to nearly 90% in recent years⁴. The German coal reserves, on the other hand, are extensive. Germany has been among the largest coal producers in the

² Compiled from: Agora Energiewende (2015) Understanding the Energiewende. Available: https://www.agoraenergiewende.de/fileadmin/Projekte/2015/Understanding_the_EW/Agora_Understanding_the_Energiewende.pdf; Morris, C. and Pehnt, M. (2016) The German Energiewende Book. The Global Energiewende. Available: <https://book.energytransition.org/timeline-energiewende>; Ecologic (2016) Understanding the Energy Transition in Germany. Available: https://www.ecologic.eu/sites/files/publication/2016/ew_booklet_1.2_0.pdf; Hockenos, P. (2015) Energiewende – the first four decades. Clean Energy Wire, June 2015. Available: <https://www.cleanenergywire.org/dossiers/history-energiewende>

³ Jurca, A. M. (2015) The Energiewende: Germany's Transition to an Economy Fueled by Renewables. Available: <https://gielr.files.wordpress.com/2015/03/jurca-27-1-final.pdf>

⁴ Amelang, S. (2016) Germany's dependence on imported fossil fuels. Clean Energy Wire, February 2016. Available: <https://www.cleanenergywire.org/factsheets/germanys-dependence-imported-fossil-fuels>

world and still produced 176 Mt of coal in 2016⁵, and the country remains by far the largest producer of lignite in Europe⁶. Coal was crucial for Germany's post-war reconstruction and for the welfare of several regions. In the 1960s, the coal industry employed up to 600 000 people, compared to 19 852 workers in 2016⁷.

- Despite opposition, **a programme to develop nuclear energy was launched in West Germany in the 1950s**, and it gained political momentum during the oil crisis in the 1970s when the reliability of supply and energy independence became more important topics⁸.
- In the 1970s and 80s, a fierce **anti-nuclear protest movement** blocked development at potential reactor sites resulting in the cancellation of several planned nuclear plants⁹. The **accident at the Chernobyl nuclear power plant in 1986** amplified the already heated debate. The political response was instantaneous and no new reactors were constructed in Germany after the accident.
- At the end of the 1980s, the **need to tackle climate change** emerged on the political agendas. One important milestone was the publication of a book titled: *Energie-Wende: Growth and Prosperity Without Oil and Uranium (Energie-Wende – Wachstum und Wohlstand ohne Erdöl und Uran)*¹⁰. The book was written by researchers of the Institute for Applied Ecology, located in Freiburg. It presented opportunities of how economic development can be decoupled from energy production and consumption, and the authors looked at different options for energy transition based on a phase-out of conventional energy sources (oil and nuclear)¹¹. The authors have been commonly referred to as introducers of the term 'Energiewende'.
- In March 1987, Chancellor Helmut Kohl stated that climate change was one of the most important environmental challenges¹², and Germany committed itself to **reduce its GHG emissions by 21% between 1990 and 2008** under the Kyoto Protocol.
- In 1991, Germany established the first **feed-in tariff for renewable energy**¹³, which obliged energy utilities to purchase renewable energy from third-party producers at a fixed price, in order to make renewable energy sources more attractive to investors.
- In autumn 1998 elections, Germans voted in favour of a coalition run by Social Democrats and Greens, putting the conservative party out of power after 16 years of government¹⁴. This coalition made the "ecological modernisation" their main priority. Major energy policy changes were introduced in the 2000s.

⁵ IEA (2017) Coal information: Overview. Available :

<https://www.iea.org/publications/freepublications/publication/CoalInformation2017Overview.pdf>

⁶ European Association for Coal and Lignite (Euracoal) (2017) Euracoal Statistics. Available : <https://euracoal.eu/info/euracoal-eu-statistics/>

⁷ Bundesverband Braunkohle (DEBRIV) Lignite 2016. Available: <https://braunkohle.de/3-1-Lignite-2016.html>

⁸ Hake, J.-F., Fischer, W., Venghaus, S. and Weckenbrock, C. (2015) The German Energiewende: History and status quo, *Energy* 92 (2015) 532e546.

⁹ Wettengel, J. (2017) A (very) brief timeline of Germany's Energiewende. *Clean Energy Wire*, April 2017. Available: <https://www.cleanenergywire.org/factsheets/very-brief-timeline-germanys-energiewende>

¹⁰ Hockenos, P. (2015) Milestones of the German Energiewende. *Clean Energy Wire*, June 2015. Available: <https://www.cleanenergywire.org/factsheets/milestones-german-energiewende>

¹¹ Jurca, A. M. (2015) The Energiewende: Germany's Transition to an Economy Fueled by Renewables. Available: <https://gielr.files.wordpress.com/2015/03/jurca-27-1-final.pdf>

¹² Morris, C. and Pehnt, M. (2016) The German Energiewende Book. *The Global Energiewende*. Available: <https://book.energytransition.org/timeline-energiewende>

¹³ Appunn, K. (2014) Defining feature of the Renewable Energy Act (EEG). *Clean Energy Wire*, October 2014. Available: <https://www.cleanenergywire.org/factsheets/defining-features-renewable-energy-act-eeeg>

¹⁴ Hockenos, P. (2015) Milestones of the German Energiewende. *Clean Energy Wire*, June 2015. Available: <https://www.cleanenergywire.org/factsheets/milestones-german-energiewende>

- Among the first initiatives, this coalition passed the **Renewable Energy Act (EEG)** promoting investments on renewable energies, and the **first law on nuclear phase-out in agreement with the energy utilities**¹⁵. The nuclear phase-out plan, however, did not set an exact timetable for the closure of the nuclear plants, but allocated electricity production limitations for each plant. The EEG implemented a fixed feed-in tariff for renewables, paid by means of a surcharge on consumption, creating a reliable market to support greater investment and participation in renewable energy generation.
- In 2010, the newly-elected conservative government led by Chancellor Angela Merkel adopted the **Energiekonzept**¹⁶, a long-term energy strategy calling for a renewable-based economy by 2050. It included ambitious mid and long-term targets for the development of renewable energy, improving energy efficiency, and reducing CO₂ emissions. The strategy, however, extended the lifetime of existing nuclear power plants, thus delaying the nuclear phase-out until 2036.
- In 2011, immediately after the nuclear accident at Fukushima, the German government passed the law on **nuclear phase-out by 2022**¹⁷.
- In 2014, the new **Renewable Energy Act EEG 2.0**¹⁸ introduces measures to manage the growth and competitiveness of renewable energy. Reducing fixed tariffs, creating auctions for most solar producers, recalculating the surcharge to assist large industry, and forcing self-suppliers to pay a surcharge are among the most consequential reforms.
- The **amendment made in 2017 to the Renewable Energy Act**¹⁹ moves from fixed feed-in tariffs to auction-based determination of renewable electricity prices. It also aims to ensure that the pace at which renewable capacity is added corresponds to the pace at which the grids are developed and it restricts the expansion of onshore wind power in certain areas of northern Germany that suffer grid congestion. In addition, the 2017 act also introduces an instrument designed to make use of electricity that is otherwise curtailed.
- Today, the Energiewende **enjoys support across German political parties and among citizens**. Since 2000, four different political parties have been in power, which have formed three distinct governing coalitions and all have supported the Energiewende²⁰. The consensus is not limited to politicians: 90% of German citizens believe the Energiewende vital to the country's future²¹.

¹⁵ Appunn, K. The history behind Germany's nuclear phase-out. Clean Energy Wire, July 2015. <https://www.cleanenergywire.org/factsheets/history-behind-germanys-nuclear-phase-out>

¹⁶ The Federal Ministry for Technology and Economy and The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010) Energy Concept for an Environmentally Sound, Reliable and Affordable Energy Supply. Available: https://www.bmwi.de/Redaktion/DE/Downloads/E/energiekonzept-2010.pdf?__blob=publicationFile&v=3

¹⁷ Appunn, K. The history behind Germany's nuclear phase-out. Clean Energy Wire, July 2015. Available: <https://www.cleanenergywire.org/factsheets/history-behind-germanys-nuclear-phase-out>

¹⁸ The Federal Ministry for Economic Affairs and Energy (2014) Act on the Development of Renewable Energy Sources (Renewable Energy Sources Act - RES Act 2014). Available: <http://www.bmwi.de/Redaktion/EN/Downloads/renewable-energy-sources-act-eeg-2014.html>

¹⁹ Federal Ministry for Economic Affairs and Energy (2017) The next phase of the energy transition: The 2017 Renewable Energy Sources Act. Available : <https://www.bmwi.de/Redaktion/EN/Artikel/Energy/eeg-2017.html>

²⁰ Ecologic (2016) Understanding the Energy Transition in Germany. Available: https://www.ecologic.eu/sites/files/publication/2016/ew_booklet_1.2_0.pdf

²¹ Ibid.

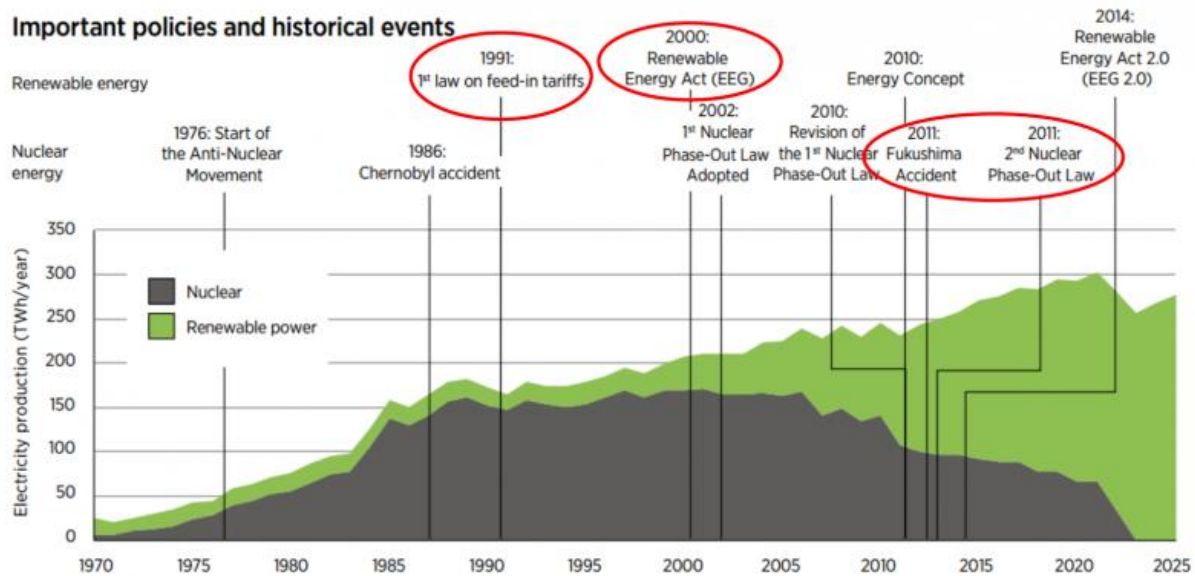


Figure 1: Important policies and historical events of Energiewende and the increasing electricity generation from renewable energy sources, 1970-2025. Source: Resilience, 2017²² and National Observer, 2017²³ (original IRENA).

Key contextual drivers of Energiewende

Ensuring a reliable, economical and environmentally sound **energy supply** is one of the greatest challenges of the 21st century and this objective is the main driving force of the Energiewende: “a central political goal for our energy system of the future: Germany should be one of the most energy-efficient and environmentally friendly economies in the world, with competitive energy prices and a high level of prosperity²⁴.” Thus, the main drivers of the Energiewende are **climate protection** and **environmental sustainability**, as well as the **reduction of energy imports, high-tech development, and economic growth**. By diversifying its energy sources, the country aims at minimising its dependence on external energy imports and getting a head start on research, development and deployment of future energy systems in order to secure its share in a growing global market for renewable energy and energy efficiency technologies. The main factors driving the energy transition are²⁵:

- The risks related to nuclear energy, illustrated by the disasters at Chernobyl (1986) and Fukushima (2011). In addition, there are concerns related to the safety of nuclear waste storage;
- The use of conventional energy sources (coal, oil, and gas) is associated to greenhouse gas emissions, the main drivers of climate change. The supply for conventional energy sources is limited, and their scarcity is reflected in energy prices, making a system based on a fossil-fuels also economically unsustainable;
- While much of the conventional energy (specifically oil, gas, uranium, and coal), must be imported, a large part of renewable energies can be produced domestically, thus

²² Jungiohann, A. and Morris, C. (2017) Germany shows it's worth fighting for Energy Democracy. Resilience, June 2017. Available: <http://www.resilience.org/stories/2017-06-22/germany-shows-its-worth-fighting-for-energy-democracy/>

²³ McSheffrey, E. (2017) Step one, get fossil fuel money out of politics, German analyst tells Ottawa. National Observer, May 2017. Available: <https://www.nationalobserver.com/2017/05/23/news/step-one-get-fossil-fuel-money-out-politics-german-analyst-tells-ottawa>

²⁴ The Federal Ministry for Economic Affairs and Energy (2010) Energy Concept for an Environmentally Sound, Reliable and Affordable Energy Supply, 28. September 2010.

²⁵ Agora Energiewende (2017) Germany's Clean Energy Transition - What is the Energiewende? Available: <https://www.agora-energiewende.de/en/die-energiewende/introduction/>

creating and increasing local jobs and value added, and at the same time that it reduces Germany's dependence on energy imports.

As shown in the previous section, the Energiewende dates back over three decades and has evolved from grassroots environmental activism to a politically-steered process. Several changes in the political and social power constellations, as well as endogenous policy measures and exogenous events, have shaped the process.

	Drivers	Barriers/challenges
Political	<ul style="list-style-type: none"> • Strong public and political consensus on Energiewende's targets. • International climate change mitigation agenda. 	<ul style="list-style-type: none"> • Multi-level governance (Federal State and German Länder) may lead to ineffective decision-making processes.
Economic	<ul style="list-style-type: none"> • Dependence on energy imports. • Scarcity and prices of conventional energy sources. • Creation of new domestic industry. • Decentralised ownership of the energy system (consumers as energy producers). 	<ul style="list-style-type: none"> • Overall costs of the energy transition. • A rapid increase in electricity prices due to the EEG surcharge for renewable energies. • Nuclear and coal phase out has also destroyed jobs in the conventional energy sector.
Societal	<ul style="list-style-type: none"> • Anti-nuclear movement since 1970s. • Climate change concerns. • Strong public support to the targets of the energy transition. 	<ul style="list-style-type: none"> • The elevated electricity prices may eventually erode public support.
Technological	<ul style="list-style-type: none"> • Technological leadership and pioneering work in renewable energy technologies. 	<ul style="list-style-type: none"> • Grid infrastructure capacity and digitalisation of energy transmission. • Energy storage technologies.
Legal	<ul style="list-style-type: none"> • Nuclear phase out law. • European directives and regulation related to climate and energy. 	

Table 1 : Drivers and barriers/challenges.

2.2 Strategic and operative objectives and milestones of the initiative

The political objective of the Energiewende is articulated in the Energiekonzept strategy as follows:

"Germany is to become one of the most energy-efficient and greenest economies in the world while enjoying competitive energy prices and a high level of prosperity. At the same time, a high standard of supply security, effective environmental and climate protection and economically viable energy provision are necessary for Germany to remain a competitive industrial base in the long term."²⁶

The strategy sets the following fields of action:

- A. Renewable energies as a cornerstone of future energy supply;
- B. Energy efficiency as the key factor;
- C. Nuclear power and fossil-fuel power plants;
- D. An efficient grid infrastructure for electricity and integration of renewables;

²⁶ The Federal Ministry for Technology and Economy and The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010) Energy Concept for an Environmentally Sound, Reliable and Affordable Energy Supply. Available: https://www.bmwi.de/Redaktion/DE/Downloads/E/energiekonzept-2010.pdf?__blob=publicationFile&v=3

- E. Energy upgrades for buildings and energy-efficient new buildings;
- F. The mobility challenge;
- G. Energy research towards innovation and new technologies;
- H. Transparency and acceptance.

The targets of each action line have been revised several times since the original launch of the strategy (e.g. nuclear phase-out target year, renewable energy milestones and targets after good progress made), and the current operational targets (see also the table below) of the initiative are to **phase out Germany's nuclear power plants by the end of 2022**, to transform the energy system to become **strongly reliant on renewable energy resources** and **efficient use of energy by the year 2050**. The main sources of energy will then be wind power, solar energy, hydropower, biomass and geothermal energy (min. 60% of the final energy consumption, min. 80% of the gross electricity consumption), and the primary energy consumption is expected to decrease by 50% compared to 2008. These targets are expected to lead **a reduction of greenhouse gas emissions by 80-95%** and simultaneously guaranteeing the competitiveness and growth of German economy.

		Status quo	2020	2025	2030	2035	2040	2050
Greenhouse gas emissions	Reduction of GHG emissions in all sectors compared to 1990 levels	-27% (2016)*	-40%		-55%		-70%	-80 – 95%
Nuclear phase-out	Gradual shut down of all nuclear power plants by 2022	11 units shut down (2015)	Gradual shut down of remaining 8 reactors					
Renewable energies	Share in final energy consumption	14.9% (2015)	18%		30%		45%	min. 60%
	Share in gross electricity consumption	32.3% (2016)*		40 – 45%		55 – 60%		min. 80%
Energy efficiency	Reduction of primary energy consumption compared to 2008 levels	-7.6% (2015)*	-20%					-50%
	Reduction of gross electricity consumption compared to 2008 levels	-4% (2015)*	-10%					-25%

Figure 2: Key targets of Energiewende. *preliminary results. Source: Agora, 2017²⁷.

3 Resources and management

3.1 Governance and management model

The Energiewende is a joint initiative of the German Federal State and the 16 German regions (Länder) and is coordinated by the Ministry for Economic Affairs and Energy. The coordination was less centralised until 2014 when the responsibilities for the field of

²⁷Agora Energiewende (2017) 10 Q&A on the German Energiewende. Available: https://www.renewable-ei.org/en/images/pdf/20170303/REI_Report_20170303_10FAQ_GermanyEnergiewende_EN.PDF

energy policy were pooled in the new Federal Ministry for Economic Affairs and Energy²⁸. The governance of the initiative, however, involves all levels of government, including several ministries and public administrative bodies, as well as the business community and society in general.

The Energiewende is strongly embedded in the regional level. The Federal Government and the Länder are coordinating the implementation of the energy transition on a continuous basis²⁹. Every half-year, meetings take place between the Federal Chancellor and the Federal Economic Affairs Minister with the presidents of the Länder in order to discuss the status of the energy reforms. The Ministers of the Federal Government and their counterparts in the Länder furthermore consult with each other at the biannual Economic Affairs Ministers Conference on their priorities and the next steps in the energy transition.

The Federal Ministry for Economic Affairs and Energy coordinates also the dialogue with other relevant stakeholders. This is expected to create a high level of transparency, contributing towards greater public acceptance of the energy transition. The Ministry is constantly exchanging information with representatives from business and industry, society, science and research in the energy transition platforms. The five energy transition platforms (Energy Grids, Electricity market, Energy efficiency, Buildings, and Research and innovation) are the central tools for dialogue and stakeholder consultation.

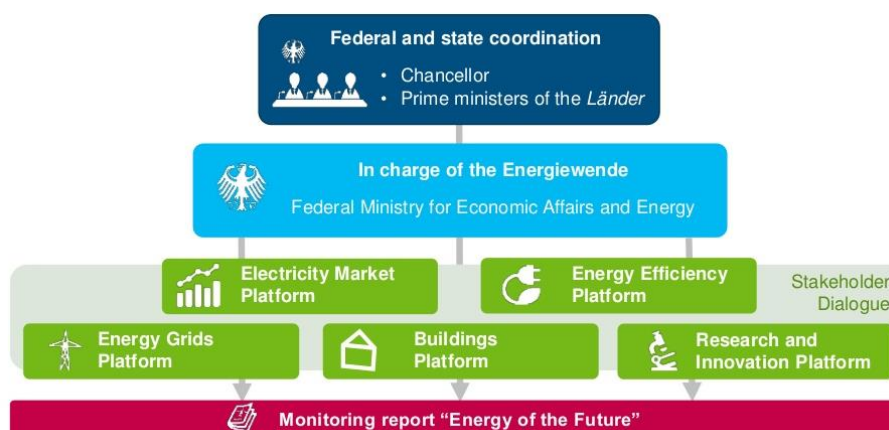


Figure 3: The coordination structure of the Energiewende. Source: The Federal Ministry for Economic Affairs and Energy and Deutsche Energie-Agentur, 2015³⁰.

It has been however argued³¹ that the steering of the initiative is not entirely coherent, and the shared responsibilities among different vertical and horizontal jurisdictions may result in unclear and ineffective decision-making processes. Also, although the policy enjoys political support cross the political parties in Germany, the parties have also presented their own energy policy proposals that may lead to conflicts of interests in future steering of the Energiewende. Similarly, the multi-level governance and the German regions having powers in matters closely related to Energiewende and this can lead the regions to head into different directions and undermine the federal coordination.

²⁸ The Federal Ministry for Economic Affairs and Energy (2017) Ready for the next phase of the energy transition. Available: <http://www.bmwi.de/Redaktion/EN/Dossier/energy-transition.html>

²⁹ Ibid.

³⁰ The Federal Ministry for Economic Affairs and Energy and Deutsche Energie-Agentur (2015) Germany's renewable energy sector in the context of energy transition. Presentation by Marc Uhlig, July 2015. Available: <https://www.slideshare.net/ccenergia/germanys-renewable-energy-sector-in-the-context-of-energy-transition>

³¹ Breaking Energy (2014) Germany's Energiewende requires sophisticated governance, political stamina. Article, December 2014. Available: <https://breakingenergy.com/2014/12/30/germanys-energiewende-requires-sophisticated-governance-political-stamina/>; Kempfert, C. et al (2013) Good Governance of the Energiewende in Germany: wishful thinking or manageable? Hertie School of Experts on the German Federal Elections 2013. July 2013. Available: http://www.claudiakempfert.de/wp-content/uploads/2016/03/Good_Governance_of_the_Energiewende_in_Deutschland.pdf

3.2 Financing model

The total budget of Energiewende is not directly available. The financing model is based on governmental **budget outlays of several Federal Ministries** and a **dedicated Energy and Climate Fund**. Based on the recent audit report by the Bundesrechnungshof, the total governmental costs of Energiewende are not entirely clear even for the leading Ministries and the delineation of the expenditure items corresponding to Energiewende is not conducted in a fully coherent manner³². Thus, the following presents an interpretation of the overall budget based on available information and should not be considered as an official budget.

The Ministry of Economic Affairs and Energy presents at its webpage the **annual budget** separating the **general budget outlay dedicated to Energy and Sustainability**, and a **specific Energy and Climate Fund including**:

- The expenditure dedicated to Energy and Sustainability in the annual budget was EUR 2.6 billion in 2016 and a similar amount is budgeted for 2017³³. The largest cost component relates to the phasing out subsidies for hard coal and rehabilitating mines, followed by energy-efficiency measures in building retrofit.
- The Energy and Climate fund was established in in 2010 to support the energy strategy (Energiekonzept)³⁴. The funding base was originally based on a tax/fee provided by the nuclear energy industry (ceased in 2012) and the ETS auctioning revenues (above a fixed threshold). The size of the fund is approximately EUR 3 billion per year (3.2 billion in 2016).

The table below presents the budget in 2016 and the estimated budget for 2017.

Table 2: Annual budget for energy and sustainability and dedicated Energy and Climate Fund. Source: The Federal Ministry for Business Affairs and Energy, 2016-2017 ^{35,36}.

	Budget 2016 ³⁷	Estimated budget 2017 ³⁸
<u>Budget line of the Federal Ministry of Economic Affairs and Energy: Energy and sustainability</u>		
Research and development projects (6 th Energy Research Programme)	EUR 347 million	EUR 430 million
Measures for improving energy efficiency	EUR 44 million	EUR 41 million
Measures for promoting the use of renewable energy (Market Incentive Programme)	EUR 250 million	EUR 230 million

³² Bundesrechnungshof (2017) Advisory Report to the Budget Committee of the German Parliament. December 2017. Available: <https://www.bundesrechnungshof.de/en/veroeffentlichungen/beratungsberichte/langfassungen/2016-report-2013-implementation-of-energy-transition>

³³ The Federal Ministry for Economic Affairs and Energy (2016) 2016 Budget Departmental budget 09: Federal Ministry for Economic Affairs and Energy. Available: <http://www.bmwi.de/Redaktion/EN/Artikel/Ministry/budget-2016.html>

³⁴ Oxfam Germany (2013) German Climate Finance: The Energy and Climate Fund. Presentation by Kowalzig, J. may, 2013. Available: http://www.klimaat.be/files/3113/8479/2885/Oxfam_EKF_15Mai2013.pdf

³⁵ The Federal Ministry for Economic Affairs and Energy (2016) 2016 Budget Departmental budget 09: Federal Ministry for Economic Affairs and Energy. Available: <http://www.bmwi.de/Redaktion/EN/Artikel/Ministry/budget-2016.html>

³⁶ The Federal Ministry for Economic Affairs and Energy (2017) 2017 draft budget, Departmental budget 09: Federal Ministry for Economic Affairs and Energy. Available: <http://www.bmwi.de/Redaktion/EN/Artikel/Ministry/budget-2017.html>

³⁷ The Federal Ministry for Economic Affairs and Energy (2016) 2016 Budget Departmental budget 09: Federal Ministry for Economic Affairs and Energy. Available: <http://www.bmwi.de/Redaktion/EN/Artikel/Ministry/budget-2016.html>

³⁸ The Federal Ministry for Economic Affairs and Energy (2017) 2017 draft budget, Departmental budget 09: Federal Ministry for Economic Affairs and Energy. Available: <http://www.bmwi.de/Redaktion/EN/Artikel/Ministry/budget-2017.html>

International cooperation on expanding the use of renewables	EUR 50 million (over the next years)	-
Phasing out subsidies for hard coal / rehabilitating mines*	EUR 1.282 billion (phasing-out hard coal mining) EUR 136 million (rehabilitation of uranium mines in Saxony and Thuringia) EUR 8 million (rehabilitation of mines in Saxony)	EUR 1.162 billion (phasing-out hard coal mining) EUR 136 million (rehabilitation of uranium mines in Saxony and Thuringia) EUR 8 million (rehabilitation of mines in Saxony)
Energy-efficient retrofitting of buildings	EUR 515 million	EUR 338 million
<u>Dedicated budget: Energy and Climate Fund</u>		
R&D	EUR 187 million	EUR 110 million
Energy efficiency	EUR 282 million	EUR 462 million
Electric mobility	EUR 66.5 million	EUR 66.5 million
Market incentive programme	EUR 112 million	EUR 87 million
Energy-efficient retrofitting of buildings	EUR 2 billion	EUR 2 billion
Grants for electricity-intensive companies to compensate for electricity prices	EUR 245 million	EUR 300 million
International cooperation on expanding the use of renewables	EUR 18.7 million	EUR 17.5 million
Improvement of pumps and heating system	EUR 100 million	-
Incentive programme for energy efficiency	EUR 165 million	-
Auction-based procurement in energy efficiency	EUR 55 million	-
Implement the energy transition in the field of electricity and grids	-	EUR 104 million
Electric vehicle purchase promotion	-	EUR 192 million

*It is not entirely clear whether this budget item should be included to the Energiewende budget.

Other Federal Ministries also contribute to Energiewende according to their responsibilities, having total expenditures of approximately **EUR 800 million in 2016**³⁹. For example, the Ministry for Education and Research is responsible of the basic research funding allocated through the 6th Energy Research Programme. Similarly, the Ministry of Food and Agriculture is responsible for bioenergy research, and the Federal Ministry of Transport and Digital Infrastructure (BMVI) collaborates in respect to mobility targets.⁴⁰ Another Ministry contributing towards the achievement of Energiewende's targets is the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

In addition to governmental budget outlays, the German government-owned **development bank KfW Group** maintains low-interest financing programmes for accelerating the transition to renewable energies and improving energy efficiency⁴¹. KfW provides sustained support to the German Federal Government in the framework of the **KfW Energy Turnaround Action Plan** with numerous financing offers in areas such as off-shore wind farms, energy-efficient construction and refurbishment, municipal

³⁹ Bundesrechnungshof (2017) Advisory Report to the Budget Committee of the German Parliament. December 2017. Available: <https://www.bundesrechnungshof.de/en/veroeffentlichungen/beratungsberichte/langfassungen/2016-report-2013-implementation-of-energy-transition>

⁴⁰ The Federal Ministry of Economy and Technology (2011) Research for an environmentally sound, reliable and affordable energy supply 6th Energy Research Programme of the Federal Government. Available: https://www.bmwi.de/Redaktion/EN/Publikationen/research-for-an-environmentally-sound-reliable-and-affordable-energy-supply.pdf?__blob=publicationFile&v=3

⁴¹ KfW Bankengruppe (2012) KfW offers incentive interest rates in major energy turnaround programmes. Press release, April 2012. Available: https://www.kfw.de/KfW-Group/Newsroom/Aktuelles/Pressemitteilungen/Pressemitteilungen-Details_10101.html

investments and technological innovations aimed at climate protection. Between 2012 and 2016, KfW issued commitments with a total volume of EUR 103 billion for projects in connection with the energy transition, in line with the KfW Energy Turnaround Action Plan⁴², thus making an important contribution towards achieving the German Federal Government's environmental and climate goals.

A recent advisory report⁴³, which audits the expenditures of Energiewende across different Federal Ministries, provides an overall critical view on aspects related to Energiewende's coordination. It is stated for instance that the Ministry of Economic Affairs and Energy "cannot clearly answer the question about energy transition's cost to the government" and "does not have a full overview of the financial impact of energy transition"⁴⁴. The report relies on information provided by each separate ministerial department and their decision as to what measures were to be considered part of energy transition. As a consequence, the report provides **rather distinct picture of the realised annual expenditures**. According to the report, the total annual expenditures of Energiewende sum-up to **EUR 4.1 billion** in 2016, including aggregated expenditure figures derived from different ministries as shown in the figure below.

Departmental expenditure on implementing energy transition¹
Federal Ministry for Economic Affairs and Energy (German abbrev.: BMWi); Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB); Federal Ministry of Transport and Digital Infrastructure (BMVI); Federal Ministry of Education and Research (BMBF); Federal Ministry of Food and Agriculture (BMEL) and ECF

Aggregate figures

Department / ECF	2014 actual figures	2015 actual figures	2016 target figures
in thousands of euros			
BMWi	1,177,262	1,071,396	1,131,467
BMVI	47,911	45,602	91,500
BMUB	61,307	213,460	250,000
BMBF	378,485	407,083	442,420
BMEL	20,623	20,229	24,689
BMF (Finance Ministry)	0	0	0
Total of departmental expenditure	1,669,795	1,746,328	1,925,000
ECF ²	1,013,943	1,128,722	2,131,488
Total	2,683,738	2,875,050	4,056,488

Figure 4: Departmental expenditure on implementing energy transition. Source: Bundesrechnungshof, 2017⁴⁵.

The Ministry of Economic Affairs and Energy (BMWi, EUR 1.1 billion in 2016) together with the Energy and Climate Fund (ECF, EUR 2.1 billion in 2016) contribute ~80% of the total expenditure, followed by the other Federal Ministries summing-up the remaining 20% including the Federal Ministry of Education and Research (BMBF, EUR 442 million), Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB, EUR 250 million); Federal Ministry of Transport and Digital Infrastructure (BMVI, EUR 91.5 million); and Federal Ministry of Food and Agriculture (BMEL, EUR 24.7 million). It should be noted that the expenditure amounts of the Federal Ministry of Economic

⁴² KfW Bankengruppe (2017) Promotion in 2016: sustained demand for KfW promotion in Germany. Press release, February 2017. Available: https://www.kfw.de/KfW-Group/Newsroom/Aktuelles/Pressemitteilungen/Pressemitteilungen-Details_396544.html

⁴³ Bundesrechnungshof (2017) Advisory Report to the Budget Committee of the German Parliament. December 2017. Available: <https://www.bundesrechnungshof.de/en/veroeffentlichungen/beratungsberichte/langfassungen/2016-report-2013-implementation-of-energy-transition>

⁴⁴ Ibid.

⁴⁵ Ibid.

Affairs and Energy **differ significantly from the budget figures presented above**. It is understood that the difference is mainly due to the fact that the **audit process excludes the following expenditure**⁴⁶:

- The budget related to phasing out subsidies for hard coal and rehabilitating mines (EUR 1.4 billion in 2016) is not considered to form a part of the Energiewende expenditure;
- The following grant-funding programmes of the Federal Ministry for Economic Affairs and the Energy and Climate Fund are excluded as they are subject to separate auditing processes:
 - Energy research on fuel cells and hydrogen (EUR 93 million in 2016);
 - Energy research concerning storage facilities and grids (EUR 18.7 million);
 - Market incentive programme (EUR 335 million);
 - CO2 building modernisation programme (EUR 1.4 billion); and
 - Energy consulting for SMEs (EUR 17 million);
- International cooperation activities.

Although the audit report duly assesses the Energiewende's expenditure in a transparent manner across the different Ministries, it excludes a considerable part of the expenditure, and thus leaves the overall picture of the Energiewende's public budget and realised expenditures **subject to interpretations**.

The **real costs of the Energiewende** are in case much higher than the public-sector involvement alone. According to Agora Energiewende the total investment in renewable energy across all sectors from 2000 to 2015 was EUR 235 billion, corresponding to an annual average of EUR 16 billion, and during the next decade the investment in the power sector alone is expected to reach about EUR 15 billion annually, EUR 9-10 billion of which will be invested in new renewable capacity⁴⁷.

Others have estimated that Germany spent EUR 25 billion on renewable energy in 2016, most of which – EUR 23 billion – was paid for by the consumers through the renewable energy surcharge on their electricity bills⁴⁸. Similarly, the total cost of the Energiewende has been estimated by Düsseldorf Institute for Competition Economics (DICE) to yield as high as over EUR 520 billion by 2025 in the electricity sector alone⁴⁹. The bulk of the costs (EUR 25 000 for a family of four) will have to be paid in coming years.

It has been argued by the Federal Court of Auditors that the German government lacks a clear overview of the costs of the country's shift to renewable energy⁵⁰. The auditors said there is "*no overview of the financial consequences of the Energiewende*"⁵¹. The criticism was promptly rejected by the Ministry of the Economic Affairs and Energy, but it is acknowledged that the total costs of the country's shift to a low-carbon economy are complex to assess.

⁴⁶ Bundesrechnungshof (2017) Advisory Report to the Budget Committee of the German Parliament. December 2017. See Annex 3 specifying the programmes excluded.

⁴⁷ Agora- Energiewende (2017) The Energiewende in a nutshell 10 Q&A on the German energy transition. Available: https://www.agora-energiwende.de/fileadmin/Projekte/2017/Energiewende_in_a_nutshell/Agora_The_Energiewende_in_a_nutshell_WEB.pdf

⁴⁸ Ibid.

⁴⁹ Initiative Neue Soziale Marktwirtschaft (INSM) (2016) EEG & Co. treiben Energiewendekosten auf 520 Milliarden Euro. Available: <http://www.insm.de/insm/Presse/Pressemeldungen/Pressemeldung-Studie-EEG.html>

⁵⁰ Wehrmann, B. (2017) Government lacks overview of Energiewende costs- auditors. Clean Energy Wire, January 2017. Available: <https://www.cleanenergywire.org/news/government-lacks-overview-energiwende-costs-auditors>

⁵¹ Ibid.

3.3 Key actors involved in the initiative

The Energiewende has required efforts from many public bodies, economic sectors and actors.

Table 3: Key actors of Energiewende. Source: Federal Republic of Germany, Foreign Office, 2015⁵².

Key actors of Energiewende	Description
Federal Ministry for Economic Affairs and Energy	Coordination of Energiewende, the main responsible body for all issues related to Energiewende.
Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety	Responsible for the national, European and international climate action, support measures for climate action, climate technologies, and emissions trading. Also, responsible for nature conservation, sustainability aspects and modernisation of cities.
Federal Ministry for Transport and Digital Infrastructure	Responsible for Energiewende in the transport sector. Evolution of the Mobility and Fuel strategy, Implementation of the EU Directive on the deployment of alternative fuels infrastructure.
Federal Ministry of Food and Agriculture	Responsible for framework conditions (land use) for the development of renewable energies and supported innovation by drawing up legislation and regulations, releasing funds in bioenergy.
Federal Ministry of Education and Research	Responsible for addressing fundamental questions related to Energiewende. Allocates basic research funding: storage and grid technologies, materials for Energiewende, and social science research.
Federal Ministry for Economic Cooperation and Development	Provides support of international climate protection policy, responsible for promotion of climate adaptation, renewable energies and energy efficiency.
KfW Bank	State-owned development bank providing low-interest financing programmes for accelerating the transition to renewable energies and improving energy efficiency.
Other federal agencies	Federal Network Agency, Federal Cartel Office, Federal Office of Economics and Export Control (Bafa), German Energy Agency (Dena), Federal Environmental Agency (UBA), Federal Maritime and Hydrography Agency (BSH).
Federal States (Länder)	16 federal states
Industry	Transmission System Operators, Industry Associations, Energy Agencies, Financing and Energy Market.

⁵² The Federal Republic of Germany, Foreign Office (2015) Who is Who of the Energiewende in Germany. Contact Partners in Politics, Industry and Society. Available: <https://www.auswaertiges-amt.de/cae/servlet/contentblob/701026/publicationFile/209429/EnergiewendeWhoisWho.pdf>

Key actors of Energiewende	Description
Research	Research organisations, universities, consultancy and training
Society	Civil stakeholders, NGOs, Think Tanks, Foundations of the political parties

3.4 Monitoring system and evaluation of the initiative

The **Federal Ministry for Economic Affairs and Energy** has been appointed as the lead actor for the monitoring process for the energy transition. At the heart of the monitoring process for the energy transition is the **Monitoring Report**⁵³, which is published on an annual basis⁵⁴. The purpose of this report is to condense the reams of statistical information on energy that have been collected into a smaller, more manageable number of selected indicators. This information provides a fact-based overview of the status of progress with regard to implementation of the energy reforms. The Monitoring Report for each year must be approved by the Federal Cabinet by 15 December and submitted to the Bundestag (Federal Parliament) and the Bundesrat (Congress or Senate). Also involved in the process is an independent commission of four renowned energy experts, who provide a scientific opinion on the Monitoring Report: Professor Dr Andreas Löschel (chairman), Professor Dr Georg Erdmann, Professor Dr Frithjof Staiß and Dr Hans-Joachim Ziesing. Their scientific opinion is published alongside the Federal Government's report.⁵⁵

Every three years, the Federal Government publishes a **Progress Report** on the energy transition, and the first report was published in December 2014. Compared to the annual Monitoring Report, the Progress Report provides a wider overview and more in-depth analysis of the progress, to extract recommendations for additional measures that might need to be taken.

To improve the monitoring process, a new ordinance on the **core market data register** was issued in 2017⁵⁶. The ordinance creates the legal basis for the establishment and operation of an online database with the core market data of energy industry. The core market data register, operated by the Federal Network Agency, will be an instrument that anyone can use, covering the main players in the electricity and gas sectors and thus serving the energy market as a whole. For the first time, the register covers all energy generation installations as well as certain consumption facilities and the facility operators. The State Secretary Rainer Baake from the Federal Ministry for Economic Affairs and Energy said: "*The core market data register serves to improve the data situation and transparency in the energy sector. Amongst other benefits, this will facilitate monitoring. In addition, it is intended to help reduce bureaucracy, because parallel reporting requirements are being replaced or simplified.*"⁵⁷ The core market data register was expected to become fully operational on July 2017, but there have been some delays.

3.5 Level and type of citizen engagement in the initiative

⁵³ The Federal Ministry of Economic Affairs and Energy (2016) Fifth Monitoring Report "The Energy of the Future" 2015. Available: <https://www.bmwi.de/Redaktion/EN/Publikationen/monitoring-report-2016-summary.html>

⁵⁴ The Federal Ministry for Economic Affairs and Energy (2017) Monitoring the Energy Transition. Available: <https://www.bmwi.de/Redaktion/EN/Artikel/Energy/monitoring-implementation-of-the-energy-reforms.html>

⁵⁵ Ibid.

⁵⁶ The Federal Ministry for Economic Affairs and Energy (2017) Cabinet adopts ordinance on core market data register. Press release, March 2017. Available: <https://www.bmwi.de/Redaktion/EN/Pressemitteilungen/2017/20170308-kabinettt-verabschiedet-marktstammdatenverordnung.html>

⁵⁷ Ibid.

The role of citizens in Energiewende is multi-faced. Apart from the fact that the citizens can be considered as the initiators of the grass roots movement of the energy transition, the citizens are also main **supporters, co-owners** and **co-payers** of the transition. The Energiewende policies benefit from **strong support within German society**: 90% of German citizen support its goals, although only 45% of Germans think that the Energiewende is properly managed⁵⁸.

The citizens have **a direct stake in the energy transition** and they can be considered to be the main driving force behind the energy transition. Already in the 1990s the citizens began to set up their own renewable energy installations such as solar panels and wind turbines⁵⁹. In 2000, the Renewable Energy Act guaranteed fixed feed-in tariffs for renewable energy generation, which further encouraged households to install solar panels on their roofs for their own consumption or feeding the electricity produced into the grid. Similarly, various forms of citizen-owned energy cooperatives have emerged as a form of building larger scale installations. Already in 2012, close to half (46%) of the installed renewable energy capacity was owned by individuals or by local and regional energy cooperatives and they had contributed almost a third of the total investments in renewable energy generation⁶⁰. This has laid the foundation for a decentralisation of the energy system, engaging citizens and communities in the process.

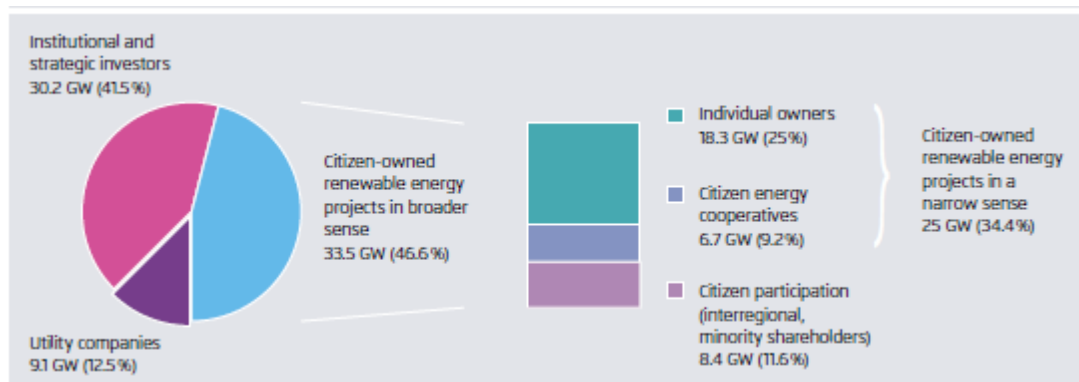


Figure 5: Installed renewable energy capacity broken down by ownership in Germany in 2012. Source: Agora (2017)

Others have argued that the transformation is placing a heavy burden on its citizens⁶¹. The feed-in tariffs provided to renewable energy producers are mainly paid by electricity consumers through an extra cost called EEG surcharge. The extra surcharge has impacted monthly household expenses, accounting for more than 22% of the average monthly electricity bill in 2016. It has been argued that the average German household expenditure on electricity has increased up to 50% from 2007, but, in European comparison, the price trajectory in Germany is similar to other countries with less ambitious renewable energy policy goals⁶². Surveys have shown, however, that households are still in favour of Energiewende and not bothered by the extra cost of renewables⁶³.

The website of the Federal Ministry for Economic Affairs and Energy (www.bmwi.de/EN/Topics/Energy/energytransition.html) is the central information portal for everything relating to the energy transition. It offers up-to-date information, data and analyses, as well as reports and publications on all aspects of energy policy. They have

⁵⁸ Agora- Energiewende (2017) The Energiewende in a nutshell 10 Q&A on the German energy transition. Available: https://www.agora-energiewende.de/fileadmin/Projekte/2017/Energiewende_in_a_nutshell/Agora_The_Energiewende_in_a_nutshell_WEB.pdf

⁵⁹ Borchert, L. (2015) Citizens' participation in the Energiewende. Clean Energy Wire, March 2015. Available: <https://www.cleanenergywire.org/factsheets/citizens-participation-energiewende>

⁶⁰ Ibid

⁶¹ Ball, J. (2017) Germany's High-Priced Energy Revolution. Fortune, March 2017. Available: <http://fortune.com/2017/03/14/germany-renewable-clean-energy-solar/>

⁶² Ibid.

⁶³ Thalman, E. (2015) German green power levy to rise in 2016 to new record. Clean Energy Wire, October 2015. Available: <https://www.cleanenergywire.org/news/german-green-power-levy-rise-2016-new-record>

also established the Energiewende Direkt newsletter⁶⁴ providing information about current developments, background and facts.

4 Policy instruments and wider policy mix used for implementing the initiative

The Energiewende is a national long-term strategy for the development of a low-carbon energy system based on **two-pillars: renewable energy and energy efficiency**. The national initiative is an integrated policy that addresses all sectors of the economy and is framed by two key policy documents, namely the **Renewable Energy Act (EEA)** in 2000 and the **Energiekonzept** (Energy Concept) strategy in 2010. The Energiewende's success depends on the technological innovations realised through research and development activities. In its **6th Energy Research Programme**, the German Federal Government outlined the principles and focus of its funding policy. It envisages concentrating funding to an even greater extent on those technologies that could contribute to the objectives of Energiewende.

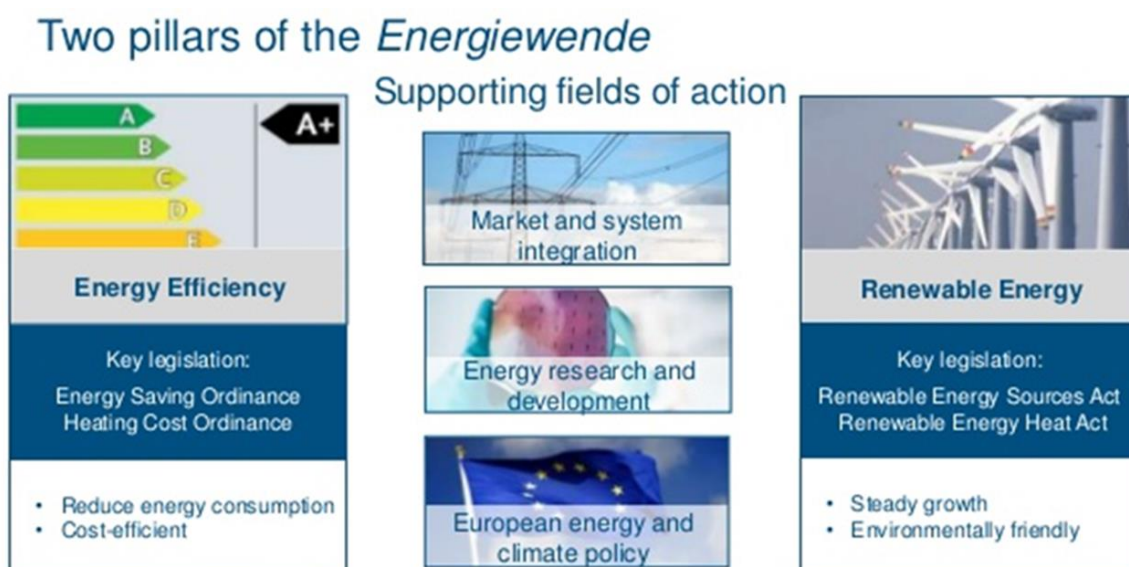


Figure 6: Two pillars of Energiewende and supporting fields of action. Source: The Federal Ministry for Economic Affairs and Energy⁶⁵.

The top level of the target architecture consists of the **policy framework** for the restructuring of our energy supply: cutting greenhouse gas emissions by 40% by 2020, phasing out nuclear energy by 2022, and safeguarding energy security and competitiveness. The initiative has two **strategic level objectives**: expanding the use of renewable energy and boosting energy efficiency. In order to achieve the two core objectives, the work is conducted in **three central areas of electricity, heat and transport**. Various measures are used to attain the steering targets in the fields of renewable energies and energy efficiency, e.g. laws, acts, ordinances and funding programmes. It should however be noted that the Energiewende is *driven* by energy transition policies (described in Chapter 4.2) and *supported* by RDI policy (described in Chapter 4.1).

⁶⁴ The Federal Ministry for Economic Affairs and Energy (2017) Good prospects: households benefiting from stable electricity prices. Energiewende Direkt, November 2017. Available: www.bmwi-energiewende.de/EWD/Navigation/EN/Home/home.html

⁶⁵ The Federal Ministry for Economic Affairs and Energy and Deutsche Energie-Agentur (2015) Germany's renewable energy sector in the context of energy transition. Presentation by Marc Uhlig, July 2015. Available: <https://www.slideshare.net/ccenergia/germanys-renewable-energy-sector-in-the-context-of-energy-transition>

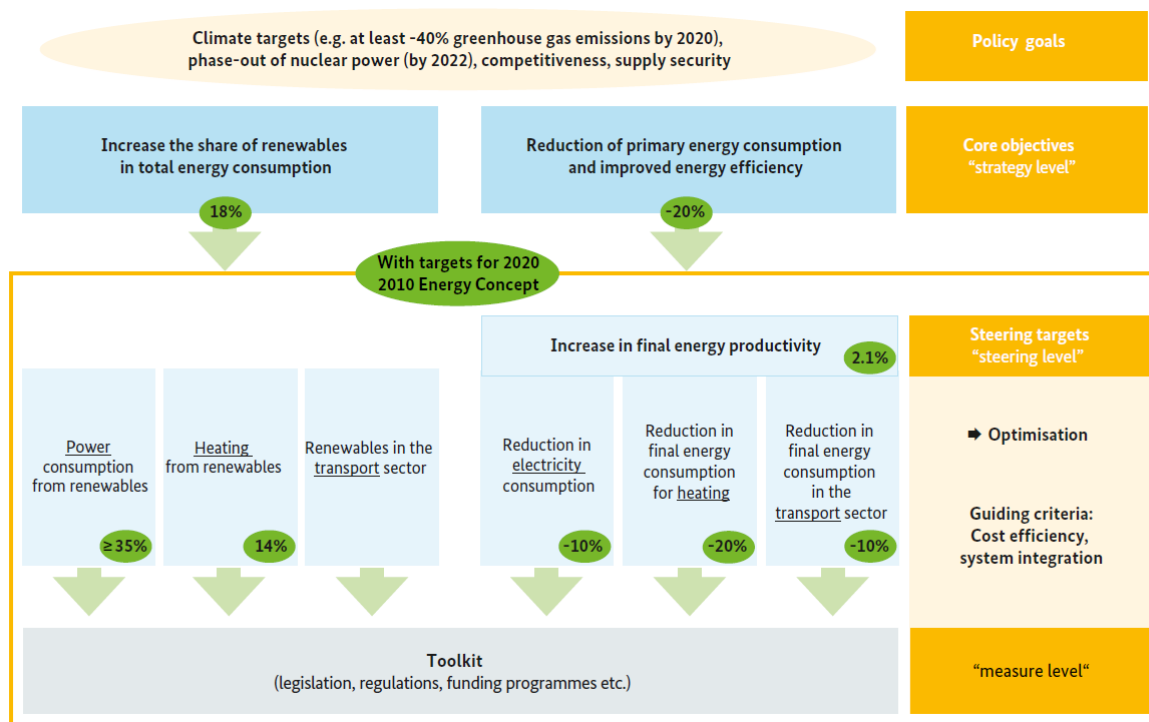


Figure 7: A target architecture for the energy transition: from policy goals to specific measures. Source: The Federal Ministry for Economic Affairs and Energy, 2017⁶⁶.

4.1 Description of the R&I policy instruments used for implementing of the initiative

The **Federal Government's Energy Research Programme**⁶⁷ is an integral part of Energiewende and contributes to the energy transition by developing technologies that aim to secure a reliable and competitive supply of power and heat based on renewable sources of energy. The ongoing **6th Energy Research Programme**⁶⁸, adopted in 2011, defines the current principles and priorities for funding for innovative energy technologies, primarily aiming at technologies that meet the requirements of the energy transition. The funding for the key areas – energy efficiency and renewable energy – focuses on technologies used to generate energy through wind and photovoltaic installations, the increase of renewable energies in the heating sector, energy-optimised buildings, and neighbourhood and industrial energy efficiency. It pays particular attention to systemic solutions for the integration of new energy supply technologies, new grid technologies, energy storage, and sector coupling⁶⁹. The main objectives of the policy are:

1. Contribute to achieving the targets of energy and climate policy;
2. Enhance the leading position of companies in the field of modern energy technologies;
3. Secure and enhance technological options.

The strategy is supported by **a long-term funding policy**, which, at the same time, aims to be sufficiently dynamic and flexible to permit generation of innovative solutions.

⁶⁶ The Federal Ministry for Economic Affairs and Energy (2017) A target architecture for the energy transition: from policy goals to specific measures. Available: <http://www.bmwi.de/Redaktion/EN/Artikel/Energy/target-architecture.html>

⁶⁷ The Federal Ministry for Economic Affairs and Energy (2017) 6th Energy Research Programme of the Federal Government. Available: <https://www.bmwi.de/Redaktion/EN/Artikel/Energy/research-for-an-ecological-reliable-and-affordable-power-supply.html>

⁶⁸ The Federal Ministry of Economics and Technology (2011) Research for an environmentally sound, reliable and affordable energy supply. Available:

https://www.bmwi.de/Redaktion/EN/Publikationen/research-for-an-environmentally-sound-reliable-and-affordable-energy-supply.pdf?__blob=publicationFile&v=3

⁶⁹ Referring to the combined and optimised management of the electricity, heating and cooling sectors, for example.

Over the last 40 years, since launching the first Energy Research Programme in 1977, the Federal Government has invested around EUR 12 billion to fund over 17 300 projects in the field of non-nuclear energy research⁷⁰. The R&D spending to energy technology has more than doubled over the years in general (EUR 400 million in 2006 to over EUR 800 million in 2016), and the relative importance of renewable energy technologies has increased, as shown in the figure below. In 2016, EUR 876 million of government funding were used for energy research compared to EUR 862 million in 2015⁷¹. Medium-term financial planning makes provisions for a budget of around EUR 1 billion in coming years⁷².

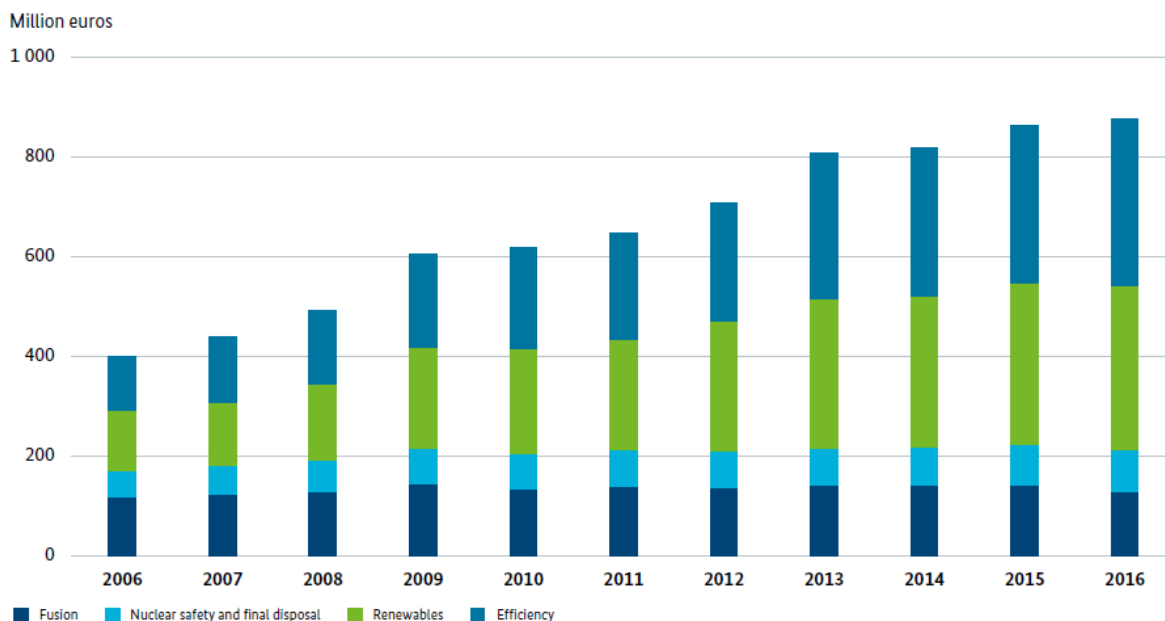


Figure 8: Overview of the Energy Research Programme funding allocation in 2006-2016. Source: Federal Ministry for Economic Affairs and Energy (2017).

Some critical voices have argued that the R&D spending on energy technology is not enough to make the energy transition successful⁷³. In 2016, Germany invested 0.028% of its annual gross domestic product (GDP) in energy R&D, amounting to nearly EUR 876 million⁷⁴. Among the leading OECD countries, only the United Kingdom invests a smaller percentage. In addition, it has been criticised that a big part of the German energy R&D budget is spent to support technologies that have only a limited future, such as nuclear energy (phased out by 2022) and carbon capture and storage, the efficacy of which is doubtful⁷⁵.

⁷⁰ The Federal Ministry for Economic Affairs and Energy (2017) Report of the Federal Government on Energy Research 2017. Available: https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/bundesbericht-energieforschung-2017.pdf?__blob=publicationFile&v=2

⁷¹ Ibid.

⁷² The Federal Ministry of Economic Affairs and Energy (2016) Fifth Monitoring Report "The Energy of the Future" 2015. Available: <https://www.bmwi.de/Redaktion/EN/Publikationen/monitoring-report-2016-summary.html>

⁷³ Kempfert, C. (2017) Germany must go back to its low-carbon future. Nature, September 2017. Available: <https://www.nature.com/news/germany-must-go-back-to-its-low-carbon-future-1.22555#/smallchange>

⁷⁴ Calculations based Eurostat (2017) Gross domestic product at market prices, at current prices, 2016 and Federal Ministry for Economic Affairs and Energy (2017).

⁷⁵ Kempfert, C. (2017) Germany must go back to its low-carbon future. Nature, September 2017. Available: <https://www.nature.com/news/germany-must-go-back-to-its-low-carbon-future-1.22555#/smallchange>

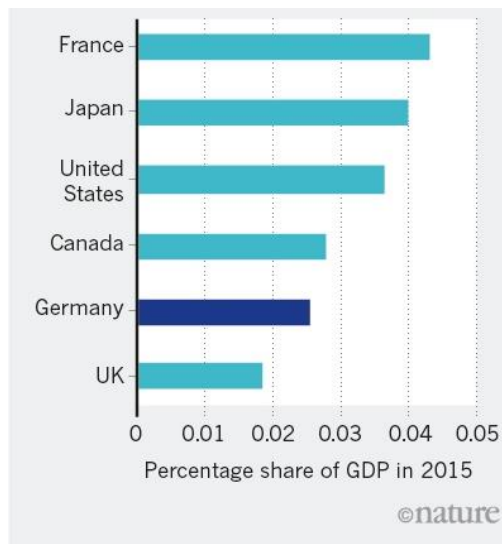


Figure 9: Germany spends less of its gross domestic product (GDP) on energy research and development than all other advanced economies, except the United Kingdom. Source: Kemfert⁷⁶, 2017.

The **Federal Ministry for Economic Affairs and Energy** is responsible for the coordination, programmatic orientation and further development of the Energy Research Programme, and the other key Ministries responsible of the implementation of the Energy Programme are **the Federal Ministry of Education and Research (BMBF)** and **the Federal Ministry of Food and Agriculture (BMEL)**⁷⁷.

Table 4: Governance of the Energy Research Programme. Source: Federal Ministry for Economic Affairs and Energy (2017)

Administration	Description of responsibilities
Federal Ministry for Economic Affairs and Energy	Overall coordination, orientation and development of the programme Responsible for applications-oriented research, development and demonstration for the entire spectrum of the energy system (energy generation, transmission, distribution, storage) and efficient use of energy in different sectors.
Federal Ministry of Education and Research	Responsible for the project-oriented basic research in the areas of energy efficiency, renewable energies, nuclear safety, waste disposal, radiation research and fusion. Also, responsible for institutional research at the Helmholtz Association (excluding the German Aerospace Center), the Fraunhofer Society, the Max-Planck, and the Leibniz Association.
Federal Ministry of Food and Agriculture	Responsible for funding for bioenergy research projects.

The direction of energy research policy is subject to continuous adaptation, which is conducted through **stakeholder dialogue** with the national stakeholders in the Federal Government and the business and scientific communities. The long-term aspects and

⁷⁶ Ibid.

⁷⁷ The Federal Ministry of Economics and Technology (2011) Research for an environmentally sound, reliable and affordable energy supply. Available: https://www.bmwi.de/Redaktion/EN/Publikationen/research-for-an-environmentally-sound-reliable-and-affordable-energy-supply.pdf?__blob=publicationFile&v=3

direction of the strategy are developed in specific agenda processes within **Energy Transition Research Forum**, while more short-term issues are discussed in the **Energy Transition Research and Innovation Platform**, in which all relevant stakeholders from the fields of science and business and from civil society participate.

The administrative parties involved carry out reviews of the funding activities implemented by the Energy Research Programme, and the annual Energy transition monitoring also evaluates the progress of R&D activities. The **Federal Report on Energy Research**, is an annual report reflecting the implementation of the Energy Research Programme and describing in detailed manner the main activities carried out and reviews the overall progress made in the transformation of Germany's energy system. These efforts are supported by a newly developed centralised **information system for energy research called EnArgus⁷⁸**.

The main instrument of the Energy Programme is **project funding**, and the major part (close to 90%) of the funding is dedicated to applied research⁷⁹. In 2016 alone, approx. 1000 new energy projects were approved for funding, most of them in the fields of photovoltaics, wind energy, and energy efficiency in the industrial and commercial sectors and in buildings⁸⁰.

Table 5: Funding allocation by technology areas 2012-2016 and number of ongoing projects 2016. Source: The Federal Ministry for Economic Affairs and Energy, 2017⁸¹.

Funding area	Disbursements in million euros					Number of on-going projects
	2012	2013	2014	2015	2016	
Energy conversion	222.62	242.02	237.14	242.06	222.90	1,822
Photovoltaics	67.08	63.59	58.34	71.26	63.99	397
Wind Power	38.42	52.57	53.06	53.04	49.69	93
Bioenergy	40.86	42.61	42.97	42.10	37.88	468
Deep geothermal energy	20.82	17.10	15.55	13.38	12.54	83
Power plant technology and CCS technologies	27.54	31.62	29.60	28.20	28.52	312
Fuel cells and hydrogen	19.47	24.88	27.16	22.32	19.69	147
Solar thermal power plants	7.45	8.41	9.25	10.09	8.58	76
Hydroelectric and marine power	0.98	1.25	1.21	1.68	2.01	17
Energy distribution and energy use	123.57	183.39	187.11	204.14	211.24	1,943
Energy storage	31.02	59.30	56.99	61.59	53.00	395
Power grids	16.74	30.95	34.88	52.85	70.93	620
Energy efficiency in buildings and cities (incl. other programmes)	45.81	56.76	60.55	54.86	53.60	549
Energy efficiency in industry, commerce, trade and services	30.01	36.38	34.70	34.85	33.70	379
Horizontal issues and analysis	8.60	11.70	10.82	11.46	13.67	147
Disbursements of	9.69	9.82	13.45	25.29	46.86	382

⁷⁸ <https://www.enargus.de/pub/bscw.cgi?op=enargus.eps2>

⁷⁹ Estimation based on the funding tables of Report of the Federal Government on Energy Research (Basic Research in the energy conversion and energy distribution sums-up EUR 47 million (10.8% of total R&D) in 2016.

⁸⁰ The Federal Ministry for Economic Affairs and Energy (2017) Minister Zypries: "40 years of energy research have paved the way for innovative energy technology". Press release, May 2017. Available: <https://www.bmwi.de/Redaktion/EN/Pressemitteilungen/2017/20170502-zypries-40-jahre-energieforschung-sind-wegbereiter-fuer-innovative-energiotechnologien.html>

⁸¹ The Federal Ministry for Economic Affairs and Energy (2017) Report of the Federal Government on Energy Research 2017. Available: https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/bundesbericht-energieforschung-2017.pdf?__blob=publicationFile&v=2

other project funding BMBF							
Disbursements in the area of nuclear safety research	41.59	41.61	43.29	45.74	45.73	349	
Disbursements in institutional energy research	290.17	298.78	303.41	302.57	303.78	--	

Apart from project funding, the Energy Research Programme includes other specific activities to strengthen the collaboration of the different stakeholders and to accelerate the technology development process in certain strategic areas of the Energiewende. The table below describes the **key policy measures** in energy research.

Table 6: Central policy measures of Energy Research Programme. Source: Federal Ministry for Economic Affairs and Energy 2016⁸².

Central policy measures in energy research	Description
Research and Innovation Platform	Aimed at enhanced coordination between Federal Government, the Länder, business and scientific communities and strengthened approach in transforming R&D results to innovation. The central action areas: development of energy research policy, development of new approaches, such as strategic energy system analysis, the system integration of individual technologies (particularly smart ICT systems), and the role of start-ups in the innovation process.
Energy Transition Research Forum	Key players from the Länder, the business community, academia and civil society have been meeting since 2013 to drive forward the effective coordination and long-term direction of energy research.
Copernicus projects	The aim is to better bridge the gap between basic research and practical applications in key areas of the energy transition. The first funding phase is focused on power grids in the context of a high share of renewables in the energy mix, storage and conversion, realignment of industrial processes to intermittent energy supply and sector coupling, and the projects are set for three years, and planned funding is up to EUR 120 million.
Energy Systems of the Future Academies project	The purpose is to bring together 120 representatives from German science academies to develop systemic policy options for the area of basic research with a focus on the energy system of the future. This is expected to provide a scientifically sound basis for society-wide debates on Energiewende-related issues.
Sustainable Power Grids research initiative	Joint initiative of the Federal Ministry for Economic Affairs and Energy and the Federal Ministry of Education and Research to create a necessary technological framework for the future electricity transmission and distribution infrastructure.
Energy Storage research initiative	Joint initiative of the Federal Ministry for Economic Affairs and Energy and the Federal Ministry of Education and Research to support the entire research chain from fundamental R&D work to practical application in the field of energy storage. So far, the initiative is formed by around 250 projects and EUR 200 million of funding (2012-2016).
National Innovation Programme for Hydrogen and	Joint initiative of the Federal Ministry for Economic Affairs and Energy, the Federal Ministry of Transport and Digital

⁸² The Federal Ministry of Economic Affairs and Energy (2016) Fifth Monitoring Report "The Energy of the Future" 2015. Available: <https://www.bmwi.de/Redaktion/EN/Publikationen/monitoring-report-2016-summary.html>

Fuel Cell Technology (NIP)	Infrastructure, the Federal Ministry of Education and Research and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, the industry and the scientific community, designed to speed up technology development and the process of producing marketable products. So far, more than 200 research projects with a budget of around EUR 1.4 billion for 2007 to 2016 have been initiated.
Collaboration Programme: Energy Transition Research Alliance at the German Federation of Industrial Research Associations (AiF)	Joint initiative of energy research and industrial collective research launched by the Federal Ministry for Economic Affairs and Energy specifically to strengthen the innovative capacity of non-research-focussed SMEs in the development of energy solutions. First projects started at the end of 2016 with a total funding of EUR 18 million.
Carbon2Chem research initiative	A consortium from industry and science (including Thyssenkrupp, Linde, BASF, Covestro, AkzoNobel, Max Planck Society and Fraunhofer Gesellschaft) is trialling the conversion of smelting gas from steel production into base chemicals using renewable energy, with a funding of EUR 62 million in 2016-2020.
Renewable Resources funding programme	Initiative of the Federal Ministry of Food and Agriculture for the promotion of research, development and demonstration projects in the use of renewable resources as a material and for energy purposes. In 2016, combined funding of Federal Ministry of Food and Agriculture (EUR 61 million) and Energy and Climate Fund (EUR 24.6 million) was made available.
Biomass Energy Use funding programme	R&D with a practical orientation, on forward-looking technologies and the optimisation of bioenergy processes to contribute to energy supply security. The programme was launched in 2009 and since 300 projects have been carried out with funding amounting to around EUR 44 million. EUR 61 million were available in 2016 and in addition funding of EUR 24.6 million provided from the Energy and Climate Fund.

In addition to Federal State level, the German Länder also have their own research and innovation funding programmes. According to an annual survey⁸³, the R&D spending of the German regions was EUR 267 million in 2015. Bavaria, Baden-Württemberg, North Rhine-Westphalia, Saxony and Hamburg were the states with highest non-nuclear energy research expenditure in 2015.

⁸³ The Federal Ministry for Economic Affairs and Energy (2017) Report of the Federal Government on Energy Research 2017. Available: https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/bundesbericht-energieforschung-2017.pdf?__blob=publicationFile&v=2

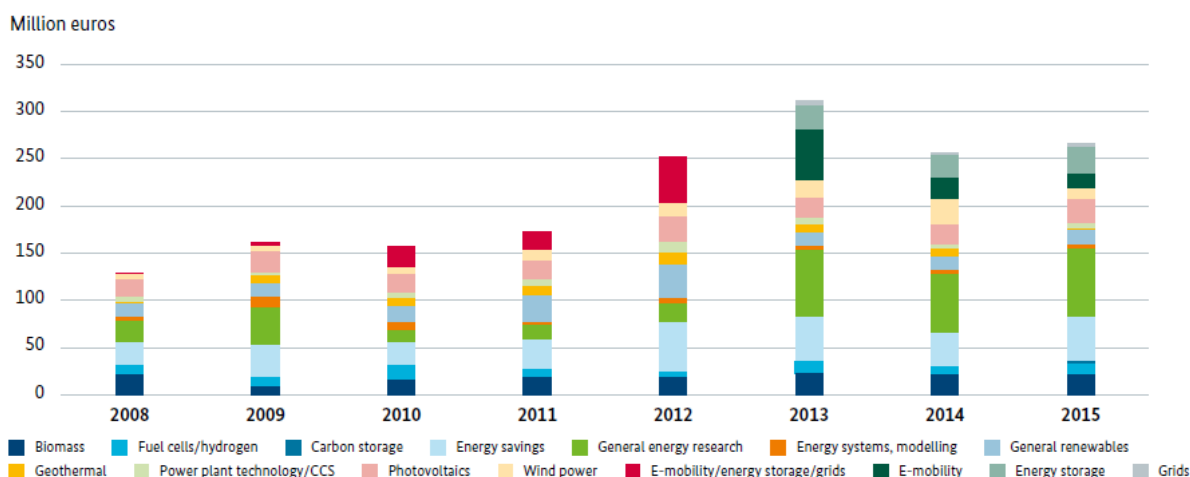


Figure 10: Expenditure by the German states for non-nuclear energy research 2008–2015, 2017⁸⁴.

Organisations from Germany also participate actively in the European Framework Programme H2020. In 2016, 12% of all applicants for funded projects for the social challenge of achieving a “secure, clean and efficient energy supply” came from Germany. The German applicants had a particularly high share of funded projects in the areas of technologies for renewable energies (24%) and intelligent cities and municipalities (15%). The recipients of funding from Germany are involved in 65% of all approved projects with at least one partner and coordinate approximately 20% of all projects.

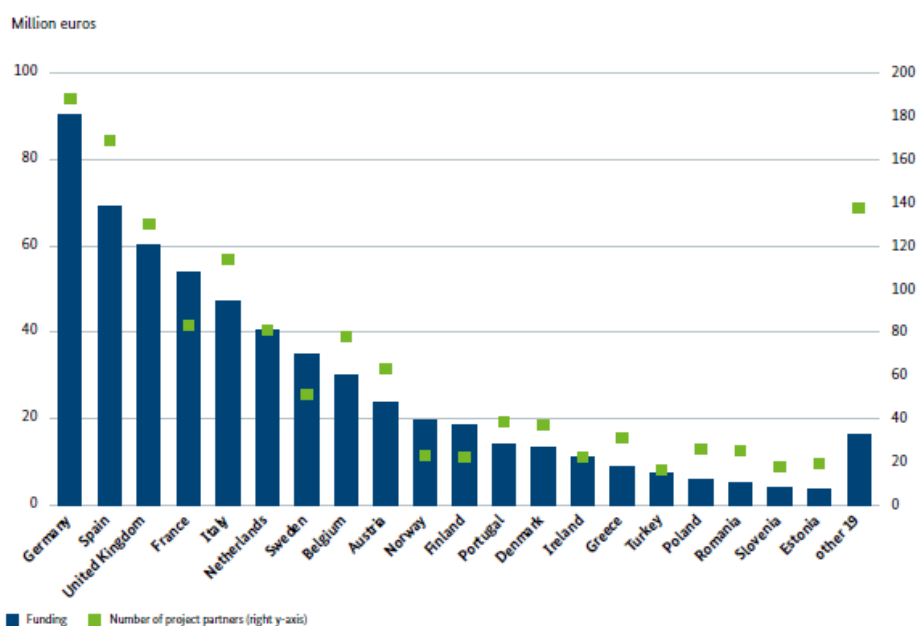


Figure 11: Distribution of funding to countries and grant recipients in the area of energy research in Horizon 2020 in 2016. Source: Federal Ministry for Economic Affairs and Energy, 2017⁸⁵.

Alignment of German research activities to international initiatives is among the strategic development lines of the Energy Research Plan. The European Commission and the EU Member States make use inter alia of the European Technology and Innovation Platforms

⁸⁴ The Federal Ministry for Economic Affairs and Energy (2017) Report of the Federal Government on Energy Research 2017. Available: https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/bundesbericht-energieforschung-2017.pdf?__blob=publicationFile&v=2

⁸⁵ The Federal Ministry for Economic Affairs and Energy (2017) Report of the Federal Government on Energy Research 2017. Available: https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/bundesbericht-energieforschung-2017.pdf?__blob=publicationFile&v=2

(ETIP), such as Smart Networks for Energy Transition, Zero Emissions Platform or the ETIP Wind and ETIP Photovoltaics. The Federal Government also pursues the Berlin model, in which bilateral and multilateral research projects are jointly funded in agreement with the Member States concerned. Scientists are given support via national funding instruments by an institution in their own country.

The BMWi also funds synergies between national and European funding within Horizon 2020 through the support of the European Hydrogen and Fuel Cell Joint Undertaking – FCH2 JU – and the European Technology and Innovation Platforms (ETIP). The BMWi also participates in ERA-Net Cofunds such as the Solar-ERA.Net, Geothermal ERA or Accelerating CCS Technologies (ACT).

4.2 Connections with other policies

Renewable energies

The **law on nuclear phase-out by 2022** and the **Renewable Energy Sources Act** are the central instruments steering the expansion of renewable energy and they promote the expansion of renewable energy sources in the electricity sector⁸⁶. Since the introduction of the Act in 2000, the share of renewables in gross electricity consumption in Germany has risen steadily from 6.2% to 32.3% in 2016. Based on extensive monitoring and evaluation of the policies, the EEG have been **subject to regular updates, amends and adjustments** made in 2004, 2009 and 2012, 2014 and 2017.

When EEG was first introduced in 2000 it included three main pillars of action: feed-in tariffs, priority grid access for renewables and the EEG surcharge⁸⁷:

- Producers of renewable energy receive fixed feed-in tariffs for 20 years. The feed-in tariffs were planned to decrease by a fixed percentage to incentivise renewable energy producers to reduce cost.
- The EEG specifies that electricity from wind, solar and biomass gets access to the grid ahead of conventional power. The law also provides that in times of excess supply, conventional power plants must ramp down their production.
- The feed-in-tariffs are not paid by government funding, but rather by the market and consumers. Renewable energy is directly sold to the market at market price. The difference between the market price and the predetermined feed-in-tariff is levied on the consumers in the form of EEG surcharge. The surcharge is applied to household consumers and small-scale industries, while the large energy-intensive companies have exemptions. Similarly, operators of renewable and small conventional power plants that use the electricity they themselves generate are also exempt from the EEG surcharge.

In 2004 and 2009, first amendments were made in order to adapt the law to the positive development of renewable energies. They included setting more ambitious targets for renewable energy and adjustments to the feed-in tariffs, and a further reliefs to EEG surcharge (e.g. railroad, and electricity intensive companies).

The EEG was reformed in 2014 to foster the market integration of renewable energies, to increase competitiveness and to ensure energy security⁸⁸. In line with the EU state-aid guidelines, the EEG 2.0, was aimed at maintaining the energy prices in lower level and to develop the electricity market further. The operators of new renewable energy installations with an installed capacity more than 500 kilowatts (kW) were now obliged to

⁸⁶ The Federal Ministry for Economic Affairs and Energy (2017) For a future of green energy. Available: <https://www.bmwi.de/Redaktion/EN/Dossier/renewable-energy.html>

⁸⁷ Agora Energiewende (2015) Understanding the Energiewende. Available: https://www.agora-energiewende.de/fileadmin/Projekte/2015/Understanding_the_EW/Agora_Understanding_the_Energiewende.pdf

⁸⁸ The Federal Ministry for Economic Affairs and Energy (2017) For a future of green energy. Available: <https://www.bmwi.de/Redaktion/EN/Dossier/renewable-energy.html>

market their electricity directly on the wholesale market, and instead of a fixed price, they receive a sliding premium in addition to the revenue they earn from sales on the market⁸⁹. With these changes to the EEG, incentives were created towards demand-driven electricity generation to better integrate renewables into national and European energy markets. The most striking features of the EEG 2.0 include:

- The EEG 2.0 **increases the number of energy-intensive companies exempt for paying a full energy surcharge** (297 companies in 2005 to 2098 in 2014). These companies are not excluded from all EEG surcharges, instead the privileged companies have to pay only 15% of their EEG surcharge.
- **Feed-in-tariffs are adjusted** automatically depending on the achievement of technology-specific targets (flexible cap). The FiT is discontinued during periods of negative prices (six consecutive hours).
- A market premium covers the difference between the fixed payment stated in the EEG and the average spot electricity price. Consumers are obligated to pay a **smaller portion of the EEG surcharge** as compared to before.
- Introduction of **competitive auctions** in a form of pilot auctions for large ground-mounted PV installations.

In 2016 the EEG was again revised⁹⁰. Apart from new objectives (increase of RE share in gross electricity consumption to 40–45% by 2025, to 55–60% by 2035, and to at least 80% by 2050) it sets objectives for the annual new capacity to be added by individual technologies. In addition, the competitive auction model piloted in PV installations has been set as a generalised policy. From 2017 onwards, the feed-in-tariffs will no longer be fixed by the government, but will be determined through **a market-based auction scheme**⁹¹. According to the German government, this new auction system will ensure that the expansion of renewables proceeds at a steady and controlled pace and at the same time with lower cost⁹².

⁸⁹ Ibid.

⁹⁰ The Federal Ministry for Economic Affairs and Energy (2017) Renewable Energy Sources Act (EEG 2017). Available: https://www.clearingstelle-eeg.de/files/node/8/EEG_2017_Englische_Version.pdf

⁹¹ The Federal Ministry for Economic Affairs and Energy (2017) For a future of green energy. Available: <https://www.bmwi.de/Redaktion/EN/Dossier/renewable-energy.html>

⁹² Agora- Energiewende (2017) The Energiewende in a nutshell 10 Q&A on the German energy transition. Available: https://www.agora-energiewende.de/fileadmin/Projekte/2017/Energiewende_in_a_nutshell/Agora_The_Energiewende_in_a_nutshell_WEB.pdf

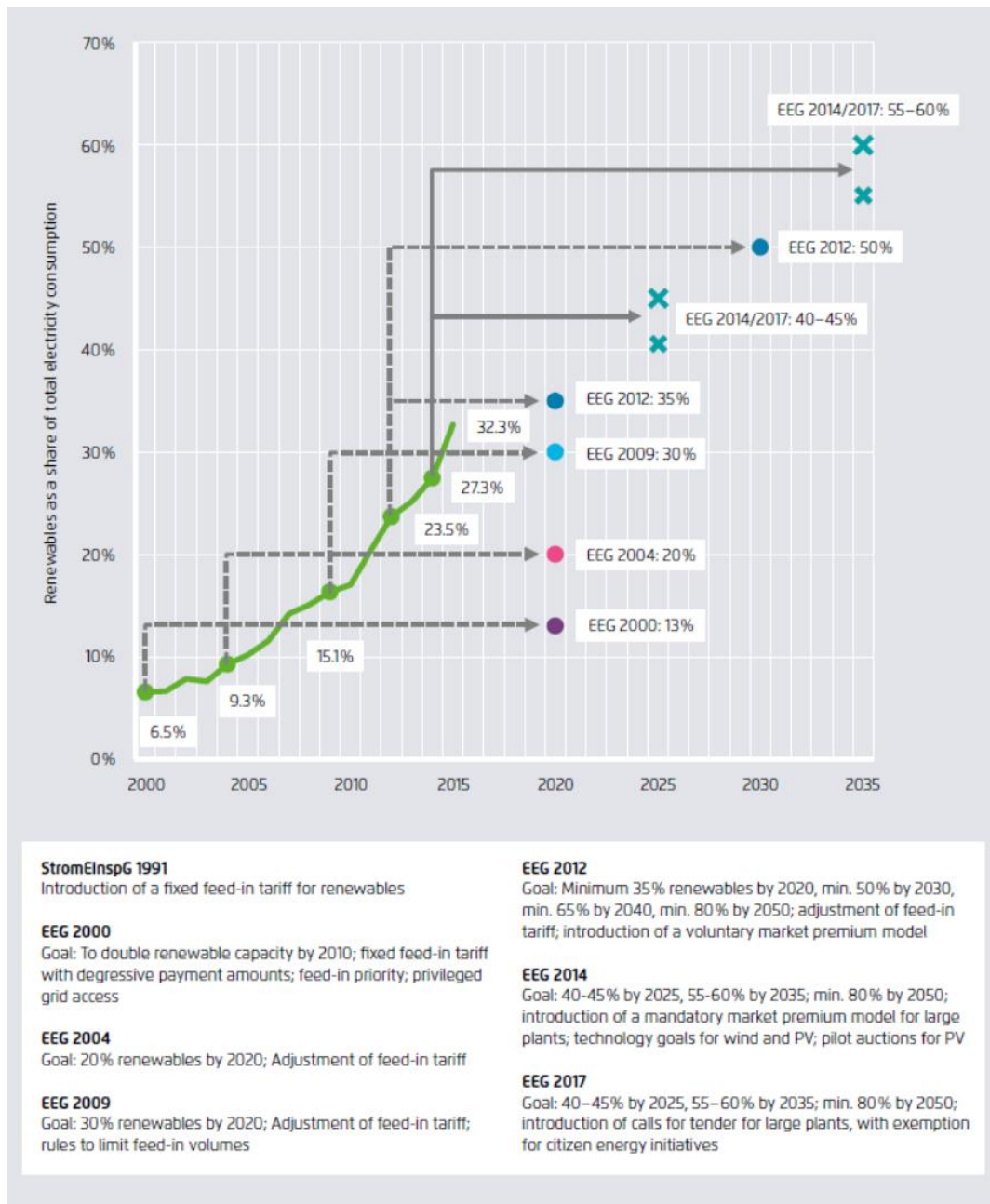


Figure 12: Development of renewable energy policy and its objectives, and the share of renewables of total electricity consumption, 2000-2035. Source: Agora-Energiewende, 2017.

Energy efficiency

The **National Action Plan on Energy Efficiency (NAPE)**⁹³ is the main policy tool for achieving the energy efficiency targets of Energiewende. NAPE is a comprehensive package of measures designed to improve the energy performance launched in December 2014. NAPE defines both immediate short-term actions and the longer-term approach to meet the Energiewende's energy efficiency goals and make significant contribution towards the national 2020 Climate Action Programme⁹⁴. All the measures

⁹³ The Federal Ministry for Economic Affairs and Energy (2014) Making more out of energy: National Action Plan on Energy Efficiency. Available: https://www.bmwi.de/Redaktion/EN/Publikationen/nape-national-action-plan-on-energy-efficiency.pdf?__blob=publicationFile&v=1

⁹⁴ The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2016) Climate Action Report 2016. Available: http://www.bmub.bund.de/fileadmin/Daten_BMU/Pool/Broschueren/klimaschutzbericht_2016_en_bf.pdf

under the NAPE follow two key principles: supply information - provide support - demand action and the corresponding policy instruments: information and consulting (instruments marked in green in the figure below), financial instruments (instruments marked in yellow in the figure below), R&D instruments (provided by the 6th Energy Research Programme, marked in blue in the figure below) and regulation (including European and national regulative initiatives marked in red in the figure below).

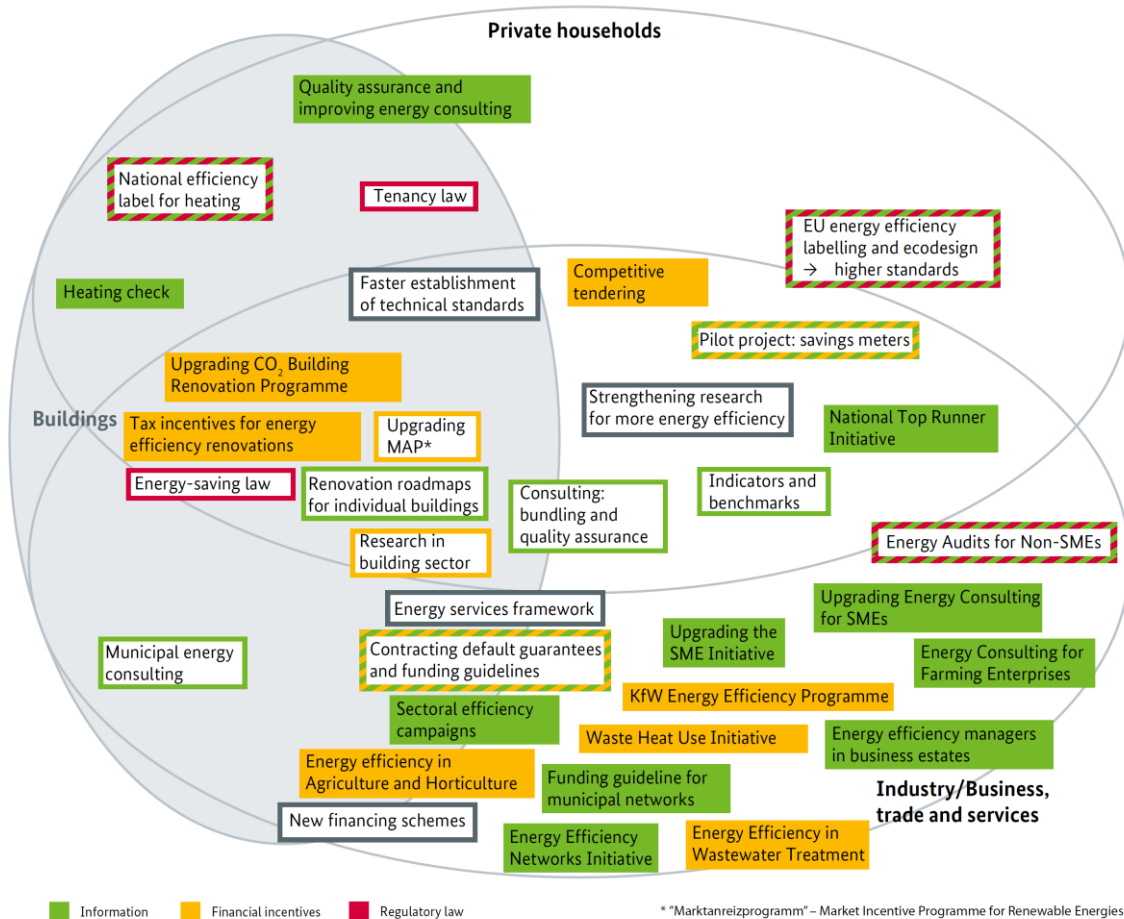


Figure 13: Key policy measures of the National Action Plan on Energy Efficiency. Source: The Federal Ministry for Economic Affairs and Energy, 2014⁹⁵.

The key pillars of the plan are:

- **Stepping up energy efficiency in buildings:** the building sector’s final energy consumption is close to 40% of the total final energy in Germany. NAPE measures include the **CO2 Building Renovation Programme** that is running until 2018. The programme is set up by the KfW and it offers low-interest loans, in-part repayment and investment grants for energy efficiency measures in buildings. The Building Renovation Programme is among the largest funding programmes in Germany and between 2006 and 2015, almost 4.1 million homes were built or refurbished under the programme, totalling investments of over EUR 220 billion⁹⁶. The programme is ongoing, and the German government has agreed to increase the funding by EUR 200

⁹⁵ The Federal Ministry for Economic Affairs and Energy (2014) Making more out of energy: National Action Plan on Energy Efficiency. Available: https://www.bmwi.de/Redaktion/EN/Publikationen/nape-national-action-plan-on-energy-efficiency.pdf?__blob=publicationFile&v=1

⁹⁶ The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2016) Climate Action Report 2016. Available: http://www.bmub.bund.de/fileadmin/Daten_BMU/Pool/Broschueren/klimaschutzbericht_2016_en_bf.pdf

million per year yielding to EUR 2 billion government funding per year until 2018⁹⁷. Other supportive measures such as tax incentives and energy consulting services are provided in order to support the KfW-funded instruments. An example of the supportive instruments is "heating checks" using voluntary checks conducted by professionals to detect weak points of heating systems⁹⁸.

- Establishing energy efficiency as an investment and business model:** The objective is to boost the development of energy efficiency services, energy efficiency technologies and competitiveness. The idea is to promote new business models, targeted especially for SMEs, for energy savings. With the introduction of the Competitive Tendering Scheme for Energy Efficiency, Germany will spearhead a new approach for promoting close-to-market and cost-effective energy efficiency solution. The pilot competitive tendering scheme for electrical energy efficiency started in 2016⁹⁹. The model was developed based on the Swiss ProKilowatt programme¹⁰⁰, and it offers two tendering rounds per year with a total funding of EUR 300 million for the pilot phase (2016-2018)¹⁰¹. Companies are also called to become actively involved in one of up to 500 energy-efficiency networks and use these to define and reach joint efficiency targets. The goal is to have 500 company networks sharing good practice by 2020¹⁰². Another measure is to offer better terms on guarantees for energy efficiency projects. Since the beginning of 2016, the 16 guarantee banks are offering easier and wider access to guarantees for energy efficiency contractors¹⁰³. The maximum amount for which guarantees can be issued will be raised to EUR 2 million (from the current EUR 1.25 million) for projects that deliver energy savings of at least 25% compared to the status quo.
- Individual responsibility for energy efficiency:** All stakeholders share the responsibility for achieving Germany's national energy efficiency goals. One of the targets of NAPE is to provide energy consumers with sufficient information in order them to make informed decisions about their energy consumption. Energy consulting services are a key element for pinpointing energy saving options. The NAPE initiative is aimed at improving the quality assurance in energy consulting and build consumer confidence in qualified consulting.

Table 7: Key policy measures in energy efficiency. Source: The Federal Ministry for Economic Affairs and Energy, 2016¹⁰⁴.

Key measure of energy efficiency	Description
CO2 Building Renovation Programme until 2018 (KfW programmes for energy-efficient construction and rehabilitation)	Subsidies or low-interest loans set up by KfW for energy-efficient construction and renovation (for residential, municipal and social service buildings). EUR 2 billion per year.
Quality assurance and optimising existing energy consulting	The aim is to provide energy consulting to investors and others to enhance their propensity to invest and

⁹⁷Berliner Energieagentur (2017) Germany's Energiewende. Presentation, March, 2017. Available: http://icaen.gencat.cat/web/.content/30_Plans_programes/38_PacteNacional/arxius/20170313_CicleDebats_2a_Sessio_BE_Alemania_pro.pdf

⁹⁸The Federal Ministry of Economic Affairs and Energy (2016) Fifth Monitoring Report "The Energy of the Future" 2015. Available: <https://www.bmwi.de/Redaktion/EN/Publikationen/monitoring-report-2016-summary.html>

⁹⁹The Federal Ministry of Economic Affairs and Energy (2017) Energy Efficiency Platform. Available: <https://www.bmwi.de/Redaktion/EN/Artikel/Energy/energy-efficiency-platform.html>

¹⁰⁰The Federal Ministry of Economic Affairs and Energy (2017) STEP up! - German tendering scheme for electrical energy efficiency. Presentation by Lerch, D. IEA Workshop, January 2017. Available: https://www.iea.org/media/workshops/2017/S4Lerch_StepUp.pdf

¹⁰¹The Federal Ministry of Economic Affairs and Energy (2017) Was ist STEP up!? Available: <https://stepup-energieeffizienz.de/step-up/was-ist-step-up>

¹⁰²The Federal Ministry for Economic Affairs and Energy (2014) Making more out of energy: National Action Plan on Energy Efficiency. Available: https://www.bmwi.de/Redaktion/EN/Publikationen/nape-national-action-plan-on-energy-efficiency.pdf?__blob=publicationFile&v=1

¹⁰³The Federal Ministry for Economic Affairs and Energy (2015) Federal Ministry for Economic Affairs and Energy to offer better terms on guarantees for energy-efficiency projects: Press release, December 2015. Available: <https://www.bmwi.de/Redaktion/EN/Pressemitteilungen/2015/20151217-bundeswirtschaftsministerium-verbessert-buergschaftsbedingungen-energieeffizienzprojekte.html>

¹⁰⁴The Federal Ministry of Economic Affairs and Energy (2016) Fifth Monitoring Report "The Energy of the Future" 2015. Available: <https://www.bmwi.de/Redaktion/EN/Publikationen/monitoring-report-2016-summary.html>

Key measure of energy efficiency	Description
Tax incentives for energy-efficient renovations	acceptance of refurbishment measures. Supplementing the CO2 Building Renovation Programme by offering tax reductions for enhancing energy efficiency and the use of renewable energy in residential buildings.
Upgrading KfW production facilities and processes energy efficiency programmes	KfW programme based on interest subsidies for promoting energy-efficient production plants/processes will be upgraded to include both a new basic standard (10% savings) and a new premium standard (30% savings). Annual programme funding of EUR 165 million through to 2018.
Introduction of a competitive tendering scheme	Competitive tendering is targeted at energy service providers, municipal utilities, energy cooperatives, manufacturers and other actors to find economic ways to save energy. The participants suggest the funding area themselves and offer cost-effective measures for carrying the initiatives.
Funding for energy performance contracting (including default guarantees)	Lowering the risks (long contract terms, investment risk of contractor, etc.) of energy performance contracting by expanding the guarantee facilities of guarantor banks. Assistance will also be given to municipalities and SMEs in making use of energy performance contracting.
Energy Efficiency Networks Initiative	The object of this measure is to set up and implement nationwide energy efficiency networks on a voluntary basis, where companies can define and implement energy efficiency targets for their network in a direct exchange of experience supervised and moderated by energy consultants. The goal is to have 500 energy efficiency networks set up and established on a voluntary basis by 2020. Over 90 new networks with around 1000 businesses have been set up so far.
Top Runner Strategy – at national and EU level	The National Top Runner Initiative (NTRI) are measures for speeding up the market penetration of high-quality services and products (top runners) that contribute to reducing energy consumption. As part of EU Energy Labelling Directive, Germany will advocate informative labels for consumers, faster decision-making processes and a stronger EU Top Runner Strategy.
Energy audit obligation for non-SMEs	Large-scale enterprises are obliged to carry out regular energy audits (complying with DIN EN 16247-1) every four years.
National energy efficiency label for old heating installations	The aim of the measure is to motivate building owners to replace old, inefficient heating systems to raise the replacement rate. Approximately 13 million boilers will be labelled over the next eight years. The measure has the potential to increase the annual replacement rate by approx. 20% to 3.7%.
Promotion of heating optimisation using high-efficiency pumps and hydraulic balancing	Promotion of the replacement of old pumps with high efficiency heating and warm water circulation pumps in buildings and optimised heating. The funding programme seeks to support the replacement of up to two million pumps in buildings and the additional optimisation of up to 200 000 heating systems per year by 2020, with the aim of cutting around 1.8 million tonnes of CO2 by 2020. The programme commenced in August 2016 with annual funding of roughly EUR 100 million.

According to the Energiewende Monitoring Report¹⁰⁵, all energy efficiency measures are under way or already implemented. In order to achieve the ambitious Energiewende targets for energy efficiency, the existing potential for raising energy efficiency needs to be exploited even more and the process needs to be fastened. To explore how this might be done, the Federal Ministry for Economic Affairs and Energy launched a public consultation on energy efficiency in 2016. The resulting Green Paper was published in 2016 looking at the key questions and points for discussion concerning the most important fields of action in the short term and the primary challenges in the long-term time perspective. The plan is to publish a White Paper on Energy efficiency in 2017, including new and enhanced policy instruments to support energy efficiency¹⁰⁶.

Market and system integration

One of the most important recent policy measures is the **Electricity Market Act**, which amends various acts and ordinances, including the Energy Industry Act, the Renewable Energy Sources Act and the Reserve Power Plant Ordinance¹⁰⁷. The electricity market is undergoing a period of transition as the renewable energy is taking a leading role and the nuclear energy will be phased out in 2022. At the same time, the electricity market must provide the same services as before. The balance between power generation and consumption must be maintained, especially since the shares of wind and solar energy in the power supply mix will increase. To achieve this, it must ensure that sufficient capacity is available (i.e. reserve function) and that the capacity is used in a cost-efficient way. Electricity market regulations play a decisive role in fostering flexibility¹⁰⁸.

The key measures in the White Paper¹⁰⁹ are now being implemented in the Electricity Market Act and the Capacity Reserve Ordinance. The most important measures are:

Key policy measures	Description
Guaranteeing free price formation	The measures taken will strengthen free, competition-based price formation and will permit price peaks to occur on the electricity markets.
Monitoring of security of supply	Monitoring of the electricity market will be improved to safeguard energy security in the new regulatory environment. The monitoring will no longer focus solely on national output levels, but will give greater consideration to the contribution to security made by the European internal market in electricity.
Upholding balancing group commitments	The responsible electricity providers and traders to purchase sufficient electricity for their clients will be requested more rigorously.
Prolonging the grid reserve	To respond to congestion in the grid and to ensure secure grid operation, the grid reserve will be prolonged beyond 31 December 2017, and the rules on cost reimbursement will be brought into line with practical needs.
Improving transparency on the	Transparent and up-to-date electricity market data

¹⁰⁵ The Federal Ministry of Economic Affairs and Energy (2016) Fifth Monitoring Report "The Energy of the Future" 2015. Available: <https://www.bmwi.de/Redaktion/EN/Publikationen/monitoring-report-2016-summary.html>

¹⁰⁶ Berliner Energieagentur (2017) Germany's Energiewende. Presentation, March, 2017. Available: http://icaen.gencat.cat/web/.content/30_Plans_programes/38_PacteNacional/arxiu/20170313_CicleDebats_2a_Sessio_BE_Alemanya_pro.pdf

¹⁰⁷ The Federal Ministry of Economic Affairs and Energy (2016) Electricity Market 2.0. Available: <http://www.bmwi.de/Redaktion/EN/Artikel/Energy/strommarkt-2-0.html>

¹⁰⁸ Agora- Energiewende (2017) The Energiewende in a nutshell 10 Q&A on the German energy transition. Available: https://www.agora-energiewende.de/fileadmin/Projekte/2017/Energiewende_in_a_nutshell/Agora_The_Energiewende_in_a_nutshell_II_WEB.pdf

¹⁰⁹ The Federal Ministry for Economic Affairs and Energy (2014) An Electricity Market for Germany's Energy transition. Available: http://www.bmwi.de/Redaktion/EN/Publikationen/gruenbuch.pdf?__blob=publicationFile&v=5

Key policy measures	Description
electricity market	can promote efficient generation, consumption and trading decisions. For this reason, a national information platform and a core market data register will be set up.
Reducing and sharing more fairly the costs of grid expansion	More efficient grid planning reduces the costs of grid expansion. In future, it will no longer be necessary to expand the grids to cope with the "last kilowatt-hour" generated by wind and PV installations. The costs will also be shared more fairly.
Introducing a capacity reserve	The capacity reserve will be established outside the electricity market in order to ensure security of supply in the face of unforeseeable events.

The Federal Ministry for Economic Affairs and Energy provides funding for renewables-based installations used for the heating and cooling of homes under the **Market Incentive Programme (MAP)**¹¹⁰. Small and large-scale investments such as solar thermal energy installations, heat pumps or pellet boilers, and the construction of heating grids and heat accumulators are supported under MAP. The Federal Office for Economic Affairs and Export Control (BAFA) provides subsidies in forms of investment grants for small-scale plants, and larger-scale investments are being supported via repayment grants for low-interest KfW loans under the KfW "Renewable Energies – Premium" Programme. The Market Incentive Programme was launched in 2000, as a multimillion financial support scheme for renewable heating systems, and more than 1.5 million systems have been funded via MAP since 2000¹¹¹.

The **buildings sector plays a central role in the energy transition** as the building energy consumption corresponds 35.3% of the total final energy consumption¹¹². In addition to the launch of several new funding programmes – main instrument being the KfW Building Modernisation Programme, advisory services and the efficiency campaign – the first measures from the Energy Efficient Buildings 2050 were also implemented including a customised renovation roadmap. The Energy Efficient Buildings 2050 strategy aims to achieve a virtually climate-neutral building stock by 2050 by combining greater energy efficiency with the increased use of renewable energy.

Transport is another key sector that is subject to transformation and contributes significantly to the goals of Energiewende. The transport sector accounts for 30% of total final energy consumption in Germany. However, the final energy consumption in the transport sector stagnated across all modes of transport apart from rail transport.¹¹³ The efficiency improvements made in the transport sector have so far been exceeded by the significant increase in the volume of traffic. With the Mobility and Fuels Strategy (2013) and the 2020 Climate Action Programme, the Federal Government has established a mix of support, advice, funding and an enhanced regulatory framework for the mobility and transport sector, following the EU regulation on transport emission reduction targets. In 2016, the Electric Mobility Market Incentive Package was adopted to speed up the expansion of electric mobility and charging stations.

Grid infrastructure and digitisation of the energy transition

¹¹⁰ The Federal Ministry for Economic Affairs and Energy (2017) Frequently asked questions about the Market Incentive Programme (MAP). Available: <http://www.bmwi.de/Redaktion/EN/FAQ/Marktanreizprogramm-MAP/faq-marktanreizprogramm-map.html>

¹¹¹ Ibid.

¹¹² The Federal Ministry of Economic Affairs and Energy (2016) Fifth Monitoring Report "The Energy of the Future" 2015. Available: <https://www.bmwi.de/Redaktion/EN/Publikationen/monitoring-report-2016-summary.html>

¹¹³ Ibid.

The rapid expansion of renewable energies has put much pressure on the German electricity transmission network¹¹⁴. The gradual phase-out of conventional power plants (nuclear, coal) that are typically located in areas where energy demand is high (e.g. the industrial Ruhr region and areas close to southern German metropolitan hubs), has set new requirements for energy supply security. The renewable energy installations, however, are often operated in areas where electricity consumption is low (e.g. offshore wind farms, renewables in relatively sparsely populated areas in eastern and northern Germany) and the electricity must be transported over long distances to the final consumers. The existing electricity network infrastructure has reached the limits of capacity, and these targets can only be met by stepping up expansion of the extra-high voltage grid, which in turn requires accelerated planning and approval procedures as provided for by the Power Grid Expansion Act 2009 (EnLAG) and the Grid Expansion Acceleration Act 2011 (NABEG)¹¹⁵.

Digitisation affects all levels of the value chain in the energy industry: generation, grids, trade, supply and consumption. It can offer significant benefits by linking power generation and consumption, enabling the flow of larger volumes of data and new analytical approaches, which in turn can unleash new potential for infrastructure optimisation and energy efficiency.

Key policy measures	Description
Revision of the Incentive Regulation Ordinance	The aim is to improve investment conditions for distribution grids and strengthen incentives for efficiency, while keeping the costs for consumers to a minimum and increasing transparency.
Act to Amend Provisions of the Law Governing Power Line Construction	The objective is to increase acceptance for grid expansion, and accelerate the expansion of the grid as a result
Continued development of the monitoring of German grid expansion projects	Create transparency and awareness among all stakeholders regarding realistic planning and implementation assumptions, and identify delays in grid expansion at an early stage.
Act on the Digitisation of the Energy Transition	The Act aims to signal the start of the smart grid, smart meters and the smart home in Germany. With the smart meter gateway, the Act introduces a secure communication platform to interconnect all energy transition stakeholders in a secure and efficient manner.
Smart Energy Showcases – Digital Agenda for the Energy Transition (SINTEG)	In large-scale pilot regions, the SINTEG programme aims to demonstrate the feasibility of a climate-friendly, secure and efficient power supply with a high percentage of intermittent power generation derived from wind and PV.

2050 Climate Action Plan

The Federal Government adopted a national 2050 Climate Action Plan¹¹⁶ in November 2016 as a result of the outcome of the Paris Convention on Climate Change. The Climate

¹¹⁴ Bundesnetzagentur (2017) Why is grid expansion necessary? Available: <https://www.netzausbau.de/EN/background/why/en.html>

¹¹⁵ Bundesnetzagentur (2017) Legal background. Available: <https://www.netzausbau.de/EN/background/legal/en.html>

¹¹⁶ The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2016) Climate Action Report 2016. Available: http://www.bmub.bund.de/fileadmin/Daten_BMU/Pool/Broschueren/klimaschutzbericht_2016_en_bf.pdf

Action Plan introduces 97 strategic measures for regions, municipalities, associations and citizens, and a roadmap towards a nearly climate-neutral building stock.

The plan will be underpinned with measures (see an overview below) and the first programme will be adopted in 2018 to ensure that the GHG emission reduction targets 2030 are achieved. The National Action Plan on Energy Efficiency and the Renewable Energy Act are the key policies contributing towards GHG reductions.

Central policy measures	Contribution to GHG emissions reduction in 2020 in million tonnes of CO ₂ equivalent	
	Contribution according to original estimate, as at December 2014	Contribution according to current expert assessment (rounded figures)
National Action Plan on Energy Efficiency (NAPE) excluding measures in the transport sector	Approx. 25–30 (including building energy efficiency)	25–30 (including building energy efficiency)
“Climate-friendly building and housing” strategy	Approx. 5.7–10 in total (1.5 - 4.7 of which in addition to NAPE)	4.2 to 5.0 in total (0.8 of which in addition to NAPE)
Measures in the transport sector	Approx. 7–10	1.15–1.6
Reduction in non-energy-related emissions in the sectors:		
Industry, trade, commerce and services	2.5–5.2	1.2–2.5
Waste management	0.5–2.5	0.05
Agriculture*	3.6	0.6–2.1
Reform of the emissions trading system	Depends on how the ETS is organised at the EU level	
Additional measures, particularly in the electricity sector	22	18.3–19.5
Advice, information and independent initiatives for more climate action		0.23–1.8
Total	62–78	47–58

Figure 14: Contribution of central policy measures to reaching the 40% target. Source: Climate Action Report, 2016¹¹⁷.

Links to European and international policies

The Energiewende is directly aligned with and pursuing the delivery of the global energy transition:

- Paris Convention on Climate Change and UN SDG on clean energy and climate action;
- European climate and energy policy (EU 20-20-20, Single Energy Market, EU emissions trading system (EU ETS)).

In addition, the German Government plays an active role in multilateral organisations, forums and initiatives, e.g. G7 and G20 frameworks, the International Renewable Energy Agency (IRENA), the International Energy Agency (IEA), the UN’s Sustainable Energy for All (SE4All) initiative, Mission Innovation, the Africa-EU Energy Partnership (AEEP), the Renewable Energy Policy Network for the 21st Century (REN21), the Clean Energy Ministerial (CEM) and the World Bank’s Energy Sector Management Assistance Programme (ESMAP)¹¹⁸.

4.3 Key turning points of the initiative and policy adaptation measures

Major changes / turning points of the initiative	Description of the flexibility mechanism / policy adaptation measures
Fukushima accident in 2011	Shortly after the earthquake and tsunami in Japan, leading to the nuclear reactor meltdown in Fukushima, the Nuclear Phase Out Law

¹¹⁷ The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2016) Climate Action Report 2016. Available:

http://www.bmub.bund.de/fileadmin/Daten_BMU/Pool/Broschueren/klimaschutzbericht_2016_en_bf.pdf

¹¹⁸ The Permanent Mission of Germany to the United Nations New York (xxxx) SDG 7 in the German

National Sustainable Development Strategy. Presentation by Schmid-Lübbert, S. Available:

<https://sustainabledevelopment.un.org/content/documents/22380Ms.%20Stefanie%20Schmid-Luebbert.pdf>

	was passed in the German Bundestag in 2011.
Fast growth and declining market prices of renewable energy	The renewable energy intermediate targets have been revised several times (see the overview in the Figure 11, p. 27). The main policy instrument providing the central framework for renewable energy targets is the EEG originally introduced in 2000. The Act has undergone continuous development since its introduction, including amendments to the Act in 2004, 2009 and 2012, and revisions in 2014 and 2017. These amendments and revisions have gradually changed the original feed-in-tariff based support of renewable energy towards more market price-based model (i.e. auction schemes introduced in 2017). The fast growth of renewable energy has also resulted to shifting the focus of R&I increasingly on the system integration and sector coupling – i.e. the integration of the electricity, heating and transport sectors – and the integration of innovative technologies at the system level to better deliver the goals of the energy transition.
Slower pace of achieving the energy-efficiency goals	Introduction of National Action Plan for Energy Efficiency (NAPE) in 2015 to accelerate the achievement of the energy efficiency targets, including dedicated measures to step up energy efficiency in the buildings sector, establishment of a business model for generating returns on investment for energy efficiency actions, and to increase personal responsibility for energy efficiency.

5 Realised or expected outputs, outcomes and impacts

5.1 Outputs (and new instruments)

Investments are a key factor successfully moving ahead with a cost-effective energy transition. Economic and energy policies have significantly supported businesses and private households to invest in a variety of areas such as building energy retrofits, renewable energy installations, power grids and greater energy efficiency. This framework was further strengthened by the adoption of the Renewable Energy Sources Act 2017, the Electricity Market Act, and the reform of the Incentive Regulation Ordinance. The Act on the Digitisation of the Energy Transition adopted in July 2016 is expected to give further impetus for new business models in the field of digital technology. All the key measures of the National Action Plan on Energy Efficiency (NAPE) are targeted to promote more private investment in efficiency technology. As a result of these measures¹¹⁹:

- Investment in residential building energy retrofits were EUR 36.4 billion in 2015 compared to EUR 35.7 billion in 2014. In addition, EUR 16.8 billion were invested in the existing non-residential buildings in 2015;
- In 2015, EUR 15 billion were invested in renewable energy installations (construction, expansion and upgrading). At the same time however, the installed renewable capacity continues to grow, indicating declining costs per installed facility. Investments are concentrated on wind power and PV technologies, which together account for around 75% of total investment (See the Figure below);
- Investment in the power grids remains high. In 2015, roughly EUR 5.9 billion was invested in the construction of new infrastructure and in grid reinforcement. In addition, grid operators also invested additional EUR 3.3 billion in the maintenance and repair of the grid infrastructure.

¹¹⁹ The Federal Ministry of Economic Affairs and Energy (2016) Fifth Monitoring Report "The Energy of the Future" 2015. Available: <https://www.bmwi.de/Redaktion/EN/Publikationen/monitoring-report-2016-summary.html>

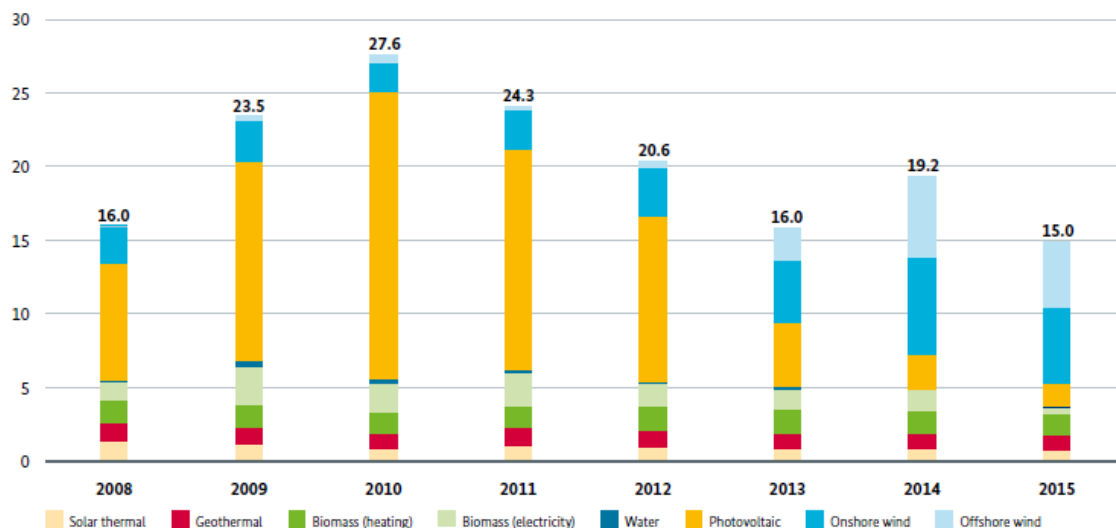


Figure 15: Investments in renewable energy installations 2008-2015. Source: The Ministry for Economic Affairs and Energy, 2016.

5.2 Outcomes

Renewable energies and nuclear phase-out

The German electricity mix has undergone a significant transformation over the last two decades:

- A substantial increase in renewable energy (from 3.6% of the power production in 1990 to 29% in 2016, corresponding to 32.3% of national power consumption),
- A progressive phase-out of nuclear power (13.1% of domestic power production in 2016, down from 27.7% in 1990),
- Constant rates of lignite and slowly declining hard coal power production.

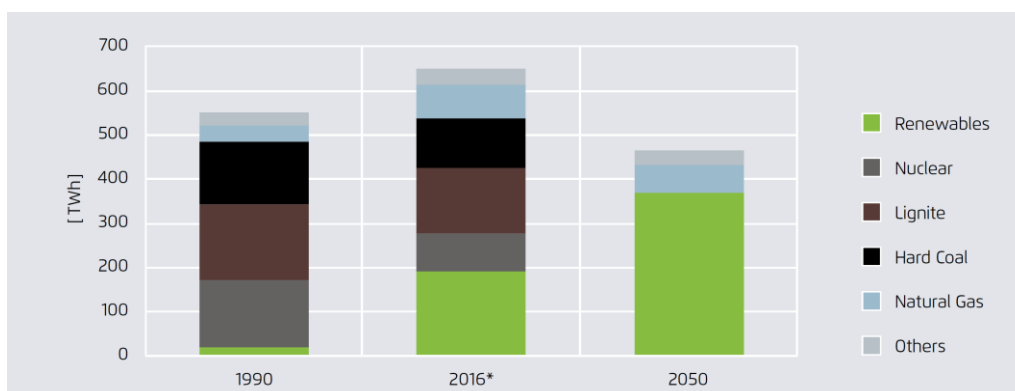
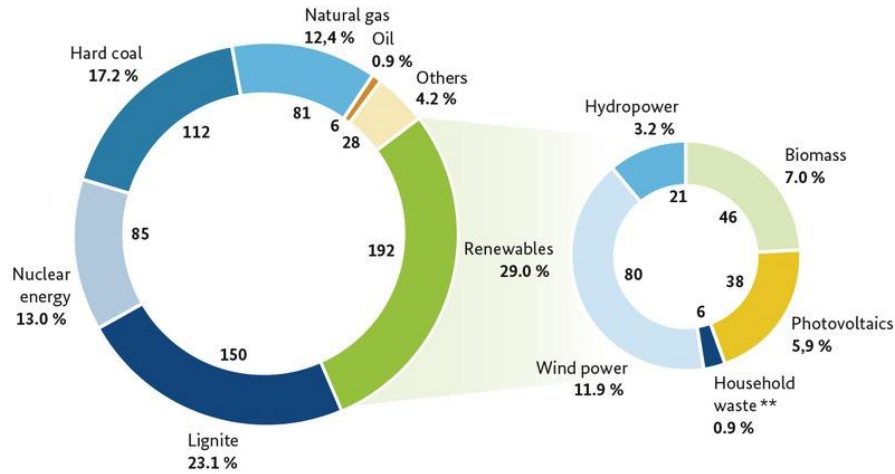


Figure 16: Gross electricity generation (Twh) 1990, 2016 and 2050. Source: Agora-Energiewende, 2017.



* Preliminary figures ** Regenerative part

Figure 17: Gross electricity generation in Germany in 2016*, status: March 2017. Source: The Federal Ministry of Economic Affairs and Energy, 2017¹²⁰

Energy efficiency

- There has been a moderate decrease in power consumption over the last ten years (about -0.5% annual average), but the primary energy consumption has been growing during the last couple of years.
- Germany has, however, been able to decouple economic growth from energy consumption as shown in the figure below.

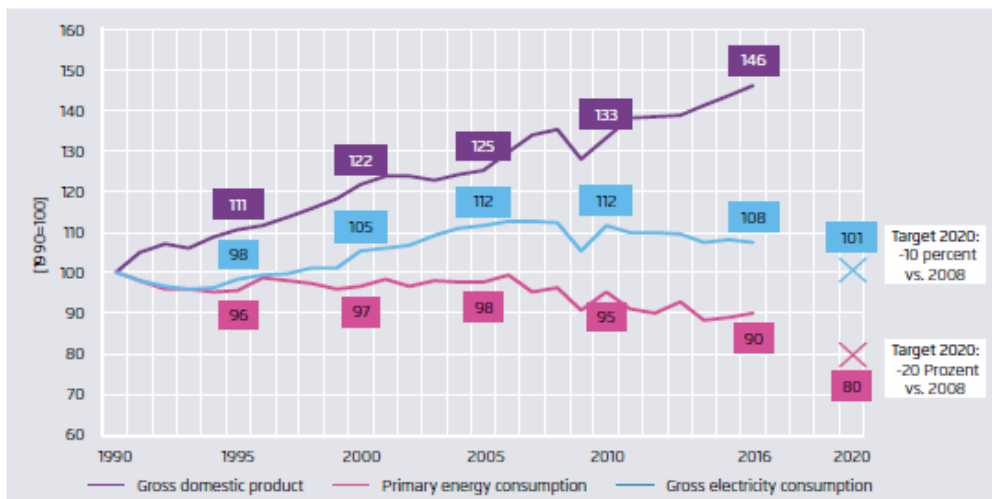


Figure 18: Gross domestic product, primary energy, consumption and electricity production, 1990-2016 (indexed, 1990=100). Source: Agora-Energiewende, 2017.

Greenhouse gas emissions

- In 2016, the **greenhouse gas emissions were 27% below 1990 levels**, as shown in the figure below.

¹²⁰ The Federal Ministry for Economic Affairs and Energy (2017) For a future of green energy. Available: <https://www.bmwi.de/Redaktion/EN/Dossier/renewable-energy.html>

- However, over the past three years, **overall greenhouse gas emissions have slightly increased**. This has been attributed to insufficient emission reductions in the power conversion, industrial, heating and transportation sectors.
- The German power sector (coal and lignite) is the largest emitter, responsible for about 40% of overall national greenhouse gas emissions. The simultaneous nuclear phase-out and increased energy consumption has resulted in unchanged levels in the use of conventional energy sources and made the target of 40% GHG emission reduction rather impossible to meet.

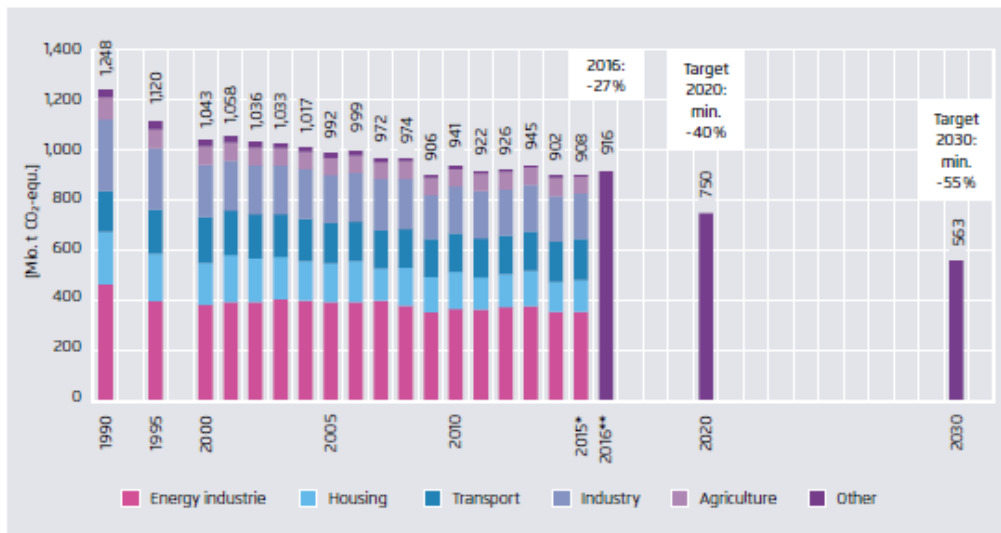


Figure 19: Greenhouse gas emission by sector, 1990-2016, together with reduction targets for 2020 and 2030. Source: Agora-Energiewende, 2017.

Costs of energy

The power prices have increased by about 50% since 2007 (in nominal terms), due to a continuous increase in levies for renewable energy, grid tariffs, and various other levies and taxes, but also other costs¹²¹. The EEG surcharge has risen continuously over the years and is currently set at EUR 6.88 cents per kWh (for a total of EUR 24 billion in 2017). The EEG surcharge compensates the difference between the cost of the feed-in tariffs paid to energy producers, and the revenues from selling the power generated at market price. However, the lower market prices of electricity, due to renewable energy expansion, is at least partially offsetting the high EEG surcharge and expected to do so especially in the coming years.

¹²¹ Agora- Energiewende (2017) The Energiewende in a nutshell 10 Q&A on the German energy transition. Available: https://www.agora-energiewende.de/fileadmin/Projekte/2017/Energiewende_in_a_nutshell/Agora_The_Energiewende_in_a_nutshell_WEB.pdf

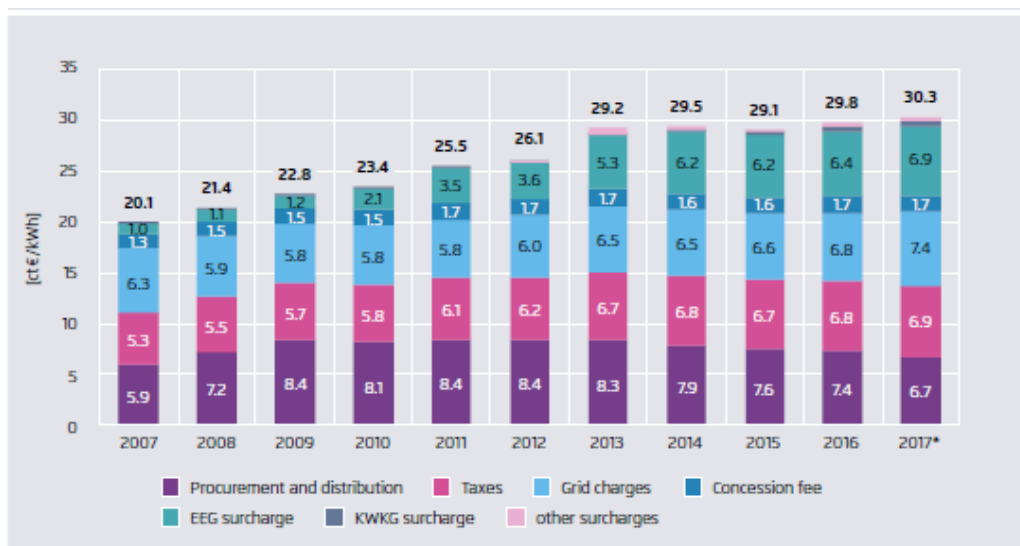


Figure 20: Average household electricity prices for a four-person household (3500 kWh annual use), 2007–2017. Source: Agora-Energiewende, 2017.

Energy import dependence

Germany has been a net exporter of electricity since 2003. This trend has accelerated since 2011, despite the closure of eight nuclear power plants. In 2016, Germany’s net power exports reached 51.2 TWh, representing 8.6% of national power consumption. At the same time, the power imports to Germany were 27 TWh¹²².

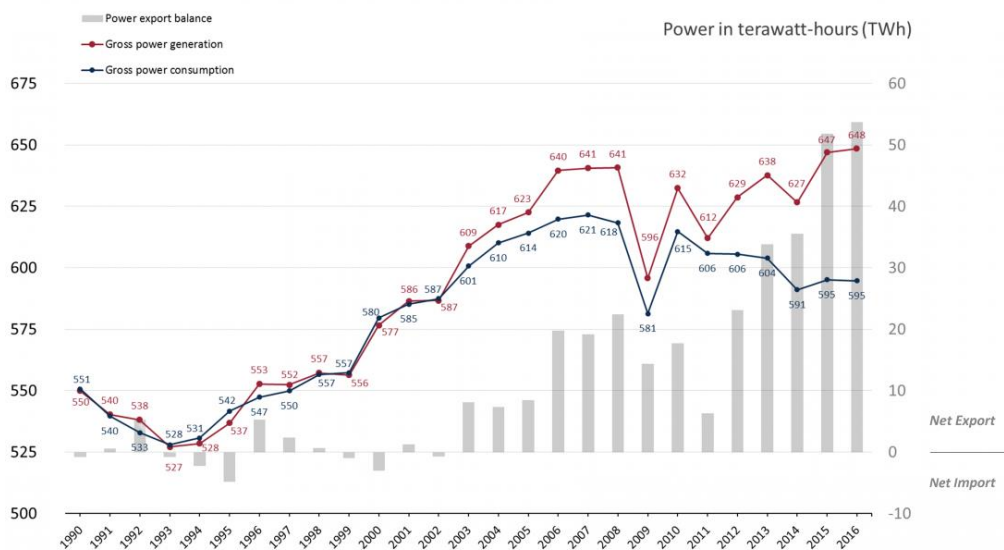


Figure 21: Power export balance in Germany 1990–2016. Source: Clean Energy Wire, 2017¹²³.

The overall picture for the energy sector at large is, however, different: **Germany still relies heavily on energy imports** to cover its energy demand. In 2015, the net imports amounted to 62% of Germany’s energy consumption¹²⁴. This is higher than the average import dependency of the EU28 (54%).

¹²² Fraunhofer- ISE (2016) German annual power trade statistics in 2016. Available: https://www.energy-charts.de/trade.htm?year=2016&period=annual&source=sum_energy

¹²³ Appunn, et al. (2017) Germany’s energy consumption and power mix in charts. Clean Energy Wire, November 2017. Available: <https://www.cleanenergywire.org/factsheets/germanys-energy-consumption-and-power-mix-charts>

¹²⁴ Statistisches Bundesamt (2017) Germany relies on imports to meet majority of its energy demand. Available: <https://www.destatis.de/Europa/EN/Topic/EnvironmentEnergy/EnergyImportDep.html>

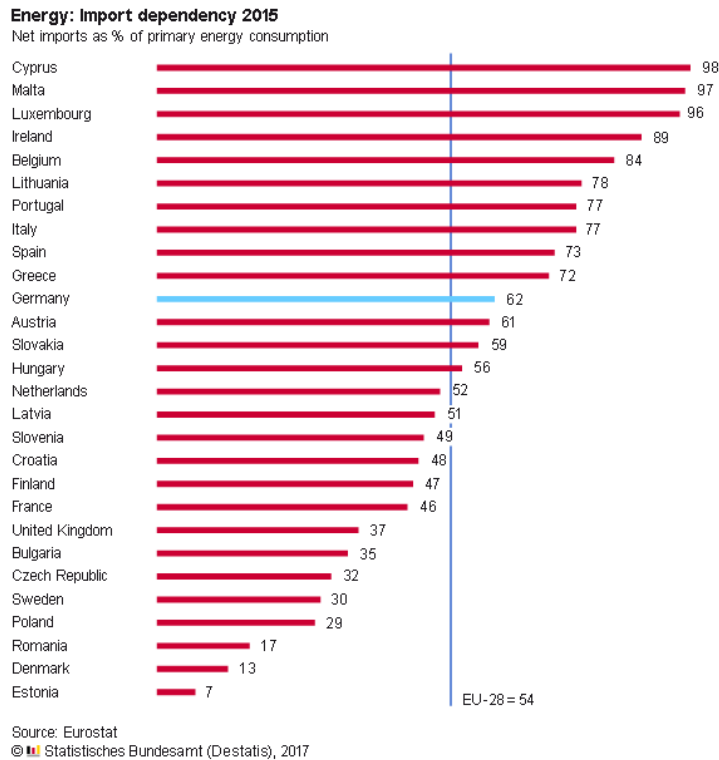


Figure 22: Energy import dependency in EU28. Source: Statistisches Bundesamt, 2017¹²⁵.

5.3 Impacts

The Energiewende has stimulated significant investment in energy sector as shown in the section of the output, which in turn is encouraging employment and growth.

Germany remains the European country with the highest number of jobs in renewable energy sector with **334 000 jobs**¹²⁶. Despite the declining trend over the last years, the German RES sector employs almost as much as the RES sector in France, the United Kingdom, and Italy combined. The development has been quite different for the different technologies^{127,128}:

- Jobs in wind energy (approximately 142 900 jobs in 2015) have been growing over time yielding to stabilised growth rates more recently;
- Jobs in biomass (113 200 jobs) follow the share of biomass use in Germany, which has been more or less constant since 2007;
- Jobs in PV (42 200 jobs) have shown a dramatic up and down: In 2015, jobs fell to one third of the peak in 2012, due to a massive cut back in PV installations in Germany and increasing international competition in PV cell manufacturing.

¹²⁵ Ibid.

¹²⁶ IRENA (2017) Renewable Energy and Jobs. Annual Review 2017.

¹²⁷ Ecofys (2017) Job Potentials of Renewable Energies and Energy Efficiency - A View on Germany and Poland. Available: <https://www.ecofys.com/files/files/ecofys-2017-job-potentials-of-re-ee-ger-pol-factsheet.pdf>

¹²⁸ Agora- Energiewende (2017) The Energiewende in a nutshell 10 Q&A on the German energy transition. Available: https://www.agora-energiewende.de/fileadmin/Projekte/2017/Energiewende_in_a_nutshell/Agora_The_Energiewende_in_a_nutshell_WEB.pdf

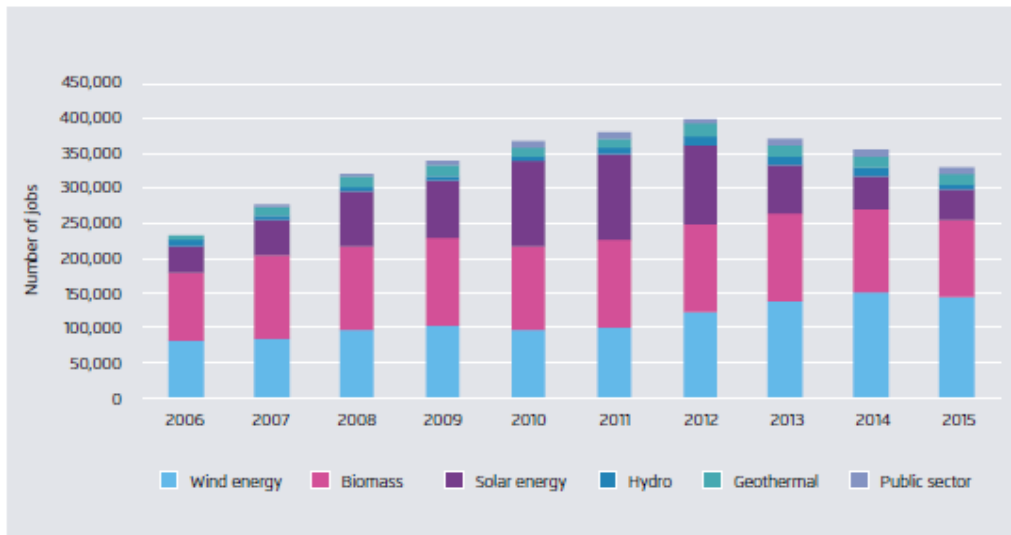


Figure 23: Employment in the German renewable energy sectors from 2006 to 2015. Source: Agora-Energiewende, 2017.

However, given its transformative nature, the Energiewende is **crowding out investment and employment in conventional energy sectors**¹²⁹. According to a study commissioned by the Ministry of Economics, the impact of energy transition on employment is positive, with a yearly **net increase of 18 000 jobs up to 2020** when compared to a scenario without the Energiewende. Although Energiewende contributes to generation of jobs, the levels are similar to the annual job generation found in sectors like the chemical or manufacturing industry in Germany¹³⁰.

Direct value added from renewables is expected to grow in Germany, and the scenarios have estimated the **value added to rise from EUR 18 billion in 2012 to approximately EUR 25 billion in 2030** (depending on the installation rates)¹³¹ (see also the Figure below).

Germany benefits from renewables because it has a strong industry base and is also **exporting renewable energy technologies**. In 2015, the export ratios reached 70% for PV, 66% for wind, 50% for biodiesel and 66% of heat pumps produced in Germany were consigned for export¹³². However, it should be noted that a larger share of the jobs related to renewables comes from **domestic use and installation**. It has been estimated that in the case of PV, 50% of the value added corresponds to manufacturing PV systems, whereas another 50% stays in the region where the plant is actually located and operated. Similarly, the shares for local value added are even higher for wind energy (60%) and bioenergy (70 to 80%). This indicates that it is farmers, landowners, local installers, maintenance and construction companies and small-scale investors, who most benefit from the value added generated by Germany's transition towards renewables.

¹²⁹ Ibid.

¹³⁰ Agora Energiewende (2015) Understanding the Energiewende. Available: https://www.agoraenergiewende.de/fileadmin/Projekte/2015/Understanding_the_EW/Agora_Understanding_the_Energiewende.pdf

¹³¹ Ecofys (2017) Job Potentials of Renewable Energies and Energy Efficiency - A View on Germany and Poland. Available: <https://www.ecofys.com/files/files/ecofys-2017-job-potentials-of-re-ee-ger-pol-factsheet.pdf>

¹³² Ibid.

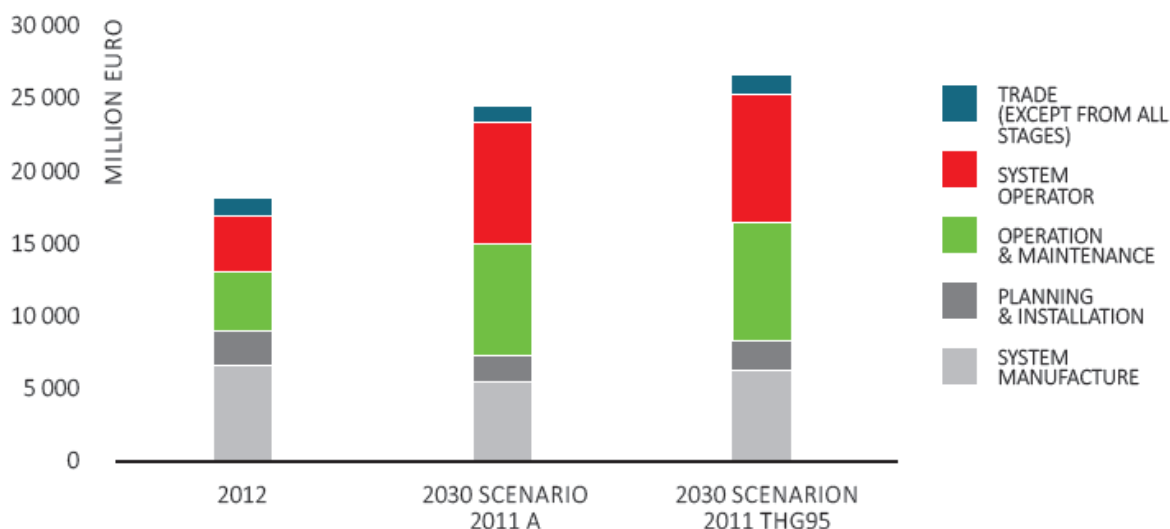


Figure 24: Current and future direct value added through renewable energy technologies along the value chain. Source: Ecofys, 2017.¹³³

Investment in energy efficiency also has positive effects on the national economy. Model-based calculations have suggested that comprehensive measures to improve energy efficiency could provide 190 000 jobs, mainly in the construction industry through building energy retrofits and the construction of new energy-efficient buildings, among other factors¹³⁴. A recent study by Ecofys¹³⁵ (2016) finds that GDP was around 0.3% higher in 2015 as a result of investments triggered by energy efficiency instruments than it would have been in a hypothetical reference scenario without these measures.

The Energiewende is a large-scale societal project and the citizens have played an important role demonstrating a strong desire to phase-out nuclear power and transform the way energy is supplied and consumed. There is a strong consensus in favour of Energiewende's targets, which receive support from 90% of the German citizens¹³⁶. Wind and solar energy are considered as the fundamental pillars of the energy system. The citizens are bit more critical however on the progress of the Energiewende.

¹³³ Ibid.

¹³⁴ The Federal Ministry of Economic Affairs and Energy (2016) Fifth Monitoring Report "The Energy of the Future" 2015. Available: <https://www.bmwi.de/Redaktion/EN/Publikationen/monitoring-report-2016-summary.html>

¹³⁵ Development of a strategy to reach national energy savings goals by 2020 and by 2050, also with due consideration to relevant EU requirements in the context of a holistic climate and energy policy ("Energy Efficiency Action Plan"); Karlsruhe, Berlin, Freiburg, 2016.

¹³⁶ Agora- Energiewende (2017) The Energiewende in a nutshell 10 Q&A on the German energy transition. Available: https://www.agora-energiende.de/fileadmin/Projekte/2017/Energiewende_in_a_nutshell/Agora_The_Energiewende_in_a_nutshell_WEB.pdf



Figure 25: Public opinion about the Energiewende. Source: Agora-Energiewende (2017)

All in all, it can be said that the energy transition is progressing well and is really triggering a transition in the German energy sector.

5.4 Summary of the key indicators

Key indicators	
Timeline:	2010 - ongoing
Objective and targets:	The goal of the initiative is to phase out Germany's nuclear power plants by the end of 2022, transform the energy system to become strongly reliant on renewable energy resources (min. 60% of the final energy consumption, min. 80% of the gross electricity consumption) and enhanced energy efficiency, and to reduce GHG emissions by 80-95% by the year 2050.
Total budget:	Total budget of Energiewende is not available. The annual public budget can be estimated to be EUR 5.8 billion in 2016 (including the annual budget outlay of the Ministry for Economic Affairs and Energy dedicated to Energy and Sustainability and the specific Fund for Climate and Energy). In addition, other Federal Ministries contribute to Energiewende according to their responsibilities (approximately EUR 800 million in 2016). The dedicated budget (distributed under several Ministries) for energy R&I was EUR 876 million in 2016. Also, the German Development Bank (KfW) offers low-cost finance for investments related to renewable energy and energy-efficiency.
Annual budget:	See above.
Share of budget, public funding:	Energiewende is essentially a publicly-led policy but involves a part of government annual budget outlay funding from a dedicated fund for Climate and Energy and low-cost loans provided by the German Development Bank (KfW).
Share of budget, private	-

investment:	
Leverage effect (additional public/private investments the initiative has triggered):	<p>Energiewende policies have a considerable bearing on the decisions of businesses and private households to invest, such as in building energy retrofits, renewable energy, power grids and better energy efficiency. In 2015, the investments were:</p> <ul style="list-style-type: none"> • Residential building energy retrofits EUR 36.4 billion; • Non-residential building energy retrofits: EUR 16.8 billion; • Renewable energy installations: EUR 15 billion; • New grid infrastructure and in grid reinforcement: EUR 5.9 billion. <p>In addition, Energiewende, co-governed by the federal and state levels, has encouraged many Länder to direct their funding policies (e.g. R&I support, support to state energy agencies, SME innovation) to overall targets of Energiewende.</p>
Key (official/public) indicators applied for monitoring the progress towards the targets:	<p>Key monitoring indicators:</p> <ul style="list-style-type: none"> • Reduction of greenhouse gas emissions (compared to 1990 levels); • Increase of renewable energy: <ul style="list-style-type: none"> – Share of gross final energy consumption; – Share of gross electricity consumption; – Share of heat consumption; – Share in transport sector; • Improved efficiency and consumption: <ul style="list-style-type: none"> – Primary energy consumption; – Final energy productivity; – Gross electricity consumption; – Primary energy consumption in buildings; – Heat consumption in buildings; – Final energy consumption: transport. <p>In addition, the Annual Monitoring Report establishes a detailed indicator architecture including the above mentioned but also more detailed indicators for the support action areas (Security of supply, Affordability / Competitiveness, Grid expansion, Sector coupling / Digitisation and Europe / International (see Annex 1 for all the indicators).</p>
Other key indicators (e.g. outputs/outcomes/impacts):	See above and Annex 1.

6 Conclusions and lessons learned

6.1 Identification and assessment of key strengths and weaknesses of the initiative

Strengths	Weaknesses
<ul style="list-style-type: none"> • The Energiewende has shown significant progress towards the goals set. Today, almost one third of German electricity is generated from wind, solar and biomass, making renewable energy the number one source of electricity. The nuclear phase-out plan is also progressing as planned. • Energiewende enjoys strong support within German society and there is a widespread consensus in favour of renewable energy 	<ul style="list-style-type: none"> • Decline of the new investment in renewable energy in post-feed-in-tariff period. • Slowdown of progress towards GHG emission target 2020. Simultaneous phase out of nuclear energy and growing energy demand has led to unchanged levels (same level as 1990) of energy generation from gas, coal and lignite leading to slower

Strengths	Weaknesses
<p>and more decentralised production.</p> <ul style="list-style-type: none"> • The continuity, stability and clear directionality of the energy and climate policy and regulation over the last two decades have resulted in favourable conditions and confidence for private sector investors. • A large share of the renewable energy systems is financed and owned by non-utility actors, including households and energy cooperatives, leading to a highly decentralised energy system and the wide transition “ownership”. • The German business community is broadly supportive of the Energiewende, as it offers new domestic and international business opportunities. • The German state-owned development bank KfW has played a large role in providing access to low-cost finance to citizens and business owners. • Energiewende has set Germany in a pioneering position for many renewable energy technologies, which offers large opportunities for German research and industry in international markets. • The Energiewende is being monitored carefully on international scale and could be translated to European or global scale, although this would require more transparent information on the real costs and benefits of the initiative. • The future EU and global climate change and energy policies, e.g. the progress of Energy Union, ETS trading scheme, possible European “Supergrid”, global policies for tackling climate change can all become both opportunities and threats for the future of the Energiewende. 	<p>decrease in GHG emission levels.</p> <ul style="list-style-type: none"> • High electricity prices that can eventually erode support and complaints of German citizens and industry. • So far, rather weak integration of the transport sector and German city-level administration (streamlining with e.g. smart city initiatives) to the energy transition. • Scale of the initiative and the high ambition levels result to complex governance structures and difficulties to monitor the real costs of the initiative. • Losing credibility in the international context if not achieving the GHG emission targets by 2020. • The technological challenges, such as grid capacity, stability, and flexibility may become obstacles for the Energiewende’s future development. • The new government after the autumn 2017 elections, combined with the challenges the Energiewende is facing, may become a threat for efficient and effective political decision making. • The future EU and global climate change and energy policies, e.g. the progress of Energy Union, ETS trading scheme, possible European “Supergrid”, global policies for tackling climate change can all become both opportunities and threats for the future of Energiewende. • The neighbouring countries of Germany have very different energy supply policies that have in past resulted in complaints on unfair competition for electricity prices and could also lead to criticism in future.

6.2 Lessons learned and key messages for European R&I policy

The Energiewende is extremely ambitious, complex and risky initiative, yet it seems to work and counts on the support of the German citizens.

It has been said that Germany is testing a “mix of top-down direction-setting and bottom-up buy-in”¹³⁷ to make the Energiewende work. The strategy is characterised by centralised coordination and very clear and ambitious objectives on one hand, and widespread support of citizens, on the other. This legitimacy has been gained through engagement of citizens in the various stages of the initiative: strong support of nuclear

¹³⁷ Economist (2012) Germany’s energy transformation Energiewende. Available: <http://www.economist.com/node/21559667>

phase-out at initial stages turned the citizens into initiators of the Energiewende. Later on, the citizens became co-owners of the distributed energy generation system through households or energy-cooperatives investing in renewable energy generation. This has been largely incentivised by the feed-in tariffs and facilitated by low cost loans offered by German development bank KfW. The recent changes to support schemes and the slow-down of renewable growth in Germany in very recent years, however, could be seen as indicators that new business models and different, non-economic support schemes are required now that renewables, and especially PV, are almost competitive in terms of cost with traditional, centralised generation.

The electricity consumers are also the payers of the Energiewende in the form of EEG surcharge, which is used to compensate the feed-in tariffs provided to the energy producers. Due to the EEG surcharge, the average household electricity costs have increased over the last decades, which, however, has not had a negative impact on the positive public opinion on the Energiewende.

To be a success, the energy transition or any large-scale endeavour aimed at transforming a system, depends largely on the extent to which a new technology can be used to fulfil society's expectations, meet people's needs and win their acceptance and support¹³⁸. The energy policy has shown at least in the past decade a high degree of continuity in its central aspects and transparent manners to communicate progress. As a result, the policy is fundamentally anchored in the public opinion and enjoys a high degree of commitment of citizens.

The Energiewende has also successfully utilised the "windows of opportunity" created by external factors, e.g. the Fukushima accident or international and European energy and climate agreements. The government has efficiently and rapidly taken these windows to pass complex political decisions.

Among the key components of the success of the Energiewende is the fact that it didn't prioritise one kind of renewable technology over another, but rather provided a general direction, without specifying objectives for different renewable energy technologies. *"There was no master plan, but rather a general direction and a support scheme with priority access for renewable energies. No one knew in 2000, for example, that the cost of photovoltaics would sink so dramatically and become such an important pillar of the Energiewende"*¹³⁹ according to Dr. Nina Scheer, a former Member of the Bundestag (Social Democrat Party).

It can be said that the Energiewende is transforming the German energy sector and thus is creating important societal benefits in the long run. From the economic perspective, the costs and benefits are perhaps less clear.

¹³⁸ Hake, J. -F. et al. (2015) The German Energiewende – History and Status Quo. Available: http://www.fz-juelich.de/SharedDocs/Downloads/IEK/IEK-STE/DE/Publikationen/preprints/2015/preprint_10_2015.pdf?__blob=publicationFile

¹³⁹ P2Foundation (2015) Energiewende. Available:<http://wiki.p2pfoundation.net/Energiewende>

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Annex 1: Monitoring indicators

Monitoring Indicators	
<p>Renewable energy</p> <ul style="list-style-type: none"> • Share of renewable energy sources (RES) in gross final energy consumption • Share of RES in gross electricity consumption • Renewable electricity generation by technology • Gross electricity generation by energy source • Share of RES in heating and cooling consumption • Share of RES in the transport sector • EEG surcharge • Sum total of EEG surcharge plus electricity price on the exchange 	<p>Competitiveness</p> <ul style="list-style-type: none"> • Energy spending of private households • Electricity prices of private households • Energy costs for industry • Oil and gas prices • Electricity prices on the exchange • Electricity prices of non-privileged industrial enterprises • Macroeconomic energy spending • Energy prices compared to other countries
<p>Efficiency and consumption</p> <ul style="list-style-type: none"> • Primary energy consumption • Primary and final energy productivity • Gross electricity consumption • Share of final energy consumption of buildings in total energy consumption • Final energy consumption of buildings/heating final energy consumption • Specific final energy consumption for space heating • Primary energy consumption in buildings 	<p>Grid expansion</p> <ul style="list-style-type: none"> • Projects under the Energy Line Expansion Act and Federal Requirements Planning • Grid investment • Grid charges • Costs for ancillary services
<p>Transport</p> <ul style="list-style-type: none"> • Final energy consumption in the transport sector • Specific final energy consumption of the transport sector • Number of 3-wheel-plus vehicles with an electric drive • Number of 3-wheel-plus vehicles powered by fuel cells and natural gas • Shift to rail transport • Shift to public transport 	<p>Sector coupling / Digitisation</p> <ul style="list-style-type: none"> • Number and electricity consumption of heat pumps • Number and electricity consumption of electric cars • Digitisation of the energy transition • Remote controllability and remote readability of RES installations • Metering and measuring technology among domestic customers • Metering and measuring technology in industry
<p>Greenhouse gas emissions</p> <ul style="list-style-type: none"> • Greenhouse gas emissions • Greenhouse gas emissions by source group • Energy-related CO2 emissions by sector • Greenhouse gas emissions avoided through use of renewables • Specific greenhouse gas emissions in relation to the population and GDP 	<p>Europe / International</p> <ul style="list-style-type: none"> • EU 20-20-20 targets • Trade-related flows of electricity • Physical flows of electricity • Emissions trading in the EU-ETS • Effort sharing in the non-ETS sector • Global investment in renewable energy and energy efficiency • Global installed renewable capacity • Research innovation • Industry spending on R&D • Federal research spending in the Energy Research Programme • Project funding from EU funds • Patents • Market uptake of innovative technologies in energy consumption • Investment •
<p>Security of supply</p>	<p>Growth / Employment</p> <ul style="list-style-type: none"> • Investment in renewable energy and energy

<ul style="list-style-type: none"> • Installed capacity of power generation plants • Distribution of power plant capacity across the Länder • CHP electricity generation • Conventional generation capacities: new plant construction and dismantling of plants • Capacity of pumped storage power stations 	<p>efficiency</p> <ul style="list-style-type: none"> • Investment in grids and electricity supply • Primary energy sources saved as a result of the use of renewable energy • Numbers employed in conventional electricity supply • Numbers employed in renewable energy sector
<p>Nuclear phase-out roadmap</p> <ul style="list-style-type: none"> • SAIDI index • Electricity outage duration compared to other countries • Affordability 	

Source: Energiewende Monitoring Report 2016, p. 10.

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This is one of a series of case studies developed to support mission-oriented research and innovation policy at EU level.

The Energiewende is a German national long-term strategy for the development of a low-carbon energy system based on renewable energy and energy efficiency. The initiative is an integrated policy that addresses all sectors of the economy and is driven by four objectives: fighting climate change, phasing-out nuclear power, improving energy security and guaranteeing industrial competitiveness and growth. The goal of the initiative is to phase out Germany's nuclear power plants by the end of 2022, transform the energy system to become strongly reliant on renewable energy resources (min. 60% of the final energy consumption, min. 80% of the gross electricity consumption) and enhanced energy efficiency, and to reduce greenhouse gas emissions by 80-95% by the year 2050. The Energiewende relies on the technological innovations realised through research and development activities and depends on citizen engagement on the systemic transition.

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