HEINRICH BÖLL STIFTUNG

Energy Transition
The German Energiewende

By Craig Morris, Martin Pehnt

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Authors:
Craig Morris
Martin Pehnt

Editors:
Rebecca Bertram
Stefanie Groll
Kathrin Glastra

Design:
Lucid. Berlin

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Heinrich Böll Stiftung
Schumannstr. 8
10117 Berlin
Germany

Phone: +49 – (0)30 – 285 34 – 0
Fax: +49 – (0)30 – 285 34 – 109

Email: energiewende@us.boell.org

You can also contact one of our 29 offices worldwide
working all on energy and climate issues

About us

The Heinrich Böll Foundation – is a catalyst for green visions and projects, a think tank for policy reform, and an international network. The primary objectives guiding our work are establishing democracy and human rights, fighting against environmental degradation, safeguarding everyone's rights of social participation, supporting non-violent conflict resolution and defending the rights of individuals. We work with 160 project partners in over 60 countries and currently maintain offices in 31 countries.

Authors

Craig Morris – Born in the United States, Craig has been living in Germany since 1992 and working in the renewables sector since 2001. In 2002, he founded Petite Planète, a translation and documentation agency focusing on renewables. He is the author of two books in German and English, has served as editor of several energy magazines, and is contributing editor at Renewables International. In 2013 and 2014, he served as technical editor of IRENA's REmap 2030, and in 2014, he won the IAEE's award for journalism in energy economics. He is co-author of the book "Energy Democracy."

Martin Pehnt – A trained physicist, Martin is scientific and managing director of the Institute for Energy and Environmental Research (ifeu), where he also heads the Energy Department. He previously worked at the National Renewable Energy Laboratory (USA) and the German Aerospace Center (DLR). He now serves as an advisor for many national and international organizations, including German federal ministries, the Environmental Protection Agency, environmental NGOs, utilities, the World Bank, IRENA and the GIZ. Pehnt teaches at various universities.

Editors

Rebecca Bertram – is the Director of the Energy and Environment Program at the Heinrich Böll Foundation's Washington office. Her work focuses on building a global and transatlantic dialogue on German and European energy and climate policy. Rebecca holds a Masters degree in International Affairs and Economics from the Johns Hopkins University's School of Advanced International Studies (SAIS).

Stefanie Groll – is the Head of Department for Environmental Policy and Sustainability at the headquarters of the Heinrich Böll Foundation. Her main focus is the promotion of the German energy transition and questions regarding the decarbonization of the economy. Stefanie is active in the anti-coal and climate movement in Germany. She holds a PhD in political science and is a communications expert.

Kathrin Glastra – is the Liaison for Energy Transition in Western Europe and Deputy Director of the Climate and Energy Program at the Heinrich Böll Foundation's EU office in Brussels. She coordinates the Foundation's network EnergyTransition@EU, a joint project between the offices in Berlin, Brussels, Prague and Warsaw. This network aims at discussing challenges and opportunities of energy transitions in Europe; strengthening a mutual, solution-oriented dialogue among the EU Member States and promoting visions for a European Energy Transition. Kathrin holds an MA in Political Science, Law and Spanish and an MA in Advanced European Studies from the College of Europe (Bruges).

Silvia Weko – is the project assistant for the German Energy Transition project. at the headquarters of the Heinrich Böll Foundation. She is currently pursuing an MA in European History at the Humboldt University in Berlin.

Media Development

Lucid. Berlin – as a media solutions laboratory, Lucid develops tools and designs which enable foundations, NGOs and institutions to inform, foster dialog and involve people. "www.energytransition.de" is the second international web project after discover boell that lucid has designed and produced for the Heinrich Böll Foundation.

About the project

Germany has drawn a lot of international attention for its aim to switch to a renewable energy economy and leave nuclear and fossil energy behind. A lot of the international reporting about the German Energy Transition, or *Energiewende*, has, however, been misleading – for instance, when it comes to the role of coal power, energy price trends, competitiveness and carbon emissions.

This website aims to explain what the *Energiewende* is, how it works, and what challenges lay ahead. It is intended to provide facts and explain the politics and policies to an international audience. The website highlights the effects of the *Energiewende* on the German economy, environment and society and addresses the most important related questions. We also aim to highlight that energy transitions can be structured very differently around the world depending on the energy mix and policy priorities of individual countries.

On our Energiewende Blog, a team of international energy experts write on how the German energy transition continues and how it relates to other countries.

We welcome your feedback and encourage you to comment and discuss the German *Energiewende* with us.

Content

Content

1 Why the Energiewende

There are reasons to switch to renewable energy and to increase energy conservation, and there are reasons to do so now.

A – Fighting climate change

The burning of coal, oil, and gas is causing our climate to overheat. Our current energy supply is not sustainable. One major aim of the *Energiewende* is to decarbonize energy supplied by switching to renewable sources and reducing demand by means of greater efficiency.

Based on a large body of research conducted by scientists from around the world, the International Panel on Climate Change (IPCC), which does not conduct its own research but rather reports on the general international scientific consensus, has repeatedly warned that the rampant effects of climate change could be disastrous.

In 2015, a survey found that 55 percent of Germans believe that climate change is a "very serious" problem, far more than the mere 27 percent who felt that the economic crisis was the biggest problem – perhaps because Germany's economy has proved so resilient over the past few years partly thanks to green technology. Not surprisingly, the survey determined that 79 percent of Germans believe that energy efficiency and combating climate change are good for economic growth and can create jobs. Survey repeatedly find that fewer than 10 percent of Germans are "climate skeptics.

The German business world generally agrees that clean tech is an economic opportunity. After the COP21 conference in Paris, for instance, a group of 34 leading large midsize German firms from a wide range of industries openly declared their support for the agreement and promised to be pioneers in climate protection themselves. Even skeptical onlookers are coming around: in 2014, only a third of those surveyed by the World Energy Council said that the *Energiewende* would have long-term economic benefits, compared to 54 percent in 2015.

Yet too many German industrial firms continue to fight emissions regulation procedures; for example, the German steel sector voiced its opposition to a floor price on carbon in 2016.

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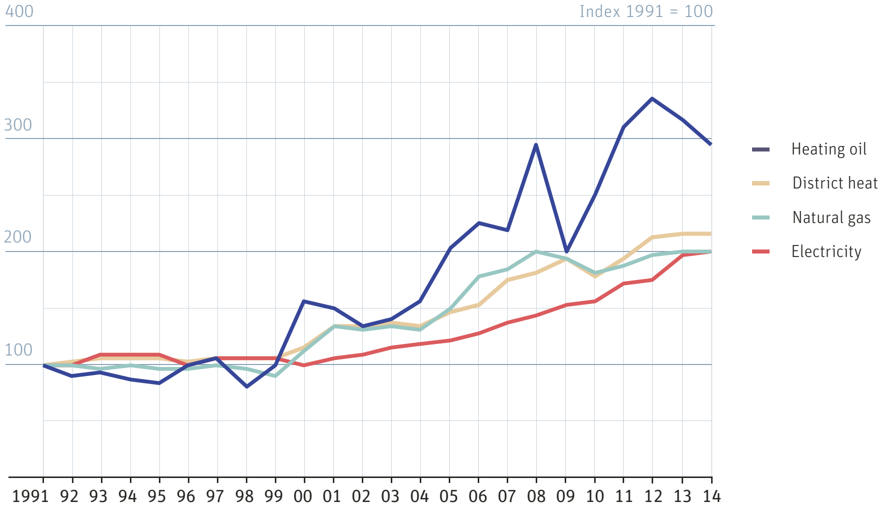
The German public, at least, feels a responsibility to act. They understand that they are one of the countries that have contributed the most to carbon emissions over the past 150 years, and their current position as a leading industrialized nation brings with it a responsibility towards countries that not only still have a lot of development ahead of them, but will also be more severely impacted by climate change. Germans assume this responsibility mainly in two ways:

1. a commitment to international climate funding; and
2. the energy transition.

Cost of electricity has risen less than other energy sources in Germany

Index of household energy prices relative to 1991

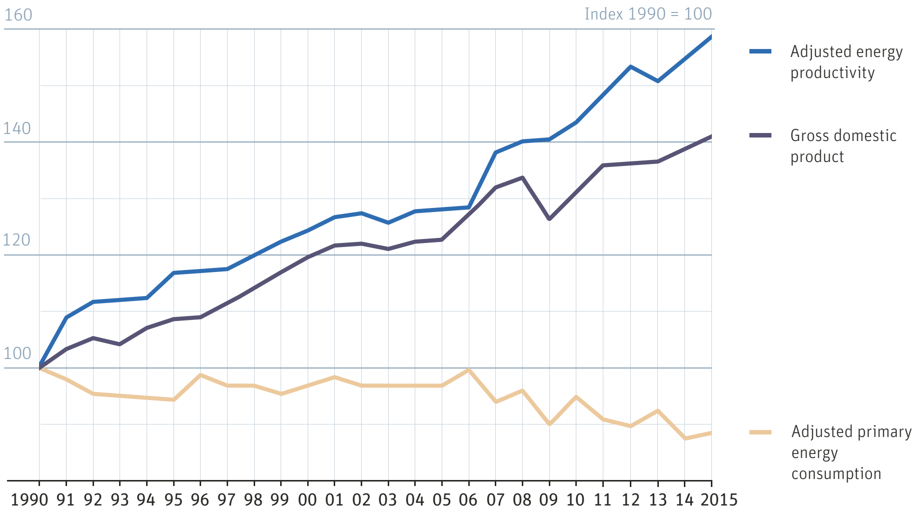
Source: BMWI



Germany is getting more value from less energy

Energy consumption is shrinking though power generation is up thanks to efficiency

Source: Federal Statistical Office (Destatis); Working Group on Energy Balances (AGEB)



The carbon budget

Climate experts say that a certain amount of global warming is unavoidable at this point because the climate reacts with such inertia, and the warming would continue for a few decades even if carbon dioxide concentrations in the atmosphere were to stabilize at the current levels – which are drastically higher than anything in recent history. Around the beginning of the Industrial Revolution in the 19th century, the atmosphere had 280 parts per million (ppm) of carbon dioxide, but we are now exceeding 400 ppm.

In order to keep the planet from heating up more than two degrees Celsius, which would prevent the most disastrous changes, we need to keep that figure from rising above 450 ppm. Many scientists believe that returning to 350 ppm is a good long-term goal, but that would require a net subtraction of carbon dioxide (CO2) from the atmosphere – at present, we continue to add CO2 to it.

Relative to 1990, Germany reduced its carbon emissions by 27.2 percent at the end of 2015, thereby overshooting its target for the Kyoto Protocol of 21 percent for the end of 2012 in the process. Germany aims to go further, with an 80 to 95 percent reduction by 2050. For 2020, Germany has a voluntary target of a 40 percent reduction that is unfortunately unlikely to be met due to still high levels of coal generation.

While these targets may seem ambitious, the industrialized world needs to move faster in light of the consequences we face. If we are to stay within the "carbon budget" of 450 parts per million, then no more than 1,230 billion tons of greenhouse gases can be added to the atmosphere. In 2014, around 50 billion tons of such heat-trapping gases were emitted; at that rate, we would use up this budget in only 25 years, meaning we would ideally need zero emissions globally starting in 2030.

Furthermore, if we admit that developing countries have a right to increase their emissions slightly as they develop, then the burden of lowering emissions falls even more upon already industrialized countries. In other words, Germany needs to reduce its emissions by 95 percent, not 80 percent. Note that a reduction in emissions will not necessarily lead to less economic growth; from 1990 to 2014, EU member states reduced their carbon emissions by 19 percent even though they posted 45 percent economic growth.In 2015, Germany's economy grew by 1.7 percent, while greenhouse gas emissions rose by less than one percent due partly to colder weather and record power exports.

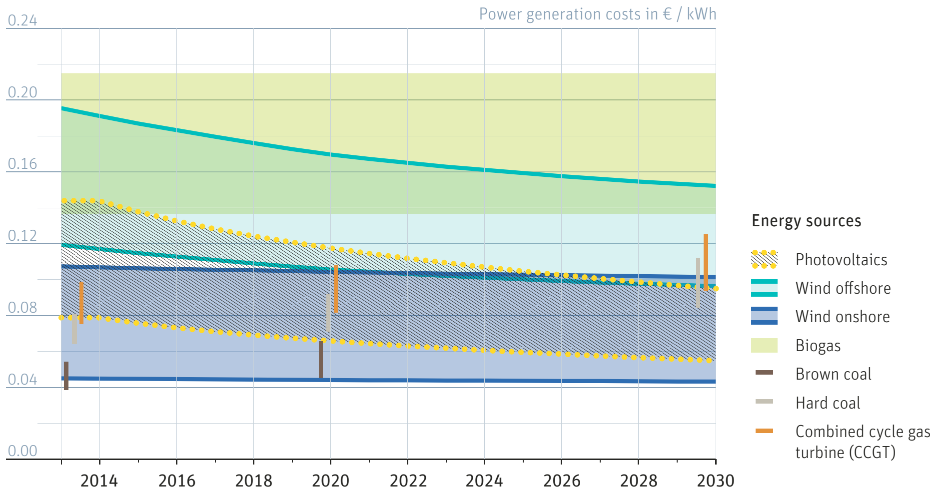
Renewables and efficiency are the solution

Germany produces several studies a year on what a 85-90 percent carbon reduction might look like by 2030 – without reducing the standard of living. The short answer is that we can first become considerably more efficient in order to reduce energy demand, including for heat; parallel to that,,

Renewables are becoming competitive

Forecast of power generation cost in Germany up to 2030

Source: Fraunhofer ISE



we switch our power supply over to renewables. The transportation sector will be a major challenge, where a wide range of solutions will be needed.

Many efficient technologies are already available, such as LED lights instead of conventional light bulbs. When it comes to air conditioning and heating, passive houses can provide pleasant levels of comfort at very low levels of energy consumption. Electric vehicles are finally becoming more popular as well. Aviation and long-distance shipping remain fields where renewable solutions are more complex, however.

Renewables can increasingly cover a larger share of the energy we still have to consume. In Germany, renewables offset an estimated 168 million tons of CO2-equivalent emissions in 2015, 103 million tons of which was in the power sector alone. Biomass is also generally carbon-neutral, meaning that the amount of carbon emitted is roughly equal to the amount that the plants bound during growth. Biomass in the German heat and transport sectors reduced CO2 emissions by roughly 41 million tons in 2015.

B – Reducing energy imports

Germany imports about two thirds of its energy. Renewables and energy efficiency help reduce imports significantly, thereby increasing Germany's energy security.

In 2013, Germany spent around 90 billion euros on energy imports, equivalent to eleven percent of its expenses for imports. Germany imports two thirds of its energy, including uranium. The German Environmental Ministry estimates that renewable energy offset 9.1 billion euros in energy imports in 2013 alone. Most of that renewable energy was electricity and heat, however, with domestic renewable motor fuel production making up only around five percent of the pie.

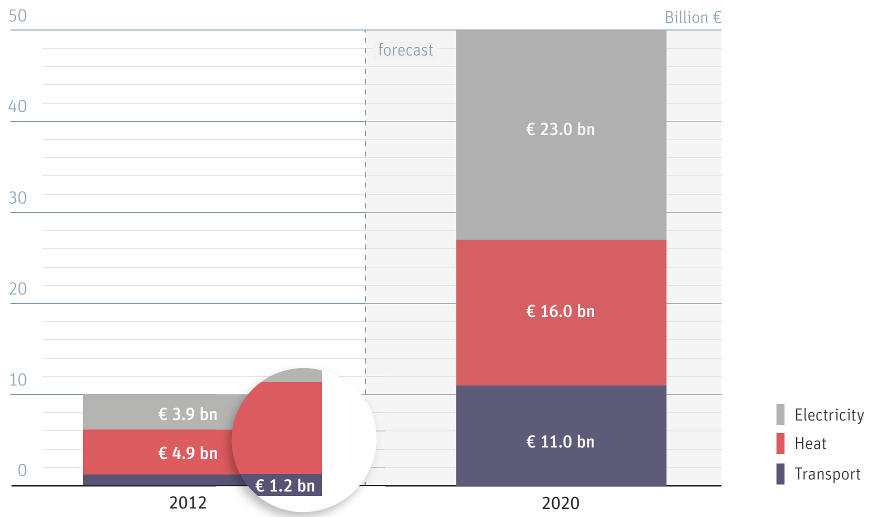
Energy efficiency can also significantly help reduce energy imports. A study conducted by the IFEU Institute of Heidelberg, in cooperation with the Institute of Economic Structures Research, found that a scenario with more efficient energy consumption would reduce energy imports by four billion euros in 2030 compared to a scenario without these efficiency gains – and that figure would continue to rise. In this respect, the energy transition also increases energy security.

The conflict with Russia and Ukraine has also highlighted the importance of energy security. In 2014, a study conducted by the Fraunhofer IWES found that the growth of renewables could offset the equivalent of Germany's current gas consumption from Russia by 2030.

Renewable energy offsets expenses for fossil fuel imports

Benefits of renewables in energy use, Germany

Source: AEE



C – Stimulating technology innovation and the green economy

The energy transition boosts green innovations, creates jobs, and helps Germany position itself as an exporter of green technologies.

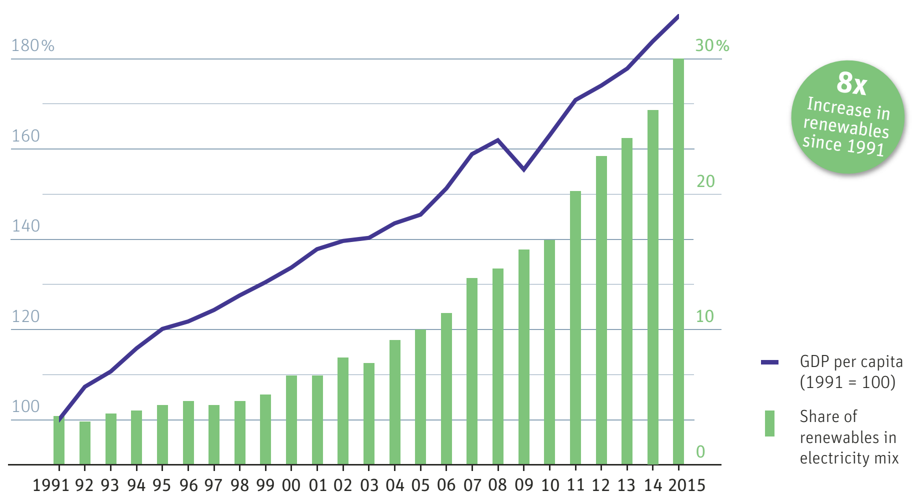
Germany is an export-based economy and is positioning itself as an innovator in green technologies. The German Solar Energy Association (BSW) estimates that exports made up 65 percent of German PV production in 2013, up from 55 percent in 2011 and 14 percent in 2004 – and the target is 80 percent for 2020. The German Wind Energy Association (BWE) puts the wind industry's current export ratio at 65 to 70 percent.

The market for products that increase energy efficiency is already significant, which is especially important, because this market will only continue to grow, similar to the market for renewables. Germany is a major player on both of these markets.

Renewables do not hurt Germany's economy

Gross Domestic Product and share of renewables in power generation from 1991-2015

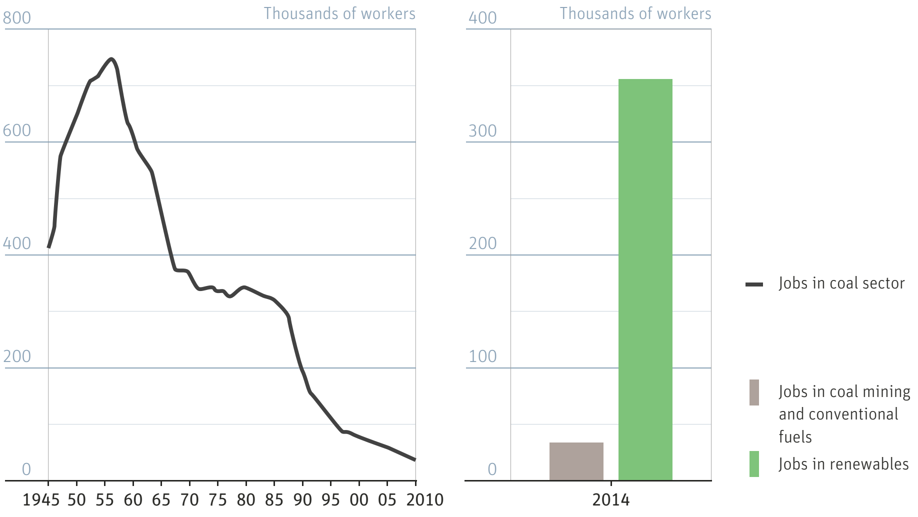
Source: BMWI, AG Energiebilanzen, Destatis



Renewables create more jobs than coal power does

Employment in Germany in renewable and conventional energy sectors

Source: DLR, DIW, GRS, Kohlenstatistik.de. Renewables data from 2014.



These figures represent "gross job creation," meaning the absolute number of jobs that have been added. A thorough study of the German market estimates a net job creation of around 80,000, rising to 100,000 – 150,000 in the period from 2020 to 2030. One reason why renewables have such a positive impact on net job creation is that renewable power directly offsets power from nuclear plants, and very few people work in those sectors.

A study conducted by corporate consulting firm Roland Berger found that the market for energy efficiency products will continue to grow rapidly, doubling in volume from 2005 (450 billion euros) to 2020. Not surprisingly, a lot is being invested in development in this sector, where Germany makes up the second largest share of the pie at 20 percent, behind the US at 24 percent.

In particular, midsize firms are benefiting from the growing demand for energy efficiency products and applications, with more than half of the sales revenue from environmental protection goods (of which energy efficiency is a subcategory) being posted by firms with fewer than 250 employees.

A strong position in local and global green technology markets creates jobs. In Germany, roughly 355,000 people already worked in the renewables sector in 2014, down from a peak of 380.000 in 2011 mainly due to layoffs in the solar sector. In 2015, the German Ministry for Energy and Economic Affairs estimated that the net number of additional jobs brought about by renewables would reach 100,000 by the year 2030 and 230,000 by 2050.

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D – Reducing and eliminating the risks of nuclear power

Germany rejects nuclear power because of the risks, the costs and the unsolved waste issue. In addition, nuclear power does not have the potential to play a major role in future world energy supply.

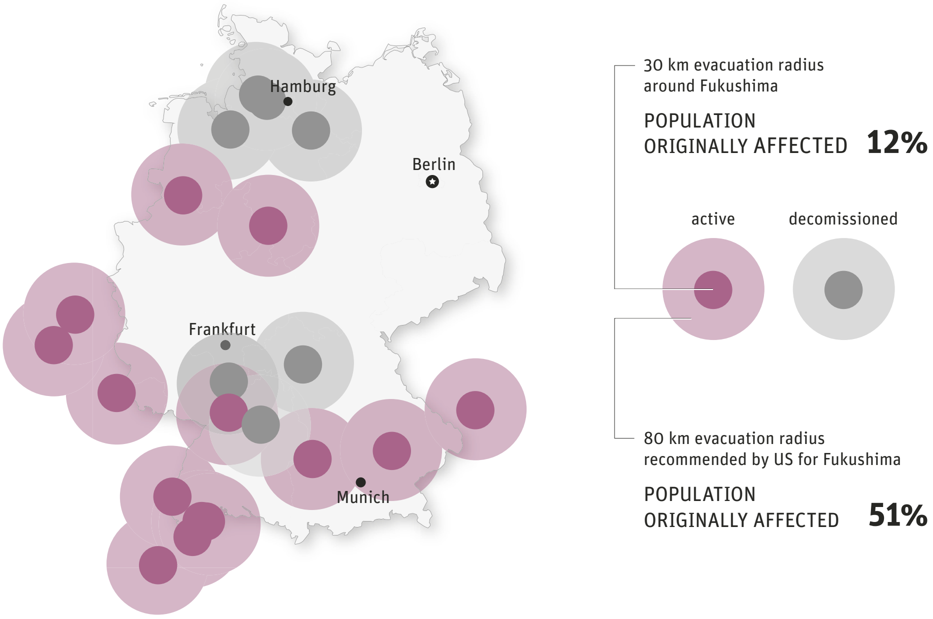
In the debate about the *Energiewende*, the environmental community often focuses on carbon emissions. Supporters of nuclear power no longer speak only of "power too cheap to meter" but now also call for "low-carbon technologies" (though some carbon is emitted during plant construction and uranium mining), a term that encompasses not only renewables, but also nuclear power.

The German public sees a significant difference between nuclear and renewables, however. Indeed, as we discuss in the History section, the *Energiewende* movement started in the 1970s as a popular protest against nuclear power.

Recognizing the danger of nuclear power

30/80 km radius around nuclear reactors in Germany and nearby reactors of neighbouring countries

Source: http://opendata.zeit.de/atomreaktoren



There are six main problems with nuclear power:

1. the risk of a nuclear disaster at a plant (such as the rather well-known ones at Fukushima, Chernobyl, and Three Mile Island, but also lesser-known ones, such as the Kyshtym accident);
2. the risks of proliferation (plutonium from nuclear plants for military purposes);
3. the risk of radiation from the storage of nuclear waste;
4. the cost, with nuclear being unbankable at the moment – banks will not finance the construction of new nuclear plants because the cost is too high in comparison to renewables, so all plants currently on the drawing board in Western countries have massive state support – the Hinkley Point nuclear plant proposed in the UK is to have feed-in tariffs higher than what Germany pays for solar power in addition to state guarantees for bank loans; and
5. the limited availability of uranium resources, and
6. the incompatibility of inflexible baseload power with fluctuating wind and solar.

The third risk is even greater because it will be passed it on to future generations, who will not be able to consume the nuclear power we produce today but will be forced to deal with our waste. Even when all of our nuclear fission plants have been shut down globally, mankind will have to protect its repositories of spent nuclear fuel rods for up to 100,000 years.

Those who nonetheless support nuclear power and deem these risks manageable also believe that we will not be able to reach a 100 percent renewable energy supply. In fact, nuclear power is far more limited than renewables. Indeed, as with current coal plants, the use of waste heat from nuclear plants is a technical challenge, and nuclear security trumps waste heat recovery.

In contrast, solar heat is quite efficient, and systems can be installed directly where heat is consumed (such as on your house). Waste heat from biomass units is also easily recovered, and such cogeneration units can have high total efficiencies well above 80 percent.

The true future of nuclear power

In the end, however, it does not matter whether you believe 100 percent renewables is possible or not. Nuclear power is simply too small a player on global markets; it does not even account for six percent of global energy supply right now, and more plants are scheduled to be taken off-line over the next decade than are expected to go online. The International Energy Agency, which has supported nuclear power since its founding in 1973, believes that the world can roughly triple the number of nuclear plants from the current level (approximately 440) to around 1,400 by 2050 – equivalent to 35 new nuclear plants per year – but the WWF has estimated that this highly unlikely scenario would only lower global carbon emissions by ten percent. That outcome is too little, too slow, and too expensive to contribute meaningfully to tackling climate change. In addition, severe resource issues would arise in the process. At current rates of consumption, uranium for light-water reactors will only be available at affordable prices for roughly the next 30 years. Nuclear is therefore not a solution, even if you believe the risks are manageable and your main goal is to reduce carbon emissions.

If we can gradually shift to a renewable energy supply, then it seems irresponsible to have nuclear plants today – and unethical continue passing on these risks to future generations.

E – Energy security

Renewables reduce Germany's dependency on energy imports, making Germany less vulnerable to unpredictably fluctuating prices for fossil fuels and to political influence from abroad.

Energy security reflects the availability of affordable energy. Demand for energy is increasing in a growing number of emerging countries – especially those with large populations, such as China and India – and may outstrip supply, which could eventually lead to considerable price hikes. Germany is especially vulnerable here because it imports so much of its energy.

In addition, as the world saw in the 1970s when OPEC restricted its oil supply to certain countries, energy imports can dry up for political reasons overnight. A few years ago, Russia discontinued its natural gas supply to Ukraine, which also affected downstream western European countries. The recent armed conflict in eastern Ukraine has only worsened the situation. The more energy a country gets from within its own borders, the less vulnerable it is to such political disruptions, for which it may not even be responsible. A diversification of energy carriers also means a diversification of producing countries.

In western Europe, Germany is by far the largest importer of gas from Russia. What's more, Germany only produces around 15 percent of its own natural gas, importing roughly 40 percent from Russia.

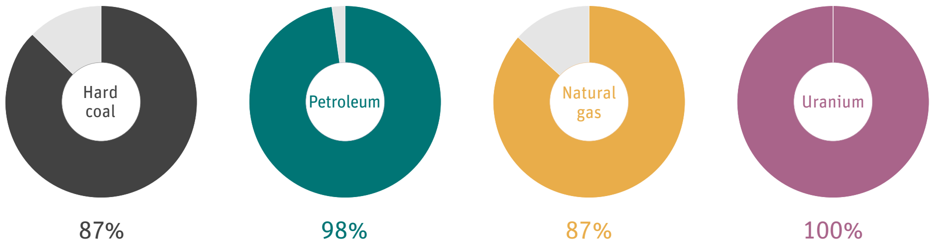
In the winter of 2011–2012, Russia even reduced imports to Germany by as much as 30 percent because Russians were consuming so much gas themselves during a long cold spell. While Germany does have sufficient storage reserves to cover such gaps, domestic production of renewable gas will make supply more reliable.

Much has been written about Germany's reliance on coal, gas, and oil from Russia, but the dependence goes in both directions. Russia cut off supplies to Ukraine when the Ukrainians insisted that the "friendship price" agreed between the two countries should be continued. Germany pays the market price for energy from Russia. The plummeting prices for these fossil resources has hurt the economies of exporters. In return, these low prices can make investments in renewables less attractive; governments must ensure that the clean transition continues even as the move away from fossil resources drives down their prices.

More renewables strengthen Germany's energy security

Share of imports of conventional energy sources in Germany, 2014

Source: BMWi



Renewables and energy conservation can reduce the dependence of countries that consume energy on countries that provide energy resources. Over the past few decades, this dependency has constantly increased. Reducing this dependency would also promote global peace; after all, wars over resources and the "oil curse" are directly related to the problems that many politically fragile regions face.

Renewable energy can consist of numerous small, distributed units, but it can also consist of a small number of large, central plants. In the latter case, the power stations can be gigantic solar arrays in deserts or large wind farms on coastlines. The former Desertec project, which aimed to set up large solar power plants and wind farms in Mediterranean countries (including northern Africa) to generate electricity for Europe, is one example showing that renewables need not be distributed. Proponents of Desertec said the cost of such large-scale electricity would be lower, economic development would be stepped up in relatively poor countries, and power generation would be more reliable because the best sites would be chosen. The project was discontinued, however, in 2014, at least as a concerted effort to export renewable electricity to Europe. Yet northern Africa continues to pursue renewable energy projects for domestic consumption. It remains to be seen whether renewable power would continue to be exported from northern Africa to Europe if there were political turmoil.

F – Strengthening local economies and providing social justice

Local ownership of renewables provides great economic payback to investing communities. Energy efficiency and renewables together give the poor a way to hedge against fluctuating prices for fossil fuels.

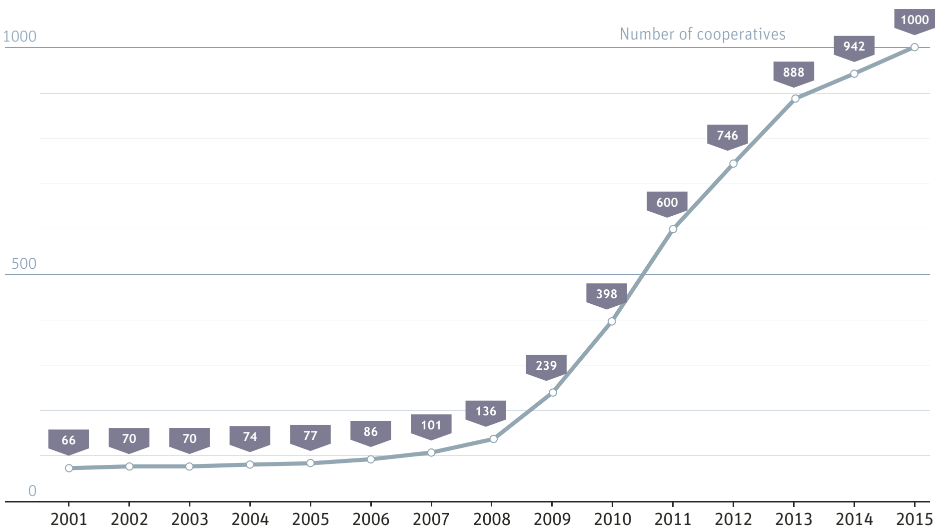
When communities invest in projects themselves, the economic payback is much greater than when large, out-of-town firms invest. But while community ownership has been widespread in Germany, it faces tremendous obstacles. Since 2014, the German government has focused on offshore wind, which is largely owned by incumbent utilities, not communities. The policy switch to auctions across Germany and the EU is expected to discourage community projects further.

For instance, you can import heating oil to heat your home, and that money leaves the country, but if you install solar hot water collectors to cover part of your demand for heat, you get the energy for free and a much greater share of your energy expenses will stay within your country – and possibly even within your community. Some of your investment will come back to benefit you indirectly as tax investments in infrastructure (schools, roads, research, etc.). There have been a number of estimates for specific programs in Germany. For instance, a lot of government funding for renewables is funneled through Germany's development bank KfW. Its building renovation program has been estimated to produce three to five euros in tax revenue for each euro of tax money invested. And these building renovations not only help decrease imports of heating oil and natural gas, but also protect and create a lot of jobs in the construction sector.

Citizens form cooperatives to drive the energy transition

Number of energy cooperatives in Germany, 2001–2015

Source: www.unendlich-viel-energie.de



Local added value also has a welcome side effect – it increases acceptance of change. When the wind farm is funded partly by the community, there is far less NIMBY-ism than when an anonymous out-of-town investor is behind the project. In Germany, hundreds of energy cooperatives have come about; here, citizens come together to collectively invest in renewables – and, increasingly, in energy efficiency. In addition to numerous power plant projects, local power grids are also being purchased from large grid operators so that communities can have more control of their own grids.

German regions and municipalities are discovering the economic opportunities in renewables and energy efficiency, especially for communities that produce more energy than they consume over the year. For more on how investments in renewables can stimulate the local economy, see the section 2 – I – Energy by the people.

Protecting the poor

Another important aspect of the energy transition is social justice. Energy efficiency in particular not only helps promote domestic added value, but also reduces energy poverty. As prices rise in Germany, energy poverty moves into the foreground as an issue. Over the long run, the price of renewable energy will remain stable (there are no fuel costs for wind or solar, and equipment costs continue to drop), whereas the cost of fossil fuel and nuclear will only continue to fluctuate, so the energy transition itself is a way of keeping energy poverty in check.

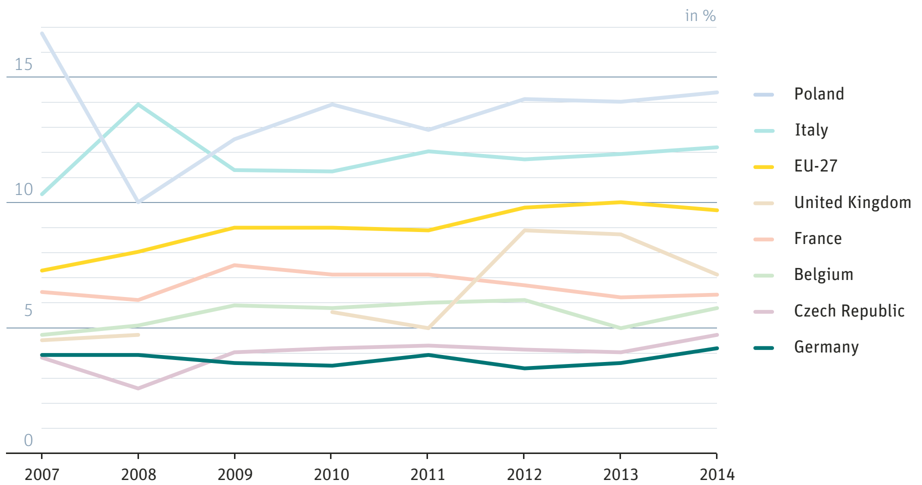
Rising energy prices impact low-income households the most; after all, on average they spend a higher portion of their income on energy needs and are the least likely to be able to afford investments in energy efficiency such as energy renovations, efficient appliances, and fuel-efficient vehicles. The most efficient way to combat energy poverty is to implement energy efficiency measures on a large scale – including renovating low-income households to reduce energy demand.

The German government is currently sponsoring "energy audits" in a nationwide project as part of the *Energiewende*. The goal is to help people including those on welfare, to conserve power, heating energy, and water. In addition, fixtures that reduce power and water consumption (such as compact fluorescent light bulbs, power strips with on-off switches, and water-saving showerheads) are provided. These energy audits are one example of how the *Energiewende* can produce innovative cooperation concepts.

Energiewende not causing "energy poverty" in Germany

Percentage of households unable to pay energy bills on time

Source: Source: Eurostat. UK data for 2009 not available.



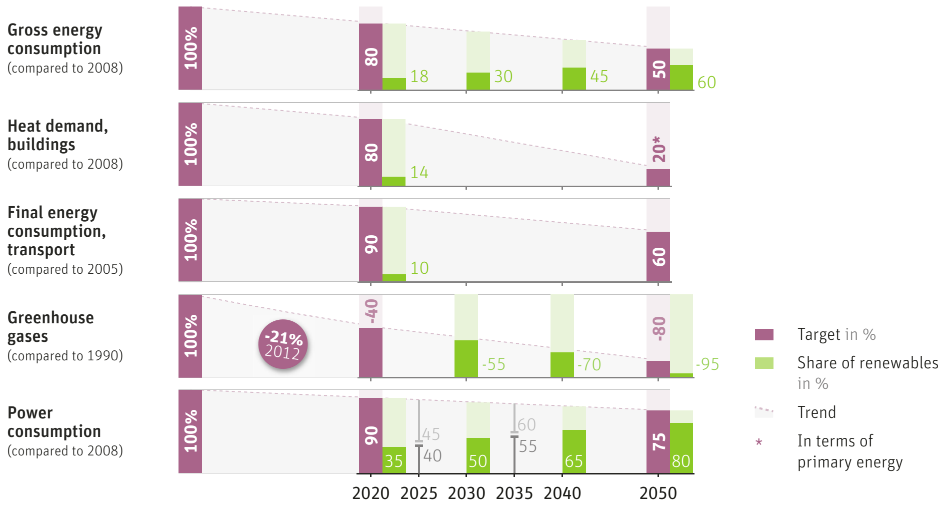
2 Technology as a key issue

Germany has resolved to replace fossil and nuclear energy with renewables – but the process is more complicated than that. Most of all, it involves lower energy consumption through efficiency and conservation and requires that energy consumption be tailored to availability. And in addition to all of this, people who used to be mere consumers will increasingly also become energy producers.

German energy transition: high certainty with long-term targets

Long-term, comprehensive energy and climate targets set by the German government

Source: BMU



A – Efficiency

A renewable energy economy will only be possible if we lower energy consumption considerably. Policies to improve efficiency are in place, but they consistently fall short of what is not only theoretically possible, but also what is reasonable.

When people talk about Germany's energy transition, they often think mostly of the switch from nuclear and coal power to renewables – but in fact, a renewable future will only be possible with significantly lower energy consumption.

As the authors of Factor Four showed about 20 years ago, lower consumption does not entail a lower standard of living – on the contrary, our consumption of fossil energy detrimentally affects our health and is contributing to climate change, which is a threat to civilization. Furthermore, by consuming nuclear power, we create "mines" of nuclear waste that will threaten future generations for millennia.

Over the past two decades, economic growth has generally outstripped the growth in energy consumption and greenhouse gas emissions in most industrialized nations. It has been estimated that energy productivity – economic output per energy consumed – increased by 59 percent from 1990 to 2015.

Perceptions of energy use

What people want is not energy, but energy services – the things we do with energy. In other words, we do not want gallons of gas, but mobility; not electricity and fuel oil, but cold food storage and well lit, comfortable homes. Over the past decade, our computers and handheld devices have become far more high-performance even as they increasingly make do with less power. Such advances are possible in a wide range of fields. In our buildings, for instance, we can provide a comfortable indoor climate with not only energy-intensive air conditioning and heating systems, but also properly filtered air and low concentrations of carbon dioxide. In other words, buildings of the future will provide even greater comfort than the ones today even though they consume less energy.

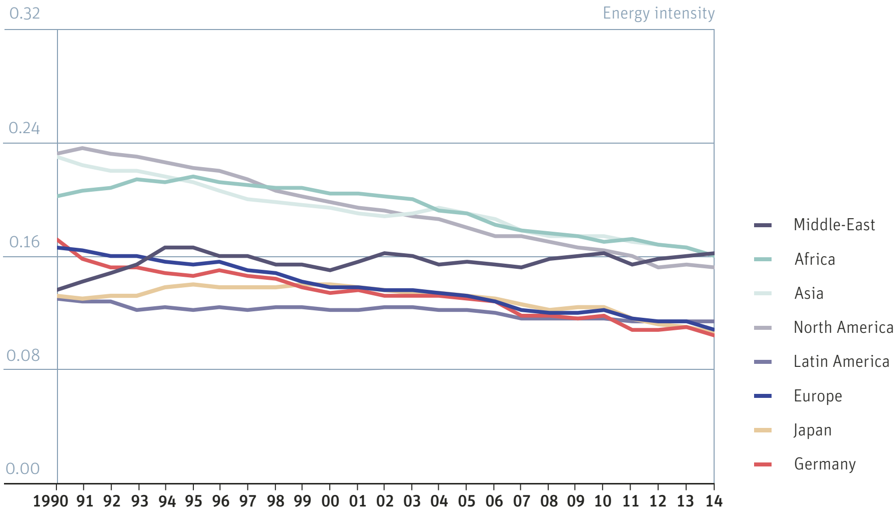
When it comes to efficiency, however, we face a special obstacle: information. Economists who believe that the market takes care of everything most efficiently assume that all market participants are equally and sufficiently informed – and therefore that all efficiency measures that pay for themselves have already been utilized.

In fact, while most consumers may know what their monthly power bill is, they may not know how many kilowatt-hours they consume, nor are they used to assessing how much a particular appliance will cost them per year in terms of power consumption. Yet, without such information, it is impossible

Germany continues to produce more GDP with less energy

Energy intensity (=energy use per unit of GDP) of different world regions, 1990–2014

Source: Enerdata Yearbook



to assess the payback on investments in energy efficiency. So even if we believe that the market comes up with the best solutions, the government still needs to ensure that everyone is properly informed.

Raising awareness

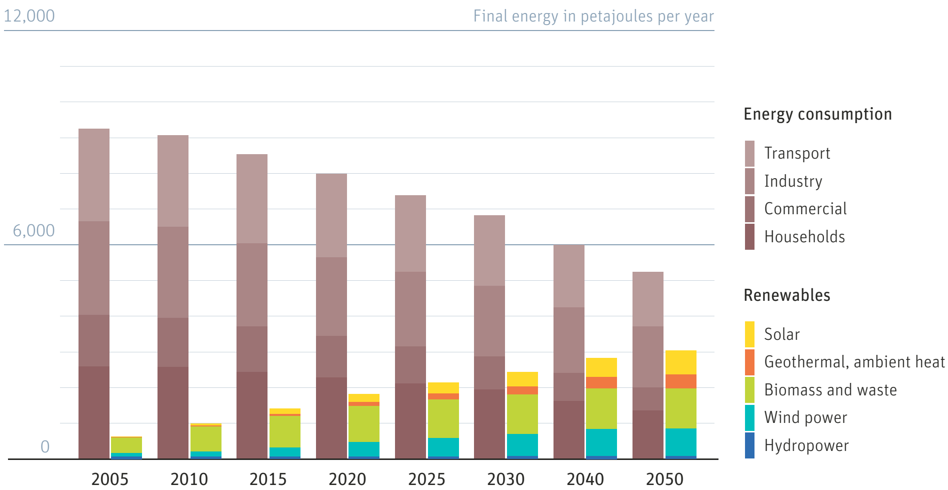
The example of standby power consumption is especially illustrative. Unbeknownst to most consumers, household appliances – from coffee machines to toasters, televisions, game consoles, and computers – consume power even when they are "off." Recent estimates show that such "standby consumption" amounted to six percent of a typical electricity demand of a typical European household. Consumers are not always aware that the annual power costs for an inexpensive appliance might even exceed its purchase price.

One example of the government providing market participants with information is the European Union's Ecodesign directive, also known as the ErP (Energy-related Products) directive. It aims to make products more sustainable over their entire lifecycle (not just in terms of energy) partly by providing labels

Germany's plan: ramp up renewables, drive down energy consumption

Final energy supply and demand in Germany 2005–2050, scenario

Source: DLR Lead Study, scenario A



as guides for consumer purchases and by imposing stricter energy efficiency standards for designs. This law is dealt with in detail in its own section; see Ecodesign/ErP Directive.

The European Union (EU) is also working to reduce energy consumption in buildings, and Germany is at the forefront of that movement as well. In 2002, it adopted the Energy-Conservation Ordinance, which was made stricter in 2009 and 2014. Some homes built as early as the 1990s demonstrate what the standard of the future will be: passive houses, which become plus-energy homes when solar roofs are added to them. The EU will require that all houses constructed starting in 2020 be "nearly zero-energy homes," essentially making German passive houses the standard within Europe.

While these new laws will help when it comes to new buildings, Germany needs to address the situation with existing buildings. The country's renovation rate, the number of buildings renovated per year, is too low in Germany at around one percent; the figure needs to be doubled. In addition, renovations often do not go far enough. Frequently, not enough insulation is added, and the building service technologies used do not fulfill the requirements that buildings will have to meet in 40 years.

These matters are also dealt with in their own section; see Energy-Conservation Ordinance (EnEV). As of 2015, however, Germany was not scheduled to meet its targets for efficiency by 2020 because primary energy consumption has not fallen enough, partly due to record high power exports.

Improving efficiency

Another area where there is a lot of room for improvement is power efficiency. Studies have shown that the yearly power consumed by electric motors used in industry could be reduced by around 30 TWh up to 2020 – enough to make several central power plants redundant. Similar conservation potential can come from the use of efficient lighting systems and a switch from inefficient electric heaters to more efficient systems.

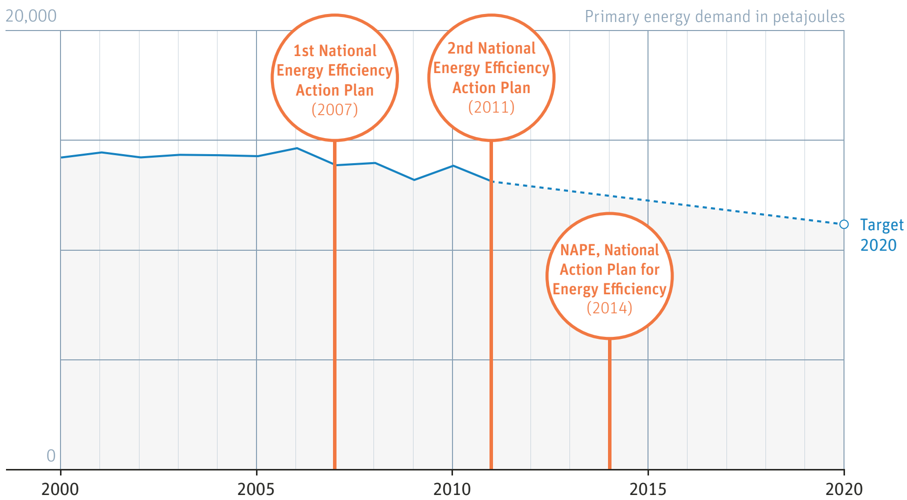
Germany has set an ambitious goal for itself of a ten percent reduction in power consumption by 2020 and a 25 percent reduction by 2050. As of 2015, however, Germany was not on schedule to meet its targets for efficiency by 2020.

Unfortunately, not enough is being done to promote energy efficiency. While the EU has binding targets for carbon emissions (a 20 percent reduction below the level of 1990 by 2020) and renewables (20 percent by 2020), the target for energy efficiency (a 20 percent reduction in primary energy consumption by 2020) is not binding. For 2030, there is a binding 40 percent reduction of greenhouse gas emissions. The target for renewable energy by that year is 27 percent, but it is only binding for the EU as a whole – there are no any specific targets for member states. Finally, the target for efficiency is also 27 percent, and it is nonbinding.

Germany's plan: drive down energy demand

Primary energy demand in Germany, 2000-2020

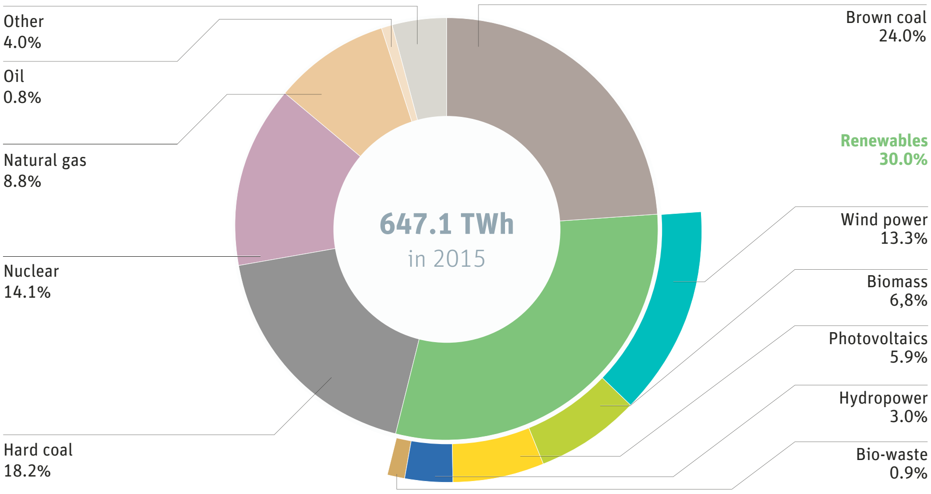
Source: AGEB, BMWi



Germany reaches 30 percent renewable power in 2015

Gross power generation mix

Source: AGEB



At the end of 2014, this lack of political action was recognized by the German Government, leading to the National Action Plan for Energy Efficiency in December 2014. This package contains several dozens of efficiency instruments, including better energy efficiency financing, a new tender scheme for energy efficiency, and better information and audit activities both for companies and private households. While this package is still in the process of being implemented, one major instrument, a tax credit scheme for the renovation of buildings, failed to pass due to strong opposition in one of the German states.

We will not be able to get 100 percent of our energy from renewables if we continue to consume at the current rate. Energy efficiency is not a nicety – it is indispensable for the success of the *Energiewende*.

B – Less electricity from coal

To meet the climate targets, Germany must reduce electricity from coal. In the interim, coal consumption has fluctuated, rising from 2011 to 2013 and falling by more than 6 percent from 2013 to 2014, but the rising price of carbon and the increasing competitiveness of renewable power will make this trend short-lived – and Germany will stay within its carbon emission limits during the process. In 2014, electricity from fossil fuels (including gas) hit a 35-year low. In 2015, power from lignite, hard coal, and natural gas continue to shrink, falling slightly by less than one percent.

Furthermore, carbon capture and storage is expensive and unsafe, and the German government has already stated that it will not promote the technology against popular will.

When Germany resolved to shut down eight of its seventeen nuclear plants in 2011 and phase out the rest of them by 2022, there was concern that coal power would be ramped up to fill the gap left behind by nuclear – but that is not the plan, because the country cannot meet its climate targets with coal power. After all, roughly half as much carbon is emitted when natural gas is burned instead of hard coal. Lignite, which is domestically available in Germany in large quantities, is three times more carbon intensive than natural gas. Furthermore, coal plants do not ramp up and down as fast as flexible turbines fired with natural gas do, making the latter a better way of filling in hourly gaps in renewable power production. For more information on natural gas as a bridge to a future with renewable gas supplies, see 2 – H Flexible power production.

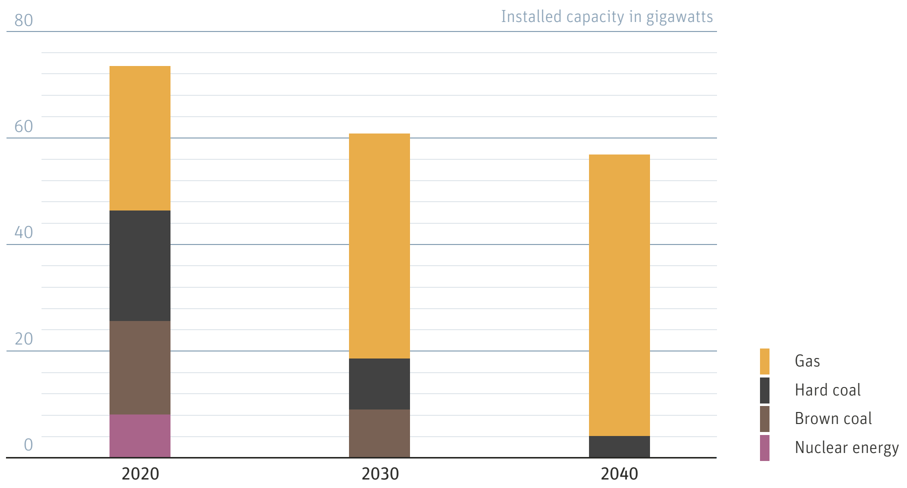
For a number of reasons, however, coal power consumption temporarily increased:

1. The decision to shut down eight nuclear power plants came suddenly, and industry has not yet had time to replace the missing capacity, so power providers have no choice but to fall back on existing power plants.

Germany's plan: declining role for coal power

Overall installed conventional electricity generation capacity in Germany, 2020-2040

Source: Fraunhofer IWES



2. The economic downturn within the EU has reduced energy consumption, thereby indirectly reducing carbon emissions and making the price of carbon – and hence, the price of coal power – lower (see Emissions trading).
3. At present, a few new coal plants are going online that had been planned and constructed several years before the decision to phase out nuclear energy.

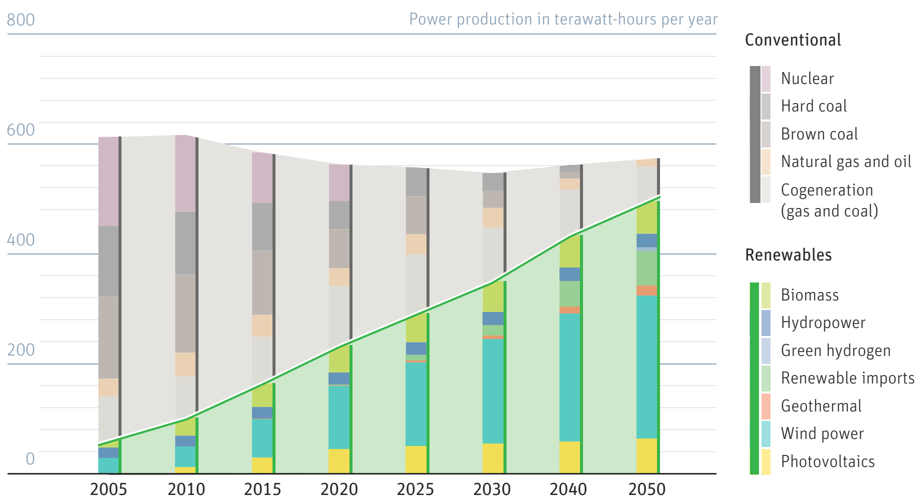
Plans for new coal plants

Just a few years ago, Germany's biggest four energy firms planned to build more than 30 new coal plants, but their current plans are much more modest. A number of projects have been abandoned for various reasons ranging from tremendous local protests to difficulties in procuring water rights and – most of all – a reassessment of profitability in light of the boom in renewables. By 2015, coal power capacity (both hard coal and brown coal) increased in Germany by nearly 9 gigawatts, but these plants will increasingly face a lower capacity factor as renewables offset more and more medium load and baseload power supply. Furthermore, no coal plants have been proposed since the nuclear phaseout of 2011, while several on the drawing board at the time have since been abandoned.

Germany's plan: switch from coal and nuclear to renewables

Electricity generation in Germany 2005-2050, scenario

Source: DLR and Fraunhofer IWES



In this chart based on Lead Scenario 2012, a scenario study commissioned by the Federal Ministry of the Environment, renewables would make up 85 percent of Germany's power supply by 2050. New electricity consumers (electromobility, heat pumps and, starting in 2030, hydrogen for transportation), however, slow down the reduction in consumption.

Due to the reduced electricity demand in 2014, lignite electricity production went down by more than 3 percent. However, during the nuclear phase-out (up to the end of the year 2022), the share of lignite in the power sector is likely to remain relatively stable. Depending on how fast the share of renewable electricity grows, power from hard coal may be significantly offset even during the nuclear phase-out.

In 2015, there was a concerted effort to launch a coal phase-out in Germany. Labor unions proved too powerful, however; they took to the streets in protest, estimating that some 100,000 jobs would be on the line. The ambitious plan to place a limit on carbon emissions from coal plants older than 20 years was therefore blocked. In its place, a "reserve" was created for lignite plants; 2.7 GW of them were taken off the market. They are to be reactivated if need be. In the meantime, they receive special compensation for their "standby readiness."

Critics point out, however, that these plants are not "ready" at all. The plants are to be given ten days notice of the need to ramp up. Experts argue that there will never be a situation in which a grid bottleneck or power generation shortfall can be foreseen then days ahead. In effect, this policy pays the polluters instead of making them pay.

But the debate on coal in Germany continues. In 2016, there were signs that labor union leaders had begun accepting the inevitability of a coal phase-out and would begin focusing on getting the best deal for workers.

CCS not an option for coal power

Over the past decade, there has been a lot of talk worldwide about carbon capture and storage (CCS), which the technology's proponents misleadingly call "clean coal." Essentially, this technology captures pollutants and carbon dioxide for separate storage. For industrial processes such as cement production, in which it is extremely difficult to reduce emissions further, CCS could be an option to reduce greenhouse gas emissions. In power plants, however, CCS is viewed by most energy experts as unattractive because it drastically reduces the efficiency of the power plants, thus severely increasing fuel costs.

Furthermore, CCS investments turn out to be prohibitively expensive. Germany set up the first such test facility designed by Siemens in 2006 at Schwarze Pumpe, a coal plant run by Swedish utility Vattenfall. The results were apparently not encouraging, since Vattenfall announced at the end of 2011 that it had abandoned plans for a second demonstration project of 300 megawatts, which would have been ten times the size of the pilot facility at Schwarze Pumpe, thereby even foregoing funding from the EU for the first full-size CCS plant. Vattenfall said it was unable to go ahead with its plans because the German states with suitable storage potential refused to accept the risk.

In addition, environmentalists are generally not excited about the technology, as stored pollutants and CO2 will only create further problems for future generations, who will have to make sure that the storage facilities do not leak. Local communities do not wish to have repositories for carbon dioxide near them, so Merkel's coalition – which supports CCS – reached a compromise with the German states in 2012. Now, the states will be able to veto plans to construct carbon dioxide repositories, making it highly unlikely that any such repository will ever be built. The agreement also specifies that the states – and hence taxpayers – will be liable after the first 40 years of operation, with the company liable for the first 40.

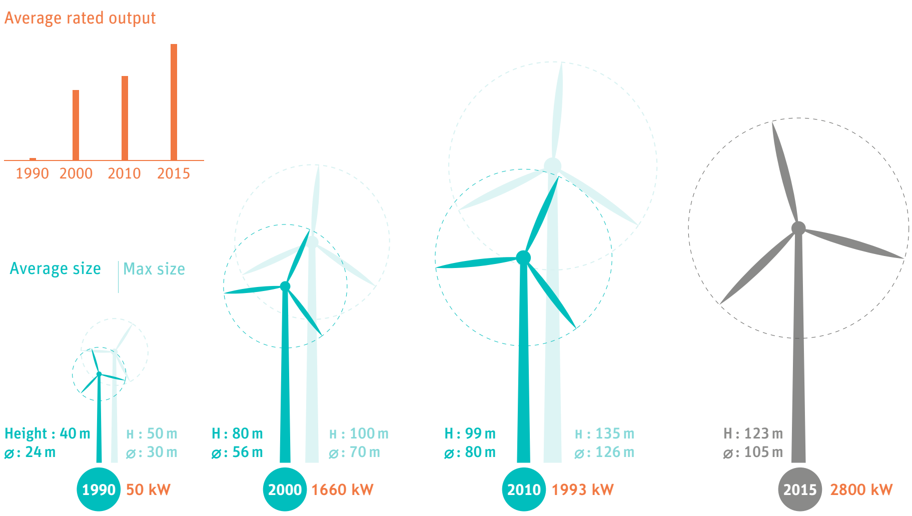
Furthermore, the target for storage has been reduced from eight million tons per year to four million. To put this into perspective, it has been estimated that 3.5 billion tons of carbon dioxide would need to be stored away each year worldwide if we are to stay within our emissions targets. In other words, Germany now plans to contribute roughly 0.1 percent of carbon storage towards that goal.

In July 2012, former German Energy Minister Peter Altmaier himself gave up on the idea of CCS within Germany: "We have to be realistic. We cannot store carbon dioxide underground against the will of the population. And I do not see any political acceptance in a single German state for CCS technology with hard coal and brown coal power plants."

Wind turbines 50 times more powerful today than 20 years ago

Development in size and power of wind turbines, 1990–2015

Source: DEWI



C – Wind power

Germany began switching to renewables primarily with wind power in the early 1990s. Nowadays, onshore wind power is the cheapest source of new renewable power and made up roughly 12 percent of the country's power supply in 2015. What's more, the onshore sector is largely driven by midsize firms, cooperatives and small investors. Both of those aspects will, however, be different in the fledgling offshore wind sector.

In 2015, Germany got roughly 14.7 percent of its electricity from wind turbines, almost all of which were onshore. By 2020, Germany plans to roughly triple the share of wind power (both onshore and offshore). But the fledgling offshore sector differs greatly from traditional onshore wind; while the latter mostly consists of midsize firms and distributed wind projects owned largely by communities and small investors, the former is almost entirely in the hands of large corporations and utilities, many of which initially opposed the switch to renewables. The traditional onshore sector therefore argues that older onshore wind farms should be repowered; turbine technology has made great advances since the 1990s, so far fewer turbines can now produce much more power. Onshore wind power is also considerably less expensive than offshore wind power.

Repowering is an important issue in Germany. Because the wind sector has been at work here for two decades, the first wind farms that received feed-in tariffs have reached the end of their service lives, and even the ones that still have a few years left do not use the available space as efficiently as the latest turbines can. After all, the output of an average turbine installed today is about ten times greater than that of the average turbine made in the mid-1990s. In other words, by replacing old turbines with new ones – by repowering – we can produce ever greater amounts of wind power even as we reduce the visual impact of wind farms.

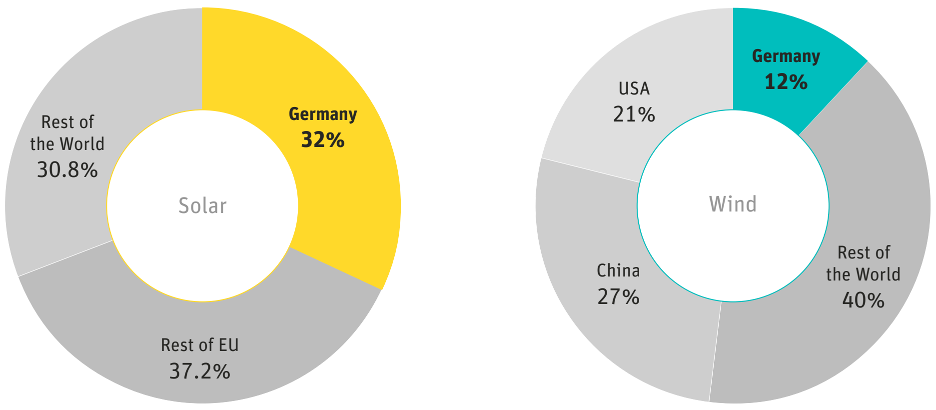
Germany also has plans for offshore wind power: the government aims to have 6.5 gigawatts installed in German waters by 2020, and 15 GW by 2030. 2015 was a record year for offshore wind in Germany, with some 2.2 GW newly installed, bringing the total up to 3.3 GW. In 2010, Germany's first offshore wind farm – the Alpha Ventus test field – was connected to the grid, followed by Bard 1 and Baltic 1, the first commercial wind farms, in 2011. Permits have already been granted for an additional 20 offshore wind farms within Germany's Exclusive Economic Zone in the North Sea along with three in the Baltic.

Offshore wind farms are expected to provide power more reliably, as the wind on the open sea is more constant. On the other hand, offshore wind power currently costs up to two to three times more than onshore wind power. Furthermore, the German wind sector is somewhat lukewarm about offshore wind power because these projects are firmly in the hands of large corporations, whereas onshore wind in Germany is largely owned by citizens; indeed, the Merkel government's support for offshore wind is sometimes interpreted as a special incentive for Germany's largest power companies,

Germany paved the way for solar and wind at an early stage

Solar and wind operating capacity, Germany and rest of world, 2012

Source: REN21



whose nuclear plants the government is shutting down. At the end of 2015, Germany had just over 3.3 gigawatts of offshore wind capacity completed.

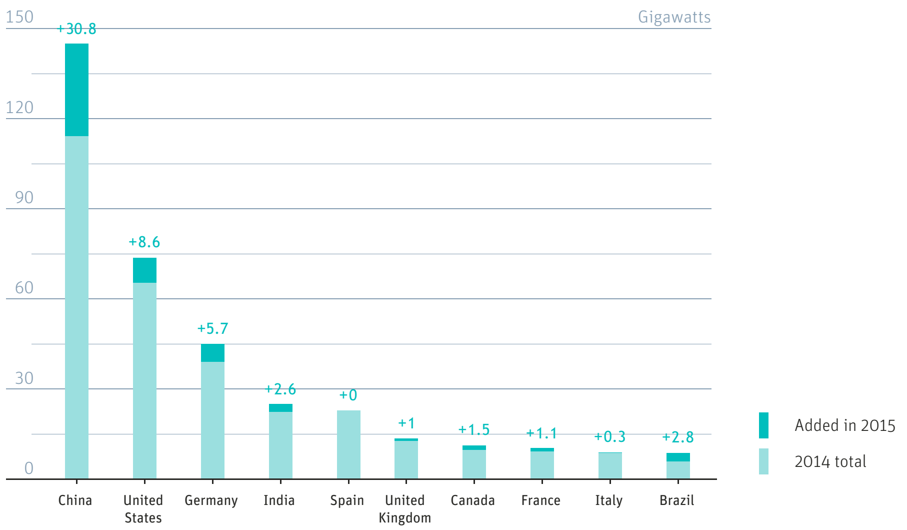
Increasing acceptance of onshore wind

In contrast, the German wind sector has traditionally consisted of community-owned projects that grow "organically": a few turbines are put up, and when the community realizes what good returns the wind farm provides its investors, more people want to get involved and install new turbines. As the turbines go up, people also realize that concerns about noise are grossly exaggerated. Internationally, concern about the health impact of wind turbines is restricted to places with very few of them. Health effects are an issue in the debates in Germany and Denmark, the two countries with the greatest density of wind turbines. On the contrary, people realize that the health effects are positive when clean wind power replaces dirty coal power and potentially dangerous nuclear power. Finally, as the wind farms grow, people get used to the "visual impact" and start to see the turbines as no more intrusive than power pylons, buildings, and roads – and less

Germany is a leader in wind power

Top 10 countries for wind power in terms of total installed capacity, 2015

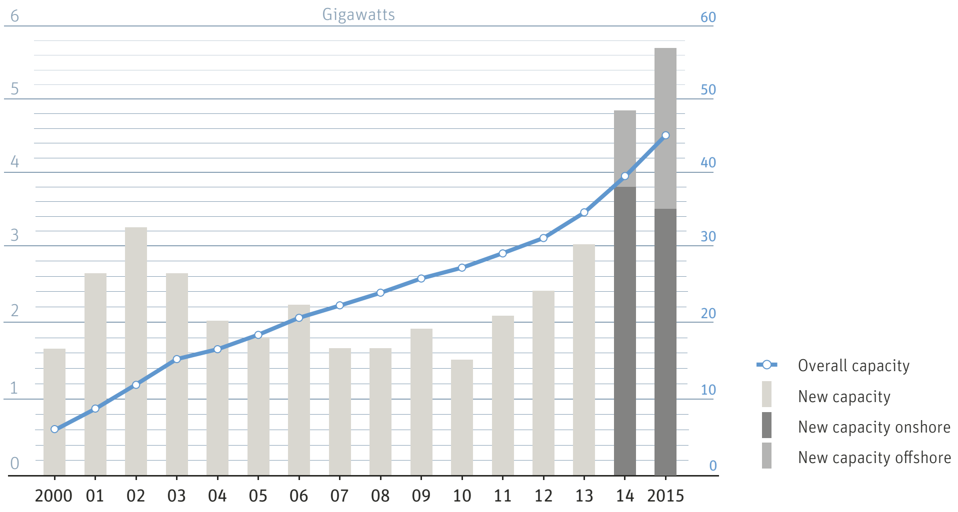
Source: REN21



Germany has steady wind power growth

Cumulative and newly installed wind power capacity in Germany, 2000–2015

Source: DEWI



Germany's wind sector peaked in 2002, when roughly 3.2 gigawatts was newly installed. The market stabilized at nearly 2 gigawatts of new capacity per year for a decade, equivalent to 2.5 percent of peak demand (around 80 gigawatts).

noisy than cars. For more information on community ownership of renewables in Germany, read 2 – I "Energy by the people".

Thanks to the technical developments seen in recent years, the use of wind power has also become more attractive in inland regions. In southern Germany – especially in the southwestern state of Baden-Württemberg, which still has very little wind power – planning barriers were removed to facilitate the installation of wind turbines on hillsides and in forests. At the same time, new turbines must fulfill strict ecological criteria. The state of Baden-Württemberg – which for the first time ever has a government led by the Green Party – plans to increase its annual newly installed capacity significantly, reaching ten percent wind power in the power sector by 2020. Baden-Württemberg is one of Germany's most economically strong states.

Germany's wind sector peaked in 2002, when roughly 3.2 gigawatts was newly installed. The market stabilized at nearly 2 gigawatts of new capacity per year for a decade, equivalent to 2.5 percent of peak demand (around 80 gigawatts).

The onshore wind sector was clearly the big success story in 2014: A record 4.4 gigawatt was added, roughly a quarter of which replaced older turbines that were decommissioned. Another 3.5 gigawatts was built in 2015. Market experts believe that planners are currently rushing to build before the country switches from feed-in tariffs to auctions in 2017. In addition, a number of federal states improved the conditions for onshore wind, removing some of the barriers for wind installations.

In contrast, the US is the second largest wind power market in the world behind China in terms of absolute capacity; US peak power demand is just under 800 gigawatts. Americans would have to install nearly 20 gigawatts of wind turbines each year to keep up with Germany's performance. The US never came close to reaching that level, having peaked at 13.1 gigawatts in 2012.

D – Biomass

Biomass is the most versatile of all types of renewable energy as it can provide heat, electricity, and motor fuel. Not surprisingly, biomass is expected to make up nearly two-thirds of Germany's renewable energy consumption by 2020. But serving as a source of energy is only one thing biomass does well – it also provides food and materials for production (such as timber and oils). As a result, demand for biomass is great from a number of competing sectors. Unfortunately, the potential for sustainable biomass is limited, and the focus in German policy is on promoting the use of residue and waste.

Biomass is a special source of renewable energy in a number of ways. First, it can directly provide all three types of energy carriers: electricity, heat, and fuel (liquids, solids, and gas). Second, it is easily storable and dispatchable; when there is not enough sun or wind, biomass-fired generators can be ramped up as need be. Third, the major drawback: biomass requires strict management to be sustainable. No matter how many solar panels we install, we will not use up the sun any faster, nor will we measurably reduce the amount of wind on Earth if we keep installing wind turbines. But with biomass, we have to avoid resource depletion, prevent monocultures from reducing biodiversity, and ensure that the energy needs of rich countries are not met at the expense of food needs in poor countries.

Because it can cover such a wide range of energy services, biomass makes up a far greater share of the world's energy supply than hydropower or nuclear (which only provide electricity) – indeed, more than all other renewables combined. According to Ren21, biomass covered more than 14 percent global final energy demand in 2012 (most of which was traditional biomass), whereas the share of nuclear power had fallen to 2.5 percent.

Biomass in Germany

Nowadays, when we talk about biomass, we increasingly mean ethanol from corn, biodiesel from rapeseed, biogas from organic waste and corn, wood pellets made from sawdust, etc. – as opposed to firewood, dung, etc.

Bioenergy generally comes from two sources: forestry and agriculture. Within the EU, Germany is the greatest producer of wood, and wood is by far the greatest source of bioenergy in the country. Roughly 40 percent of German timber production is used as a source of energy, with the rest used as material. Germany is also the leading biogas market – beginning in 2015, almost two-thirds of Europe's biogas plants were installed in Germany.

n 2015, Germany already used nearly 2.5 million hectares of its arable land for energy crops. This area is equivalent to 15 percent of the 16.7 million hectares of agricultural land in Germany. The upper limit for bioenergy is 4 million hectares by 2020. Studies show that the share of bioenergy can be increased within these limits as a result of the decrease in population in the next few decades and increasing hectare yields in the agricultural sector. Environmental organizations, however, point out the environmental impacts of energy crops; for instance, the large increase in the cultivation of corn for use in energy production (and the problems associated with corn monocultures) is frequently associated with the plowing of valuable grassland. Energy crops can also have adverse effects on the quality of groundwater and cause soil erosion. To prevent these effects, Germany's Renewable Energy Act (EEG) limits the amount of corn and grain eligible for special compensation. In addition, a set of incentives seeks to encourage increased use of less environmentally polluting substrates, such as material from landscape management activities and residues.

enewable energy made up around 13 percent of total final energy consumption in 2015. Nearly 37 percent of that was biomass in the heat sector, along with over 10 percent biofuels and eight percent biogas in the power sector. In total, bioenergy made up 57 percent of total renewable energy supply in Germany in 2015, equivalent to 7 percent of primary energy consumption.

The potential of sustainable domestic bioenergy in Germany would therefore seem to be limited to around ten percent of overall energy supply – at least at current levels of consumption – but Germany could increase those shares by reducing consumption (see 2 – A – Efficiency).

Today, Germany uses biomass mainly of domestic origin. The challenge will be to increase biomass usage for energy without drastically increasing imports. Germans are already concerned about the clearing of rainforest for palm oil plantations and about conflicts with food production in developing countries. As the German Environmental Ministry has stated, "the expansion of biomass production for energy use [must not conflict] with food security, the right to food, and the protection of the environment and nature." Therefore, along with the European Renewable Energy Directive, biofuels and other liquid bioenergy carriers must satisfy strong sustainability criteria to count towards the targets for quotas and be eligible for the bonuses set forth in the Biomass Sustainability Ordinance. It remains unclear, however, whether strict criteria are sufficient to prevent the use of biomass for energy from increasing food prices around the world.

For the future, the use of biomass seems particularly important in three areas: as fuel for air transportation and heavy-duty vehicles (where electric mobility or other technical alternatives are not readily available), for industrial process heat, where high temperatures are required, and for cogeneration, because cogeneration plants convert biomass to electricity and heat with the highest efficiency and greenhouse gas benefits.

In addition, biogas and hydrogen in particular are seen in Germany as a crucial way of storing energy seasonally to provide sufficient electricity on the dark evenings of winter, when power consumption is the highest in Germany and no solar power is available (see 2 – H – Flexible power production). Nevertheless, the German government imposed a limit of 100 MW of new biogas units per year in August 2014, partly because of concern about environmental impacts, but primarily in order to rein in costs. In the future auctions, between 150 and 200 MW of biomass power plants will be tendered.

E – Photovoltaics (PV)

Over the past decade, Germany has been criticized for its commitment of photovoltaics, which was once an expensive technology. But PV now is cheaper than offshore wind, competitive with biomass, and scheduled to become competitive with wind power in the foreseeable future. Germany has helped make solar inexpensive for the world. The challenge now is to integrate large amounts of solar power in the country's power supply.

Photovoltaics is the term for solar panels that generate electricity. Solar thermal produces heat, such as for hot water supply or space heating. Solar heat can also be used to generate electricity in a technology called concentrated solar power (CSP), though the technology is mainly useful in deserts, not in Germany.

Though not known to be particularly sunny, Germany developed one of the largest solar photovoltaics market in the world. The price of photovoltaics has plummeted over the past two decades, more than for any other type of renewable energy, and experts believe that it will be competitive with coal power sometime in the next decade. Already, solar power can provide up to 50 percent of German power demand for a few hours on sunny days of low power consumption. In July 2015, the electricity production from PV was, for the first time, higher than from nuclear power. But the German example shows that power markets will need to be redesigned for solar to go further because solar drives down wholesale power rates, making backup power plants increasingly unprofitable.

Photovoltaics (PV) is what most people think of when they hear the word "solar." While PV has long been considered the most expensive type of renewable power widely used commercially, prices have plummeted in the past few years (by roughly 70 percent from 2008 to 2015), and PV is now cheaper than concentrated solar power and offshore wind power.

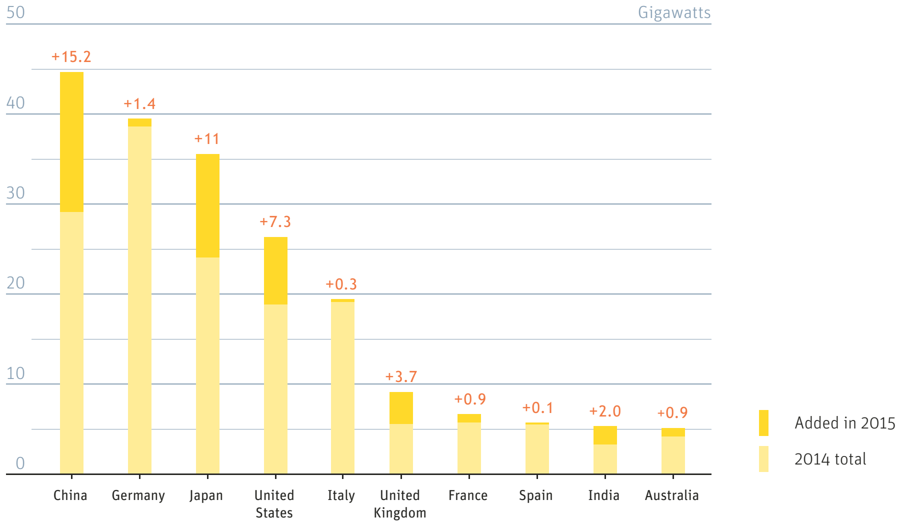
IIn absolute terms, Germany has more PV installed than any other country except China (roughly 39 gigawatts at the end of 2015), but perhaps the most important comparison is installed PV in relation to peak summer demand. After all, the most solar power is generated on summer afternoons.

In Germany, power demand is lower in the summer than in the winter because Germans can largely do without air conditioning in the summer, whereas a lot of electricity is needed in the

Germany is a leader in solar

Top 10 countries for solar power in terms of total installed capacity, 2015

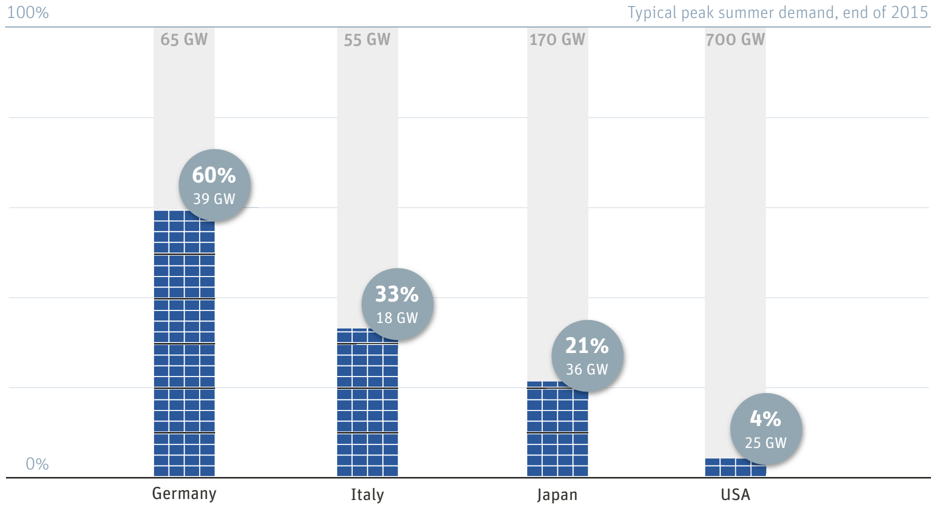
Source: REN21, BNetzA



Germany's installed solar PV capacity is already half of power demand

Germany has most solar PV installed in absolute (39GW) and relative terms (58% of peak demand)

Source: REN21, own calculations



winter for heat, lighting, etc. On June 6, 2014, German solar production reached an all-time peak at 24.2 gigawatts, peaking at a third of total power demand, though solar power only made up around a sixth of power demand for the day as a whole. In April 2015, a new record was set at 27.3 gigawatts.

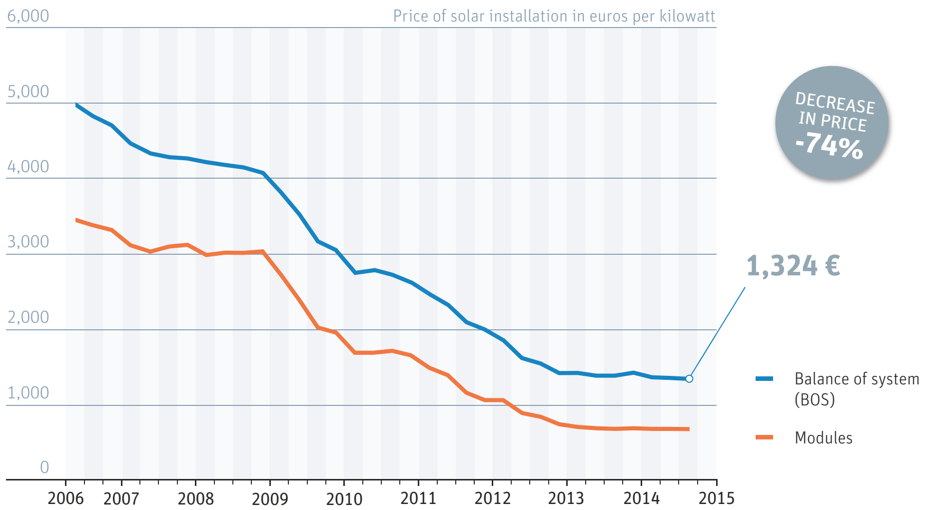
For years, proponents of photovoltaics have pointed out how production of solar power coincides with peak power demand around lunchtime, so that relatively expensive photovoltaics turns out to be a good way of offsetting even more expensive power generators to meet that peak demand. Almost everywhere, PV is still an excellent way to meet peak demand – everywhere except Germany, that is, for the country now has so much PV installed that peak demand is no longer an issue. Photovoltaics now offsets a large chunk of the medium load during the summer in Germany and can even offset a bit of baseload production.

One result of all of this solar power is drastically lower profits for the country's conventional power plant owners, whose plants are now simply no longer able to run at full capacity; in addition, they cannot sell at such high prices because PV obliterates the need for peak power at noontime. All of

Price of solar down in Germany by 74 percent since 2006

Average system price for installed rooftop solar from 10 to 100 kilowatts

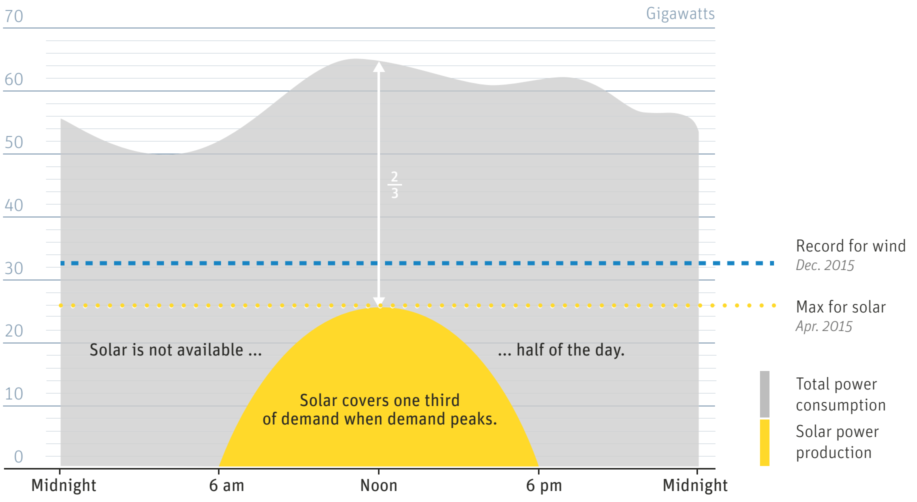
Source: EUPD Research and BSW-Solar



Solar power can already cover a third of peak power demand

Power demand and solar power production in Germany, estimate based on actual data from April 2016

Source: Frauenhofer ISE, EEX



On a normal business day in Germany, solar power (yellow) is produced exactly when power demand picks up. In the example above, conventional power (gray) only has to increase from around 33 gigawatts at three in the morning to around 42 gigawatts at 8 AM and again in the evening. In the middle of the day, wind power (not shown here) and solar power keep conventional plants from having to ramp up to more than 60 gigawatts, as they would have had to do 20 years ago. With additional wind electricity, even less conventional power will be needed.

this has come about so quickly that politicians are now looking for ways to redesign the German power market to ensure that enough generating capacity remains online and dispatchable for those hours in the winter when Germany reaches its absolute peak power demand for the year (around 80 gigawatts), which also happens to be a time when no solar power at all is available. In this respect, Germany offers a unique glimpse into the future for other countries.

On the shortest day of 2015, Germany's installed PV capacity still managed to produce around 7 gigawatts – as much power as five large nuclear reactors for two hours, thereby helping to offset peak demand for power.

F – Other renewables

Other types of renewable energy include solar heat and geothermal energy (which can be used to generate electricity and provide heat). While Germany does not have great geothermal potential like Iceland and the United States, for instance, certain applications are nonetheless worthwhile. Solar heat has not been as successful as solar electricity mainly because the cost of collectors has not been reduced considerably over the past ten years, mainly due to high installation costs.

Germany also has geothermal resources – heat from below ground. The first geothermal power plant in Germany went into operation in 2003, though it has not yet led to many subsequent projects.

The general public remains concerned about microseismic activity, noise, and impacts on groundwater. Early community involvement, careful siting of the power plants, and the best available exploration and operation technology are therefore crucial to minimize risks and increase acceptance. Nonetheless, compared to North America and Asia, the geothermal potential in OECD Europe (including Germany) is markedly smaller and restricted to certain attractive regions, where good energy yields with high temperatures can be achieved. Growth of geothermal electricity generation is therefore expected to be significantly slower than for wind and solar.

Hydropower

The original feed-in tariffs of 1991 were implemented primarily to help existing small hydropower facilities to remain profitable. Some new systems have been built in the past 25 years, but the potential of hydropower in Germany has largely been tapped. For instance, in 1990, some 17.4 TWh of hydropower was generated compared to 19.3 TWh in 2015. However, that roughly ten percent increase depends a bit on the weather; in 1996, 22 TWh was generated. Against that benchmark, hydropower production has actually decreased by ten percent. Parallel to the modernization of the systems, environmental improvements at many hydro plants have been installed over the past decade.

Renewable heat

When heat is generated from renewable energy – such as biomass and solar thermal – one speaks of "renewable heat," but the term can also encompass the recovery of waste heat for heating applications. Because heat makes up roughly 40 percent of German total energy consumption, the potential for renewable heat is greater than for renewable electricity, since overall electricity only makes up 20 percent of the country's energy consumption. Nonetheless, Germany has not had the same success in promoting renewable heat, partly because it has never offered feed-in tariffs for it. The German government has a goal of getting 14 percent of the country's heat from renewable sources by 2020. Under the Renewable Heating Act, all new buildings are required to have a heating system with a minimum share of renewable energy.

Renewable heat from biomass

Up to now, most renewable heat has come from biomass, with the most common feedstock being woodchips, firewood, and, increasingly, wood pellets. Germany's Market Incentive Program also supports the generation of renewable heat from biomass, with strict requirements for efficiency and emissions. In addition, waste heat from biomass units is used in district heat networks. Indeed, Germany's Renewable Energy Act requires that most biomass units recover part of the waste heat produced in the process of generating electricity ("cogeneration of heat and power").

Renewable heat from heat pumps and solar thermal

Increasingly, new technologies using renewable energy sources are appearing on the market. In addition to biomass, for instance, there is "shallow" geothermal, in which heat is taken from just below ground or from groundwater. This heat can then be used in combination with heat pumps, as can heat from ambient air. In 2013, a third of new buildings in Germany had heating systems with a heat pump.

Solar thermal collectors can be also installed on homes and businesses to cover demand for heat. At the end of 2015, Germany had 2.15 million solar thermal systems installed across approximately 19.2 million square meters of surface.

In the case of buildings, in particular, the investments in efficiency may offset consumption over decades, but the upfront costs may still be prohibitive. To overcome such obstacles, Germany has implemented a Market Incentive Program, which provides funding for renewable heat systems (solar thermal collectors, modern biomass heaters, and efficient heat pumps). For more information, see Market Incentive Program (MAP) in Chapter 3F.

Nonetheless, this market has not grown nearly as quickly as the PV sector. One reason for solar thermal's sluggishness is that Germany does not have special feed-in tariffs for solar heat, only for solar power. Solar heat has therefore depended partly on government rebates funded by an eco-tax and emissions trading. Although the costs of solar thermal collectors has decreased, overall system costs have not, partly due to persistently high installation costs. In addition, the market for solar thermal collectors has been largely restricted to small one and two family house applications. Other countries, particularly Denmark, have favored large ground-mounted collectors, offering fivefold decreased collector prices and competitive heat generation costs. In Germany, even though the systems are supported financially, this market segment has potential to develop further. As part of the federal government's "Strategy for the Efficiency of Buildings", further activities to support large solar thermal installations in district heating have been announced.

At present, solar heat only covers around one percent of Germany heat demand, which is especially unfortunate since heat makes up around 40 percent of German energy consumption, whereas electricity only makes up 20 percent (the other 40 percent is motor fuels).

In other words, the potential for renewable heat is much greater than the potential for all sources of electricity in Germany's transition to renewables.

G – Grid and power storage

While everyone agrees that the German grid will need to be expanded for renewables to make up a greater part of power supply, there is no consensus on what exactly needs to be done. Some estimates put the amount of new lines that need to be built at 4,500 kilometers, whereas the renewables sector believes half of that would suffice. Today, the German grid consists of 35,000 kilometers of ultra high-voltage transmission lines plus 95,000 kilometers of high-voltage lines – all of which was built for the conventional power sector, so the new lines required for renewables are minor in comparison. There are 510,000 kilometers of medium-voltage power lines and around 1,1 million kilometers of low-voltage distribution lines.

The switch to renewable electricity will be technically challenging because solar and wind power are not dispatchable, meaning that you cannot turn wind turbines and solar panels on the way that you can ramp up central coal and nuclear plants to match power demand. A number of solutions are possible.

The general problem is that the exact amount of electricity that is needed at a given moment has to be available at that moment, lest the grid collapse. We have therefore traditionally tailored power production to demand. A number of storage options are currently being discussed, from underground compressed air in natural caverns to pumped storage (hydropower), flywheels, and batteries. Most importantly, Germany plans to use natural gas in the interim as a bridge fuel to be eventually replaced by sustainable biogas and hydrogen made from excess wind power and solar power; here, solar and wind power could be stored as a gas (called "power to gas" or P2G), allowing it to be used as a motor fuel, for heat applications, or to produce dispatchable power. Finally, "smart grids" will help tailor power demand to the available renewable power supply – the opposite of what we do now.

In 2016, the German government is focusing on "digitalising" the power sector. In light of Germany's history with abusive secret services in Nazi Germany and the communist former East Germany, the German public is – perhaps understandably – highly concerned about data privacy issues that smart meters and other technologies entail. Quite possibly, smart meters will be rolled out in businesses first; the relatively low level of household power consumption may not (yet) make them a profitable investment at the retail level.

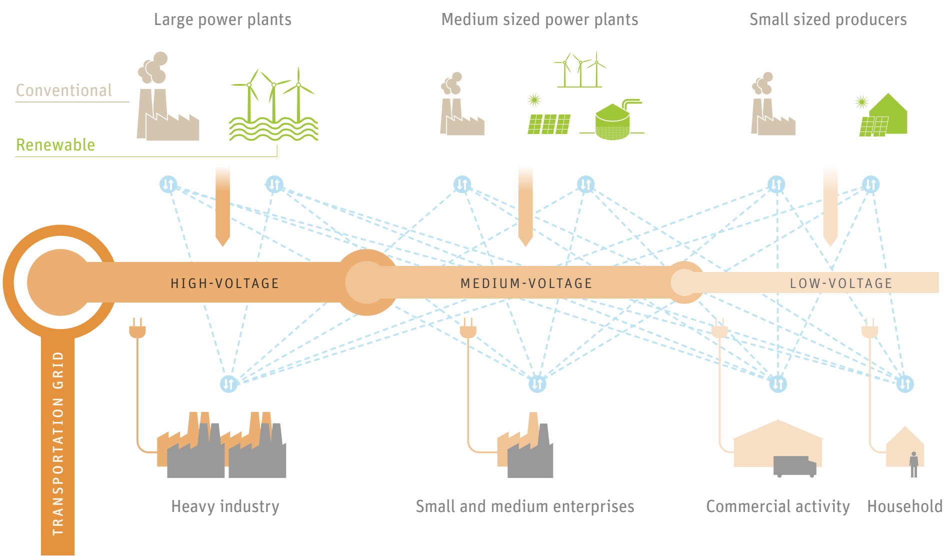
The need for power storage

European integration could be a solution, especially in light of Germany's limited pumped-storage capacity (hydropower). It has been proposed that Germany could export large amounts of power to Norway and Switzerland, for instance, which have tremendous hydro-storage potential, but at the moment connections are insufficient. But work is being done: in 2015, plans were finalized for a new 1.4 gigawatt connection between Norway and Germany. Called Nordlink, the cable is to go into operation in 2020. It remains to be seen, however, whether Norway or Switzerland (neither of which

The future power grid will be bidirectional and intelligent

Electricity and information flow in power grid

Source: IFEU



is even a member of the EU) would be willing to flood more of their pristine valleys and fjords so that Germans can have a stable supply of renewable electricity.

Over the midterm, most experts believe that the need for power storage will be minimal in Germany. A study produced for the WWF found that there would not be a major market for storage technologies until 2030, and the German engineering organization VDE does not expect much demand for storage until Germany has 40 percent renewable power, a target that is admittedly likely to happen closer to 2020. Furthermore, Fraunhofer ISE point out that the amount of storage needed is not relative to the share of fluctuating renewable power alone, but rather to the combination of fluctuating renewables and inflexible baseload power. In other words, the need for power storage can be reduced by decreasing baseload generation capacity, mainly lignite and nuclear plants.

Putting renewable grid expansion into perspective

To put all of this in perspective: First, Germany has gone from 3% renewable power at the beginning of the 1990s to 32 percent in the first quarter of 2016 without any major changes to its grid. After all, wind power, biomass, and solar power are largely distributed sources of energy – at least the way Germany is doing it (see 2 – I "Energy by the people").

Critics of renewables sometimes complain when the grid has to be expanded for renewables. The problem with wind farms is that they are built in places where there is no need for electricity. As a result, the produced electricity has to be moved elsewhere."

In fact, this describes coal power better than wind power. You can spread solar, wind power, and biomass fairly evenly across the landscape in a way that you cannot do with conventional power. In contrast, brown coal plants are never built where power is needed, but rather where the brown coal is dug out of the ground. Even power plants fired with hard coal, which is traded globally, were traditionally built close to the source of the coal, such as in Germany's Ruhrgebiet (Ruhr Area). Clearly, however, it is much easier and less expensive to transport large amounts of power across power lines than it is to haul loads of coal. And while one could argue that coal plants are often located close to industry (as is the case in the Ruhr Area), this description puts the cart in front of the horse. Go back some 200 years to the beginning of industrialization – most of the towns in the Ruhrgebiet were small villages. Coal plants were not built in the Ruhrgebiet because industry was there; rather, industry developed there because the area was full of coal reserves.

Furthermore, while nuclear plants are built more or less where power is needed, not where uranium is mined, all central plants are so huge that the grid is always expanded for them. In the 1960s and 70s, new nuclear power plants in Germany not only required the grid to be expanded, but also led to the installation of a large number of electric home heating systems that generated heat from power overnight so that the nuclear plants would not have to be ramped down each day. A distributed supply of renewable power is a much softer approach with a much smaller impact on the environment. Hermann Scheer, the late German expert on renewables, once compared distributed power supply to our conventional centralized power supply by saying that the latter is like "cutting butter with a chainsaw."

Grid expansion

There is a consensus that the grid needs to be expanded for more renewables to be integrated, but there is less agreement about a number of details, such as how many lines need to be added, where they need to go up, and what kind of lines should be used. Furthermore, the renewables sector itself has an interest in making the energy transition affordable and has therefore come up with a number of inexpensive alternatives to extensive grid expansion. In addition, people do not want to live near power lines, so public input is needed for planning – and that requires greater transparency.

The current German grid is divided up as follows:

The transit grid consisting of some 35,000 kilometers of 220 and 380 kV lines. This is the ultra high-voltage level at which Germany is connected to its neighbors and power is transported across long distances.

The distribution grid consisting of the following:

1. Some 95,000 kilometers of high-voltage lines (60 to 110 kV) for conglomerations and large-scale industry.

2. Some 500,000 kilometers of medium-voltage lines (6 to 30 kV) for many large facilities such as hospitals.

3. Some 1,100,000 kilometers of low-voltage lines (230 and 400 V) for households and small businesses.

Germany has four investor-owned utilities operating the four sections of its transit grid, but there are some 900 distribution grid operators.

How many kilometers?

So what needs to be done for the country's *Energiewende*? At the moment, a lot of wind power is in the north and a lot of solar is in the south. The German Energy Agency (dena) published two studies (Grid Study I and II) estimating that some 4,500 kilometers of ultra high-voltage lines would need to be added if Germany is to increase its wind power capacity from 27 gigawatts to 51 gigawatts by 2020 – ten gigawatts of which would be offshore in the North Sea and Baltic Sea. But some in the renewables sector believe that this length could be cut by more than half.

Starting in 2016, the Grid Development Plan is to be updated every two years. It currently contains 22 projects covering a total of 1,876 kilometers of new lines, 487 of which had been completed by mid-2015.

Indeed, these plans have been met with great criticism among proponents of renewables in Germany, mainly because the underlying data was not published, so the findings could not be further scrutinized. But even at the proposed level, a near doubling of wind power capacity would still apparently only require the transit grid to be expanded by less than 13 percent. Furthermore, a lot of these lines would not be needed if the government promoted more onshore wind in the south rather than additional offshore wind in the north. In the past few years, the wind industry has come up with special wind turbines with taller towers and longer blades designed especially for use in weak-wind locations, such as southern Germany. Such onshore turbines in the south would not require as many power lines, thereby reducing the overall cost of Germany's energy transition, and onshore wind is also much less expensive than offshore wind to boot.

Likewise, some proponents of solar would also like to see feed-in tariffs for photovoltaics adjusted by region (as is done in France) so that more PV is installed in the north, thereby facilitating grid integration.

Grid upgrades often face local opposition (people do not wish to live next to overhead power lines), and complicated red tape and financing also slow things down. Underground cables are an option, but they are more expensive. As of 2016, the government has decided to prefer underground cables over overhead power lines for the high voltage direct current lines, which are built to connect northern Germany with southern Germany. For AC lines, the number of underground cables has been increased compared to earlier plants, too. As part of the revised Renewable Energy Act, it is also discussed to reduce the number of new wind energy installations that are auctioned in areas with grid bottlenecks.

But again, keep in mind that we are talking about adding roughly 1,900 kilometers to a grid consisting of hundreds of thousands of kilometers set up exclusively for the country's nuclear and fossil energy supply.

Alternatives to grid expansion

Germany's renewables sector is not, however, just sitting back and waiting for the government to provide a future-proof grid. The solar sector has come up with a way of making the use of ultra high-voltage lines more efficient: solar power plants can act as "phase-shift oscillators" to stabilize the grid's frequency. The solar sector hopes that this approach will reduce the number of lines that need to be built.

The wind sector is also full of ideas. Under German law, there is a regulation called "n+1" it means that whenever a line is set up, there has to be a reserve line that can take up its capacity in case it fails. The wind sector has come up with a solution that could mean that this requirement is no longer necessary: dedicated power lines to connect renewables.

Furthermore, the European Union – as part of its Energy Union plans – aims to step up interconnections between countries to strengthen the continent's energy security and keep costs down. At the same time, however, surges in wind and solar power production in Germany are already pushing power into Poland and the Czech Republic, in particular, so further integration would be a challenge for those countries. Some Polish officials have already stated that they might need to reduce rather than enlarge their power connections with Germany so they can have better control of their own grid. Transformers are installed in June 2016 for this purpose.

H – Flexible power production (no more baseload)

Already, it is clear that intermittent solar and wind power will eventually cut deeply into baseload power. Germans have been aware that baseload power is incompatible with intermittent renewables for years. To complement renewables, we will need dispatchable power plants that can ramp up and down relatively quickly. Such plants more closely resemble today's medium and peak load (such as gas turbines) than the baseload (such as nuclear plants, which do not ramp easily). To pay for such reserve generating capacity, the power market will need to be redesigned, however, which is why Germany is now increasingly talking about a capacity market and a strategic power reserve.

In 2015, Chancellor Merkel stated her opposition to capacity markets, so Germany is unlikely to have one in the medium term. However, the "winter reserve" is expected to be expanded from 2.5 to 4 gigawatts. The winter reserve covers power plants that are not needed except in emergency cases, generally when power demand peaks during the heating season. These plants receive compensation for their standby services but are prohibited from selling power otherwise.

What do you do when the sun is not shining and no wind is blowing? Outside Germany, it is often said that conventional power plants will be needed as bridge technologies as we switch to renewables this century. In particular, there is talk about the need for baseload power, which fluctuating wind turbines and solar panels cannot provide. Germany already gets so much of its power from wind and solar that it has a different viewpoint. To the surprise of many foreign onlookers, Germans realize that baseload power demand will soon be a thing of the past. What is needed is flexible, quickly dispatchable power generation, not baseload. The difference is easy to understand if we consider central power stations, such as coal and nuclear plants. Ideally, these plants are switched on and run near full capacity until they need servicing. Nuclear plants in particular do not easily ramp up and down within a matter of hours, and attempts to do so are bad for the bottom line in two ways: first, fixed costs remain the same, with only fuel costs being slightly reduced, so the cost of power from the plant increases; and second, the plants themselves undergo thermal fatigue, which can shorten their overall service lives.

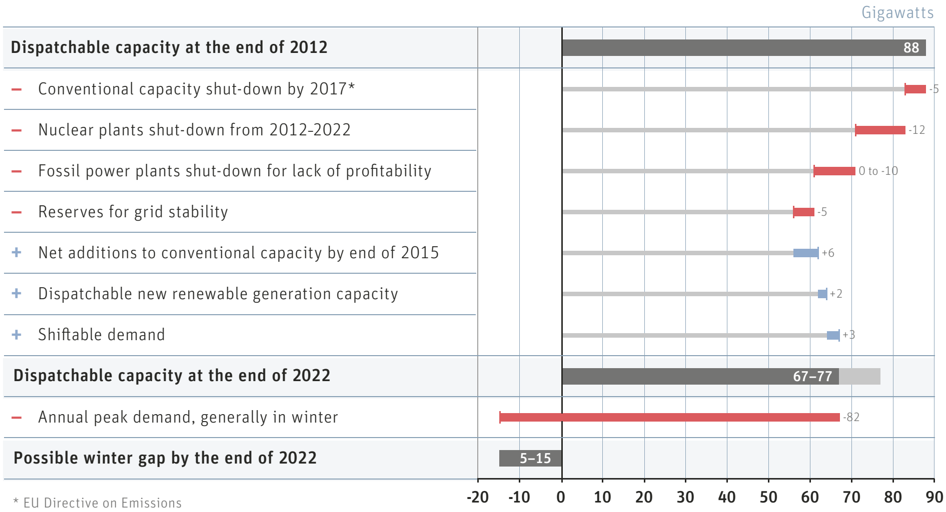
For Germany's four biggest power companies, this new situation represents quite a dilemma. They set up their generating capacity based on the assumption that they would be able to sell power at a great markup during times of peak consumption. Now, power consumption remains unchanged and still peaks at above 70 megawatts on certain days, but solar and wind push back conventional power production into the lower 40s – roughly the level of baseload power that big power corporations are set up to cover. Just a decade ago, these power companies still belittled wind and solar power as niche technologies that would never be able to make up a big chunk of power supply; now, solar and wind power are increasingly making these firms unprofitable.

In 2015, German utility E.On split into two companies: one for renewables and new services, and one for conventional energy. Wholly owned by the Swedish state, the utility Vattenfall has also announced plans to step away from its coal assets in Germany, but the motivation is political, not financial; the Swedish government elected in 2014 wants the firm to be as clean abroad as it is at home. The state government of Baden-Württemberg ownes utility EnBW, which now pursues a "greener" strategy. The utility RWE also split into two companies. RWE has too much lignite (more than a third of its power generation), which remains relatively profitable on the German power market. In contrast, E.On has only six percent lignite; a third of its power generation came from oil and gas in 2015. E.On is the firm affected most by the nuclear phase-out; RWE, the most affected utility by talks of a gradual coal phase-out. Most of these utilities mainly invest in renewables abroad – RWE in the UK, E.On in the UK and the United States – where these investments do not conflict with their existing assets.

Does Germany need a capacity market to close the "winter gap"?

Trends in dispatchable capacity 2012-2022

Source: Agora Energiewende



Unintended outcome: renewables push back natural gas

This outcome is partly intentional (see the next section, "Energy by the people") and partly unintentional. The unintentional part is that renewables are making investments in natural gas turbines unattractive by replacing the medium load, meaning that natural gas turbines do not run for as many hours a year. Essentially, Germany needs to have a dispatchable installed capacity at the level of its peak demand for the year, which is currently around 80 gigawatts and occurs on winter evenings – when the sun does not shine. A large part of that 80 gigawatts therefore needs to be built as dispatchable gas turbines. This option is generally considered the best technically as it requires no additional infrastructure and would allow electricity to be stored seasonally. German researchers have estimated that the storage capacity in the country's current natural gas lines can contain enough gas to meet the country's power demands for four months.

Though this option seems the best in terms of technology, it faces a financial challenge: wholesale power prices are now so low on the power exchange that investments in additional generating capacity would not be profitable. Not only are Germany's four biggest power firms abandoning plans to set up new gas turbines; there have also been rumors that some of the existing turbines might be taken off-line because they are no longer running for enough hours per year. However, in 2016, the profitability of gas turbines improved somewhat, so a renaissance of power from natural gas may yet be coming.

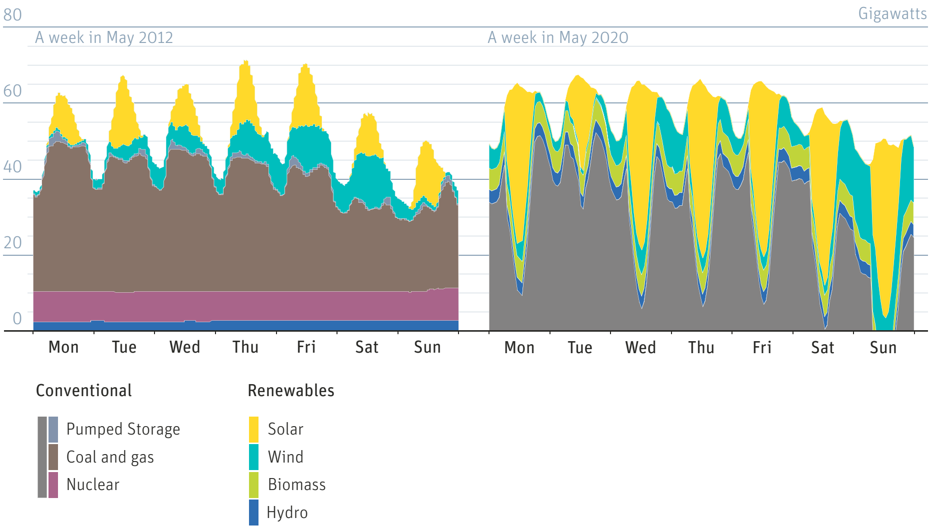
While this outcome was predictable, the situation has come about much faster than most proponents of renewables expected, especially in light of the extremely fast growth of photovoltaics from 2010 to 2012, when 7.5 gigawatts was installed annually. If the German PV market had continued to grow at the level of those three years (in 2014 only 1.9 gigawatts was installed; in 2015, only 1.4 gigawatts), the country would eventually have had more than 150 percent of peak demand in the summer, when demand peaks at between 60 and 70 gigawatts during the week and as little as 50 gigawatts of the weekend. One German researcher's "dental chart" shows what the effect would be if "only" 70 gigawatts of PV is installed by 2020 (keep in mind that the government's official target is 52 gigawatts by 2020).

One possible remedy currently being discussed is capacity payments. Here, owners of quickly dispatchable generators would be paid not only by the kilowatt-hour generated, but also by the kilowatt kept on standby. Similar programs exist in other countries, such as Ireland. The UK also rolled out such a scheme in 2014, though it has met with fierce criticism by providing payments to all power plants. In 2015, the German government resolved to keep the passive the payments small by increasing the "winter reserve" from 2.5 to 4.0 gigawatts. The winter reserve, which consists of power plants generally used on only one or two days a year, is quite small given the more than 100 GW of dispatchable generation capacity in Germany.

Renewables need flexible backup, not baseload

Estimated power demand over a week in 2012 and 2020, Germany

Source: Volker Quaschning, HTW Berlin



This chart has no baseload power at all; the gray area now represents medium and peak load. Clearly, Germany will need a fleet of very flexible, dispatchable power generators that can ramp up every day from around ten gigawatts to 50 gigawatts or more within just a few hours. The country does not have this much flexible generating capacity at present, and all current plans for new power plants are now in question given the new market conditions of lower wholesale prices. From 2010 to 2015, wholesale power prices on the German power exchange fell by nearly half. One main reason is the rise of solar power in particular: because most of it is generated around noon time, demand for peak power at midday has been greatly offset.

I – Energy by the people for the people

Germans can switch power providers. In fact, they are not only free as power consumers, but also free to become "prosumers" – simultaneously producers and consumers. They can even sell the power they make at a profit. Germany's Renewable Energy Act stipulates that the little guy's renewable power has priority over dirty power. German feed-in tariffs have helped produce all of this community ownership, thereby simultaneously reducing NIMBYism (not in my backyard) and increasing acceptance levels for renewables.

In most countries, the energy sector has long been in the hands of large corporations because electricity came from large central power stations. Renewables offer an opportunity, however, to switch to a large number of smaller generators, and this distributed approach offers an opportunity for citizens and communities to get involved. Germany has an unusually high level of citizen involvement in the *Energiewende*. One in every sixty Germans is now an energy producer.

Some countries are switching to renewables by requiring utilities to produce more green power with policies called "quota systems." These policies set targets for utilities to reach, and penalties can be imposed if the targets are not met. The focus here is generally on cost, with the assumption being that utilities will choose the least expensive source of renewable power. For instance, the British Wind Energy Association lists wind projects as submitted, approved, refused, and built, categories that do not exist in countries with German feed-in tariffs. Rejections are thus a natural part of requests for proposals, which are also common in the US.

In contrast, no single organization in Germany has the task of reviewing wind farm proposals for approval or rejection; instead, local governments decide where wind farms can be built and how they will be designed (space, number of turbines, etc.). Utilities face no penalties because, in fact, it is not their responsibility to ramp up renewables. Utilities are also eligible for feed-in tariffs, but these firms have nonetheless rarely made such investments. Overall, the difference between the two approaches – feed-in tariffs versus quotas – is striking. Under quotas, only the least expensive systems go up after time-consuming reviews, and they remain in the hands of corporations; under feed-in tariffs, everything worthwhile goes up quickly, and ownership of power supply rapidly transfers to citizenry. In other words, Germany is democratizing its energy sector.

This focus on cost is justified in quota systems (like Renewable Energy Portfolio Standards in the US) because excess profits would go into the hands of a small group of corporations. Proponents of such quota systems correctly charge that the cost impact of feed-in tariffs is generally greater than the cost of quota systems, but they overlook two aspects: first, countries with feed-in tariffs generally install a lot more renewable generating capacity; and second, if properly designed, profits from feed-in tariffs go back to small investors, not multinational players, thereby breaking the stranglehold that large corporations have on the energy sector. In other words, many of the people who face slightly higher retail rates also receive revenue from those increases.

Proponents of quota systems argue that they are "technology-neutral," meaning that they do not prefer one technology over the other. They charge that feed-in tariffs "pick winners." But the charge is unusual in light of the different market outcomes. Quotas promote the least expensive type of renewable energy, which has generally been onshore wind up to now. Not surprisingly, PV – relatively expensive until recently – has sometimes failed to win bids in auctions altogether unless there was a set-aside for photovoltaics (though that situation may be changing now that PV is so affordable). In contrast, markets with feed-in tariffs for all renewable sources generally see a buildup of everything. And if you want an energy transition, you will need a proper mix of renewable sources, not a focus on the cheapest one.

Ironically, the allegedly "technology-neutral" policy (quotas) has led to a focus on a single energy source (onshore wind), while the policy that allegedly "picks winners" has led to a technology mix. Furthermore, while auctions are called "competitive," competition takes place between energy sources; companies also compete with each other in auctions, but the auctions lead to greater market concentration. Feed-in tariffs have produced far more open markets, with new players competing on a level playing field against incumbents.

Until recently, the American Wind Energy Association (AWEA) had a section on its website called Projects, which listed wind farms by location, size, and owner. At the time, Germany had the most wind power capacity of any country in the world. Nonetheless, DEWI, the organization that collates statistics on German wind power, said they never produced such a table: "We cannot say who owns a particular wind farm in Germany because ownership is splintered across scores, and sometimes hundreds, of local citizens and businesses."

These examples from Germany are common, not exceptional. Dardesheim was not even the first in 1994. That honor goes to the small town of Friedrich-Wilhelm-Lübke-Koog near the Danish border. Meanwhile, in Freiburg, Germany, a town of some 220,000 people in the southwestern corner of the country, citizens funded roughly a third of the investment costs for four turbines put up on a nearby hill, with the other two thirds coming from bank loans. The project manager says interest rates from the bank were around 4.5 percent, whereas the project paid a dividend of up to six percent to citizen investors. The citizen investments counted as equity; in other words, the banks provided relatively low interest rates because so much equity was available. On the other hand, a lot more paperwork is involved when you have hundreds of small investors instead of a few big loans from banks. But the Freiburg project, like so many others in Germany, focused on greater community acceptance – so that locals can negotiate with locals, not with an out-of-town corporation that makes everyone feel like it could get its way.

The latest projects attempt to make communities not just net exporters – selling excess power to the grid and only purchasing power from it when not enough renewable energy is available – but entirely self-sufficient. For instance, the Island of Pellworm has combined solar, wind, biomass, and geothermal in a hybrid power plant connected to a smart grid with energy storage to reduce the dependency of its 1,200 inhabitants on energy imports by 90 percent.

There are also community-owned biomass projects. In 2004, a local farmer in the village of Jühnde formed a cooperative with nine other farmers who wanted to grow energy crops. More than 70 percent of village residents agreed to switch their heating systems over to a district heating network connected to a new village biogas unit. The biomass unit runs largely on local corn crops. For several years now, the villagers have been paying local farmers and businesses for their heat instead of paying for foreign oil and natural gas.

When Jühnde switched over to its renewable heat supply, it drew a lot of attention across the country and served as an example for scores of other communities – and continues to do so. Indeed, there was a bit of a boom in corn as an energy crop, which drew some criticism. People feared monocultures and were concerned about the impact on biodiversity and landscapes, but anyone who has seen the Corn Belt in the United States, soy plantations in Brazil, or palm oil plantations in Malaysia would find Germany's largest cornfields quite small in comparison.

New projects will continue to depend on local support. If the citizens affected do not want to be surrounded by even more cornfields, the project will not go forward.

Overall, it is estimated that "energy cooperatives" – community-owned renewables projects – had leveraged more than 1.67 billion euros in investments from more than 130,000 private citizens in 2014. It is often said that only the wealthy can make such investments; for instance, critics charge that you need to own your own home to have a solar roof. But more than 90 percent of Germany's energy cooperatives

A community-owned PV array on a noise barrier in Freiburg, Germany. Source: fesa GmbH 2006

have already set up solar arrays, and a single share in such cooperatives costs less than 500 euros in two thirds of the cooperatives – with the minimum amount less than 100 euros in some cases. As the head of Germany's Solar Industry Association (BSW-Solar) puts it, "Energy cooperatives democratize energy supply in Germany and allow everyone to benefit from the energy transition even if they do not own their own home."

Furthermore, energy cooperatives are moving beyond power production to include grid ownership. In the 1990s, the movement began with the Schönau Power Rebels, residents of a village in the Black Forest that forced their local utility to let them purchase the local grid. Now, the movement continues to spread across the country. In 2014, Germany's second-largest city – Hamburg – voted to buy back its grid. A similar campaign in the capital city Berlin failed, however. Citizens are even to be allowed to purchase stakes in transmission lines expanded for offshore wind, albeit to a very limited extent.

Social transition

The *Energiewende* is not just a technical challenge; it will also challenge us to change our behavior. If the goals are to be met, Germans will have to pursue "sufficiency strategies" focusing on a cultural transformation – a process that cannot be completed overnight, but will take time and require a lot of awareness-raising. Germany is a society in which people love their creature comforts, so as all of these devices become more efficient, we must ensure that people do not simply decide, say, that a car with twice as good gas mileage means they can drive twice as much for the same price. This discussion about policies to change behavior is just getting started in Germany. Already, it is clear that new ownership and financing models (such as energy cooperatives) will not only allow people to get involved in new ways, but also increase acceptance of local change and awareness of energy consumption.

The Dardesheim wind farm has grown organically over the past two decades, and turbines continue to be gradually added. Visiting the wind farm is like going to a wind turbine museum. At the bottom of the tower on the right, local children were allowed to paint life-size figures. Photo: Craig Morris

Increasingly, new modes of flexibility will need to be tried out. Housing associations are working on flexible housing concepts to allow rooms to be easily separated in order to put an end to the unbroken growth in per capita living area over the past few decades. Elsewhere, residential complexes now have ultra-efficient washing machines for common use in the basement, and car sharing provides people with efficient mobility to suit their needs. But people should not be forced to adopt such ideas. Rather, they will come up with such solutions themselves as they become more aware of the problems posed by unpredictably fluctuating energy prices and the impact of carbon emissions.

J – Sector Coupling

Energy is consumed in three end-use sectors of buildings (for heating and cooling), transportation, and industry. The power sector is also often included in the list because of the importance of electricity. Connecting these three sectors will be crucial for the energy transition's success. The term describing this is "sector coupling."

At the moment, the focus of the Energiewende in Germany is on the power sector alone. Little progress has been made with renewable heat and energy efficiency, and the transport sector. Fortunately, the problems with all three sectors can partly be addressed by connecting the power sector with the heat and transport sectors. Electrification is one example of sector coupling. For instance, solar and wind power are the two fastest growing sources of renewable energy worldwide. Eventually, a growing number of countries will begin to have excess amounts of this green electricity when the sun is shining and the wind is blowing. At that point, electricity will be inexpensive on wholesale markets, so it will increasingly be used to generate heat for use in buildings and industry. This option will be used first because it is highly efficient and requires no expensive equipment.

Next comes electric transportation. It already exists largely in form of trains and trams, but increasingly electric bicycles and electric cars will be on the roads. Batteries are still quite expensive, however, and most countries (including Germany) lack price signals to encourage people to charge their battery vehicles when excess renewable power is available. But as more citizens use electric vehicles, the need to coordinate charging with wholesale power prices will increase. For instance, power consumption in Germany generally peaks in the evening when people get home from work and start making supper or watching television. If these people also plug in their electric cars at that time, power demand will skyrocket at a time when the grid is already pushed to its limits. Smart meters would be one way by which vehicles can charge overnight as power demand subsides.

3 Policies for clean energy

Germany has implemented a number of laws and programs for its energy transition, and there are also some at the level of the EU. The most important ones are listed below.

A – Nuclear phase-out

The nuclear phase-out is a central part of Germany's *Energiewende*. Germans view nuclear as unnecessarily risky, too expensive, and incompatible with renewables. In 2022, the last nuclear plant in Germany is to be shut down. At the beginning of 2011, 17 were in operation; in early 2016, eight were still online. The country plans to fill the gasp left behind by nuclear power with electricity from renewables, power from natural gas turbines, lower power consumption (efficiency and conservation), demand management, and – in the interim – the rest of its existing fleet of conventional power plants.

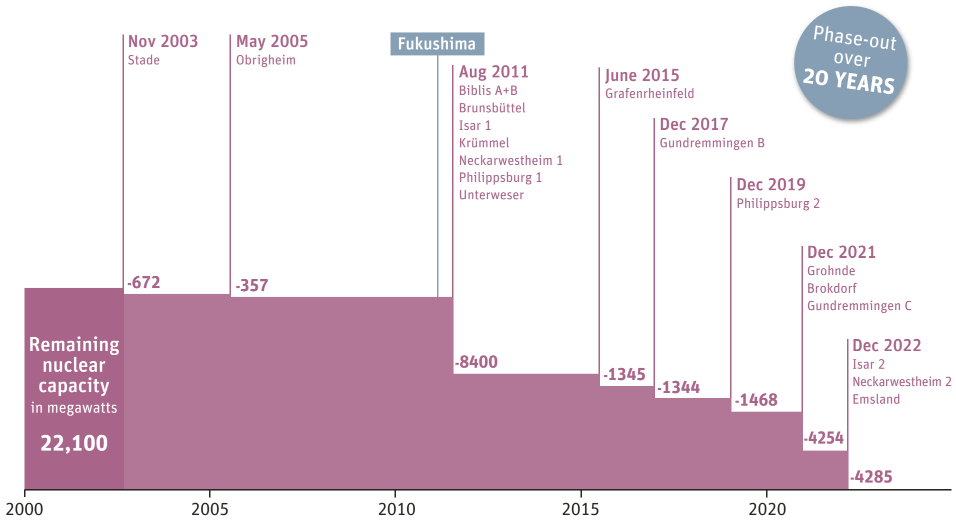
The 2011 nuclear phase-out was not the first German nuclear phase-out. In 2000, the governing coalition of the Social Democrats and the Greens under Chancellor Gerhard Schroeder reached an agreement with Germany's nuclear sector to shut down the country's nuclear plants after an average service life of 32 years. At the time, the country had 19 nuclear plants with commissions that had not expired.

The firms were allowed, however, to allocate kilowatt-hours from one plant to another. In this way, the firms themselves could decide to shut down one plant ahead of schedule but transfer that plant's remaining kilowatt-hours to another plant that, say, was located in a more critical area on the grid.

Germany is gradually shutting down all nuclear power plants

Declining nuclear energy installed capacity in Germany, 2000–2022

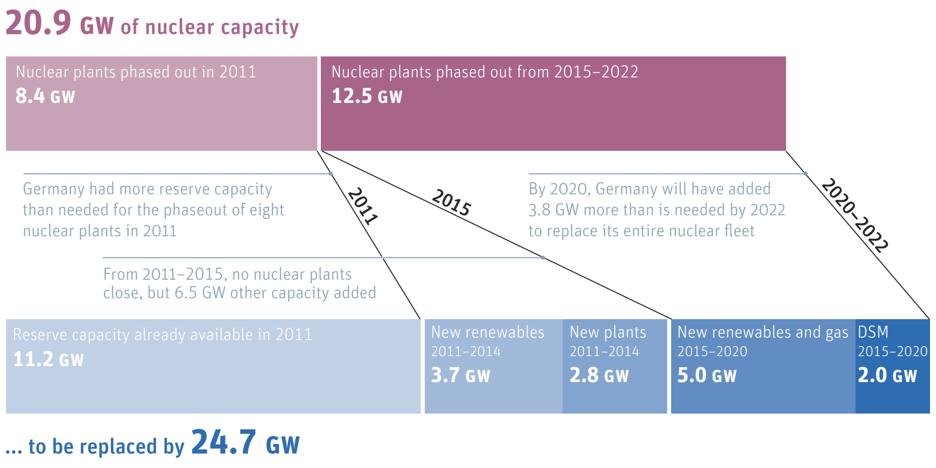
Source: Institute of Applied Ecology, BMJ, own calculations



Germany can easily replace its nuclear capacity on the phaseout schedule

Replacing nuclear plants with reserves, new renewables, gas, and demand-side management (DSM)

Source: Institute of Applied Ecology, own calculations



Depending on how much nuclear power had been produced by then, Germany would have switched off its last nuclear plant around 2023.

Germany's Big Four power companies (EnBW, RWE, Eon, and Vattenfall of Sweden) had no choice but to accept this compromise they had reached with Chancellor Schroeder's government, but they seem to have pursued a strategy of waiting it out – and of switching from nuclear to coal and natural gas rather than to renewables. By the end of 2011, these firms collectively only made up seven percent of Germany's new investments in renewables (to learn more about citizen investments in renewables, (see 2 – I "Energy by the people"). During that same timeframe, the share of nuclear in German power supply fell from 30 percent in 1999 to 23 percent in 2010. As of 2016, Germany had closed nine of its 17 reactors still online in 2010.

Policy reversals

Then came the nuclear meltdown in Fukushima, Japan, on March 11, 2011. In Berlin alone, an estimated 90,000 people took to the streets to protest nuclear power. The German government resolved to shut down eight of the country's 17 reactors immediately. The decision became final two months later, essentially meaning that Chancellor Merkel's coalition suspended the previous nuclear phase-out for only a few months before reinstituting a similar deadline. Now, Germany is back on course to be nuclear-free by 2022. For each of the remaining nine nuclear plants, a concrete date has been set for decommissioning.

In 2016, the phase-out debate turned its focus to financing decommissioning and the final waste repository, which will have to be maintained practically indefinitely, E.On's split into two companies was an attempt to move its nuclear liabilities into the new conventional power company; if it goes bankrupt, the new company focusing on renewable energy would not be liable. However, the German government and the nuclear companies are currently working on a deal to ensure that liquidity is set aside in a special fund. Up to now, the money has not actually been set aside, but reinvested – and would therefore not be available in case of bankruptcy. In 2016, the German government proposed a fund worth 23.3. billion euros, roughly 6 billion more than the firms had previously set aside. Furthermore, the money would actually be paid into this fund, not merely set aside on the books.

B – Renewable Energy Act with feed-in tariffs and auctions

Perhaps no other legislation has been copied worldwide as much as Germany's Renewable Energy Act (EEG), making it a tremendous success story. The law specifies that renewables have priority on the grid and that investors in renewables must receive sufficient compensation to provide a return on their investment irrespective of electricity prices on the power exchange. The resulting high level of investment security and the lack of red tape are often cited as the main reasons why the EEG has brought down the cost of renewables so much. In contrast, quota systems do not provide investors with security or incentives to ensure that a wide range of renewables technologies are deployed so they can become less expensive.

In the early 1990s, Germany came up with a very simple policy to promote electricity from renewable energy sources, including wind power, solar energy, and small hydropower generators. In 2000, these feed-in tariffs were revised, expanded, and increased; every three to four years, they are reviewed and the law is amended, (see Chapter 4 – History of the Energiewende). The last major revision is being undertaken in 2016 to continue the switch from feed-in tariffs to auctions.

Owners of solar arrays and wind farms have guaranteed access to the grid. Grid operators are required by law to purchase renewable power, with the (intended) result being that conventional power plants have to be ramped down – in the process, renewable power directly offsets conventional power production.

While feed-in tariffs themselves have been widely copied outside of Germany in more than 50 countries, the central aspect of grid access is occasionally overlooked. Projects that would be profitable thanks to feed-in tariffs may then remain stuck in limbo for lack of a grid connection.

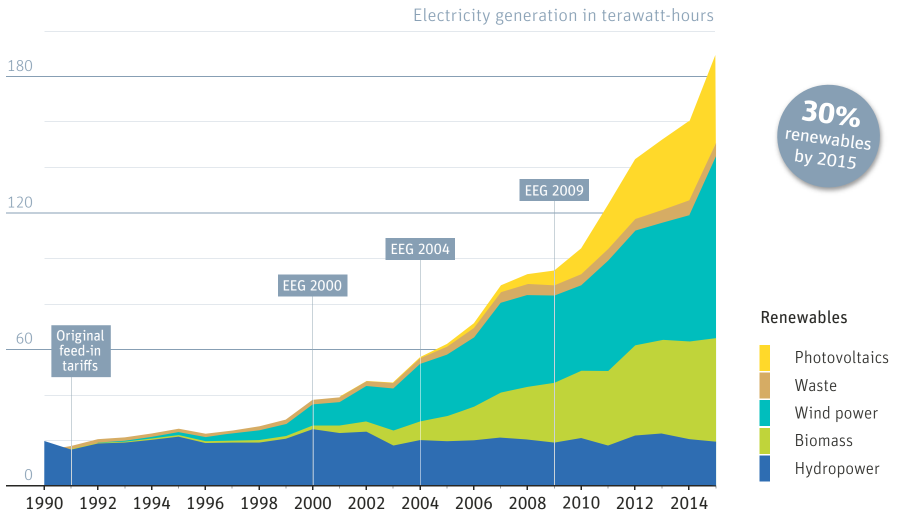
The situation is by no means perfect in Germany, either; any German project developer can probably complain about delays in the grid connections. But overall, most grid connections are fairly easy to get in a timely fashion, and project planners in other countries would probably love to have the grid access terms stipulated in Germany's EEG.

The standard contract for feed-in tariffs that you sign with your utility is two pages long in Germany. In contrast, the United States has Power Purchase Agreements (PPAs), which can easily be 70 pages long and are individually negotiated between the seller and the buyer (say, a utility company). In Germany, feed-in tariffs are guaranteed for 20 years, which would be unusually long for PPAs. And let us not overlook one important aspect – you will need a lawyer, if not a team of lawyers, to formulate a PPA, whereas the average German has no problem understanding the two-page contract for feed-in tariffs.

Feed-in tariffs grow renewables

Renewable electricity generation in Germany, 1990-2015

Source: BMU



Flexible tariffs

The feed-in tariffs themselves are quite simple to explain. Basically, you take the cost of a particular system, divide that figure by the number of kilowatt-hours the system can reasonably be expected to generate over its service life (generally 20 years), and you get the cost of that system per kilowatt-hour. Now, tack on whatever return on investment (ROI) you want to provide, and you have your feed-in tariff. In Germany, the target ROI is generally around five to seven percent (although the levels vary in practice).

This approach allows distinctions to be made not only between technologies (such as solar, wind, and biomass), but also between system sizes. After all, a giant ground-mounted photovoltaic array on a brownfield will produce electricity that is cheaper than power from a large number of distributed solar rooftops on homes. By offering different feed-in tariffs for different system sizes, you ensure the economic viability of the various applications, thereby preventing windfall profits for large projects.

The EEG sets very ambitious targets. For instance, Germany plans to get at least 40 to 45 percent of its power from renewables by 2025 and at least 80 percent of its power from renewables by 2050. This legal requirement to switch power generation almost entirely to renewable sources is one of the main pillars of Germany's *Energiewende*.

Criticism of feed-in tariffs

Critics of feed-in tariffs charge that the policy does not promote the least expensive type of renewable energy.

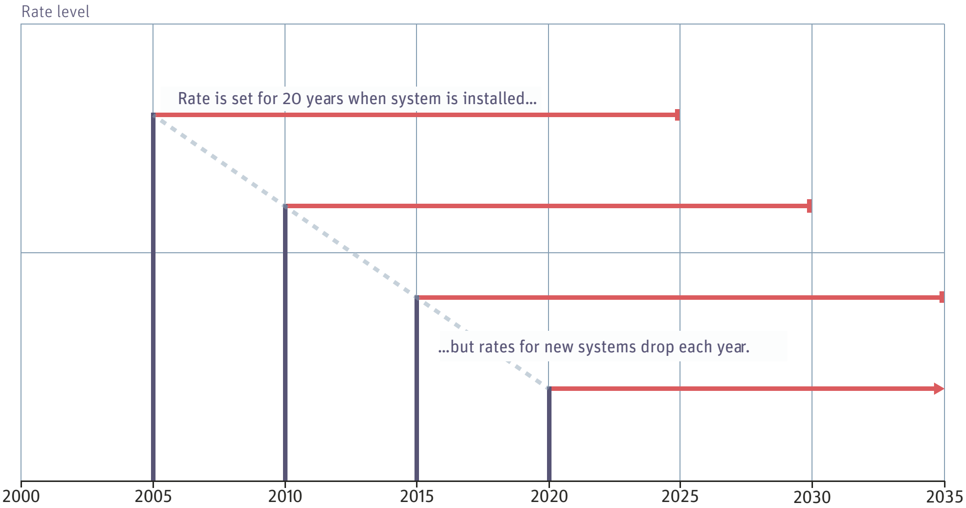
This outcome is not, however, unintended; it is what makes feed-in tariffs successful to begin with. Think about it – quota systems (such as Renewables Obligations in the UK and Renewable Energy Credits in the US) generally require utilities to generate or purchase a certain amount of their electricity from renewables (say, ten percent by 2020). The utility then looks for the cheapest source of renewable power, which is almost always wind power – and it is almost always large wind farms, not community projects with just a few turbines. But we will never bring down the price of photovoltaics by focusing only on wind turbines.

Repeatedly, critics of feed-in tariffs have charged that the policy "picks winners," but in fact quota systems always pick wind, whereas feed-in tariffs support all of the specified types of energy equally. The confusion is based on a misunderstanding. Up to now, conventional power sources have generally competed with each other. For instance, power companies leave their least expensive power plants online as much as possible and only switch to more expensive generators as demand increases. But if renewable power always has priority, then it does not compete with conventional power on price anyway. In addition, in quota systems, financing institutions add risk surcharges. Thus, financing costs are higher than in a feed-in tariff scheme, which provides long-term reliability for investors.

Feed-in tariffs provide investment certainty and drive costs down

Simplified generalization of feed-in tariff with 20 year duration

Source: Own estimates based on WFC



It would not be correct, however, to conclude that there is no competition with feed-in tariffs. For a given feed-in tariff, companies – from panel manufacturers to local installers – compete for customers. For instance, let's say you want to put a solar array on your house. In Germany, you will get a couple of estimates from local installers, who will probably also give you a couple of options (such as monocrystalline or polycrystalline panels, or panels made in Germany or abroad). All of the companies you could buy from compete with each other.

Feed-in tariffs unleash the market

Not surprisingly, feed-in tariffs do not lead to unnecessarily high prices. In fact, Germany has the cheapest solar power in the world not because it has so much sunlight, but because of investment certainty and market maturity due to its feed-in tariff policy. Solar arrays are so much cheaper in Germany than it is in sunny parts of the US, for instance, that the largest, most cost-efficient utility-scale solar power plants there still produce considerably more expensive power than small to midsize arrays in Germany.

Up until 2008, when the bottleneck in the supply of solar silicon finally worked itself out, critics of feed-in tariffs charged that Germany had been paying too much for photovoltaics with its feed-in tariffs, thereby keeping the cost up for the rest of the world, including developing countries in particular. But since prices began to plummet in 2008, we do not hear that criticism anymore – because it wasn't true in the first place.

Changes in German feed-in tariffs for PV did not bring about these lower prices; on the contrary, German politicians have been rushing to reduce solar feed-in tariffs to keep up with falling prices. Those who once claimed that German feed-in tariffs kept the price of solar up for the rest of the world should now explain why prices are down so much without being driven by cuts in German feed-in tariffs for PV.

The truth is that solar can get cheaper even if feed-in tariffs remain unchanged because there is still a competitive market. If you want to install a solar roof, you will pick one of the least expensive offers on the market.

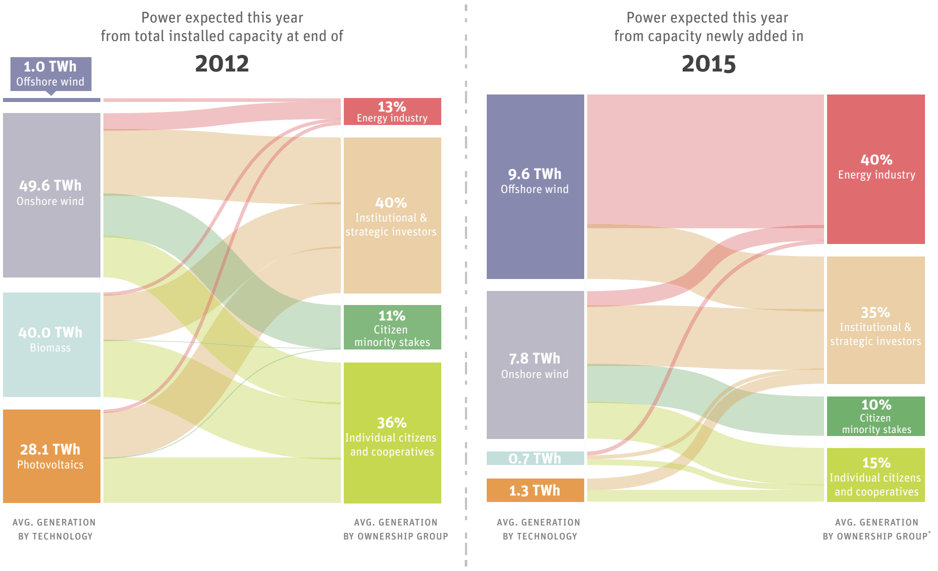
Cost of the EEG

The EEG's feed-in tariffs have scheduled reductions, usually annually, to ensure that the price for renewable power continues to drop. For wind and PV, there is now also a "growth corridor" with a target of 2.5 gigawatts per year. If that level is surpassed, the scheduled reductions are stepped up. Unfortunately, the current market design has a flaw that actually makes the retail rate increase for consumers when renewables lower the wholesale rate for industry. Green electricity is sold on the

German government hands power sector back to energy corporations

Average electricity generation by non-hydro renewables and ownership structure

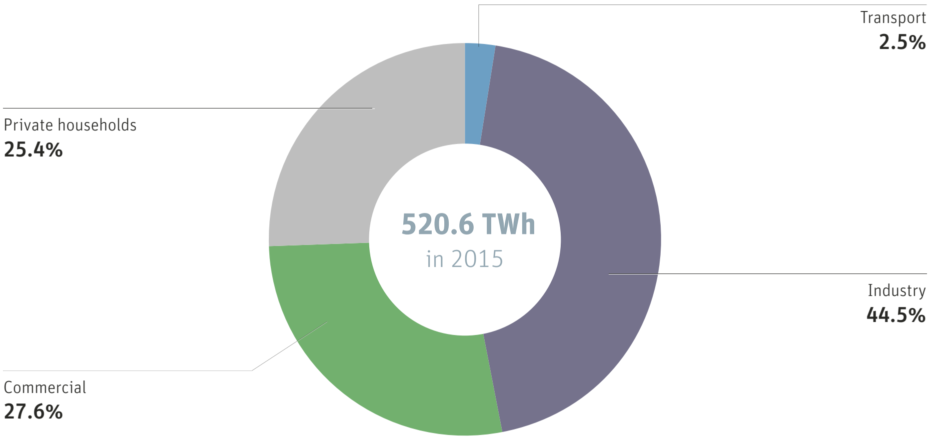
*Source: AGEE, Leuphana, EnKlip | *based on 2012 market shares*



Industry by far biggest power consumer in Germany

Electricity consumption by sector, 2015

Source: BMWI, StBa



power exchange, and the difference between feed-in tariffs paid to producers and the revenue from the power exchange is passed on as the renewable energy surcharge.

To maintain dynamic development for renewables on the market, the feed-in tariffs for newly installed systems decrease from year to year. The "degression rate" – stepped, scheduled tariff reductions – depends on the maturity of the different technologies. Hydropower tariffs go down one percent per year, wind 0.4 percent per year, PV 0.5 percent per month, and biomass 0.5 percent per quarter. For biomass, photovoltaics and wind, the regression rate depends partly on the market volume in the preceding year. If the PV market falls below one gigawatt per year, rates will even increase.

The cost of these feed-in tariffs is passed on to power consumers. By 2016, this surcharge had raised the retail price by around 6.4 cents per kilowatt-hour – equivalent to roughly a quarter of the retail power price (not including the monthly hookup fee). These investments not only reduce energy imports, but also lower greenhouse gas emissions and the cost of resulting climate change.

But while renewable power has raised the retail rate in Germany, it has lowered wholesale prices. Solar power in particular is generated in the early afternoon at a time of peak consumption. Normally, even the most expensive generators are switched on during such hours (the technical term is "merit-order effect"), but less expensive solar power largely offsets this costly peak demand power in Germany now.

Some changes are needed

Ironically, lower wholesale rates increased the EEG surcharge because of the way that surcharge is calculated – the price of wholesale power is reduced from the cost of renewable power, and the difference is passed on as the surcharge. Hence, as renewables made wholesale power cheaper, they also seemed to make up an ever larger share of the power price, so consumers perceived renewable power as a cost driver – simply because of the calculation's design.

In contrast, energy-intensive industry is benefiting tremendously from this trend. Not only do they generally pay wholesale rates, not retail rates, but energy-intensive industry and the railway sector in particular are largely exempt from the EEG surcharge. In other words, German retail consumers and small businesses currently cover an inordinate share of the cost of green power.

Increasingly, however, the EEG surcharge is becoming an issue for social policy – how will the poor continue to pay their power bills? Proponents of renewables are increasingly calling for the exemption for energy-intensive industry to be done away with, as the sector already benefits from lower wholesale prices thanks to renewables and should gradually have to share a greater chunk of the burden. It has been estimated that the EEG surcharge would have come in around 4 cents per kilowatt-hour in 2015 (rather than 6.1 cents) had energy-intensive industry been required to pay the full surcharge.

EEG 2016

By 2017, Germany is to phase out feed-in tariffs for systems larger than 100 kilowatts and switch to auctions, in which the buyer receives bids from sellers. In 2016, the government continues to finalize the details for a transition from feed-in tariffs to auctions. The fourth round of pilot auctions for ground-mounted PV produced a price of 7.4 cents, which is competitive with the scheduled reduction for feed-in tariffs. The government is therefore happy with the progress.

During the summer of 2016, the German government is working to implement further changes to its EEG to take effect on January 1, 2017. The effect could be to slow down the growth of renewables – ironically, just after signing the international climate agreement. What may these changes entail for each energy source?

Solar, which is already expected to fall short of the annual target of 1.5 megawatts for the second year in a row, will probably slow down further. Now, arrays larger than 750 kW will no longer be eligible for feed-in tariffs and instead have to be auctioned. Below that level, solar will increasingly offset power purchases from the grid, but the governments wants to rein in this potentially strong market as well. If more than 20 MWh of solar power is consumed directly, the electricity tax of 2.05 cents per kWh is payable for the entire amount of electricity in addition to roughly 2 cents for the renewable surcharge. Solar power from new arrays may only cost nine cents, but the German government is adding four cents to systems of this size. Mainly, very large commercial roofs are affected.

Biomass, which also fell short of the 100 megawatt annual target last year with only around 71 megawatts built, will receive an annual limit of 150 megawatts for the next three years, followed by 200 megawatts per year. The question remains whether those targets will be reached at all, as with solar.

Arguably, the biggest battle took place in the wind sector. Here the compromise reached has a gross limit of 2.8 gigawatts. Because Germany installed 3.2 gigawatts in 2002, there is therefore likely to be a net reduction of 0.4 gigawatts when those systems reach the end of their 20-year eligibility for feed-in tariffs and come up for repowering. This reduction only applies to onshore wind, which is the cheapest source of new electricity in Germany; there are separate targets for offshore wind (6.5 gigawatts by 2020 and 15 gigawatts by 2030).

There has been widespread dismay over this outcome. The overwhelming consensus is that the German government is slowing down the Energiewende and pushing back citizen energy. The policy switch from feed-in tariffs to auctions is widely expected to produce numerous losing bids; small cooperatives that cannot pass losses across multiple projects are likely to refrain from participating to begin with. Any onshore wind project larger than one megawatt must now be auctioned.

C – Emissions trading

An emissions trading system (ETS) puts a limit on emissions for the long term. The policy is the main instrument in the EU to lower greenhouse gas emissions in industry, the power sector, and most recently the aviation sector. The EU-ETS has been criticized, however, for a lack of ambition and too many loopholes – an outcome that comes as no surprise, given that policy makers had to make concessions to strong electricity and industry lobbies to get the system launched at all. These concessions include offsets, not ambitious targets, and a lack of adjustments to economic downturns.

The EU-ETS

The EU's main climate policy instrument for the industrial and power sector is its Emissions Trading Scheme (EU-ETS), which covers roughly half of the greenhouse gas emissions within the European Union. Overall, the goal is to cap the emissions for different sectors. Each year, the amount of carbon that can be emitted is reduced, putting pressure on firms to lower their emissions by investing in efficiency measures or buying allowances from other emitters.

This system thus produces a price for carbon. Proponents of emissions trading point out that the least expensive solution will always be chosen. For example, it might be cheap for a utility firm to shut down a very old coal plant and switch to natural gas or renewables to replace that capacity. As a result, that utility might not emit as much carbon as it holds in carbon certificates, so it could sell the unused certificates to another utility firm, which has a relatively new coal plant in operation but needs to purchase a few allowances nonetheless.

Absolute cap, but bumpy start and design flaws

The EU-ETS has, however, gotten off to a bumpy start. Launched in 2005 in a pilot phase, it was comprehensively revised in 2009/2010. The price of carbon remained low, thus giving little financial incentive to switch from coal to low carbon fuels. Nonetheless, the platform does put a ceiling on emissions, which is why Germany's nuclear phaseout will not lead to more emissions. The ETS caps the power sector, so Germany's carbon emissions cannot rise above that level with or without nuclear power. (See Chapter 6 – Question and Answer)

A number of design flaws have kept the system from being more successful. To begin with, when the pilot phase began in 2005, a generous volume of certificates was handed out for free to major emitters. The result was nonetheless higher power prices because the firms charged consumers for the value of the certificates they had received for free. Since 2013, certificates have no longer been allotted for free but have instead all been auctioned off for the power sector; major carbon emitters will finally have to pay for all of their carbon allowances.

The economic downturn since 2008 and other, partly unknown factors mean that too many allowances are still in circulation. In 2014, the EU had already reached its target for 2020 on the European trading platform, which sounds like good news but in fact reflects the inability of the platform to react to the success of renewables and the economic downturn. As a result, carbon prices are not expected to rise from the current level of around 5 euros per ton to the 30-50 euros originally envisioned in 2005. In 2014, the "backloading" of certificates was passed, postponing the sale of 900 million carbon allowances to the period of 2019 to 2020 to stabilize current carbon prices. Starting in 2019, the amount of auctioned allowances will be reduced in case of excess emission allowances (market stability reserve).

A major problem continues to be the role of offsets. They basically allow European companies to reduce their emissions not at home but in developing countries, with the Clean Development Mechanism (CDM). Unfortunately, the requirement that offsets be "additional" (meaning that the project would not have taken place anyway to fulfill existing environmental laws) may be preventing environmental regulations from being made stricter; after all, stricter rules would require more action, and the CDM then has to go even further. In other words, the stipulation that a project be additional may provide an unintended incentive to keep other regulations lax. Steps must therefore be taken to ensure that offsets are not barriers to stricter environmental regulations.

Overall, criticism of offsets centers on the question of whether developed countries "outsource" too much of their emission reduction responsibilities to the developing world, thus avoiding structural changes in their own economy.

Emissions trading and feed-in tariffs

Emissions trading has sometimes been viewed as in conflict with feed-in tariffs (see Chapter 3B – Renewable Energy Act with feed-in tariffs). While the ETS aims to reduce emissions in the traditional power sector, feed-in tariffs promote investments in renewables. Some analysts argue that if the only goal is lowering greenhouse gas emissions, the ETS would deliver this goal most efficiently because market members would choose the cheapest way to reduce emissions; they charge that many types of renewable energy are only economically viable because of feed-in tariffs.

In fact, renewable power primarily offsets gas turbines and electricity from hard coal plants in Germany, thereby reducing carbon emissions dramatically. Rather than viewing feed-in tariffs and emissions trading as competitors, most Germans understand that feed-in tariffs allow us to reduce the ceiling on carbon emissions for emissions trading faster than we would otherwise be able to do.

During the discussions in 2009, Germany's premier economic research institute, DIW, came out strongly in favor of both instruments in a paper entitled "We need both," arguing essentially that if renewable energy has the potential to reduce carbon emissions faster than the emissions trading platform can, then the obvious thing to do would be to lower targets for emissions trading – not to get rid of feed-in tariffs.

In reality, as the upturn in demand for German coal power from 2011 to 2013 shows, both renewable energy and emissions trading is needed. A higher price for carbon would have encouraged a transition from coal to natural gas in the power sector.

Emissions trading internationally

Outside of Europe, emissions trading has been struggling even more up to now. Nonetheless, the policy will likely pick up not only in the EU, but also worldwide. California started its own cap and trade program in 2013, and its carbon price is higher than the EU's; it is complemented by the voluntary emissions trading platform along the East Coast of the US (RGGI). China recently implemented a pilot platform in seven provinces.

Finally, it is worth mentioning that Germany is one of the few countries that not only met its Kyoto targets, but surpassed them with flying colors. The Germans had what sounds like a relatively ambitious target of a 21 percent reduction below the level of 1990 by the end of 2012 (the UK's target was a 12.5 percent reduction; France's, zero percent), but 10 percent of that was related to the special situation of the former East Germany, whose decrepit industrial sector was shut down or revamped in the 1990s. Nonetheless, Germany overshot the target by a wide margin, reducing its emissions by 24.7 percent by the end of 2012. At the end of 2014, the reduction had reached 27 percent.

Germany is not, however, on course to reach its voluntary 2020 emissions reduction target of 40 percent. Additional political action is needed. In December 2014, the government adopted a Climate Action Program 2020 to help close this emissions gap, and the government has since been discussing the limiting emissions from old coal plants. Another Climate Action Plan 2050 is currently in preparation.

D – Environmental taxation

Tax the bads, not the goods – as the slogan puts it, environmental taxation increases taxes on environmentally unfriendly activities (such as fossil fuel consumption). But it is also revenue-neutral, for the tax revenue can be used to lower the costs of something society considers good (such as, in the case of Germany, labor, when the revenue is used to offset payroll taxes). The policy was very successfully implemented in Germany and created some 250,000 jobs even as it reduced fuel consumption and made German workers more competitive internationally.

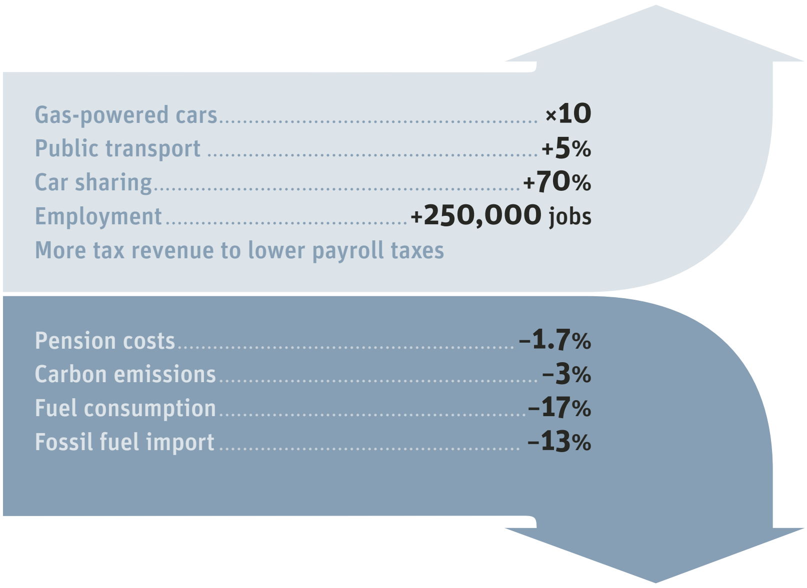
Since 1951, Germany has had a petroleum tax, which has been called the energy tax since 2006. As of 2007 (the last time it was changed), 65.45 cents was charged per liter of gasoline, for instance, roughly equivalent to around 2.50 euros (more than three dollars) per US gallon. In other words, Germany's petroleum tax alone costs roughly the same as gasoline itself does in the United States, for instance, and we still need to add on sales tax!

Unlike the previous petroleum tax, environmental taxation is revenue-neutral, meaning that it offsets a revenue stream somewhere else. In the case of Germany's "eco-tax," some of the revenue went to a budget that funded renewables, but most of it was used to lower payroll taxes because the

Eco tax reform: taxing energy instead of jobs

Benefits of Germany's ecological tax reform which raised taxes on energy and cut payroll taxes

Source: Green Budget Germany



government felt that the main thing hurting the German businesses was the high cost of German workers. From 1999-2003, an eco-tax was implemented for the first time in annual increments under the governing coalition of the Social Democrats and the Green Party. It applied not only to gasoline and diesel for vehicles, but also to heating oil and fossil fuel (natural gas, coal, oil, and liquefied petroleum gas) used to generate electricity.

Tax the bads, not the goods

The idea that a tax paid at a filling station should help offset employee pensions struck Germans as a bit odd at the time, but it is in fact what makes revenue-neutral environmental taxation special. The idea is that you tax "bad" things so that people will consume less of them (such as finite fossil fuel), not "good" things that you want more of (such as jobs). And because the tax is revenue-neutral, political opponents cannot claim that taxes are being raised – because another revenue stream already being paid is lowered in the same amount of the new levy.

Each year from 1999-2003, the tax on a liter of gasoline/diesel was increased by 3.07 cents, which is not much, but it sent a signal to consumers to get ready for a 15.35 cent increase over that five-year period. The public was able to react to these higher prices in a number of ways, all of which were desirable: driving less, driving in a way that reduced fuel consumption, buying more efficient cars, carpooling, taking public transport, cycling or walking, or moving from the countryside into the city, where they could more easily do without a car.

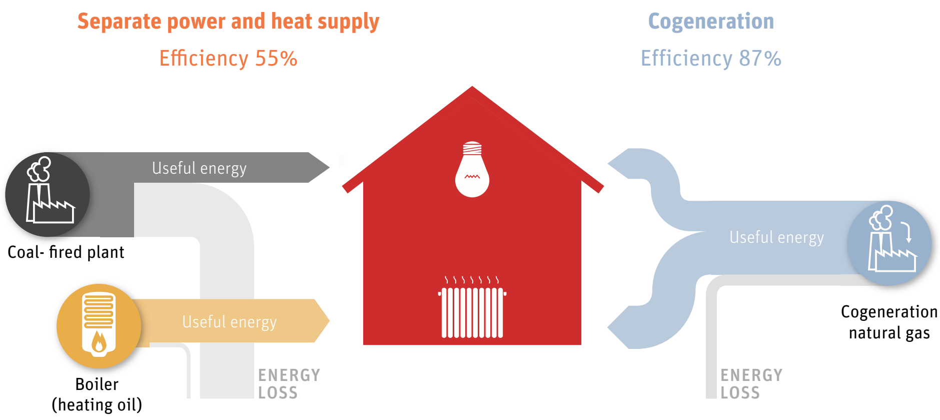
According to Green Budget Germany, which lobbied for the eco-tax, fuel consumption dropped each year during the implementation of the eco-tax, and the number of people using public transportation increased every year. Likewise, sales of efficient cars also increased each year. In addition, payroll taxes dropped by 1.7 percent, and less expensive labor is estimated to have led to the creation of 250,000 new jobs.

However, since 2007, the eco-tax has not been adjusted, leading to a gradual depreciation of the impact.

Why cogeneration is more efficient than conventional coal power plants

Comparing the energy efficiency of cogeneration with conventional coal power plant and heating system

Source: ASUE



With a coal fired power plant, more than half the energy input is wasted.
Cogeneration reduces the primary energy demand by 36%.

E – Cogeneration Act

Germany wants to get 25 percent of its power supply from cogeneration units by 2020 because cogeneration is much more efficient than separate power and heat generation. The Cogeneration Act therefore pays bonuses for cogeneration relative to system size irrespective of the feedstock.

Although it is possible to count kilowatt-hours of heat just as we count kilowatt-hours of electricity, Germany has never offered feed-in tariffs for renewable heat. Instead, in 2002 the country adopted the Cogeneration Act.

Cogeneration is when part of the waste heat from a power generator is recovered, thereby increasing the overall efficiency of fuel consumption. The goal defined in 2009, when the first amendments went into effect, was for Germany to get 25 percent of its power supply from cogeneration units by 2020 (compared to 14.5 percent in 2010). Because heat can be much more easily and efficiently stored than electricity, such units could generally be ramped up when power is needed, and heat would be stored for later.

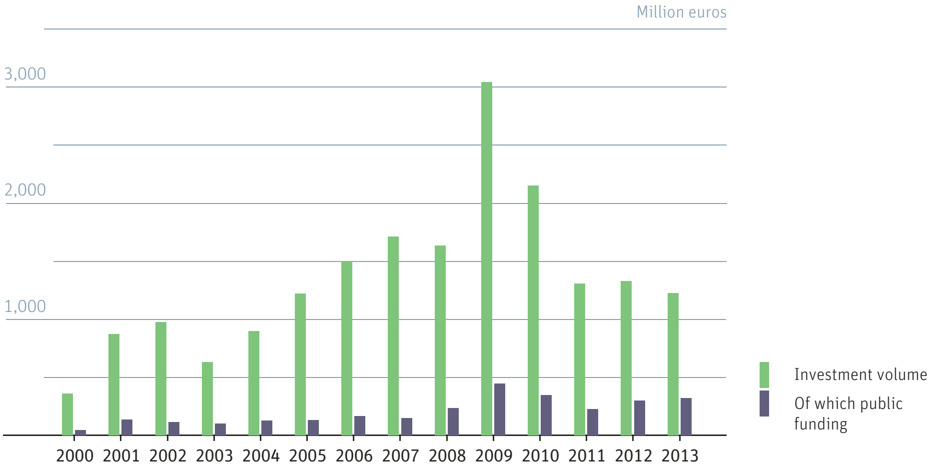
There is a debate in Germany about whether cogeneration units should be run based on power demand as opposed to heat demand, however. Critics of the current policy argue that shortfalls in heat production may require the use of inefficient backup heating systems to cover peak demand, which can worsen overall efficiency. Nonetheless, it is clear that cogeneration is far more efficient than the separate generation of power and heat. German energy conservation organization ASUE puts the potential total efficiency of cogeneration at 87 percent, compared to only 55 percent for separate power and heat generation.

The law sets a bonus for each kilowatt-hour of power produced by the cogeneration unit, and that power has priority on the grid. Interestingly, there is no special payment for the heat generated; the incentive comes in the form of a bonus for the power produced. Furthermore, the only requirement for efficiency is that the cogeneration unit must reduce primary energy consumption by ten percent compared to the provision of the same amount of heat and power from separate generators.

Public funding triggers private investments

Renewable energy support in the heating sector under under the German market incentive program (MAP)

Source: BMWI



F – Renewable Energy Heating Act and Market Incentive Program (MAP)

Germany's Renewable Heat Act aims to increase the share of renewable heat to 14 percent by 2020. New building owners are obligated to get a certain share of their heat from renewable energy, and owners of old building get financial support for renovations. This funding was temporarily cut during the economic crisis although every euro spent here generated more than 7 euros in private investments. Now, the program is back in place.

In 2009 – long before the disaster in Fukushima – Germany's Renewable Energy Heating Act was passed. It aims to increase the share of renewable heat to 14 percent by 2020. New building owners – private persons, firms, and the public sector, even if the building is to be rented – are required to get a certain share of their heat from renewable energy systems (such as solar collectors, a heat pump, or a wood-fired boiler). The owners can choose how to meet these obligations at their discretion. Those who do not wish to use renewables can use more insulation or get heat from district heating networks or cogeneration units. As the government is obliged, by European law, to introduce a nearly zero energy standard, it plans to combine the renewable heating obligation with the building code.

Because renewable heating systems can be planned from the outset when new buildings are constructed, the Renewable Energy Heating Act only applies to this sector. In existing buildings, the German government supports renovations of heating systems with its Market Incentive Program (MAP), which was originally instituted in 2000. This program primarily supports existing buildings; new buildings are eligible only for certain types of innovations.

Homeowners, small and midsize businesses, freelancers, and municipalities can apply for special funding for the following types of systems:

- small and large solar heat collectors
- biomass-fired furnaces with automatic feed systems (such as wood pellets)
- highly efficient firewood gasifiers
- efficient heat pumps
- district heating systems, heat storage and biogas pipelines
- geothermal heat supply systems.

The purpose is to ensure that sensible ways of using renewable energy are promoted when the current building standard does not go far enough. The MAP has a budget of more than 300 million euros annually. The MAP is, in terms of its market impact, a very effective program: every euro in MAP funding has generated more than seven euros in private investments.

Budget reliability

During some uncertain years, the available funding was dependent on the emissions trading volume, and therefore the MAP was vulnerable to the whims of policy makers. In the last amendments to the program in 2015, however, the subsidies were enhanced significantly to increase the dynamics in this market segment. This triggered the market for renewable heating even though the low energy prices extenuated this effect.

G – Act on Accelerating Grid Expansion

The energy transition will need an expanded, adapted grid to cope with more renewable power. Neither has been progressing fast enough, so the German Parliament has passed the Act on Accelerating Grid Expansion. But there is no agreement on how much needs to be done where. Official plans are in place, but several of the projects remain contested.

The *Energiewende* will require properly functioning infrastructure; in particular, the grid will have to be adapted and be made smarter. The current grid is designed to take power from central power stations to consumers, but the future will be more complex.

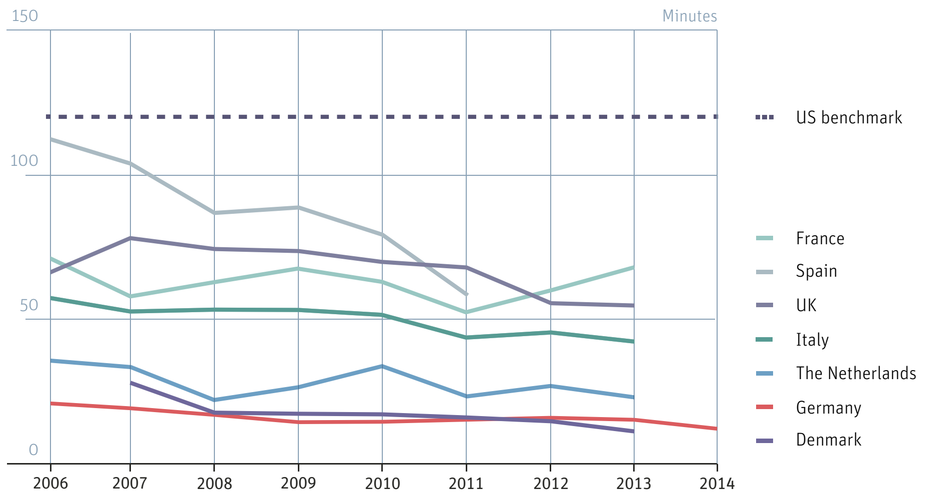
Large power plants will continue to export power to the transit grid, but it will need to be changed so that power from wind turbines (both onshore and offshore) in the north can reach consumer centers in the west and the south. These lines will also be used for power trading. At the low-voltage and medium-voltage levels of the grid, a growing number of small, distributed generators – solar arrays, cogeneration units, individual wind turbines, and small wind farms – will be connected, and special controls will ensure that everything runs smoothly. The grid will become more intelligent.

Up to now, grid expansion has not been progressing fast enough. Only a quarter of the 1,800 kilometers of new lines planned had been completed by mid-2015. Lines to connect offshore wind turbines are especially crucial. For some time, it was unclear who was financially liable if wind turbines had been installed offshore, but the grid connection was not ready. In the summer of 2012, the German government brokered a compromise between wind farm investors and grid operators by resolving that the former would be compensated by the latter – but the costs could be passed on to consumers. This compromise sets a double standard for wind power. Small onshore wind farms have to pay for their own connections up to the nearest transformer station, and they receive no compensation from grid operators if the capacity behind the transformer station needs to be upgraded and is not done in timely fashion. The onshore wind sector, which has traditionally been driven by community projects and small to midsize businesses, is therefore frustrated because grid operators – former subsidiaries of Germany's Big Four utilities, which have not always helped small onshore wind farms – are getting special treatment for their grid connections.

Grid reliability and growth in renewables go hand in hand

Minutes of power outages per year (excl. exceptional events), based on Saidi

Source: CEER and own calculations



In 2011, the German Parliament passed the Act on Accelerating Grid Expansion (NABEG). It calls for a review of ultra-high voltage lines by Germany's Network Agency and for high-voltage (110-kilovolt) lines to be installed as underground cables as a rule. In addition, there is to be great public input and transparency at an early stage of planning to increase public acceptance. In 2014, two drafts of the Grid Development Plan analyzed the necessity of creating a "Federal Need Plan", which would become law. The goal is not just grid expansion; existing grids will also be upgraded and optimized. For instance, special temperature-resistant power lines could be used to transport greater amounts of electricity without requiring further lines to be installed. Temperature monitoring would also allow power lines to be used closer to full capacity when the wind cools them off – which generally happens when there is also a lot of wind power. The NABEG was complemented by a special law to promote underground cables, particularly for long-distance high-voltage direct current lines.

H – Energy-Conservation Ordinance (EnEV) and financial support schemes

When it comes to the construction of new buildings, the German *Energiewende* began in 1990 with the development of highly efficient passive houses. Unfortunately, although many buildings can now be renovated to fulfill very ambitious standards close to the Passive House Standard, a lot of progress still needs to be made towards increasing the energy efficiency of renovated buildings. To improve things, Germany had developed an Efficient Building Strategy.

In Germany, roughly 40 percent of all energy is consumed in buildings, most of it for heating. This area is crucial in Germany's energy transition because most renewables produce electricity, which makes up the smallest part of German energy consumption at 20 percent. In contrast, oil and gas continue to dominate the heating sector with a combined share of more than three fourths of the heat market.

Building retrofits – the area that requires the most attention

In Germany, most of the energy used for heating, cooling, and hot water is consumed in buildings, most of which were built before 1978, when Germany implemented its first requirements for insulation. For instance, two thirds of the roughly 15 million single-family homes and duplexes were constructed at a time when there were no requirements for insulation. The energy transition has yet to take proper account of the potential from renovations. Instead of ensuring that renovations are as comprehensive as possible, German law has generally encouraged building owners merely to make the most urgent minor repairs.

In other words, the low renovation rate is not the only problem; not enough is done during renovations. Buildings are not properly insulated during renovation, and the technologies that would pay for themselves the most are not used often enough. As a result, buildings renovated today will soon need to be renovated again.

The reasons for these shortcomings include a lack of awareness, a lack of motivation, financing problems, low returns on investment in the short run, and insufficient skills among firms, planners, and tradespeople who perform renovations.

The dilemma of tenants and landlords is another major issue. Building owners do not have proper incentives to invest in renovations that merely lower the utility costs for their tenants. The situation is especially serious in Germany, where 22 million of the country's 39 million families do not own their own homes.

Trying to improve the situation

At present, Germany is focusing on increasing its renovation rate from one percent per year (meaning that all buildings would be renewed within 100 years) to 2 percent (so that all buildings would be renewed within the next 40 years).

The *Energiewende* has made great progress when it comes to electricity, for which a number of policy tools have been implemented, but progress in building renovations has been slower. If things are to speed up here, policies will have to be changed. The Energy Conservation Ordinance (EnEV) includes requirements for energy audits, replacements for old heating systems, and the quality of renovation steps. However, that last point is only effective if renovations are actually carried out. In Germany, there is no legal tool for speeding up retrofits.

Instead, Germany is focusing on information and financial support. Germany's development bank KfW provides special low-interest loans for energy-efficient renovations, although more than 50 percent of this funding is still devoted to new buildings. Furthermore, laws protecting the rights of tenants were revised in 2012 to help encourage building owners who rent their properties to invest in renovations.

What is needed is a substantial increase in funding for retrofits. Low-income families often live in poorly insulated buildings and therefore face high energy costs. Yet, building owners are not willing to invest in renovations because they will not be the ones who benefit from lower utility bills. The only way around this dilemma is providing funding for renovations in such situations, but the energy transition has yet to address this problem sufficiently.

As part of the National Action Plan for Energy Efficiency (NAPE) of 2014, new programs have been developed which address non-residential buildings – an area neglected so far. New tools for energy consultancy are being developed. For instance, the Institute for Energy and Environmental Research develops a tool called "individual renovation roadmap" which specifically helps owners with ambitious step-by-step renovations.

Unfortunately, one of the major instruments proposed in the NAPE, a tax break for renovations, did not pass the Bundesrat (Upper House) because of objections of a few Federal States.

The new policy for 2015 ("Hauswende") is intended to get weatherization efforts going again. The German Environmental Ministry has created this special project called "Hauswende" to facilitate the focus on energy conservation in renovation projects, which are often complex and include several trades. Additional efforts within the NAPE include a new labeling scheme for existing heating systems as well as a "heat check", a program carried out by chimney sweepers and installers, meant to increase the dynamics of heating modernization.

It would also help to move beyond building renovations and look at how entire neighborhoods and city districts can be made more energy-efficient. In 2012, the development bank KfW started a special and successful support scheme entitled "Energetische Stadtquartiere" ("Energy in urban neighborhoods") that provides financial incentives to municipalities to plan, organize, and implement district-wide retrofit schemes and to implement district heating networks. In addition, within the urban development promotion programs and another programs targeted towards municipalities, efficiency measures and the installation of renewable and district heating infrastructure is funded.

The Energy Conservation Ordinance (EnEV)

In 2002, Germany adopted its Energy Conservation Ordinance (EnEV). For the first time, this legislation provided a way of creating an eco-balance for a building by counting not only the useful energy provided to the building, but also the primary energy needed in the process, which includes losses in generation, distribution, storage, etc. In addition, EnEV includes requirements for the quality of renovation steps, energy audits, and replacements for old heating systems. The current EnEV specifies that new homes must not consume more than 60 to 70 kilowatt-hours of energy per square meter of heated indoor area per year for heating and hot water.

The EnEV is being amended in 2016 because the government has to introduce the nearly-zero energy standard as required by the European Buildings Directive. As part of this discussion, the government is considering to tighten the requirements for new buildings, reducing the energy demand even further, moving the newly built houses much closer to the passive house standard.

Way back in 1990, a number of German architects built houses that make do with only 15 kilowatt-hours of heating energy per square meter – the first passive houses. So little energy is needed for heating that some residents of passive houses simply invite friends over for dinner when the apartment starts to get cold. Heat from the kitchen and from human bodies suffices to warm the house.

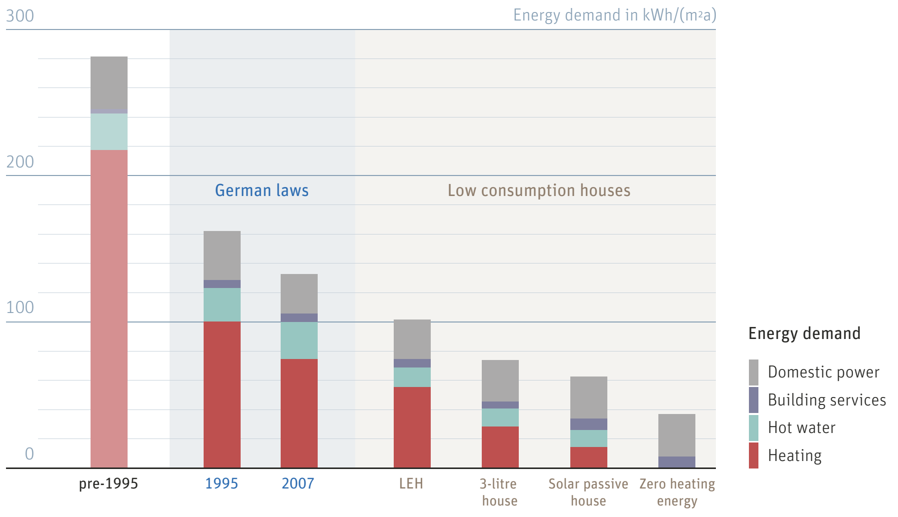
Passive houses basically allow you to completely do away with heating systems even in a cold climate like Germany's. Heating expenses are cut by an estimated 90 percent compared to a conventional new building, partly because backup heating systems can be so much smaller.

Passive houses are a combination of high-tech and low-tech. The low-tech aspect is relatively straightforward: homes are built facing the south in Germany. The southern façades have large glazed surfaces to allow a lot of sunlight and solar heat in during the cold season; in the summer, overhanging balconies on the south side provide shading, thereby preventing overheating, as do deciduous trees

The housing sector offers large potential for energy savings

Characteristic energy demand of buildings

Source: IFEU 2011



planted on the southern side of the building, which provide additional shade in the summer but lose their leaves in the winter to let the sunlight pass through.

The high-tech aspects mainly concern the triple-glazed windows, which allow light and heat to enter but largely prevent heat from exiting the building. Most importantly, passive houses have ventilation systems with heat recovery, which also help prevent mold.

In short, passive houses are an excellent example of how Germany's Energiewende will produce much higher standards of living even as energy consumption is reduced and made more sustainable.

Plus-energy homes

Some cities in Germany (such as Frankfurt) already require the Passive House Standard for all new buildings constructed on property purchased from the city. The EU has also stipulated that all new buildings will have to be "nearly zero energy" homes starting in 2020.

And when solar roofs or other ways of direct renewable energy supply are added to passive houses, you end up with homes that essentially produce more energy than they consume – at least in theory. Called plus-energy homes, or, in the terminology of the KfW, Effizienzhaus Plus, such buildings are not, however, off the grid; rather, they export solar energy to the power grid at times of excess production and consume power from the grid at other times. And of course, any gas needed for cooking purposes, etc. also has to be purchased as usual.

I – Ecodesign/ErP Directive

The Ecodesign Directive, another important energy transition tool, is the main regulatory instrument for cutting off the products with the worst environmental performance. This essential regulation was initiated throughout Europe; it remains one of the most important tools for reducing demand for new grids and power plants in Germany, thus making it a crucial part of the energy transition.

The 2005 Ecodesign Directive (called the Energy-related Products Directive (ErP) since 2009) has its roots in Brussels and the European Union. It regulates the efficiency of energy-consuming products, with the exception of buildings and cars. The ErP Directive sets minimum standards for many different product categories. It also considers lifecycle assessments for certain products to determine their environmental impact and detect ways to make improvements.

As of 2015, 11 product groups fell under the directive, including consumer electronics, refrigerators, freezers, and electric motors. The directive applies not only to products that use energy themselves (such as computers and boilers), but also to products that affect energy consumption (such as windows and showerheads). Additional directives for individual products are produced and revised in a continuous process. By 2020, the directive is expected to reduce power consumption within the EU by 12 percent compared to the business-as-usual scenario.

There are also European standards for energy labeling. This "efficiency tag" addresses the important market failure based on a lack of information; customers do not readily have the information they need about what energy consumption will cost them if they buy a particular device. The ErP Directive works to remedy that situation.

In this way, the ErP Directive cuts off the products with the lowest performance, whereas the labeling scheme tries to guide demand towards the highest efficiency level by convincing customers to buy the best products.

Specific regulations

Probably the most effective measure was the regulation of standby and off-mode power losses. Appliances on standby used to consume dozens of watts even though they were essentially off from the consumer's point of view; one example is a television that remains reachable for the remote control. Today, the ErP Directive requires that such devices must not consume more than one watt when on standby, and that amount is to be reduced to 0.5 watts. For consumers, there are no drawbacks. The most well-known directive is the one on domestic lighting, which bans the use of most incandescent bulbs. The lighting product portfolio has changed from incandescent bulbs to compact florescent bulbs and LED lighting.

By 2020, phasing out incandescent light bulbs will result in energy savings across Europe of 39 terawatt-hours, equivalent to the power generation of six old coal power plants. The eco-design regulation for electric motors will even lead to a reduction of 135 terawatt-hours by 2020 – equivalent to 20 coal power plants.

Another successful example is the regulation of vacuum cleaners. Studies found that there was no correlation between electric power and cleaning power. Therefore, a maximum power of 1.600 Watt was defined, starting in 2014, with a second reduction to 900 watts coming in 2017. The result: a very rapid market re-organisation, with more efficient, technologically optimized and more energy-efficient vacuum-cleaners gaining in market share within months.

Such efficiency rules are defined throughout Europe because the EU places great store on the free trade of goods within the common market. The ErP Directive therefore directly applies to Germany and all other EU member states.

Although the ErP Directive was handed down by the EU, it is a crucial part of Germany's *Energiewende* because it reduces the need for great expansion and new plant construction by reducing energy consumption.

J– International Climate Initiative

Germany is the second largest donor of financing for climate protection worldwide. German climate funds promote action to mitigate climate change by enabling efficiency measurements, funding renewables, electric mobility, etc. Nevertheless, Germany is far behind the internationally agreed target of 0.7 percent of gross national income for Official Development Assistance. In 2014, the level was around 0.42 percent, a level that has been roughly stable since 2008.

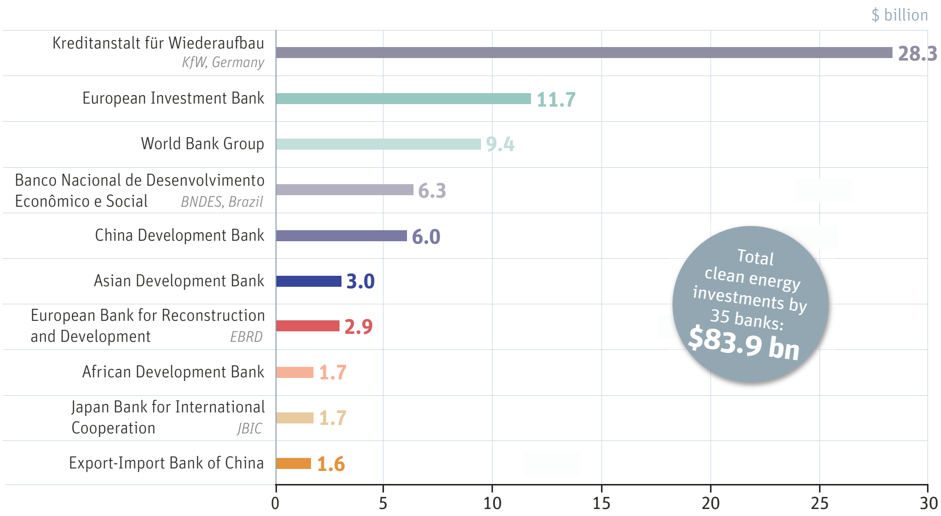
Germany has long been one of the largest donors of financing for climate protection. Nonetheless, like almost all other OECD countries, Germany is far behind the multinational commitment made at the beginning of the 1970s to provide 0.7 percent of its gross national income for official development assistance.

In 2010, the Special Energy and Climate Fund was created along with the National and International Climate Protection Initiatives (now known as Climate Initiatives). They mainly get funding from the trading of emissions certificates to promote actions that mitigate climate change, such as efficient cooling systems, small cogeneration units, energy audits for low-income households, consultation networks for small businesses, and, in the future, highly efficient industrial technologies and production processes – to name just a few examples.

German development bank by far biggest clean tech lender

Top 10 clean energy financing institutions in 2014

Source: Bloomberg New Energy Finance



The International Climate Initiative (ICI) finances pioneering projects and advisory services outside Germany. Since its beginning until spring 2016, some 500 projects were been funded, totaling some 1.7 billion euros. The ICI focuses on climate policy, energy efficiency, renewables, adaptation to climate change, and reducing deforestation and loss of biodiversity. According to the official website, priority is given to "activities that support creating an international climate protection architecture, to transparency, and to innovative and transferable solutions that have an impact beyond the individual project." Each year, multipliable projects in developing, newly industrializing, and transition countries are selected to receive support.

In addition to the ICI, the National Climate Initiative funds climate protection projects in different areas within Germany, for example municipalities, education, and companies. Until the beginning of 2015, some 19,000 projects had been funded with more than 500 million euros.

K – Coordination with the European Union

Energy has become a core issue for the European Union. However, the EU does not have an exclusive competence in this field. Making it a shared competence in the Lisbon Treaty of 2009 was a bold move forward, but it remains a natural field of conflict between Member States and many EU institutions.

Member States have the right to determine their own energy mix, but the European Commission has the competence to elaborate the EU's sustainable energy and climate policy. As the discussions about the completion of the internal energy market and the Energy Union show, the national sovereign right to decide about the energy mix remains a much valued asset. But even the most reluctant member States see the benefits of bundling competences and joining hands with their neighbors, or to even give a mandate to the European Commission to act on their behalf, when it comes to negotiating at the international level. This becomes even more important against the backdrop of energy security and energy independence from unreliable suppliers. On the global stage, the EU's former front runner role as an ambitious climate union has lost some of its sheen.

Internally, the EU has actually pushed things forward: the recent years saw the EU making clear commitments through a number of very important legislation on renewables and energy efficiency measures, or the long-term energy policy vision energy roadmap 2050. At the same time, the EU depends on its member States' ambitions and the last years have seen a fragmentation of diverging national energy policies. While some are fully engaged in clean energy transition, a nuclear phase-out and reductions in CO2 emissions, others explore unconventional resources, such as shale gas or heavily subsidize risky technologies like nuclear.

Progress of EU Member States towards 2020 climate and energy targets

Progress towards the goals of efficiency, carbon emissions, and renewable energy, 2013

Source: EEA

	Austria	Belgium	Bulgaria	Croatia	Cyprus	Czech Republic	Denmark	Estonia	Finland	France	**Germany**	Greece	Hungary	Ireland	Italy	Latvia	Lithuania	Luxembourg	Malta	Netherlands	Poland	Portugal	Romania	Slovenia	Slovakia	Spain	Sweden	UK
2013 GHG emissions and 2013-2020 projections under the Effort Sharing Decision	Partly on track	Partly on track	On track	On track	On track	On track	On track	On track	On track	On track	On track	On track	On track	Partly on track	On track	On track	On track	Not on track	On track	On track	On track	On track	On track	On track	On track	On track	On track	On track
2013 share of renewables in final energy consumption	On track	Not on track	On track	On track	On track	On track	Partly on track	On track	On track	Partly on track	On track	On track	On track	Partly on track	On track	On track	On track	Not on track	On track	Not on track	On track	Partly on track	On track	On track	On track	Partly on track	On track	Not on track
2013 primary energy consumption	On track	On track	On track	On track	On track	On track	On track	Not on track	On track	Not on track	Not on track	On track	On track	On track	On track	On track	On track	On track	Not on track	Not on track	Not on track	On track	On track	On track	On track	On track	Not on track	On track

- On track
- Partly on track
- Not on track

Where do the EU and its member States stand when it comes to the concrete implementation of climate and energy objectives? The energy roadmap 2050 aims to create a low-carbon European economy, while improving Europe's competitiveness and security of supply. In order to achieve this ambitious goal, binding interim milestones have been decided for 2020 and 2030. More concretely, the EU's 2020 climate and energy framework aims at a 20 percent CO2 emissions reduction, a 20 percent renewables share in the electricity mix and an increase in energy efficiency by 20 percent by 2020. As a tool for these emissions reductions, an emissions trading system has been set up, as the first of its kind world-wide and widely copied by other countries and regions.

However, more efforts will be needed in particular to reach the 2030 targets. After tough political negotiations in 2014, member States agreed to the lowest common denominator of reducing CO2 emissions by at least 40 percent, increasing the share of renewable energy to at least 27 percent (binding at EU-level) and increasing energy efficiency by at least 27 percent. It is still a long winding road to achieve the EU's low-carbon economy goals for 2050. Stay tuned.

4 History of the Energiewende

The German Energiewende did not just come about in 2011. It is rooted in the anti-nuclear movement of the 1970s and brings together both conservatives and conservationists – from environmentalists to the church. The shock of the oil crisis and the meltdown in Chernobyl lead to the search for alternatives – and the invention of feed-in tariffs.

Timeline Energiewende

1974
The Federal Environment Agency is founded.

1977
As a reaction to the oil crisis, the first "Thermal Insulation" and "Heat Operation" Ordinances are approved, regulating the maximum energy demand for buildings and efficiency requirements for heating systems.

1978
Germany creates the Blauer Engel (Blue Angel) label that certifies the environmental friendliness of products – 14 years before the Energy Star was created in the US. Whereas the Blue Angel was brought about by a coalition ranging from environmentalists to unions and church groups, the Energy Star was a product of the US Environmental Protection Agency.

1980
Publication of the study entitled Energiewende (Energy Transition), showing that economic growth can continue even as we consume less energy.

1983
For the first time in history, the Green Party enters the German national parliament and gives environmental concern a voice.

1986
In Chernobyl (Ukraine), a nuclear power plant melts down. Five weeks later, the Federal Ministry of the Environment, Nature Conservation, and Nuclear Safety is founded.

1987
German Chancellor Helmut Kohl (CDU) speaks of the "threat of grave climate change from the greenhouse effect" in the German Parliament.

1987
The Fraunhofer Institute for Solar Energy Systems makes the Rappenecker Cottage the first solar-powered, off-grid mountain cottage for hikers in Europe.

1991
The Feed-in Act is adopted under Chancellor Helmut Kohl's coalition of the conservative Christian Democrats and the Libertarian FDP provides the first feed-in tariffs and stipulates that green power has a priority over conventional power.

1991
The "Schönauer Stromrebellen" (the Power Rebels of Schönau, a small town in the Black Forest) form a ground-roots movement to buy back their local grid.

1992
The Fraunhofer Institute for Solar Energy Systems builds an off-grid solar home in Freiburg, Germany to demonstrate that a normal family could meet all of their energy needs at home from renewables.

1993
After the Greens and the Social Democrats had called for a nuclear phase-out in the 1980s, Energy Consensus Talks began on the future of nuclear power in Germany. The conservative government invited the opposition parties to sit at the table with representatives of utilities with nuclear assets.

1996
KfW, a state-owned development bank, launches its Carbon Reduction Program to support refurbishment of housing stock, particularly in the former German Democratic Republic.

1997
The Power Rebels of Schönau finally get control of their local grid and begin ramping up renewables.

1998
The German power market is "liberalized," meaning, for instance, that power firms and grid operators have to be legally separate entities; for renewables, the change meant that new power providers could go into business selling only green electricity; despite liberalization, the country does without a regulatory body for seven years.

1999
The 100,000 Solar Roofs Program gets the solar market going in Germany. In addition, the Market Incentive Program is launched, a multimillion financial support scheme for renewable heating systems.

1999–2003
Germany implements an "eco-tax" each year, a few cents are added to the price of a liter of gasoline and to a kilowatt-hour of fossil–based electricity; the result is greater sales of fuel-efficient cars and slightly lower overall consumption.

2000
Drawn up by the Social Democrats and the Greens under Chancellor Schroeder, the Renewable Energy Act (EEG) replaces the Feed-in Act and specifies that the rates paid will be linked to the cost of the investment, not to the retail rate.

2000
Chancellor Schroeder's coalition reaches an agreement with nuclear plant owners to phase out Germany's nuclear plants by roughly 2022.

2001
The European Court of Justice confirms that feed-in tariffs do not constitute "state aid" and are therefore legal.

2002
The Initiative Energieeffizienz is established, focusing on the promotion of end use efficiency in households and commerce.

2002
Adoption of the Heat-Power Cogeneration Act. With two subsequent amendments, it is the most important instrument to support combined heat and power.

2004
Photovoltaics is taken up without restriction in the EEG.

2005
Germany's Network Agency, which previously monitored telecommunications and postal services, starts overseeing the power grid and gas market, partly to settle a dispute about grid fees related to renewable power.

2005
The EU launches its emissions trading system.

2007
Germany's Integrated Energy and Climate Program defines new targets, policies and support schemes for efficiency and renewables.

2009
The EEG is amended for the first time without input from the Social Democrats or the Greens; the new law increasingly focuses on what Chancellor Merkel's coalition understands as "market instruments".

2009
The Renewable Energy Sources Act for Heat is the first law explicitly addressing Renewable Heating, requiring builders to implement renewable heating systems.

2009
Adoption of the Eco-design of Energy-using Products Act, which implements the European ecodesign directive in German law.

2010
Chancellor Merkel's coalition resolves to extend the commissions of Germany's remaining 17 nuclear plants by 8 to 14 years.

2010
The Sustainability Ordinance for biomass addresses the issue of sustainable biomass production.

2010
The Special Energy and Climate Fund, the first German efficiency fund, is created and funded by revenue from carbon emission certificates. Due to the low price level of these certificates, the fund's volume is cut in half. Chancellor Merkel also nullifies the nuclear phase-out of 2002 by extending the lives of nuclear power plants.

2011
The nuclear accident in Fukushima causes Chancellor Merkel to reverse her position on nuclear and adopt a somewhat more rushed phase-out of nuclear power than under Chancellor Schroeder's scheme; 40 percent of nuclear generating capacity is switched off for good within a week, with the last plant to be shut down roughly in 2022.

2012
May
50%: Germany sets new world record for solar power generation.

November
German power exports reach record level.

2013
January
Surcharge for renewables increases to 5.3 Cents per kWh. German power exports also increased by nearly 50 percent.

2014
Surcharge for renewables increases to 6.3 Cents per kWh. The EEG is amended in August, and the new government also adopts a Climate Action Plan and a National Energy Efficiency Plan in December.

2015
As part of the amended EEG, the first auction for large photovoltaic power plants takes place.

2015
Germany introduces a package of new energy efficiency instruments, such as a new support program for the modernization of non-residential buildings.

Club of Rome gets the Peace Prize of the German Book Trade Club, 1973

Source: Bundesarchiv, B 145 Bild F-F041173-0013

Photo: Reineke, Engelbert October 14, 1973

A – Origin of the term "Energiewende"

In the 1970s, the term "Energiewende" was born in an attempt by opponents of nuclear power to show that an alternative energy supply was possible.

The term "*Energiewende*" (which we translate here as "energy transition") did not just come about in the past few years. In fact, it was coined in a 1980 study by Germany's Institute for Applied Ecology.

That groundbreaking publication was perhaps the first to argue that economic growth is possible with lower energy consumption – a theme later taken up in many books, such as Factor 4 from 1998. Previous publications, such as *Limits to Growth* (1972), mainly consisted of warnings without proposing specific solutions. The *Energiewende* was one of the first attempts to propose a holistic solution, and it consisted of renewable energy and energy efficiency. Published as a book in 1982, *Energiewende*'s subtitle is "Growth and Prosperity Without Oil and Uranium."

The Institute of Applied Ecology had itself only just been founded with funding not only from environmental organizations (such as Friends of the Earth), but also from a Protestant organization that funded research. To this day, conservation and conservatism remain closely related in Germany, and this connection means that conservative politicians in Germany cannot be assumed to oppose renewables, as is the case elsewhere. On the contrary, a number of prominent proponents of renewables are members of the Christian Democrats (CDU), such as Peter Ahmels, who headed the German Wind Energy Association (BWE) for eleven years.

Another good example is German solar activist Wolf von Fabeck, who helped institute the first feed-in tariffs in Germany in his town of Aachen in the late 1980s. A former military officer, von Fabeck became an environmentalist when he saw the effects of acid rain brought about by coal plant emissions, and he became a proponent of solar when he realized the impossibility of protecting nuclear power plants from military attack. The first meetings he held about solar power took place at his local church, and his pastor was his main associate in the beginning. Other examples include Franz Alt, author of *Der ökologische Jesus (The Ecological Jesus)*. A number of modern churches in Germany have solar roofs.

B – Wyhl – the nuclear plant that never was

The Energiewende movement came out of the movement against nuclear power in the 1970s. One reason for the sustained success of the movement over the past few decades is its inclusiveness; from the outset, conservatives and conservationists worked together.

The *Energiewende* movement came out of the movement against nuclear power in the 1970s. In 1973, plans were announced to build a nuclear plant in the village of Wyhl in the Kaiserstuhl winegrowing area on the border to France. The decision turned out to be fateful, for it created a strong, sustained resistance movement across large parts of society. Students from nearby Freiburg joined forces with Kaiserstuhl winegrowers and scientists like Florentin Krause, author of *Energiewende*.

Sticker against the planned nuclear plant at Wyhl, 1975

Photo: AlMare
License: CC BY-SA 3.0

In 1983, the governor of the state of Baden-Württemberg reacted to the incessant protests by declaring the Wyhl project "not urgent," essentially abandoning plans for the plant indefinitely. The success of the movement encouraged people across Germany and Europe to believe that they could stop nuclear plants from being built. Throughout the 1980s, a number of local *Energiewende* groups were formed throughout Germany as people looked for ways to act locally.

This anti-nuclear movement was one reason why the Greens were founded as a political party. Around 1980, the Greens began consistently getting more than five percent of the vote – the limit required to enter Parliament.

C – The oil crisis

The oil crises lead to the first energy efficiency policies.

The oil crises of 1973 and 1979 also got people thinking about how energy supply could be changed. For the first time, Germany realized the economic risk of rising energy prices and that, as US President Jimmy Carter told Americans in 1977, "Conservation is the quickest, cheapest, most practical source of energy. Conservation is the only way we can buy a barrel of oil for a few dollars."

"NO GAS"
1973

License: public domain

In Germany, conserving energy was also found to be a way of reducing dependency on imports of raw materials. Some of the steps taken in Germany were short-lived (such as the ban on Sunday driving) or had limited effects (such as the implementation of daylight saving time). Nonetheless, the foundations were laid for a new policy of efficiency. Germany's Economics Ministry launched the first campaign, which was entitled "Conservation – our best source of energy." An important step came in 1976, when Germany passed the Energy Conservation Act, which set forth the first requirements for building insulation: "Those who construct buildings must design and install insulation so that preventable energy losses for heating and cooling are avoided in order to conserve energy." Even today, the current Conservation Act still begins with this first sentence of the original law.

On June 27, 1980, the Bundestag's Inquiry Commission on Future Nuclear Energy Policy made most of its energy policy recommendations under the heading of "promoting energy conservation and renewable energy." Suggestions for the transport sector included "adopting rules for limits on specific fuel consumption in vehicles" and "speed limits on the autobahn."

These proposals led to a lively, controversial discussion among the general public starting in 1982. In the end, the German government was only able to put a stop to the strong public demand for further changes by forcing the automotive industry to install catalytic converters, which can only run on unleaded fuel, thereby forcing oil firms to sell unleaded gas. In 2000, the European Union banned the sale of leaded gasoline altogether. These steps may have helped reduce pollution, but they did not improve energy conservation.

Since 1982, there have been repeated attempts to water down conservation policy. For instance, in the 1990s the tile industry opposed the use of thermal transmittance coefficients to determine the need for additional insulation. Another controversy concerned the obligation of owners of existing buildings to replace old boilers and insulate heating lines even when no other renovation was planned. Nonetheless, the basic idea of conserving energy resources has remained a part of German policy and become even more widespread since the 1970s.

D – Chernobyl – change comes slowly

In 1986, the reactor in Chernobyl exploded, and radioactive rain fell on Germany. The Germans lost their faith in the safety of nuclear power, but did not know yet how to replace it.

In 1986, the reactor in Chernobyl (Ukraine) exploded, and radioactivity detectors across Europe began registering spikes in ambient radiation levels; the Soviet Union initially did not announce the accident. Germans heard on the radio that it was not safe for children to play outside. Public trust in the safety of nuclear reactors reached all-time lows, though German engineers and politicians continued to assure everyone that Chernobyl was a fluke – the result of obviously inferior Soviet technology. Over the years, German engineers and politicians repeatedly claimed that German nuclear plants are safe and that no such accident as in Chernobyl is even possible in Germany – a claim made by Chancellor Merkel's coalition as recently as August 2010, less than a year before Fukushima changed her mind.

Still, the question in 1986 was how to replace nuclear power. Since the publication of *Energiewende* in 1980, nothing had really changed in Germany. Solar power was still so expensive that it was mainly

Chernobyl Nuclear Power Plant 2007

Photo: Mond
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only used by NASA in outer space and to provide small amounts of power in areas with no grid connections. And while wind power did get off to a big start in the early 1980s, when California already got one percent of its electricity from wind turbines, policy changes during the Reagan administration led the market to collapse. In the late 1980s, only Denmark was still expanding wind power at a considerable extent; Danish turbine manufacturers had been among the main suppliers to those first California projects.

E – Full-cost compensation for photovoltaics

At the end of the 80s, local utilities in three German towns introduced "full-cost compensation" — proto feed-in tariffs — for photovoltaics, which led to the implementation of Germany's first national feed-in tariffs.

In addition to Wolf von Fabeck (mentioned above), others were interested in finding ways to replace nuclear power and, increasingly, coal power; after all, acid rain had become a concern, as had man-made climate change from carbon emissions – with German Chancellor Helmut Kohl of the Christian Democrats even speaking in the Bundestag of the "threat of grave climate change from the greenhouse effect" in 1987.

At the end of the 1980s, von Fabeck's newly founded Solar Energy Association (SFV) managed to get the local utility in his hometown of Aachen to pay two deutsche marks for a kilowatt-hour of power from photovoltaics after it was demonstrated that the utility already paid that much or more to cover peak power demand, which photovoltaics would offset. The idea – compensation for power generated is sufficient to cover the cost of the investment – has become known as the Aachen Model. Yet, the idea did not even come from Germany. Aachen was specifically copying a similar policy in two Swiss towns, and California had adopted a similar policy at the beginning of the 1980s with its Standard Offer Contracts.

Indeed, two other German towns – Freising and Hammelburg – had even implemented a full-cost compensation policy slightly before Aachen, but Aachen drew the most attention. One person behind the success story in Hammelburg was Hans-Josef Fell (Greens), who later was one of the chief architects of the Renewable Energy Act (EEG) from 2000 along with Social Democrat Hermann Scheer.

But first, these small, disparate success stories led to the implementation of Germany's first national feed-in tariffs in 1991 in an unusual coalition between the Greens and the Christian Democrats. At the time, the two parties were hardly on speaking terms with each other (that has since changed). But the CDU had one condition – the proposed law would not be submitted as a joint effort between the Christian Democrats and the Greens, but merely as a Christian Democratic proposal.

Legend has it that the law, which was only two pages long, almost did not come about. It was the last thing voted on in the parliamentary session in 1990, and it passed mainly because the CDU did not think that a couple of windmills would do much harm anyway.

Source: EnergieAgentur.NRW

F – EU court says feed-in tariffs are "not state aid"

In 2001, the European Court of Justice ruled that feed-in tariffs do not constitute "state aid" and are therefore not illegal subsidies, thereby paving the way for the boom of renewables.

The law quickly led to a boom in in wind power in particular, so the conventional power sector decided to challenge the policy's legality. EU Competition Commissioner Karel van Miert openly stated that he considered feed-in tariffs to be illegal subsidies, and around that time German power provider Preussenelektra (which merged with Bayernwerk in 2000 to create E.ON Energie) decided to challenge feed-in tariffs in court. The matter went all the way to the European Court of Justice, which ruled in 2001 that feed-in tariffs did not constitute "state aid" and were therefore not illegal. Though this ruling concerned the first feed-in tariff act of 1991 and not the EEG of 2000, the court's decision was widely understood as applicable to both, which was one reason why the EEG was not challenged until the EU in Brussels became concerned about industry exemptions to the renewable energy surcharge in 2012.

As the Court explained in 2011, EU member states can require private power firms to purchase renewable power "at minimum prices higher than the real economic value of that type of electricity, and, second, distribute the financial burden resulting from that obligation" to consumers because renewable energy is "useful for protecting the environment" and for reducing "emissions of greenhouse gases which are amongst the main causes of climate change which the European Community and its Member States have pledged to combat."

In layman's terms, the Court basically ruled that feed-in tariffs are in fact open to everyone, including large power corporations, so they do not discriminate against any market players and therefore do not distort competition. Rather, they promote a particular type of energy to the disadvantage of other types in order to reach goals for the common good supported throughout Europe. Specifically, they are not subsidies because no particular firm receives payment from the government, and the cost of feed-in tariffs is passed on to ratepayers, not taxpayers; it is not an item in the government's budget.

G – Renewable Energy Act (EEG)

Germany's Renewable Energy Act guarantees full-cost compensation to cover the actual cost of a specific investment in terms of size and technology. The rates offered are guaranteed for 20 years starting in the year of installation to protect investments, but the rates drop for newly installed systems each year to put price pressure on manufacturers.

The main difference between this Act and the Feed-in Act of 2000 was that feed-in tariffs were no longer linked to a percentage of the retail rate, but were instead differentiated by the actual cost of the specific investment in terms of system size and technology type.

In 2004, the law was adjusted to do away with the 100,000 Roofs Program for photovoltaics, which provided an upfront bonus for the purchase price; instead, solar arrays were now eligible for feed-in tariffs in full. In 2009, the law was once again amended, making it three times larger than in 2004; what had begun as two pages nearly two decades before now had 51 pages. The law was most recently amended in 2012 and 2014.

"EEG closer to the market"

The EEG of 2009 was the first to be amended by the grand coalition of Social Democrats and Christian Democrats, with the Greens Party no longer in power. While the basic tenants of the EEG were retained – feed-in tariffs and the priority of renewable en energy – a number of Social Democrats and Christian Democrats felt that the policy should be changed to bring renewables "closer to the market."

The main changes in the 2009 EEG therefore reflect what these politicians thought constitutes a market. For instance, producers of wind power were increasingly encouraged to sell directly on the power exchange instead of receiving feed-in tariffs, and a "marketing bonus" is also offered because of the extra work involved. Yet, this option only needs to be exercised if it proves more profitable than feed-in tariffs, so it essentially constitutes a risk-free bonus – not exactly what you would expect from a policy that promises "more market." Germany's traditional onshore wind sector overwhelmingly opposes this option because it provides windfall profits and unnecessarily raises the cost of the energy transition for consumers.

In 2016, a first-instance EU court ruled, however, that the EEG of 2012 did indeed constitute "state aid." The German government had notified the EU in Brussels of the policy support, but the European Commission insisted that it have input. Berlin responded by showing a willingness to negotiate but insisted that this openness was voluntary, claiming that the EU had no right to such input. The court found, however, that the EU did indeed have such a right. Because the negotiations resulted in a compromise satisfactory to both parties (Berlin and Brussels), the EEG of 2012 does not need to be changed retrospectively. The court merely specified that Berlin does not have the right to refuse negotiations with the EU. Finally, feed-in tariffs are considered admissible aid, because the EU and its member states have renewable energy, climate and environmental targets.

Which brings us to where we are today.

5 European perspectives

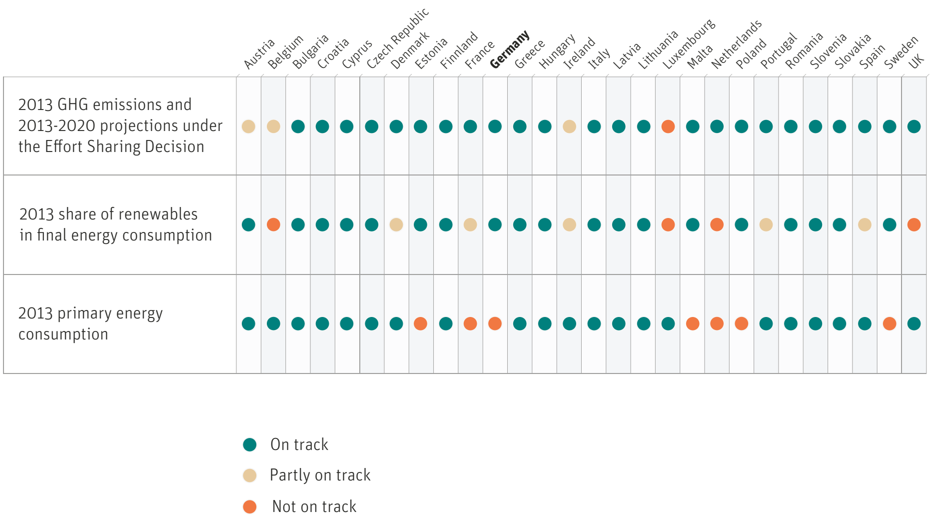
The *Energiewende*, is no longer a purely German phenomenon, but has implications across its borders. All over Europe, many more and different energy transitions are already happening. What role does energy play in the European Union's policy-making? What do other Member States do to decarbonize their energy system, and what internal and external challenges do they meet? And is there a chance to overcome these challenges by more European cooperation?

The following texts and country profiles attempt to provide a better insight into the energy transition activities in Europe.

Progress of EU Member States towards 2020 climate and energy targets

Progress towards the goals of efficiency, carbon emissions, and renewable energy, 2013

Source: EEA



A – Energy Transition – Think european

Energy has become a core issue for the European Union. However, the EU does not have an exclusive competence in this field.

Making it a shared competence in the Lisbon Treaty of 2009 was a bold move forward, but it remains a natural field of conflict between Member States and many EU institutions. Member States have the right to determine their own energy mix, but the European Commission has the competence to elaborate the EU's sustainable energy and climate policy. As the discussions about the completion of the internal energy market and the Energy Union show, the national sovereign right to decide about the energy mix remains a much valued asset. But even the most reluctant Member States see the benefits of bundling competences and joining hands with their neighbors, or to even give a mandate to the European Commission to act on their behalf, when it comes to negotiating at the international level. This becomes even more important against the backdrop of energy security and energy independence from unreliable suppliers. On the global stage, the EU's former frontrunner role as an ambitious climate union has lost some of its sheen.

Internally, the EU has actually pushed things forward: the recent years saw the EU making clear commitments through a number of very important legislation on renewables and energy efficiency measures, the declared ambition to create an Energy Union 2015, or the long-term energy policy vision energy roadmap 2050. At the same time, the EU depends on its Member States' ambitions and the last years have seen a fragmentation of diverging national energy policies. While some are fully engaged in clean energy transition, a nuclear phase-out and reductions in CO2 emissions, others explore unconventional resources, such as shale gas or heavily subsidize risky technologies like nuclear.

Where do the EU and its Member States stand when it comes to the concrete implementation of climate and energy objectives? The energy roadmap 2050 aims to create a low-carbon European economy, while improving Europe's competitiveness and security of supply. In order to achieve this ambitious goal, binding interim milestones have been decided for 2020 and 2030. More concretely, the EU's 2020 climate and energy framework aims at a 20 percent CO2 emissions reduction, a 20 percent renewables share in the electricity mix and an increase in energy efficiency by 20 percent by 2020. As a tool for these emissions reductions, an Emissions Trading System has been set up, as the first of its kind world-wide and widely copied by other countries and regions.

So far, the EU is on track to meet its 2020 objectives. A more detailed analysis can be obtained here and country profiles are regularly updated to track European progress.

However, more efforts will be needed in particular to reach the 2030 targets. After tough political negotiations in 2014, Member States agreed to the lowest common denominator of reducing CO2 emissions by at least 40 percent, increasing the share of renewable energy to at least 27 percent (binding at EU-level) and increasing energy efficiency by at least 27 percent. After the Paris climate conference in December 2015, some more ambition might be needed to achieve the "well below 2°C, towards 1.5°C" objective of the global community. It is still a long winding road to achieve this and the EU's low-carbon economy goals for 2050. Stay tuned.

B – Poland's Energiewende. No, not a Polish joke. A European transition

2015 saw Polish PV increase by 240 percent and wind farm generation by 40%. Despite these impressive numbers, Poland still remains the kingdom of coal.

By Ireneusz Sudak, energy journalist, Gazeta Wyborcza

Some figures first: Poland is the biggest coal producer in Europe. Each year, Polish mining extracts 75 million tons of coal. Coal power in Poland accounted for 85% of the country's electricity production in 2015 – 51% from hard coal and 35% from lignite coal. The Polish government said that Polish coal is the national treasure because it gives us energetic independence.

Not only has Poland continued building three new giant coal power plants (in the cities of Kozienice, Opole and Jaworzno), but is also considering to build more, in Ostroleka and Pulawy, despite serious doubts about the economic sense of this kind of investment. Wholesale energy prices are – thanks to Renewable Energy Sources, RES – so low that, according to many independent experts, building new big energy facilities is irrational. However, according to the government, this is not a matter of economics, but of energy safety.

Furthermore, Poland contests the European Emissions Trading Scheme (EU ETS) system saying that this is unfair for its country. According to the Minister of Environment Jan Szyszko, the EU ETS structure should primarily consider the specifics of the individual member states, including their energy mix. He proposes to the EU that national CO2 emissions could be set off through taking into account the CO2 absorption of the Polish forests.

New RES law

In recent months however, the course of the energy transition in Poland has changed, not to say: almost stopped. On 5 May 2016, the conservative government revealed the long-awaited draft of the new Law on Renewable Energy Sources ("RES Law"). It constitutes the basic regulation on RES and comprehensively sets out the legal framework for doing business in this sector. But instead of transitions towards a more renewables-based energy policy, the proposal basically maintains the current state of coal in Poland. Environmental organizations appealed in vain to the government for feed-in-tariffs for small manufactures of electricity, but only a bonus system for renewable energy producers was introduced. Small producers of electricity (for example up to 7kW of power roof-top solar photovoltaic system) will get 70% discount on repurchase of electricity by the energy supplier for every kWh released to the electricity network. These rules are expected to enter into force on 1 July 2016, but it is yet unclear if there will be real benefits for "pro-sumers" in Poland.

A coalition of environmental organizations such as Greenpeace and WWF criticize the new law, arguing that it hinders access for citizens to cheap, clean and green sources of energy. At the same time of the parliamentary discussions of the RES bill, the National Environmental Fund delayed the start of a parallel support scheme for microproducers including preferential loans and grants. It is somehow hard to believe in coincidence, considering a recent change of guards in the respective office.

Anti-wind bill

The second act related to renewable energy sources is connected with wind generation. As things stand now, the ruling Law and Justice party want to drastically reduce the possibility of building windmills in Poland.

The recent proposal that passed the Sejm at the end of May 2016 foresees that new turbines would have to be constructed at a distance of at least ten times their height from the nearest building or even forests and NATURA 2000 areas. Wind energy experts concluded that with this new legislation, new turbines could only be built in 1% of Polish territory. "The effect of the bill will be a complete elimination of new wind power projects from Poland," the Polish Association of Wind Energy (PSEW) said. It could be the end of Polish wind farms altogether.

In 2015, Poland installed more wind turbines than any other European country, except Germany. According to the energy regulator at the end of 2015, the total installed capacity was 4,592 MW providing 10,231 GWh, which means an increase of 40%. This makes the wind-farm capacity almost as large as in Denmark.

What's it all about

These law proposals are a deliberate action of the ruling conservative Law and Justice party. Prime Minister Beata Szydło's government is conservative not only in terms of religion and outlook on minority rights, but also in sustainable energy generation. It has been repeatedly said by the government that Poland's energy security depends on keeping coal. This ignores the recent warnings by the European Commission about the rising problem of air pollution and lack of RES policy.

The transition goes on

So, is it as bad as it looks? Surely not. The year 2015 proved to be a record-breaking year in Poland not only for wind energy, but also for solar energy generation. According to energy regulators, 2015 saw an increase in installed photovoltaic power capacity of 71 MW. This is a huge 240% increase and certainly a milestone for Polish communities and citizens. Photovoltaic systems were installed by municipalities, schools, and local companies around the country. One of the largest photovoltaic windfarms was launched in Ostrzeszow in July 2015 (100 km from Wroclaw). It has almost 2 MW power capacity and has been financed by a privately-owned local company and with EU funding.

Many companies and factories decided to develop their own electricity source to ensure additional sources of energy in case of failure of the distribution network, as well as to reduce electricity bills. Other encouraging examples include the sports hall in Gryfice (North Western Poland, around 200 km from the German border), where installed solar panels help save 5000 EUR annually. Even the state-controlled PKN Orlen, a major Polish oil refiner and petrol retailer, is considering the installation of small wind turbines on its petrol stations.

These small steps are where the true energy transition happening. Real change takes place in people's minds; today, citizen's awareness of environmental issues is the highest in Polish history. But it still takes a lot more steps.

C – The frontrunner – is Denmark losing its position?

By Tore Keller, Danish Freelance Journalist

With an exemplary decoupling of declining CO2 emissions and high economic growth, Denmark has become a household name in green technology, sustainable society building, and an energy system that has to date integrated enormous amounts of renewable energy sources. However, recent political developments cast doubt on the green resolve of the country.

The motivation for the Danish green energy leap derives from the oil crisis in the 1970s where the Danish civil society and political system were shocked by the extent of dependency on foreign energy imports. The Danes decided to rid themselves of this dependency and take another path.

The first move was to engage in comprehensive oil and gas research projects in the North Sea, to roll out large-scale energy plans for district heating using excess heating from power plants and an enhanced network for the use of natural gas.

The Danes chose to focus on renewable energy, mainly wind energy, and eventually opting out of nuclear power after intense political discussions during a period of huge rallies against nuclear power in Copenhagen in the 1970s. Denmark still imports nuclear energy from Sweden and Germany during periods of low domestic energy production, but the general political agenda does not see nuclear power as a viable option.

It was not until the UN's Brundtland commission's climate report in 1987 that climate policy and environmental concerns started playing a major role in shaping Danish energy policy. However, in 1989, Denmark became the first country in the world to create legislation aimed at curbing CO2-emmissions and since then, climate policy has been at the center of Danish energy policy. The current plan is to have a fossil free energy system by 2050. This ambition will require innovation, new technology, enormous investments and political will combined with backing from civil society and business.

Make no mistake though – Denmark today is still reliant on oil, coal and gas. The cars are not running on flowers and fairy dust. Was it not for the North Sea oil fields, the Danish story might have looked very different. Since the 1990s, the oil and gas driven from the sea bed north of Denmark have made the Danes self-sufficient regarding oil and gas, while simultaneously boosting the Danish economy.

Exports of oil and gas, high taxes on energy and a political consensus has made the many offshore wind farms in the sea surrounding Denmark feasible in the later years. Denmark has a political target of reaching a 35 percent share renewables in electricity in 2020 – in 2050 the goal is to remove all fossil fuels from the energy system.

These are ambitious targets paid for by consumers through energy taxes, which all households and companies pay. The revenue is put into renewable energy projects, such as the Horns Rev III off shore wind farm situated off the coast of western Jutland. It is the third wind farm in the area and will, once operating in 2017, produce enough green energy to sustain 400.000 households with a total production of 400 MW in addition to the 370 MW produced by its two older brothers Horns Rev I+II.

In addition to the Horns Rev wind farm, Denmark will build a 600 MW wind farm in Kriegers Flak in the waters between Denmark, Sweden and Germany. Recent political developments have, however, cast a shadow of doubt on the Kriegers Flak project. The Public Service Obligation tariff that has helped to finance many of the renewable energy projects in Denmark has been deemed illegal by the European Commission because it favored domestic projects. This means that the government will have to come up with a new model for financing renewable energy – and the new government that took office in 2015 has been floating the idea of cancelling projects including the Kriegers Flak project. A resolution is expected for autumn 2016.

It is clear that Denmark has chosen its renewable energy source number one: Wind power. Given the often bleak and rainy weather conditions, solar energy has never had a major breakthrough in Denmark. In 2014, more than 39 percent of electricity came from wind energy. That is a world record. Danish businesses are on board too. In 2015, energy technology exports accounted for 9.6 billion EUR – roughly 10 percent of Danish exports altogether, thus creating 56,000 jobs according to the Danish Energy Association. From 1990 to 2007, economic activity in Denmark increased by more than 40 percent, while CO2 emissions decreased by nearly 14 percent. In addition to support from business, almost all of the Danish political parties back the long-term energy policy for 2020. A nuclear-free energy policy thus meets a broad political consensus since the oil crisis in the 1970s.

Not all is idyllic in Denmark though. The classical tale of the "not in my backyard" is still an existing concern in green Denmark. When a test site for wind turbines on land was established in a remote nature area called Osterild in the rural countryside a couple of years ago, local citizens protested its construction, stating that they supported renewable energy but arguing that it should be placed elsewhere. Eventually, the test site was built despite the protests. Recently, the placement of off-shore turbines close to the coast has met resistance from citizens.

However, the fraction of Danes opposing the shift towards a sustainability-focused society, independent from foreign energy imports from the Middle East and Russia, remains small. Green policies have a broad backing even though Danes, as most other people, would like to see their energy bills decrease.

Recent projects researching the possibility of shale gas extraction in rural areas have met local opposition. The concern is mainly about security and the scale of a possible shale gas venture in people's backyards. This has held back shale gas explorations. However, the government that came into power after the general elections in 2015 has taken a more open approach to shale gas projects.

Although Denmark has done well to diminish its impact on the world's climate and has seen an extensive rise in green energy, Danes are maybe not as green as they seem. A recent report from the WWF shows that Danes are the fourth most polluting people on the planet if one includes the impact from its foreign imports, ranging from extensive holiday travel to the agricultural sector, which remains less regulated than other industries.

However, the Danes have taken up the climate issue locally. The island of Samsoe is 100 percent fossil free. Community projects are organized in wind turbine cooperatives, which usually have 1-3 wind turbines on land next to smaller towns or industrial areas. They can be found all over the country. Some 40,000 Danes are part-owners or individual owners of some of the more than 5200 wind turbines in Denmark.

Denmark was forced on the green path by high energy prices in the 1970s and has shown the world that with an extensive forward energy planning, incentives for green energy and a supportive population, it is possible to decrease the dependence on fossil fuels. Germany, too, is attempting to decouple its GDP with fossil fuel consumption – the Danes just got there first. The next couple of years' policies from the new government will determine if Denmark will be able to stay ahead or lose its position as the leader of the green pack.

D – Beyond the COP: the state of affairs of the French energy transition

By Kathrin Glastra, Heinrich Boell Foundation Brussels and Andreas Rüdinger, IDDRI

2015 could be described as something of an "energy and climate policy marathon" in the case of France. As a first stage, after several years of intense political debates, France adopted its first-ever national energy transition law in August 2015, supposedly illustrating the French exemplarity as a leader in the transition towards a sustainable economy. Later in December, Paris hosted the 21st international climate conference of the parties (COP 21), which carried over the heavy burden of defining an ambitious international agreement to fight global climate change for the post-2020 period. Both challenges have been met with some success in providing a new impetus and defining key milestones for future national and global action.

Considering in particular the energy transition law, the French transition plan might very well be one of the most ambitious across Europe, including all the key ingredients and objectives of a coherent climate road-map. However, its implementation will prove to be increasingly difficult, with timing becoming one of the greater challenges. Indeed, after the great focus on energy and climate in the second half of 2015, many observers fear that both political attention and willingness to commit to strong policy measures might progressively decline before entering a standstill with the upcoming 2017 presidential and parliamentary elections. Six months after the COP 21, where does France stand in the implementation of its own energy transition strategy?

Three main challenges can be outlined in this regard: the effective implementation of energy efficiency measures, initially coined as the "cornerstone of the French energy transition strategy" the measures intended at reducing the consumption of fossil fuels, in the transport sector in particular; and most importantly, the adoption of a clear trajectory outlining the evolution of the energy mix until 2030, providing a coherent picture of how the different objectives should be achieved over time.

Even though it does not receive as much attention, the objective to reduce the final energy consumption by 50% between 2012 and 2050 stands out as the most ambitious objective of the French law. However, the current measures fall short of living up to this ambition. The French government recently announced the publication of several regulations by mid-2016 which might act as positive signals. Nonetheless, the existing support schemes (tax credits and eco-loans for efficiency) have not yet been reformed or reinforced at all, neither has a large-scale financing instrument for building retrofits been set up, which is rather astonishing, given the very strong ambitions. All in all, the current path seems more to be one of small incremental changes rather than a real upheaval to enshrine the "efficiency first" principle. The same applies to the fight against energy poverty: while most experts agree that this can only be achieved through structural measures (i.e. decreasing energy consumption through more efficient homes and appliances), the only new measure concerns the implementation of an "eco-check", a 150 EUR aid to help modest-income households to pay their energy bills.

Regarding the issue of reducing fossil-fuel consumption by 30% until 2030, very few signals currently indicate a divergence from the status quo. Incentives to favor soft mobility and public transportation merely consist of a (meager) subsidy for commuters using their bicycles. And most regrettably, the French government did not seize the opportunity of record-low oil prices to adjust the increase of its carbon tax, which might have provided a significant source of funding for energy transition projects.

As a third item, the publication of the new multi-annual planning framework for energy (planification pluriannuelle de l'énergie, PPE) might possibly be considered the single most important issue with regards to the future implementation of the French energy transition. Unlike previous planning instruments, which treated all sectors (renewables, electricity, natural gas, transports, etc.) independently, the intention behind the PPE was to merge them into a coherent trajectory achieving the multiple 2030 objectives. Initially expected before the end of 2015, the PPE has recently been postponed to mid-2016. More importantly, it might eventually fail to shed light on the one issue which still seems to block a real transition in the French power sector: clarifying the future of nuclear power and the implementation of the target to reduce its share from 75% to 50% by 2025. Rather than providing any clear signals on the future evolution of the electricity mix as a whole, the government has chosen a two-fold approach to (partly) satisfy the renewables industry while avoiding the conflicting issue of possible nuclear shut-downs. On one hand, a decree published in April 2016 provides intermediary objectives for the development of renewable energies, indicating (legally not binding) target values of:

- 10 GW of installed solar capacities by 2018 (2015: 6.5 GW) and 18 to 20 GW by 2023
- 15 GW of installed wind capacities by 2018 (2015: 10 GW) and 22 to 26 GW by 2023

On the other hand, the government has stated that no decisions on the possible shut-down or lifetime extension of nuclear reactors (except the case of the oldest nuclear plant in Fessenheim, supposed to shut down by the end of 2017) will be taken before the end of 2018, effectively dismissing any responsibility in the short term. This absence of policy signals presents a series of risks:

- Considering the current level of production, reaching a 50% share of nuclear power corresponds to the shut-down of approximately 25 reactors by 2025. If this has to happen after 2020, it would represent an average of five reactors per year, with an equivalent need for an upsurge in power savings and renewables.

- Without any clear signal and trajectory by the government, the French electricity operator EDF could very well choose to carry out the investments required to extend the lifetime of the power plants before the government defines its trajectory. It is already difficult to shut down a power plant which is at the end of its lifetime; but it is much harder to shut down a nuclear plant which just benefited of a one-billion EUR retrofit.

- France is the biggest exporter on the European power market which already suffers from significant over-capacity and depressed prices (25 €/MWh on average in April 2016). In this context, reinvesting in both nuclear power and renewable capacities will necessarily produce a vast amount of stranded assets, since these plants will never recover their costs.

While this short summary gives a rather critical appraisal of the current state of affairs, it is worth outlining what is at stake. Indeed, the timely adoption of a coherent road-map and key measures to trigger the transition effort is not only a question of achieving the French policy objectives in the first place. It is most and foremost the political legacy of the current government in the field of climate change which is at risk. Indeed, the French energy transition might soon be challenged by another transition of political nature. In the event of a political changeover and right-wing government, it is most likely that the current law would be watered down and purged of many of its key objectives. The only way to avoid this is to become a "leader by example" and to advance as much as possible in the implementation on the ground, so that society as a whole takes ownership of this new vision.

E – Energy in the Czech Republic: baby steps forward, but nuclear plans still dominatee

By Martin Sedlák, Alliance for Energy Self-Sufficiency

Since 2015, a new State Energy Policy has been in effect in the Czech Republic. But government plans still rely heavily on building new nuclear reactors. Nonetheless, earlier this year renewable energy plans were also revised and updated. They count on a small amount of growth, but this new strategy raises hopes that the stagnating green energy sector will take off once again.

The Czech Way Backwards

The atomic-focused State Energy Policy of 2015 was already outdated before it saw the light of day. It is (partially) based on data which incomprehensibly does not take into account the decreasing costs of solar panels and wind turbines. There is even the looming threat that some investors will have to remove their ground-based solar projects after 20 years. The energy policy, however, stresses the further growth of nuclear energy. Over the next ten years, the government wants to put together new nuclear reactor projects. A newly established government commissioner for nuclear energy will oversee any construction. It is expected that 20 to 32 billion Czech crowns (0.74 to 1.2 bn EUR) will be spent on preparing these projects.

The Ministry of Industry is promoting nuclear energy to bolster the Czech Republic's energy independence. However, the policy forecasts growth in total consumption, which means that despite the construction of new reactors, gas consumption will increase by 10%.

It is thus clear that more reactors will not mean independence from natural gas. By focusing on nuclear energy, Industry Minister Jan Mládek has overlooked another much more important source of energy. Surprisingly, this "source" is a not source in the traditional sense; it is greater energy efficiency. Greater efficiency could reduce the Czech Republic's dependence on imported Russian gas to a minimum. Today, natural gas is used in the Czech Republic mainly for heating; thus, remodeling buildings to increase energy efficiency could halve our consumption of gas. This fact is nothing new; the numbers have been available since 2008, when experts made these calculations for the Pačes Energy Commission. It is, however, a mystery as to why the current ministry has not used this data in its updated energy policy.

The underutilized potential of energy efficiency measures is not the only problem with the new State Energy Policy. The Ministry of Industry wants new reactors so badly that it has included senselessly low costs for constructing nuclear power plants in its calculations and has essentially ignored the necessity of some form of public support for such projects—which we can see today in Great Britain and Hungary.

The Czech Republic's nuclear plans are flawed by the absence of a fair comparison between different energy sources. Take for example, the environmental impact assessment for expanding the Temelín nuclear plant. The studies do not provide a comparison between new nuclear power plants and increased energy efficiency in buildings and industry and with a renewable energy mix. According to the consulting firm Candole Partners, Czech energy consumers might even pay more for energy if nuclear is expanded. Building two more reactors at Temelín could cost consumers more than 30 billion EUR over 35 years.

Renewable Energy Sources: Are We on the Verge of a Revival?

Clean energy experienced a moment of light in the Czech Republic in 2005, when members of parliament approved the Renewables Support Act, which was inspired by the German system. The introduction of support kicked off growth in wind, biomass, and gradually even solar energy, which today cover 10% of household electricity consumption.

However, difficulties arose with solar energy in particular. In 2010 – that is, at a time when the price of photovoltaic technology significantly decreased – legislators were not able to react in time, causing investors to install a total solar capacity of 2,000 MW over the course of several years. The government then destabilized the business environment by making retroactive changes in the form of a solar tax that lowered the guaranteed revenue for solar energy investors guaranteed by law. After 2010, only new rooftop photovoltaic panels could be installed, but in 2014 support was cut off. The number of new wind turbines is only in the single digits; in 2014 biogas plants met a similar fate to solar plants, when support was cut off for them as well.

New, positive stimuli, however, are slowly beginning to have an effect. For example, subsidies for small rooftop installations for homes and business have been introduced, and support for heat-generating biogas plants has been reinstated. The Ministry of Industry has also heeded the criticisms of the Czech Solar Association, the Alliance for Energy Self-Sufficiency, and other trade groups that have repeatedly called for removing administrative barriers to operating small-scale power plants. This is the first step to raise interest in increasingly affordable renewable energy. According to a proposed amendment to the Energy Act, small sources with a capacity below 10 kW will not need a license, even if they are connected to the grid. However, whether or not this move will help revive interest in installing rooftop photovoltaic power plants depends on what the resulting statutory instruments look like.

An Action Plan for Green Energy – Not Enough Room for Growth

After years of stagnation, in updating the National Action Plan for Renewable Energy the Ministry of Industry has conceded to a strategy for meeting 2020 Czech green energy targets. The original, unambitious plan of 2010 established a target renewable share of 13%. The latest update from early 2016 increased this share to 15.9%. This growth, however, is nothing more than statistical manipulation – the Ministry of Industry is primarily counting on a decrease in consumption (which is good), but at the same time, renewables will not grow as much as they should. Nonetheless, there will be a slight increase in renewable energy sources.

Solar Hopes

The part of the Action Plan devoted to solar energy demonstrates well how the approach to renewables has changed over time. Whereas the very first National Action Plan of July 2010 essentially froze solar capacity at 1695 MW until 2020, the updated plan of August 2012 allowed for 2118 MW in 2020. The most progressive version of the National Action Plan is this year's, which has established a ceiling of 2375 MW.

Thus, over the next five years the Czech Republic could see up to 306 MW of new rooftop solar energy. Considering the fact that average household rooftop installation capacity does not exceed 5 kW, we could be talking about up to 15,000 new PV plants annually.

Batteries, for which subsidies have been available since last year as part of the New Green Savings program, will help take advantage of rooftop solar's potential.

There's Wind, but No Sails

Ten years ago, wind turbines were the face of renewable energy in the Czech Republic. Today, their symbolic role has largely been taken over by the solar panel and the biogas plant. The largest annual increase in wind turbines occurred in 2007, before the first National Action Plan was developed, when 62 went into operation. After that, 2012 was the biggest year for wind energy when 43 new turbines began producing energy.

The overall target capacity of wind turbines in this year's draft Action Plan is a third lower than it was five years ago. At the same time though, wind energy is one of the cheapest forms of renewable energy, both worldwide and domestically. There are many reasons why its potential remains untapped. New wind projects in the Czech Republic often face local opposition. Also, in accordance with the amended Renewables Support Act, new wind projects are not eligible for feed-in tariffs. This year's updated Action Plan gives a certain hope for the reintroduction of this support in a form that matches better with market principles and EU legislation. Wind energy's perspectives in the Czech Republic are examined in a study written for Hnutí DUHA and the Chamber of Renewable Energy Sources; this report claims that 18.29 TWh of electricity could be generated by wind power annually. This forecast was made based on the geographical and geophysical potential of the Czech Republic. According to these two organizations, growth in wind energy would result in 17,000 to 23,000 new jobs.

Biomass, Heat Pumps, and Geothermal Energy

Biomass is still considered to be one of the most important sources of renewable energy in the Action Plan. In total, biomass provides one-third of renewable energy to households. In total, biomass should generate up to half of all renewable energy in 2020.

According to the new Action Plan, heat pumps should experience a boom. The installed capacity of heat pumps could grow to 12,7000 TJ, a figure that is 2.5 higher than that laid down in the first Action Plan. According to estimates, it would involve 20,000 new heat pump systems for single-family houses. In the name of energy decentralization, in order for the local potential of heat pumps to be exploited, pumps should be combined with rooftop solar panels.

Another interesting renewable source given in the action plan is geothermal energy. According to the original plan of 2010, by 2013 there should have been a total installed capacity of 390 TJ of this source and by the end of the decade 696 TJ. But since there has been no increase in geothermal sources in the Czech Republic, the 2015 National Action Plan proposes the first target for 2019 (75 TJ), and in the following years growth should be up to 222 TJ.

The Political Climate: Looking for Stability

Ten years of renewable energy have demonstrated that the clichés about renewable energy's non-existent potential that former industry ministers bandied about are far from valid. After years of denial, the new National Action Plan has at least hinted that the Ministry of Industry could give the green light to renewables once again. If the potential of green energy is exploited in practice, and not just on paper, political stability for this progressive sector must be reinstated. Only then can local renewable energy be used to lower our independence on energy imports, to create interesting new jobs, and to give families and companies the tools to generate their own electricity

F – Energy Transition in Spain – which way forward?

By Alexa Mollicchi, student at Maastricht University and Ignacio Fresco Vanzini, Florent Marcellesi, Ecopolítica

The energy transition in Spain has been experiencing a downfall over the last few years, starting with the abolishment of economic incentives for building new renewable energy generation in February 2013. As early as 2008, a major tariff deficit became apparent, which was estimated at 25.5 billion EUR in 2012. This deficit essentially emerged due to the fact that regulated electricity prices did not completely cover the costs of electricity generation. This underlined the need for major reform of the renewables support scheme if the envisaged energy transition were to continue.

The first European Renewable Energy Directive from 2001 was a stepping-stone for Spain's influence on and promotion of a clean energy transition in Europe. This influence was mainly due to the fact that Spain already had a target in its national law for an overall 12 percent share of renewables in its energy mix by 2010. In fact, once the Directive became effective, Spain had very little to turn into its legislation. This contributed to creating an environment of trust and confidence in the Spanish market regarding the path it was taking. Moreover, Spain was the first country to adopt support measures oriented towards the production of renewables, namely the FIT and FIP schemes. In general terms, up until 2007, the renewables sector in Spain was doing remarkably well, increasing by 8.9 percent between 2005 and 2006. However, it was also in these years that the problem of the tariff deficit started to emerge; this led to the adoption of policies that rendered the possibility of Spain to become a leader in this sector unachievable.

The 2009 Renewable Energy Directive laid down mandatory renewables targets and the regulation of three different sectors: electricity, biofuels used in transportation, and heating and cooling. The first sector is where Spain experienced the most significant growth. In fact, according to information the Spanish government shared with the European Commission on April 2016, share of renewables in the interim target period of 2013-2014 was 37.8% of the electricity mix, while for the renewable heating and cooling sector the share was 15.8%. In the transportation sector, the share was only 0.5%, far below the 10% target. Overall, the renewable energy consumption in 2014 was 16.2%, well above the goal of 12.09% for the 2013-2014 interim target period.

If the same trends continue in the coming years, it should be relatively easy for Spain to comply with its 2020 targets. However, a number of factors such as the evolution of the economic crisis, the lack of a credible energy strategy, and the total tariff deficit reaching the astounding amount of EUR 25.5 billion, are leading Spain into a period of stagnation and creating considerable uncertainty about the country's ability to reach these goals.

In order to diminish electricity costs and the tariff deficit, the government suspended the support measures to newly built energy plants in January 2012. Eventually, this led to a retroactive elimination of renewable support schemes in 2013, putting at risk the main support for renewable electricity generation and blocking the access to finance new plants. Cutting support measures for renewables was based on the assumption that the deficit was due to high investment costs in renewables. However, other important factors contributing to the deficit were the aid schemes for coal-fired power, or the failure to adapt the electricity tariff to the cost increase of conventional power around the year 2000. In addition, a new self-consumption decree and tax (publicly known as the "Tax Solar Decree") was approved in October 2015. As a consequence, prosumers have seen their right of access to the grid and a fair market price restricted. These hostile measures demonstrate a lack of coherence with the EU's energy policy for 2020, and the compromises made in Paris during the COP21.

As an important consequence of these government measures, however, is that Spain might not be able to comply with its national 2020 targets. This is not only disappointing for producers' efforts but also for the overall strong position Spain held in this sector. Additionally, these measures have highly contributed to the boosting of energy prices, leading to a worrying situation with regards to energy poverty for about 10 percent of the Spanish population that cannot afford the high electricity bills. Given the importance of the energy sector for the national economy, there is no doubt that a clear, coherent and long-term policy perspective is necessary.

In a country with an energy dependency rate of about 70.5%, cutting support measures cannot be seen as an appropriate decision. Spain should be deciding which energy policy it wants to implement on a long-term basis. Instead of doing so, Spain is currently only applying short-term actions aimed to mitigate the efforts of the economic crisis and to reduce the tariff deficit, without projecting any further goals beyond that.

The revision of the EU Renewable Energy Directive by end of 2016, together with the actions to be taken in line with the Paris agreement from 2015, might encourage Spain's transition to a low-carbon energy system. Spain could take further measures, for example the following:

Maintain public audits of the tariff deficit

Following the opening of an infringement procedure by the European Commission, the (interim) Spanish government approved in February 2016 the first decree regulating energy audits for large companies (<250 employees) to evaluate their energy efficiency. However, the Spanish energy system is a black box regarding the debts generated and its real costs. In order to promote a proper reform and transparency, two additional audits are necessary. First, a tariff deficit audit to analyze the political decisions and responsibilities that led to the accumulation of the tariff deficit and the exact amount owed. Second, an electricity sector audit of every cost attributed to the electricity tariff, as well as the definition of the guidelines determining the price of kWh for the different electricity tariffs.

Erase legal barriers for self-consumption of renewable energy

Spain should erase the barriers to self-consumption of renewable energy and set out the net-metering scheme ensuring that consumers who operate PV systems receive credit for any electricity their systems feed into the grid. While this scheme already exists in many countries throughout Europe, the discussion is still ongoing in Spain.

Change the industrial production model

Energy transitions essentially mean a shift from high energy consumption and CO2 emissions towards a model based on low energy consumption and CO2 emissions, but one which creates sustainable well-paying jobs for many. The key sectors for such "green jobs" are:

- Agriculture, through the promotion of organic agriculture and relocation of production and consumption;
- Energy efficiency, through better building renovation and thermal insulation, equipment of renewables facilities and the installation of more efficient energy systems. These energy efficiency measures could save Spain about 39 billion EUR by 2050; and
- Sustainable Transportation, through promoting greater use of railway transportation of goods from currently 3.2% to 10% by 2020. The transportation sector represents 40% of final energy consumption with 30% CO2 emissions and is thus a vital sector to be tackled in this regard.

Democratize the energy sector

Energy transitions imply a bigger democratic control over the energy sector. It is thus imperative to regulate the practice of revolving doors. In Spain, high-ranking politicians have become part of companies in the traditional electricity industry, such as former Presidents Felipe González and José María Aznar. This phenomenon explains the high level of mistrust towards many governmental energy policies, as this often leads to policies that align with the interests of the old electricity utilities. In order to put an end to this practice it is necessary to introduce a cooling off period to avoid conflicts of interest.

The above recommendations can contribute to deepening the ecologically and socially needed energy transition, and restore Spain's leading position in renewable energy.

G – Austria and its energy transition: Passive politicians as key risk

By Johannes Wahlmüller, Global 2000 – Friends of the Earth Austria

At first glance, the Austrian performance in the energy sector looks quite bright: In the year 2014, about 33% of the gross final energy consumption was provided by renewable energy sources.

Only Latvia, Finland and Sweden had higher shares of renewable energy in the EU. Furthermore, about 71% of the electricity consumption in Austria is already provided by renewable energy sources. The Austrian government is in favor of binding renewable targets at the European level and opposes the ambitions by the nuclear industry to receive more subsidies. But there is also a substantial dark side on the climate front. Austria failed to meet its Kyoto target: instead of reducing greenhouse gas emissions by 13% compared with 1990 levels, greenhouse gas emissions increased by 2.5% by 2012. Therefore, Austria had to buy CO2 certificates amounting to 71.55 million tonnes of CO2. There are deep-rooted reasons for this in the country's climate and energy policy of the last two decades.

Building blocks from the past

In Austria, the energy production from renewable energy sources is based on hydropower and biomass. Although it is a relatively small country, Austria is the 4th largest producer of hydropower in Europe. The core development of Austria's hydropower was completed twenty years ago. Today, there is little potential left for hydro. The same is true for biomass, therefore the potential for „traditional" renewable energy sources is already used up to a large extent.

On the other hand, the Austrian government has not been particularly open to new renewable energy sources, such as wind and solar. The share of renewable energy in the electricity sector therefore decreased every year for many years while the share of fossil energy increased. In 2011, after the Fukushima nuclear accident, the Austrian "Ökostromgesetz" (similar to the Renewable Energy Sources Act (EEG) in Germany) was substantially reformed in a way that enabled more wind and solar power onto the grid. However, this reform came too late to become effective during the Kyoto-period, which ended in 2012, but can still be regarded as a relaunch of an Austrian energy transition in the electricity sector. By 2020, Austria will likely reach a share of 80% of electricity coming from renewable energy sources, which could put Austria in a front runner position again. During the 2015 Climate Conference in Paris, Chancellor Faymann and the Environmental Minister, Mr. Rupprechter, declared that by 2030, 100% of electricity shall be supplied from renewable energy sources. However, Faymann stepped down as chancellor in May 2016 without having enshrined this ambitious goal into formal legislation.

Pioneers and lack of political support

While the electricity sector plays a major role in the country's energy transition, there are other important playing fields in the climate and energy policy that deserve attention, for example: the building sector. Buildings contribute to about one third of the Austrian final energy demand. Austria has a pioneering role with the highest density of passive houses in Europe. In the heating sector, emissions have been reduced by 34% compared with 1990 levels, and the potential for further reductions is vast.

The main drivers of this success have been subsidies incentivizing building renovations, and higher energy efficiency requirements by many Austrian states, that are responsible for regulations in the building sector. However, the last strategy agreed between the central government and the federal states to increase energy efficiency in buildings dates back to 2008, and the last step to increase efficiency requirements for building renovations was made in 2010. Furthermore, the government cut subsidies for building retrofits in 2015 by half. Therefore, the renovation rate of about 1% each year remains alarmingly low. This means that Austria would need about 100 years to renovate its entire building stock. While architects already construct the first „Plus-Energy buildings" that produce more energy than they consume over the year, more political support for energy efficiency in the building sector is desperately needed in order to build on the success stories of the past.

While the efficiency in the building sector increases slowly, the share of fossil heating systems remains high: from 3.7 million households, about 1.5 million are still heated with gas, oil, or coal. Furthermore, 616,000 households are connected to district heating systems, 55% of which is powered by fossil fuels. A lot needs to be done to put the energy transition in Austria back on track. Unfortunately, the Austrian policy-makers are alarmingly passive, while the cheap oil prices make progress even more difficult.

Furthermore, the transportation sector is still one of the biggest challenges in Austria. By 2014 greenhouse gas emissions increased by a remarkable 57.6% from 1990 levels in this sector. While policy-makers fail to deliver proposals for real emission cuts, the Austrian economic institute WIFO calculated that environmentally harmful subsidies of 3.8 to 4.7 billion EUR paid for fossil fuels in Austria. About 2 to 2.2 billion EUR of environmentally harmful subsidies are identified in the transportation sector. Mainly tax cuts, e.g. for diesel, are responsible for this high share. Therefore, incentives for a change in the modal split remain low. A real decarbonization strategy for the transportation sector is missing.

Big challenges ahead

In general, Austria has a pioneering role in many aspects, but policy-makers do not act as decisively as they should. While a poll conducted in 2014, 79% of Austrians supported a rapid phase-out of fossil energy, there is still no long-term government strategy to phase out fossil fuels in Austria. This is a major gap, as there are strong economic arguments for taking action. About 64% of the energy needed in Austria has to be imported. The import bill for fossil energy has reached 11.4 billion EUR a year in 2014.

As a consequence, a lot remains to be done if Austria wants to turn back into a real frontrunner in the energy transition. Political action and the implementation of an ambitious decarbonization strategy must be the key drivers for this change.

H – Dazed and confused? The UK's energy policy needs a sense of direction

By Naomi Luhde-Thompson, Friends of the Earth England Wales and Northern Ireland

In relation to the rest of Europe, the UK's role as market champion, nuclear champion and shale gas champion has brought its policies into sharp relief in contrast to countries such as Germany and Austria. In particular the decision to approve Hinkley Point has been challenged on the basis of the subsidies it requires, although it was allowed by the European Commission.

Over three-quarters of people in the UK support renewable energy, while only a third support nuclear, and a quarter support fracking according to the UK Government's public attitudes tracker in 2014. Sparks fly in the energy debate as people's bills rise, companies' domestic supply profits increase, and the replacement of the ageing system mean large scale investment is required.

The UK's confused energy policy

Big utilities still dominate the UK's energy policy, as community-owned renewable energy struggles to gain a foothold despite the barriers. It has only been 25 years since the privatisation of energy, but in mainstream politics and media, the rise of community-owned energy, or local authority owned energy, is seen as a minor contribution to the UK's energy system – around 3GW by 2020 is estimated by the Department for Energy and Climate Change. This will have to change if the UK is to realise a decentralised renewable energy system that meets more stringent climate change emissions reduction targets, and is efficient and fair.

Energy production in the UK

A dash for gas-fired power stations was supported by the UK Government a while ago. Opencast coal mining is still being applied for, and applications for shale gas, coal bed methane, and even underground coal gasification are all being encouraged by the current framework in England, although Scotland and Wales have both passed moratoriums on fracking. Public opposition to fracking is on the rise, particularly in places where proposals have come forward. In places like Balcombe, Sussex, the threat of fracking has kickstarted a campaign for locally-owned solar energy instead. In early 2015, solar powered the equivalent of 2 million homes in Britain, and renewable energy generation was at record levels in 2014. Electricity generation from renewable sources increased 30 percent between 2012 and 2013, up to 13.9 percent of gross electricity consumption.

Lights going out?

The fear of "lights going out" has led the current Government to prop up the existing utilities. Through the capacity market the utilities are being subsidised in effect for what they want to do anyway - which is keeping their existing power stations open, and then being paid in addition for the electricity they supply. These recently announced subsidies for nuclear and the capacity market show how strongly the utilities are fighting off any change to the current centralised energy system.

The market focus

Both main political parties in the UK are wedded to a system which relies on a market dominated by the big six energy companies. The problem with this approach is that the existing players in the market have all the advantages, and the benefits of pre-privatisation investment - for instance in the grid, while new entrants are expected to pay the cost of transformation. There are regular reports from owners of prospective community-owned renewable energy projects who are quoted astronomical sums in order to be connected to the grid, because the grid is apparently 'at capacity' – for instance in places like Cornwall.

Barriers in the system

There is no merit order where renewable electricity is prioritised for connection and supply on the grid. Supplying electricity is impossible for small producers because of the cost of the supply license. The UK Government through the Department of Energy and Climate Change has had working groups on supply, grid and community ownership, but so far there has been no structural change. In the last year, the changes to the subsidy regime and the planning regime has effectively stopped onshore wind development and is slowing down solar farm development. The community energy sector itself is responding by looking for new business models when the existing registered projects are built out this year.

What does this mean for energy transformation in the UK?

The relationship between the Climate Change Act 2008 and its carbon budgets and the Energy Acts mean that the focus for the UK Government is on 'decarbonising' electricity, but not specifically on renewable energy generation. Instead the main political parties prefer to keep their options open, with a bit of everything in the mix. This creates a huge sense of uncertainty - will fracking squeeze into an energy supply gap which may open up, or will renewables and energy efficiency take off to an extent that it is squeezed out? Will a new generation of nuclear come to pass or will it be finally killed off by cost and insurmountable waste issues? Can the grid and supply systems cope with more renewable energy? With the cancellation of the carbon capture and storage programme, and the nuclear programme on the rocks of ever increasing cost, there is a real risk that the UK will find itself at the back of the queue on transforming its energy system to be largely renewable.

What next?

The new UK Government will have to tackle these issues head on as people's energy bills rise, new energy development comes forward, and as more people engage with community energy and understand the barriers it faces. Anti-fracking campaigners will ensure that unconventional fossil fuels remain high on the political agenda, and the pure cost of new nuclear may render it unaffordable. "Community energy" is largely off the agenda, but there is a focus on infrastructure investment which may re-open the debate down the line.

The UK needs to put renewable energy first in connecting to the grid, make it mandatory for schemes to offer a share to local communities, and make it simple and affordable for local projects to supply their local community. If this happens, community energy will start to transform the way people produce and use energy in the UK.

6 International perspectives

With its *Energiewende*, Germany has raised the bar in terms of setting the pace for renewable energy policies. By going renewable, Germany has created more than 350,000 new jobs, built up the world's leading green technology sector, and has reduced its dependency on fossil fuel imports. But how is the German energy transition perceived internationally? What do other countries make of the Energiewende? Are there other best practices for an energy transition?

A – Opportunity to Leapfrog into the Renewable Age – Is India on the Right Track?

By Srinivas Krishnaswamy, CEO, Vasudha Foundation April 2016

India is poised to show the value of renewable energies to developing economies. Its new targets, government programs, alongside other factors, seem to be moving India into a renewable energy age.

India is poised to show the value of renewable energies to developing economies. The national government has set ambitious targets: develop 175 GW of renewable energy generation by 2022 (100 GW of solar and 75GW from small hydro, wind and biomass, and other renewable sources) and increase the share of non-fossil fuels in its electricity generation mix to 40 percent by 2030, as announced in India's "Nationally Determined Contribution" submitted to the United Nations Framework Convention to Climate Change in October 2015. Alongside these (and other) targets, national and state programs, infrastructure developments, and a number of external factors, India seems to be moving down the path to a renewable energy age.

In line with its announced targets, the past two years have witnessed a fairly phenomenal growth in the renewable energy sector in India. The total installed capacity for renewable energy generation grew from 29.46 GW in June 2014 to 38.8 GW as of March 31, 2016. The break up of installed capacity for renewable energy is: 25.08 GW of wind, 4.8 GW of solar, 4.5 GW of biomass and co-generation, 4.17 GW of small hydro power, and 0.12 GW of waste to energy. The bulk of the additions in renewable energy capacities from 29.46 GW to 38.8 GW in about two years has largely come from solar, which has grown from virtually a few kW of installed capacity to 4.8 GW as of March 31, 2016.

This growth, particularly in installed solar capacity, has been concentrated in just a handful of states. Rajasthan leads the pack with a total installed capacity of 1.3 GW, followed closely by Gujarat with a total installed capacity of 1 GW. Other states that have fared reasonably well in developing solar generation capacity are Madhya Pradesh, Telengana, and Andhra Pradesh.

There are a number of policies that have and are supporting renewable energy development. In India, renewable energy growth cannot easily be separated from the government's priority of addressing electricity scarcity. The national government is simultaneously pursuing policies to address electricity scarcity, including promoting electricity generated from both fossil fuels and non-fossil fuels, and launching a number of programs aimed at reforming the electricity sector for renewables. A brief description of some of the recently introduced programs is as below:

a. Ujwal DISCOM Assurance Yojana (UDAY): Initiated by the national government, this program is primarily a financial turnaround and revival package for electric distribution companies in India. It provides for state governments to take over much of the electric utilities' debt, help improve operational efficiency, and thereby reduce the cost of power.
If implemented in true spirit, this program has the potential to support further renewable energy development. Electric utilities that have been avoiding the purchase of relatively costlier electricity (particularly from solar) due to financial constraints could now be encouraged to purchase electricity sourced from solar, even if it is more costly.

b. Electrification Targets: The national government has set a target to provide 24-hour electricity to all households by 2022, preceded by a target for 100% village electrification by 2019. In light of these targets, the distributed solar and renewable energy segments have rapidly expanded. In June 2014, the total number of villages without electricity was estimated to be 21,000. From June 2014 to March 2016, the number of villages without electricity has decreased to 16,800, and the number of households without electricity, which was 45 percent as per 2011 census, is now estimated to be around 33 percent.

c. Transmission Infrastructure: The national government has undertaken and made headway in building electricity transmission infrastructure in order to ensure connectivity to a large number of solar and wind parks that are in various stages of development. As of March 31, 2016, the national government had already installed 22,100 circuit kilometers of transmission lines.

The above national programs and targets have all been positive steps towards scaling up renewable energy generation and leapfrogging India's energy sector into a renewable energy age, but there are other external factors that have and can further contribute to propelling states to increase the pace of scaling up renewable energy. The following are some of these contributing factors:

- Decline in the generation of electricity from coal: Due to an acute water shortage, two coal-fired power plants have had to shut down their operations, and a number of them have had to scale down operations. However, units that had to completely shut down their operations for a prolonged period of time include units from the Parli Power Plant and the Farakka Coal Fired Power Plant. As of April 2016, water levels are still at 28% of total capacity. In short, acute water shortages have impacted electricity generation from coal fired power plants. Competing demand for scarce water supply has forced policy makers to explore options for less water-intensive energy sources, such as renewable energy.

- Falling Cost of Solar: The cost of generating electricity from solar has fallen steadily over the last 2-3 years, internationally and in India. From an initial cost of approximately Rs. 18.00 ($0.271 USD) per kWh in 2008, the average cost of generation in India has now come down to Rs. 5.50 ($0.083 USD) per kWh as of January 2016. This cost closely competes with the cost of generation of electricity from a coal-fired power plant that operates with 100 percent imported coal, which is Rs 5/- per kWh.

- Thermal Power Plants Performance Standards 2015: In December 2015, the Indian Ministry of Environment, Forests and Climate Change issued revised standards for coal based thermal power plants in India, with the primary aim of minimizing pollution.

These new standards for thermal power plants will not only help improve the ambient air quality around the plants, they will also limit water usage in thermal power plants, and thus lead to a reduction in energy required to draw water. Once implemented, these revisions will impact the cost of generating electricity from coal.

To conclude, India has set ambitious targets and made significant progress. The national government's targets for electrification and renewable energy, its financial schemes (i.e. UDAY) and transmission infrastructure development all support a framework for continued renewable energy development. These efforts are further supported by the above-mentioned contributing factors, including water shortages, coal power plant shut-downs, decreasing costs of solar electricity, and more energy-efficient standards for thermal power plants.

Although much of the renewable energy development thus far has been concentrated in a few states, many more states have projects planned to scale up renewable energy (particularly solar). As of March 2016, 33 solar parks with a total installed capacity of 19.9 GW have been sanctioned, and most of these are in various stages of being commissioned. In addition, most states of India have also brought in policies to promote roof top solar for the residential and commercial sector, including a combination of feed-in tariffs and net metering. With all of these in various stages of implementation, it is very much possible for India to further accelerate its renewable energy development (particularly in its electricity generation mix) and possibly meet its ambitious target of 175 GW installed capacity from renewable sources by 2022. With these successes and prospects, India certainly seems to be on a pathway to go the renewable energy way.

However, the success of further renewable energy development will greatly depend on a number of issues, particularly the implementation of these policies and measures at the state level. Since electricity falls in the administrative purview of both the national and the state governments, national policies alone will not suffice. Thus far, indicators suggest that India has embarked on the right track to leapfrog to a renewable energy age, but still has far to go. Furthermore and importantly, this success in renewable energy and the reducing costs of solar could also deter India from pursuing other options, such as nuclear power, in its quest to secure India's energy future. Despite huge budgetary allocations and efforts, the total installed capacity of nuclear energy in India has grown over a three decade period to a mere 5.8 GW as of March 31, 2016. In contrast, in just two years solar has grown from virtually zero capacity to 4.8 GW. It is high time for the government to realize that with good policies, renewable energy can indeed deliver.

B – A Struggle between Coal and Renewable Energy in the Philippines

*By Pete Maniego Jr, Chairman,
National Renewable Energy Board,
Philippines
April 2016*

The Philippines was one of the first nations to commit to renewable energy and it has long abandoned the idea of nuclear power. As demand for power steadily increases, the Philippines is in a position to fill this need with renewables. How can Germany's successes inform the Philippines' continued progress?

After more than seven years since the passage of the Renewable Energy Law (RE Law) in 2008, the Philippines has finally gained momentum in the development of renewable energy resources. As of April 2016, more than 1,000 MW of renewable energy projects had been completed under the Feed-in Tariff System (FIT) of the RE Law.

Almost all of the 1,000 MW installed renewable energy capacities were completed within the last two-and-a-half years. In addition to installations under the FIT, approximately 2,500 kW have been installed under the net metering mechanism. During the construction and subsequent operations of the renewable energy plants, conservative estimates pegged the number of jobs created to around 100,000.

At first glance, it would appear that renewable energy is winning the battle against fossil fuel. However, the reality is closer to the opposite. New coal and natural gas plants built since the passage of the RE Law have much higher capacities, and have substantially reduced renewable energy's share in the power mix.

At present, there are 17 operating coal plants with several expected to go online within the next several months. Greenpeace Philippines reported that another 29 plants are in the pipeline. In addition, there are five natural gas plants, two of which started their operations in April 2016. According to Mr. James Ooi, IHS Senior Director for Gas & Power in Asia Pacific: "If coal projects are implemented as planned, Luzon's coal generation share will be over 75% by 2030, and many coal plants will be uneconomic". He observed that this will make the Philippines the country with the highest coal share in Asia. It would be a complete reversal for the country where the share of renewable energy reached a high of 44% in 1999, and that until now boasts of having the highest renewable energy share in Southeast Asia.

When the RE Law was passed in 2008, the share of renewable energy in the power mix and the installed capacity were both at almost 34%. As of December 2014, the share of renewable energy in the power mix in MWh was down to 25.6%, while the share of the total installed capacity in MW declined to 32.8%. If the rate that new fossil-fired power plants are being constructed continues, with capacities ranging from hundreds of MWs to GWs, the share of renewable energy will continue to decline in the coming years.

The Philippines has other apparent barriers to fossil fuel development. On top of the RE Law, the Philippines has one of the most stringent laws to control air pollution. The mandated standards under the Clean Air Act of 1999 are considered to be stricter than those of the United States. The Philippines had also committed to reduce its GHG emissions, conditionally, by 70% from business-as-usual under COP21 by 2030.

What then are the reasons why fossil-fired plants, especially coal, continue to be favored by the power sector over renewable energy?

The primary reason is that the Philippines has one of the highest electricity rates in the world. Thus, any incentives or measures perceived to increase the power rates will encounter strong resistance from end-users, civil society organizations and politicians. The drastic reduction in coal prices since last year delayed the much anticipated renewable energy to coal fuel parity.

Moreover, coal has many inherent advantages over renewable energy under the current regulatory regime. Under the current pricing regime that does not include externalities, such as health and environmental costs, the lowest cost power supply option will always be favored. Fossil-fuel plants are secure investments providing continuous revenue streams, since the proponents could avail themselves of automatic pass-through of their fuel costs to consumers. On the other hand, renewable energy projects are considered to be high risk investments as the resources fluctuate widely from year to year. Financing institutions are very familiar with coal plant development, and power companies are well-versed in their construction and operations. With respect to renewable energy projects, the Philippines has not yet gained sufficient experience in their development and operations and must rely heavily on foreign contractors. Thus, renewable energy project costs in the Philippines are much higher compared to Europe and the United States.

The proliferation of coal plants would also make the grid integration of variable renewable energy more difficult. Coal plants cannot be turned on and off to cope with intermittent renewable energy supply. The Electric Power Industry Management Bureau of the Department of Energy has projected that the coal plant generation will exceed the baseload demand in the Luzon, Visayan and Mindanao grids once the new coal plants are fully operational within the year. With their current low costs per kWh, the generation from these coal plants is already displacing geothermal and hydropower plants. Although the short term impact would be lower electricity rates, what would happen once fossil fuel prices inevitably rise to their former levels? Already, the exploration and development of many hydropower and geothermal plants are on-hold as they could not compete with coal.

What are approaches to counter the inherent advantages of coal-fired plants?

1. A shift from **centralized** generation to distributed generation in the Philippines

   The Philippines consists of more than 7,100 islands; interconnecting even all the bigger islands would be prohibitive and not feasible. The interconnection of the major islands had not been accomplished; Mindanao is not connected to Luzon and Visayas yet. Many of the submarine cables need to be upgraded to handle both the increased supply and demand. With more than 20 typhoons visiting the Philippines per year, transmission lines are frequently damaged, causing long black-outs and requiring costly restorations. Moreover, the long transmission lines cannot be sufficiently guarded and are subject to vandalism and sabotage.

2. A re-examination by the Energy Regulatory Commission of pass-through costs for fossil-fired plants

   Pass-through costs for fossil-fired plants shield against fuel price fluctuations and provide them an undue advantage over renewable energy sources. For big business, coal plants are virtual money machines with minimal risks and certain returns. The return on capital expenditures and operating expenses are guaranteed under power purchase agreements for 20 to 25 years. It is true that renewable energy plants are entitled to FITs. However, the developmental risks are much higher, the installations are subject to caps, and approval of new rates once the caps are exceeded could take six months to a year.

3. Implementation of all other mechanisms under the RE Law such as the Renewable Portfolio Standards, Green Energy Option, Renewable Energy Market and Renewable Energy Trust Fund

   Renewable Portfolio Standards would mandate distribution utilities to augment their power supply with renewable energy sources. The Green Energy Option would enable end-users to demand clean energy as well as benefit from the exemption of renewable energy supply from value-added tax. The Renewable Energy Market would facilitate trading in Renewable Energy Certificates. The Renewable Energy Trust Fund would provide funds for research and development, training and information dissemination.

4. Implementation of the provisions under the Clean Air Act and the Solid Waste Management Act

   The communities living around coal plants and garbage dumps have already suffered for too long from pollution-related health problems, environmental impacts and hazards. The responsible regulatory agencies and local government units must ensure that these plants and unsanitary landfills comply with all the standards under the law and severely penalize them for failure to do so.

Coal plants appear to be coming out ahead in their struggle against renewable energy sources. How could coal plants be prevented from sealing a victory?

The Philippines could follow the examples of Germany and other countries in pushing for a renewable energy transition, including closing old coal plants and preventing the construction of new ones. The Philippines would need to focus on renewable energy development in order to retain its leadership position in renewable energy utilization. The policy and objectives under the RE Law of 2008 were very clear: develop indigenous renewable energy sources to achieve energy independence and mitigate GHG emissions. The 70% GHG reduction committed by the Philippines under COP21 is achievable, but these policy directions and actions are needed if the Philippines' targets are to become reality.

C – Israel: The "Energy Island's" Transition to Energy Independence

By Noam Segal, Executive Director, Israel Energy Forum
May 2016

After several decades of stagnation, the recent discovery of significant natural gas deposits in the Mediterranean, which could supply Israel's energy needs for the coming decades, and the introduction of domestic renewable energy generation could signal a rapid energy transition for Israel.

Israel the energy island

For several weeks in the autumn of 2015, tens of thousands of Israeli demonstrators took to the streets of Tel Aviv and other cities in Israel. What was unique to this protest, the largest public demonstration in Israel since 2011, was its topic: energy policy. Despite its significance to the country's national security and economy, energy has never been an issue of public discourse in Israel. The demonstrators were protesting the government's proposed plan for the country's natural gas sector (termed the "Gas Deal"), demanding more energy security, sustainable energy and a just distribution of the profits from this national resource.

In February 2016, the Supreme Court of Israel ruled in favor of the protesters, despite Prime Minister Benjamin Netanyahu's extensive involvement in support of the gas deal and his unprecedented move in appearing before the court in person.

These demonstrations highlight the main elements of Israel's energy transition over the past decade, reflecting several domestic, regional and global developments. On the world energy map, Israel presents an interesting case study for energy policy making. Due to its geopolitical positioning, Israel cannot connect its energy system to the grids of neighboring countries. This has effectively rendered Israel an "energy island" that must be able to supply all of its electricity needs at any given time. In addition, Israel has traditionally been dependent on fuel imports to supply its energy needs due to lack of local natural resources.

Israel's energy transition: natural gas and renewable energy

In the late 1970s, following the 1973 oil crisis, Israel initiated its first major energy transition when it introduced coal to replace oil as a primary fuel in electricity generation. A further outcome of the oil crisis was a unique regulation requiring rooftop solar thermal water heating systems to be installed on all residential buildings.

A second energy transition for Israel occurred in the early 2000s when natural gas was introduced to its energy system. This resource was imported in part from Egypt as well as extracted from newly-discovered local offshore gas wells in the Mediterranean. The transition to natural gas eliminated oil in the power sector and replaced coal as the primary fuel for electricity generation (with a share of over 50%).

In 2009 and 2010, two major offshore natural gas deposits were discovered in the Mediterranean in Israel's Exclusive Economic Water Zone, which could supply Israel's needs for the coming decades. These discoveries are part of the regional transition from oil to natural gas as a primary energy source, occurring simultaneously in neighboring countries such as Egypt and Cyprus. It is due to these discoveries that Israel has been able to achieve some level of energy independence for the first time since its founding.

A third significant development in the Israel energy market is the introduction of renewable energy sources to its energy mix. Historically, Israel has been a global leader in renewable energy research and development, but has not managed to follow suit in terms of domestic power generation. In 2015, only 2% of total electricity generation in Israel came from renewable sources.

But the prospects of renewable energy in Israel appear more promising and are beginning to change: by the year 2020, as new solar facilities currently under construction are scheduled to come online, Israel is expected to generate about 7% of its electricity from renewable sources. Following the global trend and the 2015 Paris Agreement, the Israeli government adopted a resolution in April 2016 which set a new target: having 17% of annual electricity generation in Israel delivered from renewable sources by the year 2030.

Israel's energy transition coupled with deregulation

Complementing Israel's energy transition are measures taken by the Israeli government to deregulate the electricity market. In the past, Israel's electricity market was dominated by the vertically-integrated, government-owned utility, the Israel Electric Corporation (IEC), which had a complete monopoly over the country's electricity generation, transmission, distribution and supply structure. The first steps at deregulation started in the early 1990s, but it was only in recent years, reflecting domestic socio-political trends, that private companies and individuals have been permitted to generate and sell electricity. Experience around the world shows mixed evidence as to the benefits of deregulation for promoting sustainable, renewable energy, but in the case of Israel, deregulation has had a positive impact on the energy transition. According to new regulations set by the Israeli government, all Israeli homeowners can now install a rooftop PV solar panel and supply their own energy needs at a lower cost than purchasing electricity from the grid, and without producing any pollution.

The Israeli Government's April 2016 resolution confirms its commitment to renewable energy, but the targets it sets are considered low and reflect an underlying internal dispute as to the future of the country's energy market. Coal continues to be a significant primary energy source, used to supply about 40%-50% of Israel's total electricity demand. This remains the case primarily because the Ministry of Energy and Water does not consider renewable energy technologies – or natural gas – secure sources of energy. Instead, it gives preference to keep coal in place and consider nuclear energy for the long term.

Despite obstacles, renewable energy may begin to prosper in Israel. A shortage of available land in Israel presents a major challenge to a more rapid increase in the share of renewables in electricity generation. On the other hand, Israel has abundant solar resources, presenting an important opportunity to utilize roofs to install solar systems. As the price of renewable energy technologies declines, it is hoped that their share will grow, and possibly surpass the government's 17% target, improving air quality and increasing Israel's energy independence and security.

D – Is Policy on Track for an *Energiewende* in Japan?

The Fukushima nuclear disaster put Japanese nuclear power on hold. In the five years since, Japan's policies have ushered in renewable energy, but continued coal expansion remains likely.

By Kimiko Hirata, International Director, Kiko Network
May 2016

Changes in the 5 years after Fukushima

The 2011 Tohoku earthquake and tsunami that resulted in the Fukushima Daiichi nuclear accident was a clear turning point in shifting Japan's energy system. Right after the accident, all 50 nuclear reactors in Japan were shut down and required to undergo a safety check. As of May 2016, 14 reactors have declared an intent to decommission (including the Fukushima plants), only two reactors are operating, and the remaining 38 reactors are still idly waiting for permission to go back online.

Consequently, thermal power generation, mostly by LNG and oil, has surged to compensate for the short-term loss in nuclear power. This resulted in an increase in both CO2 emissions and costs for fossil fuels (primarily due to a price surge) leading up to FY2013. At the same time, renewable energy installations have sharply increased. Electricity demand has steadily declined for all 10 utilities for the 5th consecutive year (by 3.7%) following a peak in FY2010 (declining from 906TWh to 797TWh in FY2015). These developments have contributed to reduced fossil fuel imports. CO2 emissions also declined in FY2014 for the first time since the Fukushima nuclear accident. While the GDP dropped by 2.0% in FY2014, the Ministry of the Environment stated that the key factors behind the reduced CO2 emissions were reduced energy consumption and improved CO2 intensity through renewables.

Is Japan's renewable policy on track for an energy transition?

Do these recent developments ensure that Japan is on track for an Energiewende? The answer to this question is both yes and no.

One example can be observed in the recent progress and setbacks in Japan's feed-in tariff (FIT). The long-awaited FIT introduced in July 2012 demonstrated, was, at first, a success in adopting solar power. It established a guaranteed tariff of 43.2 yen (USD $0.40) per kWh for commercial scale PV over 100MW. It drove an increase in the share of renewables in electricity generation from 10% in FY2010 to 15% in FY2015 (from 1% to 4.7%, excluding hydro). This also contributed to a decline in PV costs. Residential PV costs went down from 50 yen (USD $0.46) per kWh to less than 30 yen (USD $0.28) per kWh – all within 4 years!

Currently, however, the FIT has undergone and is undergoing further changes. The original tariff, which was claimed to be too generous to PV, has declined each year. The tariff of 43.2 yen (USD $0.40) per kWh for commercial-scale PV in 2012 is now only 25.92 yen (USD $0.24) per kWh (as of FY2016). The Japanese government has also decided to allow utilities to curtail electricity from renewables unlimitedly without any financial consequence. Most recently, the government has decided that a tender system will be introduced. With these developments, the previous incentives and positive effects have been almost entirely killed off.

As a result, the future of solar power in Japan is now unclear. Experts predict that this fading FIT will discourage investments in solar power development. At the same time, high expectations remain for other renewable energies, such as geothermal, micro-hydro and wind – technologies which do not yet have high installed capacities in Japan, and whose tariffs, which is still high compared to solar, have remained the same.

The myth of "baseload electricity"

The Japanese government Cabinet approved a revised Basic Energy Plan in 2014. This plan reevaluates the role and definition of nuclear power and coal-fired power as "important baseload electricity" and declares that renewable energy would instead gradually be introduced over a longer time frame. This is reflected in Japan's Long-term Energy Supply and Demand Outlook of 2015, which projects an increase in electricity demand in FY2030 compared to FY2013 and proposes a quantitative target for the electricity mix in FY2030 (27% LNG, 26% coal, 23% oil, 21% nuclear, and 3% renewables).

These projections imply a heavy reliance on fossil fuels in 2030, almost at the same level as the 10-year average before Fukushima. The nuclear share will decrease from 27% to 21% (a difference compensated by an increase in renewables). However, the proposed 20-22% share of nuclear poses a crucial feasibility question. Assuming a capacity factor of 70%, 35GW of nuclear capacity would be required to meet this given target. At the same time, the current nuclear capacity of 40GW would be reduced to less than 20GW by 2030 if the unit lifetime is set (and maintained) at 40 years. Without extending the unit lifetime or building new reactors, it is not possible to meet the government target. Furthermore, strong public opposition to restarting existing reactors renders the target even more difficult.

Instead, a more likely scenario is coal expansion. Japan is one of very few developed countries to promote coal thermal power. There are currently 47 coal power plants (capacity of 22.5GW) being planned, most of which were planned after the Fukushima accident. If all 47 are built, this could easily cover the nuclear loss and is enough to block potential installations of renewables. The government is providing full support to construct new coal power plants as a source for "clean, stable and reliable" baseload electricity, ignoring the associated lock-in effects.

Issues for the future *Energiewende* in Japan

In April 2016, the electricity retail market was fully liberalized, allowing households and small business the freedom to choose their power company. This reform is an important step in transforming Japan's electricity system, but this step alone is not enough; it is crucial to ensure that the shift is in the right direction.

There are a few key steps that could help ensure Japan's "Energiewende" remains on track. First, Japan would need to keep effective FIT incentives for solar power and other renewables. Japan's renewable market is still immature and not yet ready for market competition.

Second, Japan would need to reconsider the notion of "baseload electricity" and reverse its priority to renewables. Priority access and priority dispatch for renewables would ensure further deployment.

Third, disclosure of electricity sources by all power companies would need to be mandatory, rather than a "voluntary request". This would ensure that consumers can choose and support more sustainable sources of electricity.

Fourth, it is crucial to integrate increased flexibility in the energy system together with a better grid connection. Unlimited curtailment without any compensation poses great uncertainty for investment in renewables.

And lastly, setting a clear vision for a sustainable energy future is inevitable. Drastic GHG reduction targets, a nuclear and fossil fuel phase-out plan, and a goal of 100% renewables – such a vision would send the right market signals to relevant stakeholders and help to stop further coal investments.

E – Uruguay: Revolution Rather than Energy Transition?

By Wilson Sierra, Director of Renewable Energy, Uruguayan Ministry of Industry, Energy, and Mining
May 2016

In less than a decade, Uruguayan citizens have been privileged witnesses of a fast change, a true revolution, in the energy sector, and they are beginning to perceive its results.

Uruguay is one of the smallest countries of South America, with nearly 3.5 million inhabitants. The country has a good record in democracy, human development and equity, as well as an inclusive agenda on human rights. From the energy point of view, Uruguay lacks gas, oil, and coal reserves, but is rich in domestic natural resources suitable for a clean energy transition.

Political shift and energy policy – how Uruguay has pushed its energy transition forward

The beginnings of a true energy revolution were set into motion over a decade ago. The presidential and political shift in 2005 sparked a review of the prevailing energy paradigm – the new government envisioned energy as a strategic asset to be leveraged in government planning, rather than an asset confined to the market alone.

With a revised approach to energy, the government approved a national energy policy in 2008 ("Energy Policy Uruguay 2005-2030"). This policy included a long-term perspective and also incorporated the social, ethical and cultural implications in addition to the classic technical-economic analysis of the energy issue.

The Energy Policy Uruguay represents a strong commitment to renewable energy sources and energy efficiency and considers access to energy as a human right. In 2010, it received a unified endorsement from all political parties with parliamentary representation.

The goals of the Energy Policy Uruguay were structured to address four areas: institutional, energy supply, energy demand, and social aspects. Overall, the policy aims to achieve energy sovereignty, reduce costs, activate national industry, and reduce dependence on oil.

The "Energy Policy Uruguay 2030" established strategic guidelines which included goals for the short (by 2015), medium (by 2020) and long term (by 2030), as well as courses of action to reach such goals. Detailed below are the short-term goals and the proposed courses of action regarding renewable energy:

By 2015, native renewable energy sources are to comprise 50% of the total primary energy matrix.

- Electrical energy: The integration of non-traditional renewable sources to account for at least 25% of the power generation, particularly:
  - Wind Energy: 1,000 MW installed by 2015
  - Biomass: 200 MW installed by 2015
- Bioethanol: Mandatory minimum of 5% of total blend with gasoline, by January 1st, 2015
- Biodiesel: Mandatory minimum of 5% of total blend with diesel, by January 1st, 2015
- Solar thermal: Introduction of this technology by residential, industrial, commercial and service sectors
- Small hydro plants (SHP): Incorporation of small hydropower installations to irrigation dams

Results of the energy transition

In an analysis of Uruguayan global primary energy mix from 2000 to 2005 (the baseline scenario), it is possible to identify at least three weaknesses: minimal diversification (only 4 energy sources in the mix), high dependence on fossil fuels and imported energy sources (representing almost 65% of the total mix), and a significant climate vulnerability. Over this time period, the share of renewable energy was limited to hydropower and biomass thermal energy (wood) for industry and residential sectors.

By the end of 2015, Uruguay had been able to turn its energy transition into the following successes:

- Growth in the share of renewable energy – Renewable energy made up more than 93% of Uruguay's electricity generation. Renewables reached a share of 57% of the total primary energy supply. Uruguay reached four times the global average in its share of renewable energy (both in the overall energy and the electricity mix). The growth in wind power (exceeding a 37% share in the electric mix) situated the electric system on the frontiers of technology with regard to the management of intermittent sources.

- From energy importer to exporter – Regionally, the role of Uruguay has shifted from being an energy importer (34% of electricity demand in 2006 was supplied by neighboring countries) to a net energy exporter (10% of electricity generated locally in 2015 was exported).

- Reduction in greenhouse gas emissions – By 2017 Uruguay will achieve an absolute greenhouse gas emissions reduction of 84% within this subsector compared to the annual average for the period 2005-2009 (with a higher consumption). By 2017, emissions from the domestic power generation system will be 17 g CO2/kWh, which is 3% of the global average.

- Economic benefits – Renewables have led to a 44% reduction in the cost of supplying electricity. This transition has also created new jobs. In 2015, the level of employment in the renewable sector (11,050 jobs, not including the 6,550 jobs in the public utility sector) reached 1.5 times that of those generated from oil refineries and distribution of natural gas combined (7,460 jobs).

It is worth noting that this energy transition has been developed without subsidies. Instead, it has been based on auctions that allocate long-term contracts with the public utility. Simultaneously, innovative ways of financing projects have been developed, in the last few years Uruguayan citizens have been financing renewable energy projects through the local stock market in association with the public utility.

Concluding Comments

These achievements have been made possible through a number of determining factors, including key institutional support, involvement from academia, and civil society participation. The state-owned companies have served as the main drivers of the transition.

Other areas of public administration have strongly supported the renewable energy integration process by reviewing the regulatory framework, adapting standards and requirements, facilitating logistics, or training human resources. Organized civil society has participated significantly in generating opportunities for exchange, reflection, or confidence-building amongst the various actors involved.

Finally, the energy transition has been accepted by financial institutions and investors who have had trust to implement projects in the country, largely due to the political stability, consistent state policy in the energy sector, and the strength of the renewable energy measures.

In summary, Uruguay's energy transition has been a success because it has enabled diverse key actors, under the leadership of the state, to come together and collectively ensure its implementation.

F – China's Energy Transition: Rapid Growth on a Long Road

China set world records, again, in 2015 with its rapid renewable energy development, but China's continued over-reliance on coal suggests a long road ahead towards a true clean energy transition.

By Rebecca Coombs, Energy & Environment Program, Heinrich-Boell-Stiftung North America, May 2016

China set a world record, again, in 2015 by adding more installed capacity of both wind and solar in a single year than any other country (32.5 GW of wind and 18.3 GW of solar). By the fourth quarter of 2015, China overtook Germany with the largest installed capacity of solar power in the world (with a total of 43 GW). Though China's increasingly ambitious policies have ushered in rapid gains in renewable energy, the country's continued over-reliance on coal suggests a long road ahead towards a true clean energy transition.

Renewable Energy in China: From Zero to Top of the Charts

Over the past two decades, China's renewable energy sector has grown from being virtually nonexistent to establishing itself as a leader in total renewable energy investment and capacity. China's central government has driven much of this change since it first began promoting renewable energy in the early 1990s.

The Chinese central government's five-year plans (FYP), a policy blueprint for China's development, provide a key illustration for the country's increasingly ambitious targets. Renewable energy first shifted into focus in China's 10th FYP (2001 – 2005) and more concrete targets were set in the 11th FYP (2006 – 2010).

Within the 12th and most recent FYP period (2011 – 2015), China met its three binding targets on energy and carbon. China was able to reduce its energy intensity (energy use per unit of GDP) by an additional 18.2% from 2010 levels, reduce carbon intensity by 20%, and increase non-fossil energy to 12% of total energy use (including hydro, nuclear and renewable energy).

China's growth in renewables has placed it at the top of the charts internationally. In addition to its 2015 world record in installed wind and solar capacity, the REN21 Renewables 2016 Global Status Report ranked China #1 in categories related to hydropower, geothermal heating, and solar hot water capacity, #1 in 2015 investments in renewables, and #2 in biopower generation. Simultaneously, China's annual coal consumption fell for the first time in its modern history in 2014 (by 2.9%), and again in 2015 (by 3.7%).

Coal's Continued Dominance and Political Pressure

Despite the growth in renewable energy and recent decline in coal consumption, fossil fuels still dominate the energy sector in China. Its sheer size is an undeniable factor; China is both the world's largest consumer of energy and the largest consumer of coal. For more than two decades, coal has supplied at least 2/3 of China's annual energy consumption (66% in 2014). Second in place in 2014 was oil with 17.1%.

China's reliance on coal presents a number of challenges, not least of which is air pollution. In 2014, the air quality in 66 of China's 74 major cities failed to meet basic air quality standards (according to the Chinese Ministry of Environmental Protection). Berkeley Earth researchers have calculated China's air pollution to contribute to 1.6 million deaths per year (17% of all deaths in China). The Chinese public is increasingly aware of the severe health and environmental impacts linked to both coal and air pollution and is showing growing discontent. The possibility that this discontent could shift to political instability generates additional pressure for the Chinese government to act.

Political pressure from air pollution is a major – but not the only – consideration linked to coal that is pushing China towards a clean energy transition. Its energy security, growth strategy, and international responsibility also play a role. China's growing demand for coal shifted the country's status in 2009 from long-time coal exporter to net coal importer, which raised the government's concerns about China's energy security. More proactively, China is also positioning an energy transition as a driver for its future economic prosperity, demonstrated, for example, in the 12th FYP featuring three clean energy-related industries out of the its seven listed Strategic Emerging Industries. Internationally, China's role as the largest emitter of greenhouse gases in the world has also built up pressure for China to take action.

Looking Ahead

In the face of its overreliance on fossil fuels, this past year has witnessed an increasing push for change. In addressing coal specifically, China has introduced a ban on new coal plants for the next three years as of January 2016, alongside plans to close more than 1,000 mines and in addition to previous coal plant closures. Internationally, the US-China bilateral plan to curb emissions, announced in 2014, is credited with building momentum in the build-up to the Paris climate agreement reached in December 2016.

China's 13th FYP (2016 to 2020), released in March 2016, sets a new round of targets on energy intensity (15% reduction) and carbon intensity (18% reduction) from 2015 levels. For the first time, it also includes a cap on total energy consumption (5 tons of coal equivalent).

The prospects for an energy transition in China are mixed. China faces numerous challenges, not only those linked to coal, but also to the fact that its annual energy consumption is expected to continue to rise in 2016, its past and planned growth in non-fossil fuel generation includes controversial mega-projects (such as mega-dams), amongst other challenges. At the same time, some experts estimate that China's coal consumption and GHG emissions could peak within 10-15 years. With its heavy reliance on fossil fuels, China's path to a true clean energy transition is steep; but if it continues to pursue new goals with agility, this zealous ambition may become within reach.

G – South Africa's Changing Energy Landscape

South Africa shows how quickly an energy transition can be. In four years, with coal and nuclear power stations on hold, South Africa's renewable energy program has nearly 100 plants in development.

By Leonie Joubert, Science Writer
April 2016

South Africa's changing energy landscape

South Africa's energy sector is changing so quickly, this publication may well be out of date before the year is out. In four years, the country's utility-scale renewable energy program has nearly 100 plants at various stages of development. The cost of solar and wind energy has dropped so significantly they are now cheaper than coal power. The country's two new coal power stations, which should have been completed in 2011, are still not ready to go online. And in the past four months, the political ground has turned to quicksand under plans to build six to eight nuclear power stations.

If anything, this shows how quickly this country's transition away from mega-infrastructure carbon-intensive energy investment could be.

New-build coal: big, expensive, and behind schedule

In 2007, when construction began on the first of two new coal-fired power stations – Kusile and Medupi in Mpumalanga and Limpopo provinces – the two were designed to add 9.6 GW of electricity to the grid, and were due to come online in 2011. They were expected to cost R69.1 billion (US$ 4.5 billion at current exchange rates) and R80.6 billion (US$ 5.3 billion), respectively.

By early 2016, the plants were still not completed. Their anticipated cost has ballooned to double the original price, now figured at R154.2 billion (US$ 10 billion), and R172.2 billion (US$ 11 billion). And their procurement has been dogged with accusations of corruption, which have been widely reported in local media.

SA's renewables: small, fast, and cheap

In the four years that these two coal stations have overshot their delivery date, the arrival of renewable energy has, quite literally, changed the face of SA's energy future: almost 2.5 GW of renewables have been added to the grid; R190 billion (US$13 billion) has come in from private investments; and the cost of solar and wind energy has gone from being uncompetitive with coal to being significantly cheaper.

The Department of Energy kicked off the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) in 2011. The aim was to bring 3.75 GW of power to the grid through a series of concentrated solar power, photovoltaic (PV), biomass, landfill, wind, or small hydro plants at various locations around the country. But the program had already exceeded that target about two-thirds of the way through the procurement process.

REIPPPP has proved so successful, it has been hailed as a global success. While the construction of Kusile and Medupi runs behind schedule, REIPPP is finalizing the fourth of its anticipated five bidding rounds, and has over 100 projects at various stages of either bidding, contracting, raising finance, being signed off, or under construction. According to the Energy Blog, one of the most comprehensive databases of the REIPPPP projects, by mid-April 2016, some 47 of these plants were fully operational, and their combined energy production added up to nearly 2.5 GW to the grid.

Professor Anton Eberhard, expert in infrastructure and associated policy development at the University of Cape Town's Graduate School of Business, said that REIPPPP has contributed to more competitive pricing, transparency in the procurement process, and greater efficiency in project rollout.

On the pricing matter, Eberhard wrote in a May 2014 report that in just two-and-a-half years since the start of REIPPPP, the price of solar PV and wind power dropped dramatically. In normative terms, he said, by 68 percent and 42 percent, respectively.

Nuclear: political quicksand

South Africa is the only country on the continent with a nuclear power station, and its ambitions to build another six to eight were put on hold in March 2016, after the High Court in Cape Town heard that the state had sidestepped its statutory and constitutional obligations around transparency and public participation, as it wrapped up a deal with the Russian government to deliver the reactors.

The controversial 9.6 GW fleet was expected to cost between R700 billion (nearly US$ 50 billion, at the exchange rate of late April 2016) to R1.4 trillion (approximately US$ 93 billion). This is the immediate cost of building, and excludes the additional cost of decommissioning the plants, handling waste, and interest on loans attached to what would amount to the biggest infrastructure project ever undertaken by this country. The R1.4 trillion, in 2015, was the equivalent to about a third of the current national budget.

Following the court action, initiated by civil society organizations Earthlife Africa and the Southern African Faith Communities' Environment Institute (SAFCEI), the state announced it had put its nuclear plans on hold.

Price volatility and prospects for renewables

Recent events have weakened the local currency and raised uncertainty for renewables. In November 2015, finance minister Nhlanhla Nene was fired unexpectedly, and replaced temporarily by an inexperienced and unknown parliamentarian (it was soon confirmed that the president fired Nene because he opposed the nuclear fleet procurement).

The decision sent the local currency into a spiral, from which it has yet to recover. This currency crash, along with rising interest rates in South Africa, are likely to impact the cost of the next wave of plants planned for the REIPPP process, according to local WWF energy analyst Saliem Fakir.

Fakir explains that "the fourth REIPPP bidding round hasn't closed, and we haven't done the calculations yet, so we don't know for certain what the impacts will be. But it could influence renewable energy prices for the projects built as a result of this bidding round. It won't stop the renewable rollout, but it could push up the price."

If so, this could offset some of the gains in terms of cost reduction which were made in the first three bidding rounds, as discussed above.

Several macro-economic trends are adding to the sudden challenges for renewable prices at the moment: the over-supply of PV panels globally has made this a buyers' market; the SA government's level of indebtedness impacts whether the state can stand as surety for private sector finance, as is the case at present (a form of indirect state subsidy but these guarantees are not limited to renewables only, says Fakir); and the strength of the local currency, relative to the Dollar and Euro.

"If foreign firms are buying locally produced services and technology for these plants," explains Fakir, "then their buying power will improve if the Rand weakens. If local firms are buying, then the reverse applies."

In conclusion, South Africa's clean energy transition is moving at rapid speeds driven in large part by highly effective government policy and dramatically falling prices for both wind and solar power. Renewable energies are becoming competitive with fossil fuels; the energy transition in South Africa is thus no longer about ideology but about economic forces. After all, it's the economy, stupid!

7 Questions & Answers

A – Is the energy transition affordable?

Yes – in fact, we cannot afford not to do it. Investments made in renewables today will pay for themselves over the usual 20-year service life of the equipment as conventional energy becomes more expensive. Renewables are already competitive with fossil energy in many places around the world. Furthermore, renewables are only seen as more expensive because some of the cost of fossil and nuclear energy is passed on as taxes and other external costs not included on power bills.

Essentially, the cost of renewables will continue to drop, while the cost of conventional energy – both fossil fuel and nuclear power – will continue to fluctuate unpredictably, with a clear long-term upward trend. Heating costs in Germany mainly from fossil fuels, reached record levels in 2013. To account for the price drops for oil in 2015, the government restricted the installation of oil heaters and began requiring renewable heat in 2016.

Germany's leading economic research institute, the German Institute for Economic Research (DIW), estimated in 2012 that the cost of the Energiewende would be 200 billion euros over the following ten years, but the net effect (some energy costs will be reduced at the same time) would then be around ten euros per month per household. In 2015, Fraunhofer IWES also calculated the net cost of the Energiewende up to 2050 and found that the expenses would be less than without a transition in a conservative estimate.

When we take a closer look at the surcharge that covers renewable power in Germany, we find that it does not explain two thirds of the increase in the average retail power rate in Germany over the past decade.

Hidden subsidies

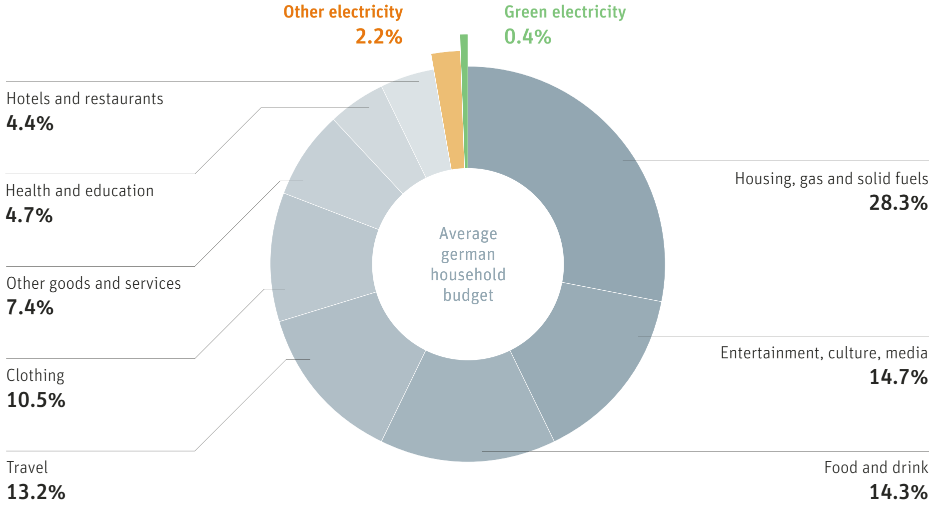
Indeed, it is worth noting that Germany ramped up renewables when they were expensive – and, in doing so, helped make them inexpensive. All along, forecasts indicated that the cost impact of the switch to renewables would peak in the first half of this decade, and now it seems clear that German investments in renewables actually peaked in 2010 and will be more than one third lower annually than that record level over the next few decades.

By investing in renewables so soon, Germany may have incurred high costs, but it also positioned itself as a major provider of future-proof technologies. In other words, as renewables become more competitive, the whole world will start switching over. German investments in PV in particular have made the technology affordable for the world, including developing countries. For example, in 2015, China built 15 gigawatts of PV, reaching 43 gigawatts overall to take the lead globally ahead of Germany. The Chinese also installed more than 30 gigawatts of wind turbines in 2015 alone. India

Green electricity less than one percent of average household budget

Expenses of an average household in Germany at a renewables surcharge of five cents, 2013

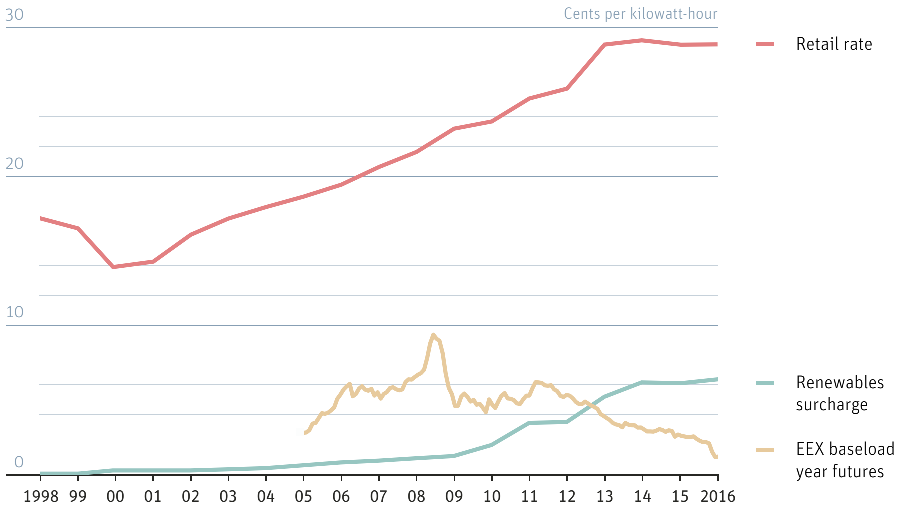
Source: www.unendlich-viel-energie.de



Renewables are not the main driver for high power prices in Germany

Trends of retail rates, spot market price and renewable energy surcharge over past 18 years

Source: www.unendlich-viel-energie.de



also has major plans to build photovoltaics and wind farms. According to Bloomberg Energy Finance, developing and emerging economies now invest more in renewables than OECD countries.

One reason that renewables seem so expensive in Germany is that so much of their full cost is paid immediately as a dedicated item (the EEG surcharge). In contrast, support for coal and nuclear power has largely come indirectly as budget items passed on to taxpayers, and because Germany has a budget deficit these costs are being passed on to future taxpayers with interest (source: Green Budget Germany).

Furthermore, the "cost" of the Energiewende cannot be seen in isolation. The non-monetary costs of energy consumption do not appear on consumers' bills for electricity, gas, and oil. Yet, the environmental impact caused by greenhouse gas emissions and pollution quickly adds up to a considerable amount. A study published by Germany's Energy Ministry in 2015 estimates that some 9 billion euros net was avoided in 2013 because people used renewable electricity and heat. These savings, however, are not separately listed on any invoice. Furthermore, Germany is gradually reducing its dependence on energy imports by investing in renewable energy at home – and by coming up with more efficient products that will also sell well on the global market.

B – How will Germany ensure that the poor can still afford energy?

In general, Germany can protect the poor by providing jobs with livable wages, which is why one of the main goals of the Energiewende is to gear up German industry for future technologies. Furthermore, the cost of electricity has risen more slowly than the cost of motor fuel and heating oil over the past decade, for instance, partly thanks to renewables.

The Energiewende is an answer to unpredictably fluctuating energy prices, not the cause of higher prices over the long run. The price of conventional energy is expected to go in only one direction: up. Since 2000, the cost of hard coal has more than doubled in Germany, while the cost of natural gas has nearly tripled.

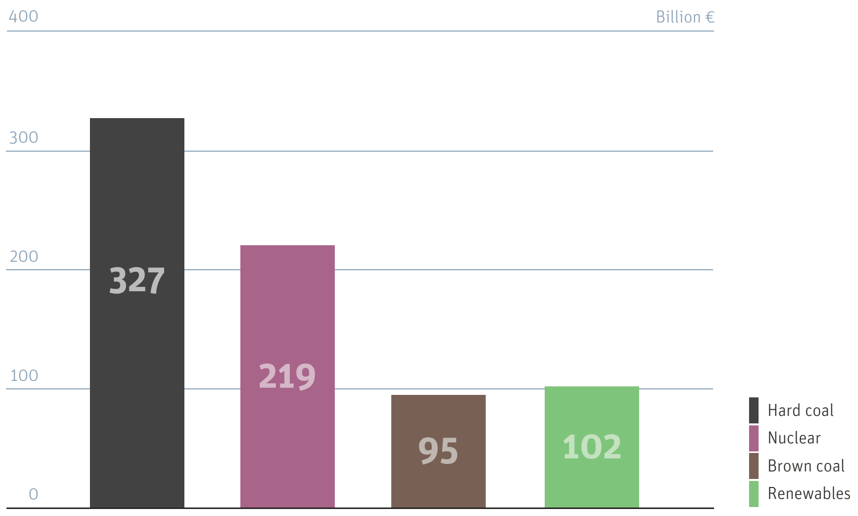
What is more, the price of electricity only increased by three percent in 2013, fairly close to the general inflation rate of two percent in Germany. And in 2014, power prices in Germany remained largely stable – even without inflation adjustments. In 2015, they remained stable in absolute terms – slightly below the price in 2014.

In contrast, the cost of renewable energy is expected to continue to drop or at least level out, depending on the specific technology. The cost of photovoltaics fell by 50 percent from 2010 to 2015, and the US Department of Energy's Transparent Cost Database shows that onshore wind power is already roughly on par with natural gas, coal power, and nuclear. Germany's Fraunhofer Institute for Solar Energy Systems estimates that solar power in the country will cost the same as coal power roughly by the end of this decade – even in cloudy Germany.

Fossil and nuclear have received by far more subsidies than renewables

Energy subsidies in Germany, 1970-2014

Source: Was Strom wirklich kostet, FÖS, 2015



Concern about energy poverty is increasing, although there are no clear definitions on what the term actually means. In recent years, some 330,000 German households have had their power cut off because of outstanding electricity bills, yet power was generally restored within a few days.

Unfortunately, reports on the number of households without electricity rarely compare Germany with other countries. It turns out that Germany performs quite well in this respect; comparisons of "energy poverty" regularly place Germany above the EU average. One reason may be that Germany combats poverty, not just energy poverty; for instance, in 2015, a minimum wage of 8.5 euros was introduced.

Energy audits are already offered to poor households in order to reduce unnecessary energy consumption. At the same time, it should be kept in mind that even low-income homes spend less than ten percent of their income on energy. It is therefore crucial that poverty itself be addressed directly with proper social policy, retirement plans, and wages. Clean power will also help mitigate global warming, which will affect poor countries inordinately. In other words, Germany's commitment to renewables will also help poor countries.

C – When will renewables pay for themselves?

They increasingly do now. The differential cost of renewables is currently peaking, so renewables are expected to help stabilize power prices and avoid high price fluctuations within the decade. Only countries that undergo an energy transition – like Germany – will be able to stabilize their energy prices within the foreseeable future.

In 2014, German research center Fraunhofer IWES published a study, which found that Germany is currently making investments into renewables that will eventually pay for themselves by offsetting conventional energy. The breakeven point is expected to come around 2030, and the net gains will be clearly positive by 2050.

Yet one thing is clear – the Energiewende will not be free. There is a wide array of factors that determine the cost; it is not just renewables and feed-in tariffs. And while the Renewable Energy Sources Act (EEG) of 2014 costs around 24 billion EUR annually, wind power has long been relatively inexpensive, and the cost of solar continues to plummet. Going forward, the cost increases are expected to taper off, and by 2020 the first generation of old systems will no longer be eligible for feed-in tariffs. By 2030, large amounts of solar arrays will also no longer be eligible for the 20-year relatively high feed-in tariffs, but they will remain in operation, so Germany will begin to have free legacy solar power. During the interim, the goal must be to keep costs in check even as we further growth enewables is ensured.

The forecast increase in the retail rate in Germany is not unusual. In July 2012, French energy regulator CRE announced that the retail rate in France is expected to rise by nearly 50 percent by 2020 due not only to the greater deployment of renewables, but also to the rising cost of nuclear.

At the end of 2013, CRE announced a 5 percent rate increase with annual price hikes in the coming years as well. The forecasts for Germany are relatively stable retail rates of the next few years.

D – Is the energy payback from wind and solar ever positive?

A common question not only among laypeople but, surprisingly, even among experts occasionally is whether solar arrays and wind turbines ever produce more energy than was consumed for their production and installation. The answer is easy: the payback has been overwhelmingly positive for decades.

The German solar research institute Fraunhofer (PDF) put the payback time at "around 2.5 years" for PV arrays in northern Europe, and that figure even drops to 1.5 years and less in sunnier locations. Keep in mind that solar panels sold over the past few years have had performance guarantees of around 80 percent for 25 years, meaning that, a 2.0 kilowatt array is guaranteed to still be able to peak at 1.6 kilowatts after 25 years of operation.

Clearly, the energy payback of PV is tremendous – the energy you get back is an order of magnitude greater than what you put in.

The payback time for wind turbines is even better; it is counted in months, not years. As a British newspaper The Guardian put it, "The average wind farm produces 20-25 times more energy during its operational life that was used to construct and install its turbines."

With coal, efficiency always represents a loss, whereas it is always a gain with solar; the coal that is consumed is gone for good, so at 33 percent efficiency, two thirds is lost. Had it not been used, it would still be in the ground.

In contrast, the planet gets a certain amount of solar every day. If a solar panel is 16 percent efficient, around 5/6 of the sun's energy is lost, but if a roof does not have solar, all of that energy is lost. The 16 percent efficiency rating is a gain. The planet roughly receives the same amount of solar energy every day, but yesterday's solar energy will be gone forever if not harvested.

In other words: coal, use it and lose it; solar, use it or lose it.

E – Why are low-carbon goals not enough in themselves?

Germany wants to fight climate change and reduce the risks of nuclear power at the same time. Nuclear power is rejected because of the risks, the costs and the unsolved waste issue. In addition, there is no economic case for it to play a major role in the world's energy supply.

Germany aims to combat climate change, phase out nuclear power, and switch to a reliable, affordable, clean energy supply. Climate targets and emissions trading contribute to some, but not all of these goals, which is why the German government is pursuing a comprehensive, long-term climate and energy strategy with policies addressing different sectors and technologies.

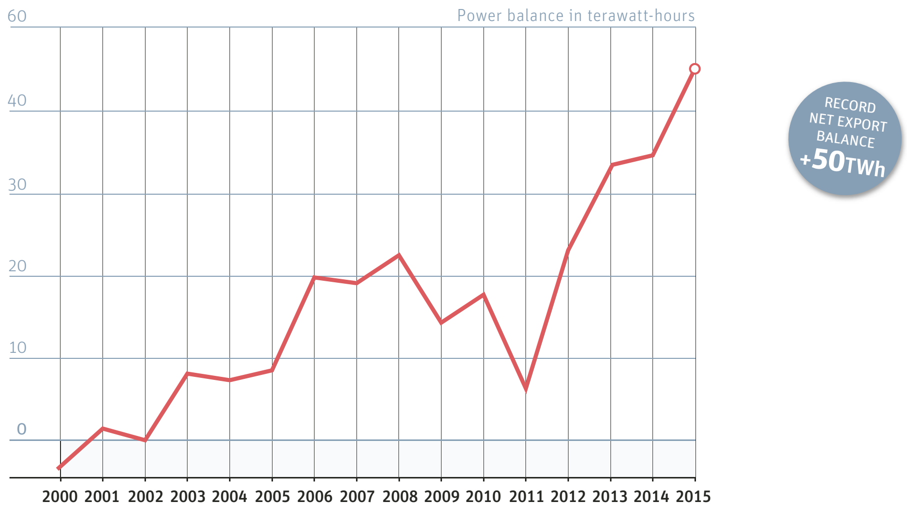
Emissions trading is an important tool, but it will not lead to the goal that Germans want. For instance, cost is the main mechanism in emissions trading, so actions are prioritized according to their cost benefits, with the intended result being that the project that costs the least is the one done next. The unintended outcome is that nothing worth doing gets done unless some investor considers it to be the cheapest option. In the case of renewables, onshore wind power practically always beats out all other competitors, making emissions trading a particularly bad way of ramping up all types of renewables.

For Germans, the goal is to reduce energy consumption to a level that can be provided by renewables even as we ensure ever higher material standards of living. While questions like "When is solar going to be competitive with coal or nuclear?" are popular, solar or wind or any other single source of renewable energy cannot replace conventional power on its own – only a mix of renewables can. And since emissions trading promotes only the cheapest option, it cannot produce that mix, so it is not sufficient for the German goals. Policy-makers in the country are convinced that they need policies that gradually increase efficiency with today's technologies (which emissions trading does) as well as policies that drive innovation for technologies that are initially more expensive, but become competitive in time (which German feed-in tariffs do).

German power exports continue to rise

Net power exports in TWh, 2000-2015

Source: Agora Energiewende, AGEB



F – Will Germany import more power from abroad after the nuclear phase-out?

Germany has been a net exporter of power for years and remained so in 2011, even after shutting down eight nuclear power plants within a week. In 2012, the country even returned to a record level of power exports, including to France.

In 2015, new record levels were set at present, renewables are growing so quickly that coal plants are being squeezed out, resulting in relatively low wholesale prices that make power exports attractive.

Overall, Germany has generating capacity far exceeding power demand. Even after those nuclear plants were switched off in March 2011, Germany still had around 100,000 megawatts of conventional generating capacity online, compared to only 80,000 megawatts of maximum power demand for the year.

At the beginning of 2011, Germany had a dispatchable (i.e., not including solar and wind) power generating capacity of 93,100 megawatts, and roughly 8,000 megawatts of that was switched off last March. According to the German Association of Energy and Water Industries (BDEW), Germany exported 90,000 megawatt-hours net per day on average in the six weeks leading up to the moratorium on nuclear in mid-March 2011, whereas starting on March 17, 2011, the country began importing an average of 50,000 megawatt-hours net per day.

To the east, more power might be imported from the Czech Republic, but not because of any electricity shortage in Germany. Rather, the German power market buys conventional electricity where it is cheapest. Countries like Poland and the Czech Republic are not complaining about having to prop up the German grid after the nuclear moratorium. On the contrary, they are mainly concerned about wind and solar power surges from Germany offsetting their own production of fossil and nuclear power.

G – Did Germany overreact to Fukushima?

A few pro-nuclear countries did not fundamentally change their stance on nuclear after Fukushima, but Germany was actually in the majority. And its nuclear phase-out dates back to 2000, so the decision in 2011 represents a sudden change in Chancellor Merkel's position, not a fundamental change in general German opinion.

Germany's nuclear phase-out has been a long time in the making, but the government's decision to shut down eight nuclear plants in the week after the accident in Fukushima still came as a surprise. Overall, however, Germany has a strong political consensus in favor of phasing out nuclear. Since the first nuclear phase-out of 2000, the political discussion in Germany has not been about whether, but about how quickly the phase-out should proceed.

While some countries – such as the US, France, and Russia – did not fundamentally change their policy on nuclear in response to Fukushima, Chancellor Merkel's coalition did an abrupt about-face. In contrast, public sentiment did not change much; the general public in Germany was overwhelmingly in support of Chancellor Schroeder's nuclear phase-out from 2000, with 65 percent of those surveyed stating that they were in favor of it in April 2010 – at a time when newly reelected Chancellor Merkel had indicated she planned to roll back Schroeder's phase-out.

In the wake of the accident at Fukushima, German support for a nuclear phase-out "only" increased by six percentage points to 71 percent, not a great difference; in comparison, a poll taken in the United States nearly a year after Fukushima found that 41 percent of US adults thought the risks of nuclear outweighed its benefits, compared to 37 percent a year earlier – an increase of around ten percent in both cases.

But while the German public can hardly be accused of panicking, Chancellor Merkel certainly did. Had she merely continued the previous nuclear phase-out and decided to speed things up, the effects might not have been so detrimental, but she essentially reversed German energy policy twice within a single year. Two main factors were probably behind Merkel's sudden change of heart in 2011: upcoming elections in the German state of Baden-Württemberg, which Merkel's party lost, and strong anti-nuclear protests in the wake of Fukushima.

Countries against nuclear

Nor did Germany react more strongly than most other countries. To the north, Denmark already had a goal of 100 percent renewable energy by 2050 when Fukushima happened. To the south, Italy – the world's seventh largest economy – had voted to be nuclear-free in a referendum in 1987, and when then-President Berlusconi attempted to change that policy in June 2011, the Italians managed to successfully conduct a referendum for the first time since 1995 by getting a majority of eligible voters to turn out. Of those who voted, more than 94 percent rejected Berlusconi's nuclear plans, and the event was a major reason for his political defeat a few months later.

In between Italy and Germany, Switzerland took modest steps to ensure that the country would be nuclear-free by 2034, and in 2012, Austria – which had resolved to remain nuclear-free way back in 1978 – went a step further by requiring its utilities to certify that they are not purchasing any nuclear power from abroad starting in 2015.

For a while, Belgium was repeatedly in the news for not having a government, but when it finally got one again, one of the first decisions made in October 2011 was to launch a nuclear phase-out starting in 2015. Germany is not alone in its nuclear position; it stands in the middle of a larger resistance movement.

H – Are renewables not a relatively expensive way to lower carbon emissions?

If you want to compare apples and oranges, yes. It is often claimed, for instance, that insulation is a much cheaper way. But even if we insulate our homes better, we still have to decide how we are going to make electricity.

But although renewables have been expensive in the past, they are increasingly becoming the cheapest option. New renewables are now much cheaper than building a new nuclear plant, and all estimates going forward are that renewables will be the least expensive source of low-carbon electricity in Germany within this decade. These prices are for new plants, not decades-old central power stations that have already been completely written down.

I – Will the nuclear phase-out not increase Germany's carbon emissions?

It didn't in 2011, when the nuclear phase-out was put into law and carbon emissions went down even further. And going forward, carbon emissions from the power sector can only go down, not up, because of the ceiling imposed by emissions trading.

Germany overshot its already ambitious Kyoto target for 2012, achieving a 24.7 percent reduction in 2012 – with the goal being just 21 percent by 2012. The country is also on track to reach its 2020 target of a 40 percent reduction. In 2014, emissions fell by 5.5 percent compared with 2013 due to a mild winter as well as increased energy efficiency measures and a growing share in renewable energies. However, resent estimates suggest that Germany is not on track of reaching its 2020 goal of a 40 percent reduction compared with 1990 levels. In 2015, the reduction reached 27 percent. To close this gap, the German government implemented a Climate Action Plan in late 2014. The Paris climate agreement should also occasion more ambitious policies, though none have been formulated yet.

The nuclear phase-out is embedded in a comprehensive, long-term climate strategy following the IPCC's (the UN's International Panel on Climate Change) recommendations to reduce emissions by at least 80 percent by 2050. Scenario studies for the German power plant portfolio show that carbon emissions from electricity production will not rise, but, in fact, fall significantly.

J – Would nuclear power not be an inexpensive way to reduce carbon emissions?

Nuclear is not bankable. No nuclear plant is currently being built in any free market without massive state support. Nuclear is currently considered an inexpensive source of power for two reasons: first, all of the currently operating plants in the West were built long ago and have been written down – the longer they stay in operation, the more profitable they become; and second, we do not pay to complete cost of nuclear power in our power bills. Some of the costs are passed on to taxpayers and future generations.

Nuclear is not bankable. No nuclear plant is currently being built in any free market without massive state support.

In the UK, French nuclear plant operator EDF is asking for a guaranteed 10 percent return on its investments over a 35-year time frame. Specifically, EDF is asking for nearly 10 pence per kilowatt-hour. In either case, this nuclear power would be far more expensive than onshore wind power currently is – and even more expensive than power from newly installed large ground-mounted arrays. For decades from now, this nuclear power will still cost more because it is indexed to inflation, whereas new solar and wind will become even less expensive.

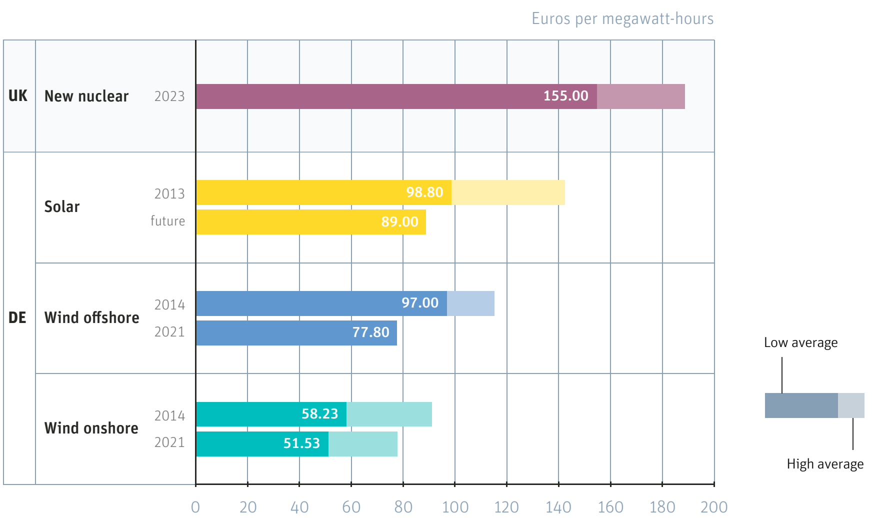
In the US, Wall Street has turned its back on financing risky nuclear power. Only the massive subsidy of 8.33 billion dollars in conditional federal loan guarantees keeps Southern Company's dream of building two additional reactors at Plant Vogtle in Georgia alive. Vogtle, however, has a history that should trouble taxpayers. The original two reactors at the Georgia site took almost 15 years to build, came in 1,200 percent over budget, and resulted in the largest rate hike at the time in Georgia.

Decades-old nuclear plants (built with heavy subsidies and governmental support) do indeed produce quite inexpensive power, but all estimates are that the cost of building a nuclear plant today without heavy subsidies would be prohibitive. The only plants currently under construction in the EU (in France and Finland) are both behind schedule and far over budget.

Price of new nuclear already higher than solar and wind

FITs for current and future solar and wind in Germany with strike price for nuclear at Hinkley

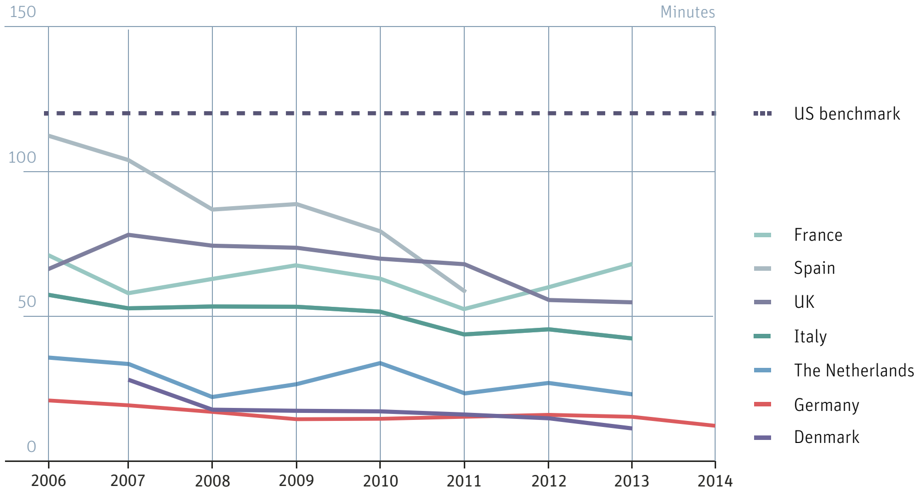
Source: Thomas Gerke, DECC, Agora Energiewende



Grid reliability and growth in renewables go hand in hand

Minutes of power outages per year (excl. exceptional events), based on Saidi

Source: CEER and own calculations



K – Will the lights go out?

Germany has had the most reliable grid in Europe since standardized statistics started being tallied in 2006, and the German grid reached a new record reliability in 2015. That level – around 12 minutes of power outages per year – has remained stable since then. Furthermore, other countries that are going renewable, such as Spain and Italy, have also seen grid reliability improve as they ramp up renewables.

Within Europe, Germany (along with Denmark) has one of the most reliable power supply. in Europe every year from 2006 to Germans have enough capacity for their households, their energy-intensive factories and industry, and their high-speed trains.

Germany has had one of the most reliable power supply in Europe every year from 2006 to today, outperformed only by Luxembourg, Denmark and Switzerland.

Power outages are always possible, of course, but a systematic shortfall in power supply will only come about if investments in dispatchable power are not sufficient to replace aging conventional plants scheduled for decommissioning. Technically, the solutions are there: a combination of national and regional cross-border grid extension and optimization, a power plant mix combining a variety of renewables, flexible backup capacity, a strategic reserve of power plants, demand management, and, ultimately, storage. The challenge is more financial. For the future, the power sector is calling for capacity payments to ensure that enough backup generating capacity remains in service.

2015 that turned out to be the fourth record year in a row for power exports for Germany. The Netherlands were the biggest net importer of German electricity,, but exports also went to nuclear France.

L – Will the *Energiewende* kill jobs?

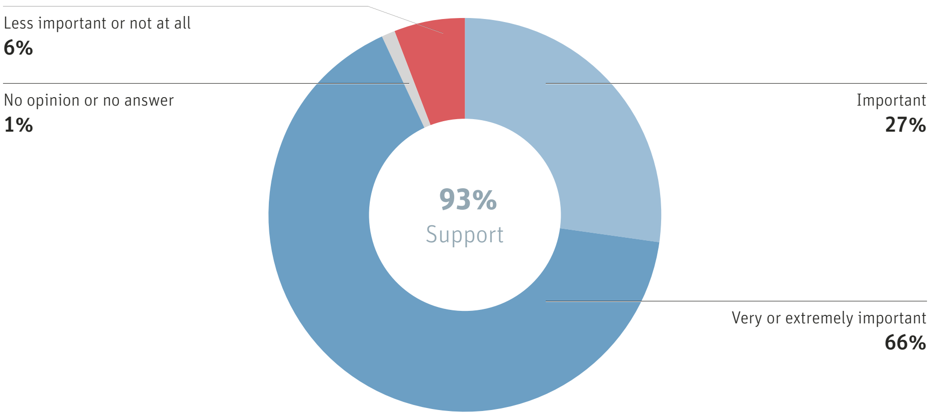
Per megawatt-hour generated, renewables create more jobs than the fossil and nuclear sectors, and most of those jobs occur at home, not abroad. Germany already has twice as many people employed in the renewables sector than in all other energy sectors combined.

The transition to renewable energy is a job engine. An estimated 350,000 jobs had been created in the renewables sector in Germany by 2015, far more than the 182,000 people working in all of the country's other energy sectors combined. Simply put, renewables and efficiency replace oil and uranium imports with local added value, keep jobs in Germany, and have a net job creation effect.

93 percent of Germans support further growth of renewables

"The use and growth of renewable energy is …", survey from October 2014

Source: VZBZ



M – Do Germans support the *Energiewende*?

Yes, and they have done so for much longer than the German government has.

In August 2015, a survey found that 93 percent of the German public said the Energiewende was important or very important to the country's development.

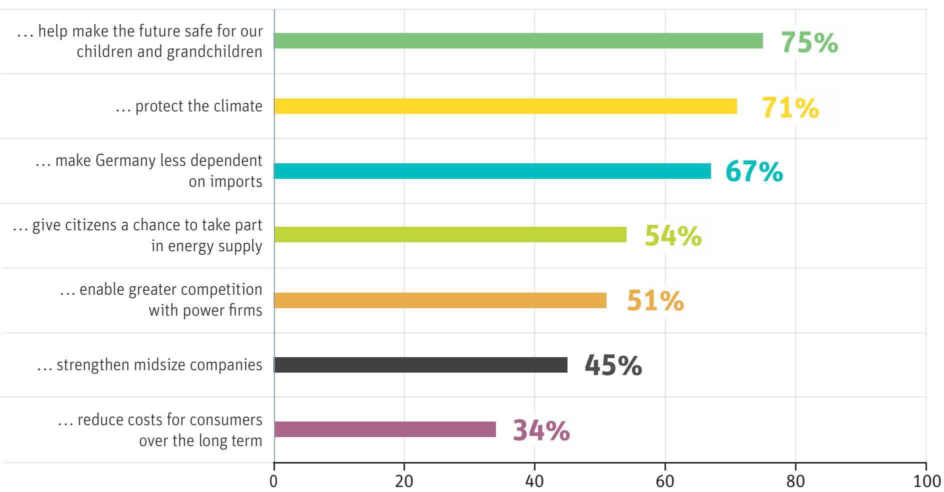
Most of the Germans surveyed (68 percent) said they would like to live near a renewable energy facility. Among those who already had such a facility nearby, the highest number was 86 percent for solar, followed by 72 percent for wind turbines. Only 53 percent would like to live near a biogas unit. The numbers were lower for people who did not yet have direct exposure, suggesting that the concerns are assuaged with direct experience.

In contrast, only 16 percent would like to live near a nuclear plant, followed by 22 percent for coal and 40 percent for gas turbines.

The benefits of renewable energy: future technologies for climate protection

"Do you agree renewables …" (multiple answers possible)

Source: TNS Emnid survey conducted for the AEE, 1015 participants – October 2014



N – How can Germany be both a green leader and remain an industrial powerhouse?

Renewables are lowering the wholesale power rate, which firms pay, and energy-intensive firms are largely exempt from the surcharge for renewable power. Energy-intensive industries therefore benefit from the cheaper electricity that renewable energy provides.

Industrial firms are increasingly generating their own renewable energy. For instance, BMW has four wind turbines installed at its production site in Leipzig, where it builds its i3 electric car. Other companies are putting solar on the roof of their buildings to offset compensation of more expensive power from the grid.

Companies that buy wholesale power are also benefiting from lower prices as those prices drop. Wind and solar are growing faster than nuclear and coal are being decommissioned, so these conventional power plants are running at lower capacity. Power plants that are more expensive also run less, resulting in lower wholesale prices.

Heavy industry also benefits from renewables in a number of other ways. Technologies like wind, solar, biogas, and geothermal power provide economic opportunities for traditional industries. For instance, wind turbine manufacturers are now the second largest purchaser of steel behind the automotive sector. A number of struggling ports in Germany are also positioning themselves for the offshore wind sector. The solar sector will support industries ranging from glass to ceramics, and farming communities will benefit not only from biomass, but also from wind and solar. The copper and aluminium sector is also poised to benefit from the switch to renewables. Thus, switching to renewable energy does not only result in developing new industries like solar manufacturing. These technologies also provide opportunities for traditional industries to become part of the transition to a renewable energy future.

Overall, Germans believe that high-tech green technologies are an industry for the future and see no contradiction between ecology and economics.

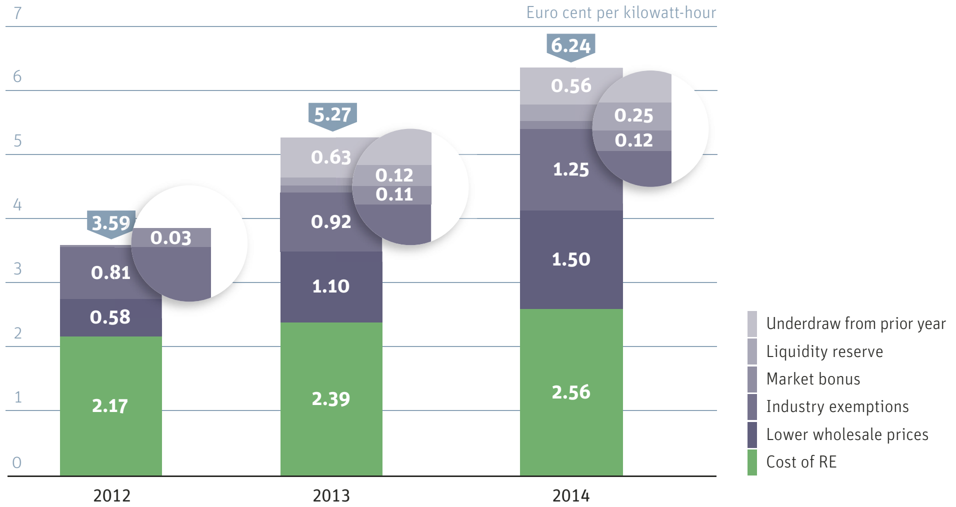
O – How are energy-intensive companies exempted from the surcharge for renewable power?

In 2003, three years after the 2000 EEG was adopted, the German government agreed that energy-intensive industry that faces international competition should be exempted from the surcharge to cover the cost of renewable power. The goal was to ensure that such firms do not "go offshore." But over the past years, the German government has unnecessarily expanded those exemptions to cover firms that do not face international competition, thereby unfairly concentrating the cost burden on consumers and small and medium sized companies.

Renewables are not the main reason for rising surcharge

Calculation of renewable energy surcharge in Germany. 2012–2014

Source: BEE



Energy-intensive industry is widely exempt from the surcharge to promote renewables. While almost everyone basically paid 6.4 extra cents per kilowatt-hour in 2015, energy-intensive firms only paid the full surcharge on the first gigawatt-hour of what they consume if their power costs make up more than 14 percent of their total production costs. Above that, energy-intensive industry pays a fraction of the surcharge of 0.05 cents for all electricity consumed above 100 gigawatt-hours per year.

In 2015, the exempt industrial firms consumed 18 percent of German power supply but only covered 0.3 percent of the total surcharge for renewable electricity. The government has increased the number of industrial firms exempted from the surcharge from less than 600 to more than 2,300. Critics point out that many of these firms do not face international competition (such as municipal public transportation providers) and therefore should not be exempt.

Overall, energy makes up a relatively small part of production costs in Germany's processing industry.

P – What role will shale gas play in the German *Energiewende*?

International onlookers sometimes wonder when shale gas will get going in Germany. Americans in particular think, based on their own shale boom, that the Germans could reduce their carbon emissions and lower their energy prices with shale gas. The situation looks much different within Germany.

Germany is currently investigating the option of shale gas production. At present, a few projects are underway, but drilling is only allowed if the shale gas to be recovered is at least three kilometers deep (in order to protect groundwater). Depending on the outcome, shale gas production might be allowed, but no decision is expected until the end of this decade. Moreover, numerous parties in Germany – such as beer brewers, who are concerned about the purity of their groundwater – oppose fracking.

In Europe, shale gas is unpopular. France has already put a moratorium on it. The German government believes that shale gas production can proceed "as soon as environmental concerns are assuaged" – which could be a diplomatic way of saying "never."

German shale gas reserves are estimated to be large enough to cover 13 years of the country's gas supply. Of course, the country would not shut down all imports of gas for 13 years, nor would it make sense to do so. Rather, domestic reserves would be stretched across decades, offsetting imports in the process.

During that time, we would run the risk of contaminating ground water and the environment. In the US, dozens of families have been affected by individual wells. Because Germany is so much more densely populated, thousands could be affected in single cases. Germans therefore wonder why they should take the risk just for 13 equivalent years of slightly more energy independence.

One reason could be lower prices. In the US, gas prices dropped, but only in parts of the country; the US does not have not a contiguous gas network. Germany, in contrast, is part of a gas network connecting Russia to the Netherlands; northern Africa is connected to Mediterranean Europe. If shale gas were made available, it could be sold to the highest bidder through a large network of buyers, so prices would not drop.

Indeed, gas prices are currently pegged to oil prices in Germany, so gas prices alone cannot fall independent of oil. But even if this pegging were done away with, gas prices would not fall because the gas could be sold on such as large market; Germans would just be taking risks with their environment so that gas companies could post greater profits.

A publication by Friends of the Earth found that the potential of shale gas may also be overstated:

- the five biggest gas wells in the US declined by 63% to 80% in the first year
- industry has downgraded its reserves several-fold in recent years
- firms such as BP, BHP Billiton and Chesapeake reduced the value of their shale gas assets accordingly by billions of dollars

In Europe in particular, FOE sees the aforementioned combination of population density and water scarcity as a general problem. Furthermore, a study conducted by the German development bank KfW found that the US industrial sector overall had not become more competitive than the German industrial sector during the shale boom largely because energy prices make up such a small share of total costs (two percent). However, this situation is different for a small number of firms that specifically consumer large amounts of natural gas.

Finally, low fossil fuel prices are not a goal of the Energiewende; keeping carbon in the ground is. As laudable as the efforts are to curb carbon emissions by switching from coal to shale gas, in the end we just take more carbon from the ground when we extract shale gas. What the world needs is an energy alternative that allows us to leave both fossil reserves in the ground. Germany is working on the most promising alternative now: renewables in combination with efficiency.

Q – Why did carbon emissions increase in 2013, fall in 2014 and rise again in 2015?

In 2013, carbon emissions in Germany rose by around one percent, then fell by almost five percent, before rising again by 0.7 percent in 2015.

In 2015, record-high power exports and slightly colder weather led to greater carbon emissions, according to the German Environmental Agency. Carbon emissions were up by 0.7 percent year over year but have fallen by 27.2 percent since 1990.

According to the AGEB, the working group consisting of utility and finance experts that collate energy data for the country, the cold first half of 2013 was the main factor that year. Here, demand for heating energy was up, 80 percent of which is fossil fuel.

To address the heat and transport sectors, which make up roughly four-fifth of German power consumption, the German Energiewende would have to truly become an "energy" transition, not just an electricity transition. Only then can German carbon emissions from energy consumption truly be addressed. While most attention continues to be paid to coal power, Germany actually emits more carbon from oil consumption.

In the heat sector, there has been a gradual shift from heating oil and coal to natural gas, which has lower specific carbon emissions, but in the power sector, natural gas is more expensive in Germany as a source of electricity, where coal is still less expensive. A European-wide carbon price from emissions trading was to facilitate the transition from emissions-heavy coal power to more environmentally friendly natural gas, but the carbon price has remained far too low.

The mild weather in 2014 reduced demand for fossil fuel in the heat sector. In combination with 2 percent more renewable electricity as well as significantly reduced electricity consumption that year, carbon emissions decreased.

Within the power sector, the increase in coal power production is mainly due to the record level of power exports, especially to the Netherlands. In 2013, German electricity exports to other countries rose at the same level as coal power production, which renewable electricity – which has a priority on the grid – would otherwise have offset. Coal plants are generally inflexible and cannot ramp up and down quickly to meet demand, so they prefer to sell power at very low cost. Likewise, the low carbon price in Europe means that coal power remains economically competitive. The solution here would be a much higher carbon price.

R – Is Germany undergoing a coal renaissance?

In 2016, only one new coal plant was in the pipeline of being built. The plants built in the past few years were planned starting in the first phase of emissions trading, which failed to provide a shift from coal power to power from natural gas. But increasingly, renewables are offsetting demand, so this additional capacity is likely to be unprofitable. In 2014, electricity production from hard coal and lignite went down by more than 6 percent. The firms are now scrambling to shut down capacity. Since Fukushima, not a single coal plant has been added to utility plans.

One of the main concerns about Germany's energy transition is the role of coal power. In 2015, talk about a possible coal phase-out shifted into high gear. Because the coal sector employs so many miners, far more jobs are at stake than in the nuclear sector – one reason for why a nuclear phase-out was politically easier. But increasingly, labor union leaders accept the inevitability of a coal phase-out and now wish to focus not on preventing it, but on shaping it. Negotiations therefore concern the decade in which the last coal mine and coal plant will be shut down and how workers and their communities can benefit from this transition.

The recent reports of new coal plants going online have also drawn a lot of attention. As Germany phases out its nuclear plants up to 2022, more space will indeed be created on the power grid for coal plants, which would otherwise be squeezed out by renewables. At present, renewable electricity primarily offsets power from natural gas, which is currently more expensive than coal power. Natural gas combustion emits only about half as much CO2 as the burning of coal. Though it would be better for the climate, a switch from coal power to natural gas will be a tough sell politically. Germany imports almost all of its gas, 40% of it from Russia, and is the world's largest brown coal producer. An estimated 35,000 jobs could be at stake in the Garzweiler region, less than a tenth of the jobs in the renewables sector.

Depending on how quickly renewables grow in power supply, however, new plants may increasingly run for fewer hours per year. A study published in 2013 for the British government found that the "apparent surge" in new coal plant construction in Germany was the result of a favorable market environment in 2007/2008 and concludes that "there will be no major new unabated coal or date night projects in Germany for the foreseeable future beyond those currently under construction."

Indeed, since the nuclear phase-out of 2011, plans to build new coal plants in Germany are down. In democracies, coal plants are not built in a couple of years, so the ones that went online in 2012 and 2013 were not a result of energy transition.

A chart (PDF in German) published by German environmental NGO Deutsche Umwelthilfe in 2013 shows that, as a reaction to the nuclear phase-out, Germany has not started building any coal plants and has even stepped away from six.

During the nuclear phase-out, renewable enlectricity is likely to fill the gap left binding by nuclear power. However, the growth of renewables will probably only slightly outstrip the nuclear decline so that coal power will remain relatively strong, especially lignite. In contrast, electricity from hard coal is expected to decline. In 2015, the German government announced plans to reduce emissions from lignite. If these plans become law, power from lignite could indeed drop during the nuclear phase-out.

Whatever the case, the coal phase-out begins with or without an official announcement after the nuclear phase-out is completed at the end of 2022 – simply because there will be nothing left for renewables to offset in Germany's power supply.

S – How much electricity storage will Germany need?

In 2015, Germany demonstrated that it could get 20 percent of its power from wind turbines (13 percent) and photovoltaics (7 percent) without any additional power storage. The amount of storage needed is not, however, relative to renewable power alone, but rather to the share of intermittent wind and solar in combination with an inflexible baseload. In general, power storage is not expected to become a major issue until the end of this decade.

In the short term, Germany will not need much storage. Based on statistics for actual power generation from the first half of 2012, energy expert Bernard Chabot has estimated that a combined future output of 46 gigawatts of wind and 52 gigawatts of PV (the current targets) would generally not peak above 55 gigawatts, meaning that this level of generating capacity – which Germany is only a few years away from – would not require a lot of power to be stored because almost all of the electricity generated could be consumed.

In 2013, researchers at Fraunhofer ISE found that Germany could still consume 99 percent of its fluctuating wind and solar power without storage if around 62 gigawatts of wind and just over 75 gigawatts of solar were installed – along with the current 20 gigawatts of must-run capacity. Here, "must-run" indicates the level that Germany's conventional fleet cannot drop below. But if the must-run level is reduced to 5 gigawatts, then Germany could have nearly 100 gigawatts of wind power and around 120 gigawatts of solar installed and still managed to consume 99 percent of this electricity without storage.

At power consumption levels ranging from 40-80 gigawatts, Germany will therefore still need nearly a full 80 gigawatts of dispatchable capacity even if these goals are met. The problem is that an increasing amount of this dispatchable capacity will be idled almost all the time, making such systems unprofitable. One solution proposed is capacity payments and the creation of a strategic reserve – but it is unclear what policy will be implemented and what the details will be. In 2015, the German government rejected the idea of a capacity market.

In addition, a number of flexibility options are developed, ranging from demand side management in energy-intensive companies, flexible biogas plants, smart customer solutions to new, innovative power-to-heat options, which use surplus wind and solar electricity to feed district heating systems. These flexibility options will create a new market of energy service companies.

T – How can the cost of Germany's *Energiewende* be lowered?

A number of steps have to be taken to ensure that the cost of renewable electricity is equally spread across power consumers, and the benefits of distributed power have to be utilized. Overall, Germany needs to start focusing on the cost impact of individual actions on the overall power supply.

A number of decisions have made Germany's *Energiewende* unnecessarily expensive; some solutions are on the drawing board.

At present, Germany pays up to 19 cents per KWh for electricity from offshore wind farms, the highest feed-in tariff of all. However, this sector will probably also switch to auctions soon, which could produce lower prices. On the other hand, the target for offshore wind remains, thereby requiring grid expansions, which are also very expensive. Unfortunately, no study has been published comparing the current plans of more distributed renewables and less grid expansion.

Feed-in tariffs have become unnecessarily expensive with the "market bonus," which is estimated to have cost an additional 530 million euros in January 2013 without having increased renewable power production. Unfortunately, the market bonus is still included in the 2014 amendments to the Renewable Energy Sources Act (EEG).

The German electricity market also needs to be redesigned so that lower wholesale prices brought about by renewable power are passed on to consumers. Furthermore, German industry needs to pay its fair share in the switch to renewables; it already benefits from lower wholesale prices, so the exemption from the surcharge for renewables is a second benefit – and industries that do not face international competition do not need to be exempt.

U – Why is Germany switching from feed-in tariffs to auctions?

In 2014, the European Commission called for a harmonization of renewable energy policy among member states in its guidelines on state aid for environmental protection and energy. Specifically, countries are to switch to auctions unless there is a detrimental impact on the national market.

German government officials have mainly argued that the policy switch is needed because the first phase (up to 25 percent renewable electricity) of the Energiewende focused on the fast build-up of renewables, whereas the second phase (up to 50 percent renewable electricity) requires a more coordinated approach. In reality, no studies have been conducted to investigate whether feed-in tariffs or auctions are better at the point that Germany has reached.

With this change, renewable electricity targets can no longer be exceeded. The volume tendered may not necessarily be built if winning bids turn out to be based on unprofitably low prices by the time construction begins; in that case, the target is not met. But firms will not build more than a standard because there is no business case then – i.e. no buyer.

By switching to auctions, German policy makers also take themselves out of the firing line. For many years, a bitter dispute was waged over the growth of PV in Germany, for instance. While the government originally aimed to only have one gigawatt built annually, the average in 2010-2012 was 7.5 gigawatts. During these years, solar rates were also excessively high because the price of PV plummeted faster than anyone had expected. Under feed-in tariffs, a wrong price was the fault of the government. If auctions fail – either to bring down the price or to build the full volume – the outcome will be considered market failure. It is not difficult to understand why policy makers would prefer the latter.

Key Findings

German *Energiewende* – Arguments for a renewable energy future

1. The German *Energiewende* is an ambitious, but feasible undertaking.

A lot of people outside Germany, including environmentalists, are skeptical. But even the skeptics like Germany's goal of demonstrating that a thriving industrial economy can switch from nuclear and fossil energy to renewables and efficiency. The German can-do attitude is based on the experience over the last two decades, when renewables matured much more quickly, become more reliable and much cheaper than expected. The share of renewable electricity in Germany rose from 6 percent to nearly 25 percent in only ten years. On sunny and windy days, solar panels and wind turbines now increasingly supply up to half the country's electricity demand, which no one expected just a few years ago. Recent estimates suggest that Germany will once again surpass its renewable electricity target and have more than 40 percent of its power from renewables by 2020. Furthermore, many German research institutes and the government and its agencies have run the numbers and developed sound scenarios for a renewable economy.

2. The German energy transition is driven by citizens and communities.

Germans want clean energy, and a lot of them want to produce it themselves. The Renewable Energy Act guarantees priority grid access to all electricity generated from renewables and is designed to produce reasonable profits. By 2013, nearly half of investments in renewables had been made by small investors. Large corporations, on the other hand, are only now beginning to invest. The switch to renewables has greatly strengthened small and midsize businesses, and it has empowered local communities and their citizens to generate their own renewable energy. Across Germany, a rural energy revolution is underway. Communities are benefiting from new jobs and increasing tax revenues, which has become even more important after the debt crisis in the euro zone.

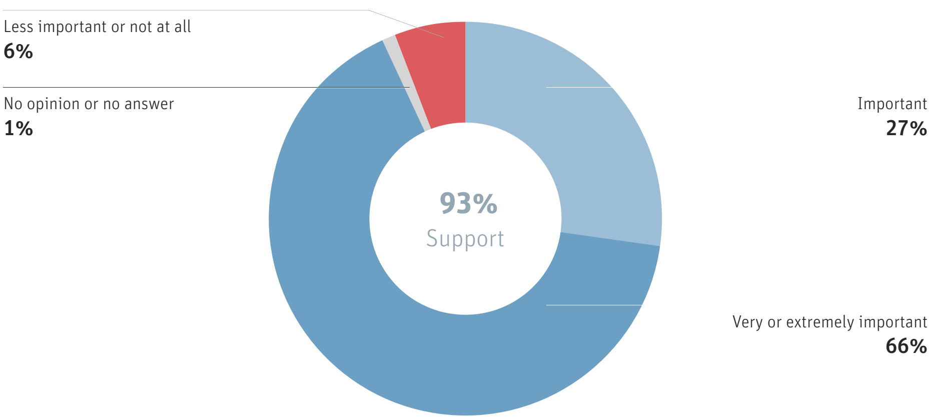
3. The *Energiewende* is Germany's largest post-war infrastructure project. It strengthens its economy and creates new jobs.

The economic benefits of the transition already today outweigh the additional cost over "business as usual". The switch to a highly efficient renewable energy economy will require large-scale investments of up to 200 billion euros. Renewables only seem to cost more than conventional energy, but they are getting cheaper, while conventional energy is getting more expensive; furthermore, fossil fuel remains highly subsidized, and the price of fossil fuel does not include environmental impacts. By replacing en-

93 percent of Germans support further growth of renewables

"The use and growth of renewable energy is …", survey from October 2014

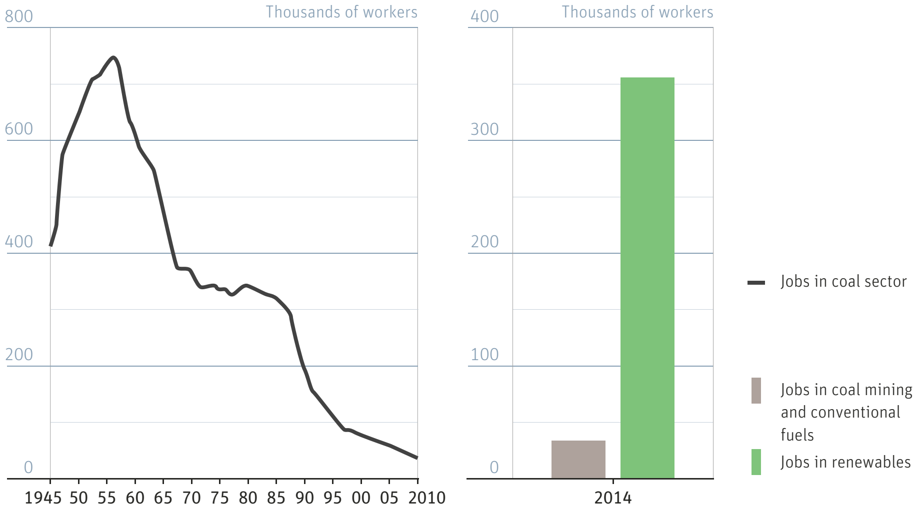
Source: VZBZ



Renewables create more jobs than coal power does

Employment in Germany in renewable and conventional energy sectors

Source: DLR, DIW, GRS, Kohlenstatistik.de. Renewables data from 2014.



These figures represent "gross job creation," meaning the absolute number of jobs that have been added. A thorough study of the German market estimates a net job creation of around 80,000, rising to 100,000 – 150,000 in the period from 2020 to 2030. One reason why renewables have such a tremendous positive impact on net job creation is that renewable power directly offsets power from nuclear plants, and very few people work in those sectors.

ergy imports with renewables, Germany's trade balance will improve and its energy security will strengthen. Already, more than 350,000 Germans work in the renewables sector – far more than in the conventional energy sector. Unemployment has reached an all-time low since reunification in 1990. While some of these are manufacturing jobs, many others are in installing and maintenance. These jobs for technicians, installers, and architects have been created locally and can't be outsourced. They already have helped Germany to come through the economic and financial crisis much better than other countries.

4. With the *Energiewende*, Germany aims to not only keep its industrial base, but make it fit for a greener future.

German climate and energy policies are designed to maintain a strong manufacturing base at home. On the one hand, industry is encouraged to improve its energy efficiency. On the other, industry benefits from exemptions to regulations (some of them probably too generous) to ease the burden on industry. Contrary to one common misconception, renewables have turned Germany into an attractive location for energy intensive industries. In 2012, wind and solar energy drove down prices on the wholesale power market by more than 10 percent. From 2010 to 2013, they were down by 32 percent. Futures prices until the end of this decade show a continued downward trend in 2016. Cheaper electricity means lower business expenses. Industries from steel to glass and cement benefit from these low energy prices. But the benefits of the energy transition extend beyond today. The demand for solar panels, wind turbines, biomass and hydro power plants, battery and storage systems, smart grid equipment, and efficiency technologies will continue to rise. Germany wants to gain a first-mover advantage and develop these high-value engineering technologies "Made in Germany". The focus on renewables and energy conservation is part of that forward-looking approach to business investments. When the world switches to renewables, German firms will be well positioned to deliver high quality technology, skills, and services for these markets.

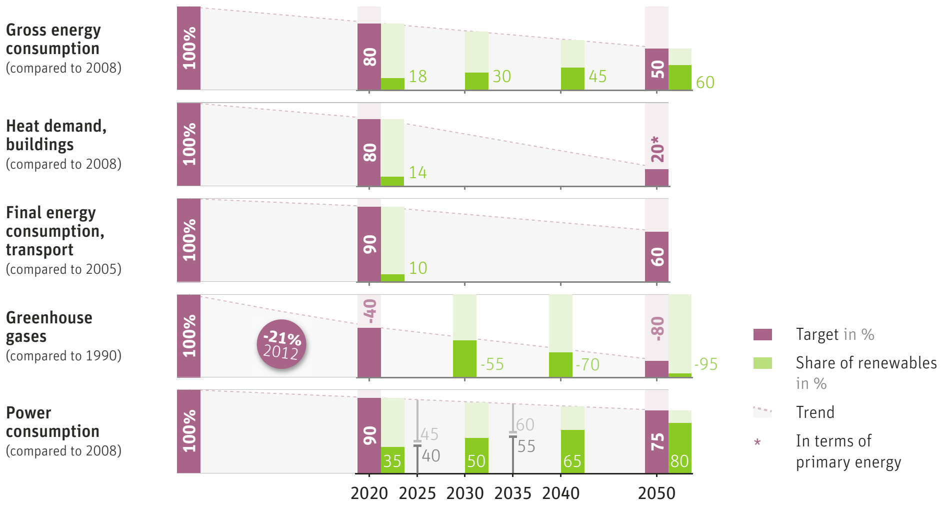
5. Regulation and open markets provide investment certainty and allow small business to compete with large corporations.

Germany's energy policy is a mix of market-based instruments and regulation. Under the Renewable Energy Act, renewable electricity has guaranteed grid access to provide investment certainty and allow family businesses and small firms to compete with large corporations. The policy enables producers of green electricity to sell their power to the grid at a set rate. The rates are "degressive," meaning they decline over time to drive down future prices. Unlike coal and nuclear power, the costs for renewables are not hidden and passed on to future generations, but transparent and immediate. The government sees its role as setting targets and policies; the market decides how much is invested in renewables and how the price of electricity develops. Consumers are free to choose their power provider so they can buy cheaper electricity or switch to a provider with a 100% renewable portfolio.

German energy transition: high certainty with long-term targets

Long-term, comprehensive energy and climate targets set by the German government

Source: BMU



6. Germany demonstrates that fighting climate change and phasing out nuclear power can be two sides of the same coin.

A lot of countries are struggling to fulfill their climate commitments. The decommissioned nuclear capacity was replaced with more renewables, conventional back-up power plants, and greater efficiency. Renewables reduce Germany's emissions by around 130 million tons annually. Overall, Germany will overshoot its Kyoto target of a 21 percent reduction for 2012. By the end of 2011, Germany had reduced its emissions by 24,7 percent and is now moving towards its 2020 target of 40 percent reductions (relative to 1990). It is not yet clear, however, whether the 2020 target can be met; in 2015, the reduction had only reached 27 percent, leaving a large gap of 13 percentage points in only five years.

7. The German Energiewende is broader than often discussed. It not only includes renewable electricity, but also changes to energy use in the transportation and housing sectors.

Germany's energy transition is not only about switching from nuclear and coal to renewables in the electricity sector. Electricity only makes up roughly 20 percent of German energy demand, with roughly 40 percent devoted to heat and 40 percent to transportation. Most public attention has focused on the power sector, with the nuclear phase-out and the switch to wind power and solar power making headlines. But in fact, Germany is a leader in highly efficient building technologies such as "passive houses," which make heating systems in homes largely redundant, as well as efficient electrical household appliances or industrial equipment.

Unfortunately, however, renovation rates are too low for the tremendous efficiency gains from energetic renovation to be fully effective. In addition, Germany has not expanded its district heating networks, which allow waste heat from power generators or from large solar thermal collector fields to be used productively, as fast as its neighbors in Austria and Denmark. But perhaps the greatest challenges lie in the transportation sector, where a number of options are being looked into worldwide – from electric mobility to hybrid vehicles. Germany is not a leader in such technologies. But the greatest efficiency gains will come about when we switch from individual mobility to public transport – and from large cars to small vehicles, such as electric bicycles, when we have to resort to individual transportation.

8. The German *Energiewende* is here to stay.

It is very unlikely that Germany will reverse its course. The transition away from nuclear power has been long in the making. Of course the Big Four utilities (E.ON, RWE, Vattenfall, EnBW) once fought hard to defend their incumbent interests by delaying the switch to renewables, but Eon and RWE have publicly announced their plans to stop building nuclear plants internationally, and EnBW is now owned by the State of Baden-Württemberg, which has a Green governor who is unlikely to instruct the company to support nuclear more. Industrial giant Siemens has also stepped away from nuclear in its global portfolio and now wants to focus on wind power and hydropower. The public strongly supports extending renewables, even in light of rising retail power rates. Germans expect their political leaders to take on the challenge of the energy transition. There are disagreements across the political spectrum about which strategies are the best, but in general all German political parties today support the energy transition because the German public overwhelmingly does.

9. The *Energiewende* is affordable for Germany, and it will likely be even more affordable for other countries.

Germany has benefited economically from its international leadership role in going renewable – similar to Denmark and other pioneers moving to renewables. Germany has created the world's largest domestic solar PV market. German commitment and Chinese mass scale production has helped to drive down the cost of renewables worldwide. In Germany, installed system prices for solar PV plummeted by 66% from 2006 to mid-2012. It will be much cheaper for other countries to invest in renewables now that the costs are lower. On top of that, many countries have much better solar resources than Germany; some of them with the capability of producing up to twice as much power from the same solar panel, because of more sunshine.

Glossary

Back-up power
Backup power is not a clearly defined term. In general, it indicates that certain power plants need to be maintained on standby in case other generators failed to produce power. In the case of wind and solar, dispatchable backup power will always be required, though this could soon increasingly, in the form of stored excess renewable power. Conventional plants occasionally malfunction themselves and have therefore always required some kind of backup capacity; countries that do not rely heavily on our imports all have a part of their generating capacity on standby almost all the time. In addition, many countries, including Germany, have "reserve capacity" – power plants that only rarely run in case of emergencies. For the German grid, oil-fired power plants are generally reserve capacity.

Baseload / medium load / peak power
Baseload power plants are those that cover the minimum amount of power a country needs around-the-clock. For instance, German power consumption rarely drops far below 40 gigawatts (link to kilowatt) even in the middle of the night, so the baseload would be considered roughly the first 40 gigawatts. Power plants that serve this load generally run around the clock when in operation. The medium load is then the load that is generally reached every day. On a normal workday, power consumption in Germany easily reaches 60 gigawatts reliably, so the medium load might be considered the area between 40-60 gigawatts. Power plants that serve this load run regularly but also ramp up and down on a daily basis. The peak load is everything above the medium load. In Germany, power demand rarely rises above 80 gigawatts, so the peak load can be considered from 60-80 gigawatts. Peak power plants run rarely, must be able to ramp up quickly, and may often be idle for days and weeks at a time.

Brown coal / lignite
See hard coal.

Carbon emissions / greenhouse
One main reason why the planet Mars is so much cooler than the Earth is that Mars has no atmosphere. Essentially, the Earth's atmosphere acts as a blanket; sunlight that reaches the Earth bounces around in the atmosphere a bit before leaving. In the process, heat builds up instead of quickly dissipating. A number of gases intensify this insulation effect more than others, but to keep things simple, experts express everything in terms of equivalent carbon emissions, with carbon dioxide being the largest factor by volume. Essentially, civilization is taking carbon that has been trapped underground (in coal, gas and oil) and pumping it into our atmosphere, thereby making the atmospheric blanket more effective. These gases are also collectively referred to as "greenhouse gases," a term that has too positive connotations for some – after all, dramatically rising temperatures are expected to have drastically negative consequences, not the pleasant ones suggested by the term "greenhouse." The term "heat-trapping gases" is therefore also used, as is the "overheating of the climate" instead of the more positive-sounding "global warming."

Capacity factor
The relationship between a generator's rated capacity (measured, say, in kilowatts) and the amount of energy produced (measured, say, in kilowatt-hours). For instance, a wind turbine with a rated capacity of 1.5 megawatts could theoretically produce a maximum of 36 megawatt-hours a day (1.5 MW x 24 hours) under ideal conditions, equivalent to a capacity factor of 100 percent – the turbine then generates its maximum output all the time. In practice, an onshore wind turbine has a capacity factor closer to 25 percent in good locations, so a 1.5 MW turbine would run at 0.375 megawatts on the average, producing nine megawatt-hours a day. In Germany, the capacity factor of onshore wind turbines is below 20 percent, whereas the capacity factor of offshore wind turbines is estimated to be in the mid-30s. The capacity factor of solar likewise largely depends upon the amount of sunlight and is generally estimated to be between 10 percent and 20 percent. See "full-load hours." Full-load hours: Whereas capacity factor is an indication of capacity utilization as a percentage, one also speaks of "full-load hours," an especially useful term for dispatchable generators, which can be switched on and off – such as biomass, coal, natural gas, and nuclear. There are 8,760 hours in a normal year. The number of full-load hours can be used, say, as an indication of how many hours a particular generator needs to run each year to be profitable. For instance, a particular power plant may need 4,000 full-load hours of operation to be profitable, equivalent to a capacity factor of 4,000 / 8,760 = 45.7 percent. If it runs at 50 percent capacity, it would need to run for 8,000 actual hours to achieve 4,000 full-load hours.

Cogeneration / trigeneration
When the waste heat of electricity generator is recovered for useful applications, we speak of the "cogeneration" of heat and power. "Trigeneration" indicates that the waste heat is partly also used to provide cooling. Not to be confused with combined-cycle gas turbines, where the waste heat (steam) is recovered to drive a second, downstream generator that produces more electricity, but does not directly provide waste heat as an application. In cogeneration, the waste heat is not recovered to produce additional electricity, but to provide space heating, process heat, etc.

Demand Side Management (DSM)
Also known simply as "demand management." Electricity cannot easily be stored, so the exact amount consumed generally has to be the same as the amount generated. Until recently, our power supply systems were designed so that the supply side was managed to meet demand; our central-station power plants ramp up and down as electricity demand increases and decreases. With intermittent renewables (see dispatchable), however, power supply will no longer be able to be adjusted so easily, so demand will have to be managed. For instance, when there is enough power, refrigerators and freezers could cool down a bit more so they can "ride through" a few hours of lower power production. In this way, peak power demand can be shifted slightly.

Dispatchable
Dispatchable power plants are simply those that can be switched on and off and ramped up and down to meet power demand. Gas turbines are the most flexible, though modern coal plants also ramp up and down well. Older coal plants prefer to be switched on and left running near full capacity, as do nuclear plants. Like gas turbines, generators running on biomass are generally quickly dispatchable, but they are the only type of new renewable source that can be considered dispatchable in Germany. Wind and solar are considered "intermittent," meaning that they do not produce power all the time, though power production can be reliably predicted at least a day ahead. Most importantly, wind turbines and photovoltaics cannot be "dispatched," i.e. switched on and off. Aside from hydropower, the only other renewable sources of electricity that are dispatchable are geothermal and concentrating solar power, which Germany does not have in large quantities.

Distributed power
Electricity produced by a large number of small generators (solar roofs, wind turbines, etc.), as opposed to a centralized power supply based on a large power stations (not only nuclear and coal plants, but also utility-scale photovoltaic power plants and large wind farms).

Efficiency
The amount of useful energy output relative to the amount input. Not to be confused with the capacity factor. For wind power and solar power, efficiency measures something fundamentally different than for non-renewable resources. For instance, an old coal plant may have an efficiency of 33 percent, meaning that a third of the energy in the coal is converted into electricity, with the other two thirds being lost as waste heat. Nonetheless, 33 percent may sound better than the 15 percent efficiency of an off-the-shelf solar panel. But there is a difference: the coal is lost forever when consumed, so it makes sense to use it as efficiently as possible; in other words, we lose what we use. While it obviously also makes sense to use sunlight as efficiently as possible, with solar and wind we lose what we do not use – the Earth gets roughly the same amount of energy from the Sun every day. Whatever we do not harvest with wind turbines and solar panels is lost forever. This distinction becomes clearer when we keep in mind that the volume of coal power is different depending on whether we count primary energy or useful energy, but the amount of wind and solar power is the same in terms of primary/useful energy.

Energy crop
A plantation whose sole purpose is to provide energy. A crop of corn planted to provide food, for example, is not an energy crop if its waste residue is also recovered and used to generate energy. To stick with the example of corn, an energy crop used to produce biogas is actually harvested before the ears become ripe enough to eat, and the entire plant is used in the process. In contrast, only the fruit – the edible part – is used to make ethanol.

Energy-intensive
In Germany, firms that consume a lot of energy and face international competition are largely exempt from the surcharge to cover the cost of renewable power. To be eligible, companies have to consume at least 10 GWh per year to fall into the category of "privileged industry." In 2011, some 300 energy-intensive firms paid 0.05 cents per kWh to cover the cost of German feed-in tariffs for 90 percent of their power and only paid the full surcharge of 3.52 cents for the first 10 percent; everyone else paid 3.52 cents per kilowatt-hour extra for all of their power. Furthermore, if a firm consumes at least 100 GWh per year and power costs make up more than 20 percent of total production costs, it does not even have to pay the full surcharge for the remaining 10 percent of its consumption.

Energy Union
The new European Commission aims to create an Energy Union over the next few years to strengthen the EU energy security. In all likelihood, only small steps will be taken; there is simply too little consensus among EU member states about what one path should be pursued for energy policy. The current debate focuses on energy security and the affordability of supply.

Full-load hours
Whereas capacity factor is an indication of capacity utilization as a percentage, one also speaks of "full-load hours," an especially useful term for dispatchable generators, which can be switched on and off – such as biomass, coal, natural gas, and nuclear. There are 8,760 hours in a normal year. The number of full-load hours can be used, say, as an indication of how many hours a particular generator needs to run each year to be profitable. For instance, a particular power plant may need 4,000 full-load hours of operation to be profitable, equivalent to a capacity factor of 4,000 / 8,760 = 45.7 percent. If it runs at 50 percent capacity, it would need to run for 8,000 actual hours to achieve 4,000 full-load hours.

Generation capacity aka rated capacity
The maximum output a generator can produce under specific conditions. For instance, a single wind turbine may have a rated capacity of 1,500 kilowatts (1.5 megawatts), but it will only produce that much power under strong winds. See "capacity factor."

Grid access
One obstacle to the growth of renewables is a lack of grid access. German law specifies that renewable electricity has a priority on the grid, meaning that conventional power generators have to ramp down production. Other countries more easily allow wind turbines and solar arrays to be disconnected to protect the profitability of conventional plants. Furthermore, German law specifies the conditions under which grid operators must expand the grid to provide a connection for wind turbines, biomass units, and solar arrays. Otherwise, investments made in renewables could come to naught if the grid operator fails to provide a connection.

Gross energy / final energy
Gross energy includes energy consumption within the energy sector along with distribution losses; final energy is the energy that reaches your doorstep as fuel or electricity. In other words, losses in production and transport are not included. For instance, gross electricity consumption in Germany was nearly 600 terawatt-hours in 2011, whereas net power consumption was reported at around 535 terawatt-hours. The "missing" 60 terawatt-hours were consumed by power plants themselves or lost in power lines. See also primary energy.

Hard coal/anthracite
Anthracite is basically another way of saying "hard coal," just as lignite is another term for "brown coal." Brown coal, which Germany has in large quantities, is the dirtiest kind of coal; it has relatively high water content and hence relatively low energy content; it is therefore not generally shipped over long distances. In contrast, hard coal is more compact with higher energy content, which make it affordable to ship around the world. Hard coal is generally what we imagine as a "lump" of coal. Brown coal is softer. But in practice, there is no clear distinction between lignite and anthracite, which are perhaps best seen as two ranges on a spectrum. Indeed, most of the coal used in the United States is called "bituminous" and has a slightly lower energy content than what Germans would call hard coal.

Kilowatt vs. kilowatt-hour
1,000 watts is a kilowatt. Likewise, 1,000 kilowatts is a megawatt; 1,000 megawatts, a gigawatt; and 1,000 gigawatts, a terawatt. A hair dryer that has "1,000 watts" written on its label consumes a kilowatt of electricity when it is on full blast. If it runs for an hour, it has consumed a kilowatt-hour. Likewise, an appliance that consumes 2,000 watts when it is on will consume 1,000 watt-hours (or a kilowatt-hour) when it runs for 30 minutes. The terms "kilowatt" and kilowatt-hour are commonly confused, but the terms refer to completely different things. If you need a memory aid, think of kilowatts as horsepower – the amount of power your car's engine can provide. Horsepower is then equivalent to kilowatts – the engine/appliance's potential. But your car rarely runs at full horsepower, and most of the day it stands around doing nothing to. So think of kilowatt-hours – the work done, as opposed to the potential – as, roughly, the number of kilometers driven.

Merit order
Indicates the order in which power is bought from power plants on the market. The merit order means that the most expensive plants currently producing determines the price of power on the power exchange. Power plants are ranked and switched on in the order of their "marginal price," which is basically the cost of operation (especially fuel); it specifically does not include the cost of plant construction, for instance. In the case of coal and nuclear, a plant is expensive to construct but relatively inexpensive to operate, so such plants have relatively low marginal prices and therefore run for a large number of full-load hours. In contrast, natural gas turbines are relatively inexpensive to build, but natural gas is expensive in many parts of the world, so gas turbines run for a fewer number of hours when natural gas is more expensive than coal, as is the case in Germany – but not, for instance in the UK. Renewable electricity has a priority on the grid and therefore is not ranked by price. The effect of renewables is therefore the same as lower consumption; the most expensive peak power plants run less often, thereby lowering the price on the exchange.

Passive house
A highly efficient building (residential or otherwise) that "passively" uses solar heat (sunshine) to drastically reduce the need for "active" heating and cooling, such as from an air conditioner and heating system. Passive houses are able to do without central heating systems. Increasingly, old buildings can also be renovated to fulfill the standard. In warmer climates, passive houses can also be built largely to offset cooling demand.

Primary energy
The amount of energy put into a supply system, as opposed to the "useful energy" that the supply system outputs to consumers. For instance, the tons of coal fed to a coal plant are considered primary energy, whereas the electricity that leaves the plant is considered secondary energy. For instance, a coal plant with an efficiency of 40 percent consumes 2.5 times more primary energy (coal) than it produces in the form of electricity (secondary energy). For wind and solar, there is no difference between primary and secondary energy. See efficiency.

Retail market
Typical retail power consumers include households and small businesses. These power purchasers have low-voltage grid connections and consume relatively little electricity. They also generally pay the highest prices because they have been "captive" up to now, meaning that they have had no affordable alternatives to electricity from the grid. The growth of renewables – and in particular, solar with storage – is changing that situation worldwide.

Smart energy
When IT is combined with energy consumption devices and power generators of all sizes, we speak of "smart grids" and "smart meters." Electricity has to be generated in the exact amount of simultaneous consumption; otherwise, storage is needed. Data can be used to adjust consumption and production levels to match each other. Industry already responds to grid needs by shifting production levels, but such steps are also possible in households. For instance, refrigerators and air conditioners could switch off temporarily to "shave off" peak power demand. When power consumption drops to a lower level, these units could then stay on a bit longer.

Spot/day-ahead market
Power can be bought and sold in long-term agreements, the most common model for the bulk of electricity in free markets like Germany. But because actual power demand cannot be exactly estimated 18 months in advance – the term sometimes applicable for power purchase contracts in Germany – the remainder is purchased on the power exchange, which consists partly of a spot market for relatively immediate purchases and the day-ahead market, for purchases the next day. The day-ahead market is especially interesting for renewables like solar and wind, which depend on the weather – and that can only be reliably predicted within 24 hours.

Wholesale market
Like other commodities, electricity is sold on both wholesale and retail markets. In Germany, big buyers (industrial firms, retail power sellers, etc.) and the big sellers (power plants) can sign power purchase agreements directly, but a significant amount of electricity is increasingly sold on the spot market in Germany. Spot market prices generally determine what prices can be arranged in direct purchase agreements, which generally apply for just a few years in Germany.