THE ENERGY TRANSITION (ENERGIEWENDE): SHIFTING TOWARDS A GLOBAL CLIMATE POLICY

This is a translated version of the original German-language chapter "Energiewende: Umsteuern zu einer globalen Klimapolitik", which is the sole authoritative text. Please cite the original German-language chapter if any reference is made to this text.

SUMMARY

At the **Paris climate summit**, 195 countries signed on to ambitious climate targets and agreed to reach net zero emissions ("emissions neutrality") in all sectors in all countries by the end of the century. This presents confirmation of Germany's own endeavours to switch to a sustainable energy supply system. However, it also highlights that if an energy transition (Energiewende) chiefly aimed at mitigating the effects of climate change is to deliver meaningful results it will need more than the actions of one country alone. Without the introduction of a **global emissions trading system** or a **global carbon tax** a credible and economically efficient strategy to actually deliver on the agreed global goals would be missing.

This global strategy would be **credible**, as the binding effect of participating in a global system would be far stronger than mere promises to reach national emission targets. And it would be **economically efficient**, as opposed to separate courses of action, it can leverage the advantages of the international division of labour in emissions abatement. To dismiss such a strategy and instead have a situation where each country takes separate steps to pursue national or even smaller-scale regional emission targets would be a waste of economic resources. For the climate summit in Paris to actually serve as the starting point for the introduction of global emissions trading, the **distribution problem** associated with the initial allocation of the number of permits would need to be resolved through negotiation.

German energy and climate policy, in contrast, has so far concentrated on Germany's own energy transition. It is based on the **"2010 Energy Concept"**, and on the Energy Transition Package adopted following the Fukushima nuclear disaster, which formulates a variety of targets at different levels to be achieved by the year 2050. At this stage, however, it seems likely that most of these targets will be missed, particularly the primary target of reducing greenhouse gas (GHG) emissions by 40 % in the year 2020 compared with the levels of the reference year 1990.

The Federal Government responded to this **foreseeable failure to meet targets** in a centrally planned manner with a host of action programmes and plans containing over 100 individual measures, which will inevitably raise the cost of the energy transition. Instead of this kind of **fine-tuning**, more emphasis should be placed on the international dimension of the energy transition in the years ahead, coupled with a clear commitment on the part of the Federal Government to the **EU-ETS as the guiding instrument**. In particular, efforts should be made to extend emissions trading to all transport sectors, private households and to the industries which are currently exempted, rendering national support instruments and numerous subsidies superfluous.

So far, German energy policy has chiefly focussed on the electricity market where the share of **electricity production derived from renewables** has risen to around 29 %. As a result, this specific sector will most probably exceed its target of 35 % for the year 2020. To curb the resulting cost increase, the Federal Government defined deployment corridors for individual technologies in the 2014 Renewable Energy Sources Act and introduced technology-specific auctions with the **2017 Renewable Energy Sources Act**. However, the definitive step towards cost containment is still missing: the switch to a support regime that is technology-neutral.

I. THE TASK OF CLIMATE POLICY

856. In December 2015, 195 states managed to arrive at a common climate agreement at the **Paris climate summit**. The ambitious goal of the deal is to bring down **greenhouse gas emissions to net zero ("emissions neutrality")** by the end of the century and in doing so to limit the global temperature increase to well below two degrees Celsius. Emissions neutrality is achieved when the same amount of greenhouse gases is emitted to the atmosphere as taken up by natural (e.g. forests and oceans) or artificial sinks (e.g. chemical processes). The common goal agreed in Paris is based, inter alia, on the concept of planetary boundaries, which was developed by an interdisciplinary team of 28 scientists in the year 2009 (Rockström et al., 2009). These boundaries define thresholds for ten Earth system processes which, if crossed, could result in irreversible and abrupt changes of the environment.

Several of these boundaries have already been crossed. One of them concerns the atmospheric carbon dioxide concentration and the resultant climate change. With its focus on greenhouse gas emissions (CO_2 equivalent), the Paris climate agreement concentrates primarily on this planetary boundary, as does this chapter of the report. Other areas, such as biodiversity, land and soil degradation or anthropogenic pollutants, which can also justify the need for economic policy action, are not dealt with in greater detail.

857. In principle climate change can be addressed in two different ways. One is "**mitigation**", which refers to the reduction of emissions to stop climate change. The other is "**adaptation**", whereby countries and individuals attempt to limit the imminent damage and impact of climate change by taking counter-measures and making adjustments. Rather than being mutually exclusive, these strategies can complement one another. Both require the use of economic resources which ultimately implies the need to weigh up the marginal returns and marginal costs of individual measures.

However, when it comes to adaptation, the users and cost-bearers of adaptation measures fall together so the design and intensity of the measures can largely be left to decentralised public- or private-sector processes (Scientific Advisory Board at the Federal Ministry of Finance, 2010). In the case of measures to limit global warming, however, the group of users generally does not coincide with the group of cost-bearers, thereby necessitating state intervention and **global coordination**. Accordingly, the Paris climate agreement primarily focuses on emission abatement measures, and not on measures to adapt to the negative consequences of global warming.

858. The ability of the Paris climate agreement to help slow down climate change will only become apparent in the coming years. The agreement is based on **national climate action plans** which will be assessed by independent experts every five years starting in the year 2023. In this context, the countries have agreed on a common system of reporting obligations and transparency rules. However, recent experience with international agreements, such as the European Stability

and Growth Pact, demonstrates how difficult it is to push through agreed goals in practice without effective **sanctions**. Not least, there are also complex problems of strategic interaction, deriving from the ability to use temporary business cycle or other obstacles as an excuse for inactivity while **free-riding** on the activities of other parties to the agreement.

859. Furthermore, it is not economically efficient to first break down global climate goals to the national level and then implement the goals with measures that have not been coordinated internationally. Instead, it would make more sense to separate the burden-sharing obligation from the question as to where and in which sector emissions can be reduced to a lesser or greater extent. Convincing solutions to this latter question have long been available. For example, the introduction of **global emissions trading** or a **global tax** on harmful emissions (carbon tax) could help reduce greenhouse gas emissions wherever this can be achieved at the lowest economic cost. The economic resources this would save would then be available for other purposes to improve general welfare. ↘ BOX 29 PAGE 436

860. Emissions trading or a carbon tax would deliver an economically efficient solution because they put a uniform price on the emission of greenhouse gases - ideally one that applies worldwide - irrespective of the source of the emissions. The resulting increase in energy costs gives businesses and households the incentive to adapt their **production processes and behaviour** and emit fewer pollutants. They will always tend to respond to this incentive if the cost of adapting is lower than the price, and otherwise be prepared to pay the price while not changing their behaviour. Therefore, the least expensive abatement options would be implemented first of all, while necessarily compliance with the politically agreed cap as a secondary condition would persist.

Everyday empiric experience in all economic processes provides evidence of behavioural changes of this kind. For instance, the two oil crises in the 1970s and at the start of the 1980s triggered similar changes in behaviour (Frondel and Schmidt, 2006). German economy switched to more energy-efficient production, for example. Climate policy should rely more on these kinds of decentralised mechanisms.

861. Setting a price on greenhouse gas emissions will undoubtedly make production and consumption more expensive in all the economies concerned, as - in contrast to the previous framework - **environmental pollution** now is **a cost factor** for the polluter. Furthermore, this burden will be completely transparent for all parties involved. Therefore, with this approach, political campaigning to address the climate problem needs to openly acknowledge that climate mitigation will initially involve additional costs for the economy if the problem of climate change should be overcome in the long term.

However, abandoning the achievement of climate goals through market-based policies and hiding the costs of climate mitigation behind an array of planned economy interventions is a far inferior solution. This could even lead to **far higher burdens** for all parties involved, as Germany's current climate policy clearly demonstrates. This is particularly true for the citizens of the industrialised countries that commit to particularly high reduction rates as, for them, the marginal costs of abatement are probably particularly high owing to the efforts already made.

862. In the Paris agreements, therefore, attention should have been paid to the national shares in the overall cost and not to national contributions to emissions reduction. The **question of efficiency** – where and how can the next tonne of greenhouse gas emissions be prevented at the lowest cost – should be separated from the **question of sharing** the resulting financial burden. The decision in favour of an economically efficient solution from a global perspective does not in any way imply a decision on how the financial burden deriving from the efforts to reduce emissions is shared. In particular, the decision would not necessarily impose these burdens unilaterally on the poorer economies.

After all, nothing would prevent the richer economies from bearing the lion's share of these costs. The lower their **initial allocation of greenhouse gas emission allowances,** the higher their contribution to these costs would be. When negotiating this initial allocation, the national climate action plans, not least, could serve as the starting point as they have already been negotiated from the aspect of burden-sharing – albeit not with a global implementation mechanism in mind.

863. Nevertheless, the Paris climate summit can be seen as another step in the right direction. The fact that greater attention has been paid to the contribution of **developing and emerging countries** to global climate change must be regarded as a major achievement. At this stage, these countries are making a marked contribution to the increase in global greenhouse gases as their economies catch up. ↘ CHART 117 Even a very ambitious reduction in German or European greenhouse gas emissions would be unable to subtend something to this increase. This is true irrespective of whether or not the developing and emerging economies actually fully meet their commitments to cut emissions.

Therefore, the biggest challenge for energy and environmental policy in the years ahead is to resolutely work to get all countries to sign up to a **global emissions trading system** or a global carbon tax– also in connection with an appropriate burden-sharing concept.

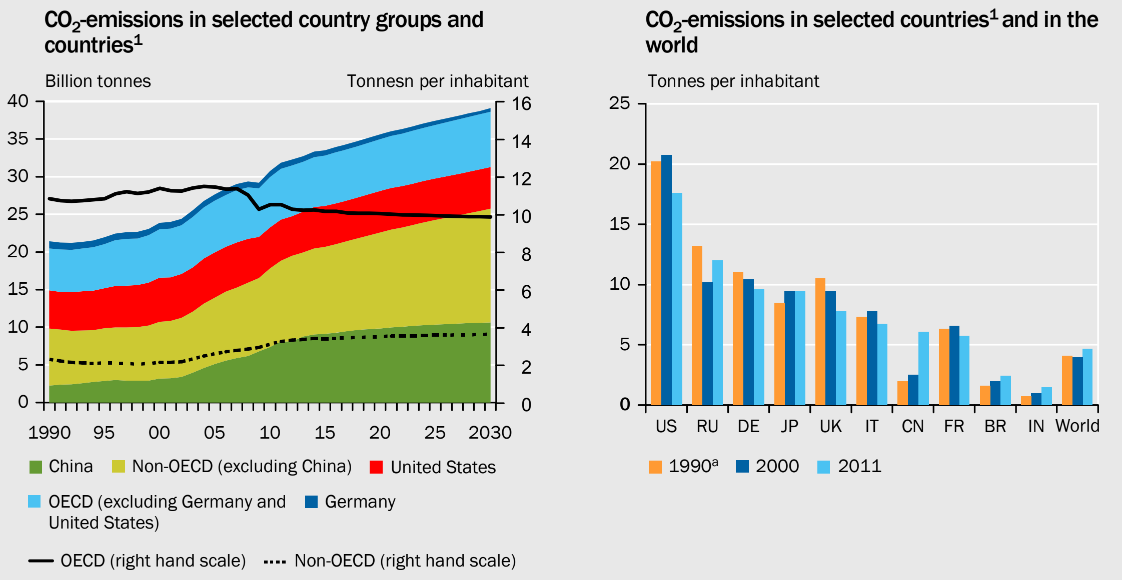
864. In its capacity as host to the G20 summit next year, Germany would have the opportunity to push for such an agreement. However, the basic prerequisites to **successfully convince** others would likely be that the German energy and climate policy:

(a) acknowledges that **global climate change mitigation** – and not national industrial policy – is its priority;

(b) makes economically efficient use of the **international division of labour** as an instrument to contain total global economic costs; and

(c) is prepared to make the cost of climate mitigation transparent in political discourse through discussions on **global burden-sharing**.

↘ CHART 117
Global CO_2-emissions



1 – Estimates for all regions from 2012, German CO_2 emissions from 2012 estimated assuming linear attainment of the goal of 45% of 1990 CO_2 emissions in 2030. 2 – US - United States, RU - Russia, DE - Germany, JP - Japan, UK - United Kingdom, IT - Italy, CN - China, FR - France, BR - Brazil, IN - India, a - DE- West Germany, RU - Former Soviet Union.

Sources: EIA, Eurostat

865. Instead, the **German energy transition** was introduced and implemented as a **national project** in order to assume a **leading international role** owing to the national reduction of greenhouse gas emissions. In doing so, Germany hoped to be able to demonstrate that a large economy can deliver major reductions in greenhouse gas emissions in a cost-effective and socially viable manner.

The energy transition is defined by the variety of climate policy goals set down by the Federal Government in its **2010 Energy Concept** and ongoing revisions. Compliance with the goals forces a radical change in the energy supply systems in the decades ahead. Following the Japanese nuclear accident in Fukushima in the year 2011, this change was accelerated further by once again bringing forward the date of withdrawal from nuclear power.

866. Today many countries in the world are promoting the development of renewable energy. However, this does not solve the problem of free-riding at the global level. For years, there has been **strong criticism** in many parts of the economic literature specifically concerning the centrally planned - and therefore economically inefficient - implementation of the German energy transition as a project of national industrial policy (2009 Annual Report, Items 366 ff.; Scientific Advisory Board at the Federal Ministry of Finance, 2010; acatech, 2012; Scientific Advisory Board at the Federal Ministry for Economic Affairs and Energy, 2012; Monopolkommission, 2013)).

↘ BOX 29

Global instruments for abatement of greenhouse gas emissions

To limit greenhouse gas emissions credited with negative external impacts on global climate, countries primarily rely on three instruments of environmental policy: requirements, emissions tax and emission allowance trading (Endres, 2007). **Requirements** are direct environmental codes of behaviour for polluters (e.g. for the emission of pollutants by cars). Being the most common political measure, they form the basis to the majority of German climate policy. However, they are not cost-effective as they ignore polluters' different willingness to pay and costs. The advantage of the other two instruments - namely allowance trading and emissions tax -, on the other hand, is that they address this information issue and process the information through a price mechanism.

The idea behind **allowance trading** is to create new ownership rights by issuing tradable emission permits. These permits essentially allow a specific part of the atmosphere to be used for the storage of CO_2. The resulting exchange market causes greenhouse gases to be reduced at the lowest possible cost. A high permit price creates incentive to invest in abatement technologies and promotes technological advances. The **emissions tax** (Pigouvian tax) is based on the idea of directly and uniformly allocating a price for each unit of pollutant emitted. In practice, however, the tax is not directly levied on the emissions. Instead other assessment bases apply, such as the amount of raw material consumed, e.g. one litre of petrol. The emissions tax and allowance trading (with initial allowance auctioning) can generate revenue for the government.

However, if applied regionally - such as in the case of EU emissions trading (EU-ETS) - and given the price-sensitive supply of commodities, emission allowance trading and the emissions tax can only make a limited contribution to reducing **global greenhouse gas emissions**. The lower demand brought about by these instruments is likely to drive down the global commodity price, which in turn will trigger higher demand in other parts of the world. In addition, the commodity suppliers could dump a large amount of their reserves on the market already today in order to counteract any future drop in demand resulting from increased emission abatement efforts. The resultant drop in commodity prices would additionally increase demand in the remaining parts of the world (green paradox, Sinn, 2008).

A significant difference between allowance trading and emisions tax is that allowance trading directly limits the **amount of emissions** while the allowance price is reached as an output variable. Greenhouse gas reduction targets are met irrespective of developments in the allowance price, and the target is reached with the least effort (economic principle). A low **allowance price** is an indicator that the current state of technology suffices to achieve the specified reduction in emissions but only provides limited incentive for innovation. When auctioning allowances, incentives for innovation can be increased by introducing price corridors (acatech, 2014) or through subsequent tightening of the emission reduction path set out (Frondel, 2015). This reduces planning security for businesses, however.

There is **inevitable interaction** between allowance trading, where emission caps have been defined years in advance, and public support of certain technologies that is stepped up afterwards. For example, the promotion of renewable energy for electricity generation in the Renewable Energy Sources Act (EEG) undercuts the incentives of allowance trading (Advisory Board to the Federal Ministry of Economics and Labour, 2004; EFI, 2013; Frondel et al., 2007; 2015 Annual Report Items 323 ff.). If the electricity subsidised by the EEG replaces fossil energy, the allowance price decreases, providing less incentive for innovation. Therefore it would be consistent if the Federal Government, while subsidising renewable energy through the EEG, bought up the corresponding amount of emission allowances and removed them from the market (Löschel, 2016). Furthermore, the EEG distorts private decisions on efforts to prevent emissions as it promotes technologies that do not correlate to the lowest marginal abatement cost.

One argument in favour of combining EU-ETS with the promotion of renewable energy through the EEG is that there would otherwise be **barriers** for potential producers to **enter the electricity market** (Sonnenschein, 2016; Lehman and Gawel, 2013). However, overall all the points listed are no different from market failure in other oligopolistic markets. However, it has proved beneficial to address the market failure with suitable regulation and the supervision of competition authorities (e.g. in the telecommunications and post market in Germany) and not with a solution based on subsidies.

In principle, an emissions tax can achieve the same results as emissions trading. The problem here is in setting the **optimum tax level** to match the scale of the external effect. Therefore, the tax must be adapted over time so that it keeps pace with technological advances as the external effect is derived from the marginal utility and marginal damage of the pollutant emissions. In contrast to permit trading, a global emissions tax can give rise to the green paradox. Furthermore, the worldwide introduction of such a tax is problematic in practice (Marron and Toder, 2014). The national tax systems and potential assessment bases are extremely diverse globally. These would need to be brought in line with each other or the tax level would vary regionally. The difficulty of such an harmonization can for example be observed in the discussions regarding a common assessment basis for corporate taxes within the EU. Additionally, it would need a global fixing of the level of the tax as well as a monitoring mechanism of the collection of the tax including possibilities.

Experience from the EU-ETS

The EU-ETS is the **world's** first international and **largest emissions allowance trading system** (European Commission, 2013). The allowance trading system comprises 11,000 energy and industrial plants in 31 countries (EU-28, Switzerland, Norway, Liechtenstein). The EU-ETS is based on the approach that the companies under the system must purchase a tradable allowance (permit) for every tonne of greenhouse gas emitted. Only a limited number of new allowances is issued each year. Strict penalties for infringement apply. The volume of new allowances is reduced year by year.

The ETS scheme applies to installations with a capacity in excess of 20 MW from the electricity generation sector and other sectors of the economy, like cement and lime production, the chemical industry, metal production and aviation. Thereby it covers **roughly 45 % of total emissions in the EU**. Businesses can buy certificates through the Clean Development Mechanism (CDM) by investing in emission reduction measures outside of Europe. Emissions allowance trading is organised in multi-year trading periods in order to balance fluctuations caused by extreme weather conditions.

Phase 1 (2005-2007)

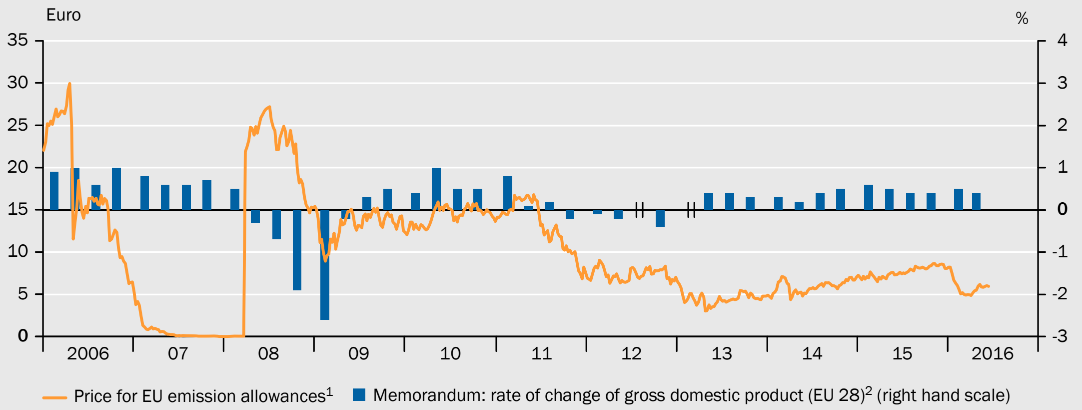
The period between the years 2005 to 2007 was seen as a **test phase** and was characterized by a vast overabundance of allowances. The number of allowances issued was supposed to be based on the emissions that would be expected if the EU-ETS were not introduced. However, the absence of reliable data resulted in an excess supply of certificates (Wackerbauer et al., 2011). Businesses bought up allowances at the start of the first trading period as they presumed allowances would be scarce. However, when it was first reported in April 2006 that the ETS emissions were far below the total number of allowances allocated in the year 2005, the price of allowances fell from €30 to €9. ↘ CHART 118 The drop in price to zero at the end of 2007 is based on the fact that the allowances could not be banked for the next trading period.

Phase 2 (2008-2012)

The allocation of allowances was subsequently tightened significantly, causing the price of allowances to climb again to over €27 by mid-2008. However, the political uncertainty about the continuance of a strong EU-ETS (Koch et al., 2014), **weak economic climate** and the significant increase in renewable energy caused the price to drop below €10 by the end of the year 2011 and remained around this level throughout the course of 2011.

↘ CHART 118

EU-ETS: Price for EU emission allowances



1 – Euro per emission allowance for one tonne of CO_2; weekly averages. 2 – Gross domestic product (real); quarters, seasonally and working day-adjusted; change on previous quarter.

Source: Eurostat, Thomson Reuters Datastream

Phase 3 (2013-2020)

Significant changes were introduced to the allowance trading system in the third phase. For one, allowances were increasingly granted through **auctions**. To stabilise allowance prices, the European Commission introduced a so called **backloading measure** in the year 2015 whereby it postponed the auctioning of 300 million allowances to 2019 and 2020 (acatech et al., 2015a; Andor et al., 2016b).

Discussions are currently underway on the framework conditions for the fourth trading period of the EU-ETS. The proposal of the European Commission (2015) intends to reduce the overall volume of certificates at a faster annual pace (2.2 % per year instead of 1.7 % today). The allocation of free certificates should become more target-oriented. Beyond that there are discussions to introduce two new funds. One is supposed to promote innovation in new environmental technologies and the other to support other member states with lower average income.

II. INTERIM REVIEW OF THE ENERGY TRANSITION

867. As a follow-up to the Paris climate summit and in light of the imminent risk that Germany will fall short of its own national climate targets which it set earlier, the Federal Government is currently debating a radical package of measures to restructure German (industrial) society - the **2050 Climate Plan (Klimaschutzplan 2050)**. This plan envisages a large number of measures and interventions in the national economy, some of which have already been introduced on a smaller scale through initiatives in recent years. It is now five years since the Federal Government announced its intention to accelerate the energy transition: high time, therefore, to take stock of the situation and assess the success of the measures implemented thus far.

1. Goals of the 2010 Energy Concept

868. In September 2010, the then Federal Government consisting of CDU/CSU and FDP adopted the **Energy Concept** which maps out the contours of the energy transition. The Energy Concept comprises a large number of climate policy targets and installation goals for renewable energy. A central component of this Energy Concept was originally to extend the operation of nuclear power plants (nuclear energy as a bridge technology). Following the nuclear accident in Fukushima in the year 2011, however, the situation changed abruptly. Swayed by this event, the Federal Government decided to repeal the extension in the operation of nuclear power plants introduced in the year 2010 and even accelerated the withdrawal from nuclear power (accelerated energy transition). This naturally makes it more difficult to achieve the ambitious targets of the Energy Concept.

869. The Energy Concept distinguishes between multiple goal levels. ↘ CHART 119 The **political goals** occupy the top-most level (BMWi, 2015a). They comprise climate targets, including the reduction in greenhouse gas emissions, the phase-out of nuclear energy for electricity generation, and safe-guarding competitiveness and supply security.

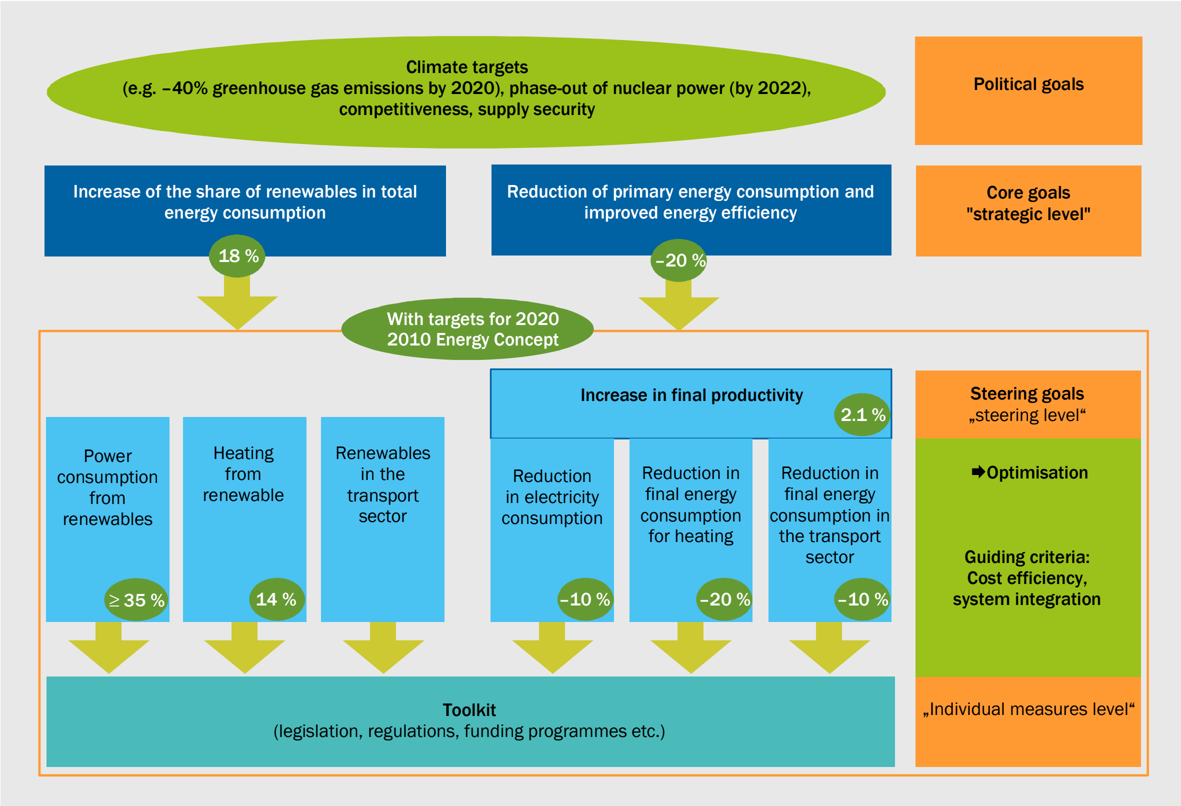
The second level of the Energy Concept contains the **core goals**. These aim to define the central strategies to drive the energy transition forward. In particular, the focus is on the expansion of renewables and the reduction in primary energy consumption. Both objectives serve the overarching objective of greenhouse gas emission reduction.

Steering goals are formulated on the last level. Through respective measures, the aim of the steering goals is to contribute to the reliable and cost efficient attainment of the higher-level objectives. A large part of the steering goals are directed at the electricity sector. For example, providing technology-specific support under the Renewable Energy Sources Act (EEG) attempts to increase the share of renewables in gross electricity consumption to 35 % by the year 2020. In addition, the catalogue of targets also includes other sectors such as transport or heating with specific objectives. In the transport sector, for instance, the goal is to reduce final energy consumption in the year 2020 by 10 % compared with the level of the reference year 2008.

870. At the end of the transformation process, the German energy system would ultimately be one in which all the goals – a low-emission economy that uses energy efficiently and is characterized by a high proportion of renewable energy technologies – are essentially reconciled with one another. The **actual problem,** however, is in the design of the **transformation** of the system. Unfortunately, policy-makers have so far refused to enter into a more in-depth discussion on how to address conflicting goals that arise as a result, or even an attempt to prioritise the goals (Umbach, 2015). In addition, implementation has largely focussed on the electricity generation sector and limited itself to large-scale funding for renewable energy in this sector.

↘ CHART 119

Federal Government Energy Concept - intermediate goals for 2020



Source: Federal Ministry for Economics and Energy

2. Most goals not reached

871. Despite considerable progress, it is already apparent that it will not be possible to fully meet most of the goals set out in the Energy Concept for the year 2020. This applies in particular to the primary goal of **reducing greenhouse gas emissions** by 40 % compared to levels in 1990 - the reference year. Up to 2001, the decline in emissions was still consistent with the specified target as a result of the economic transition in the new Bundesländer. This can be attributed to the changeover from coal to less-polluting energy sources and the shutdown of older plants.

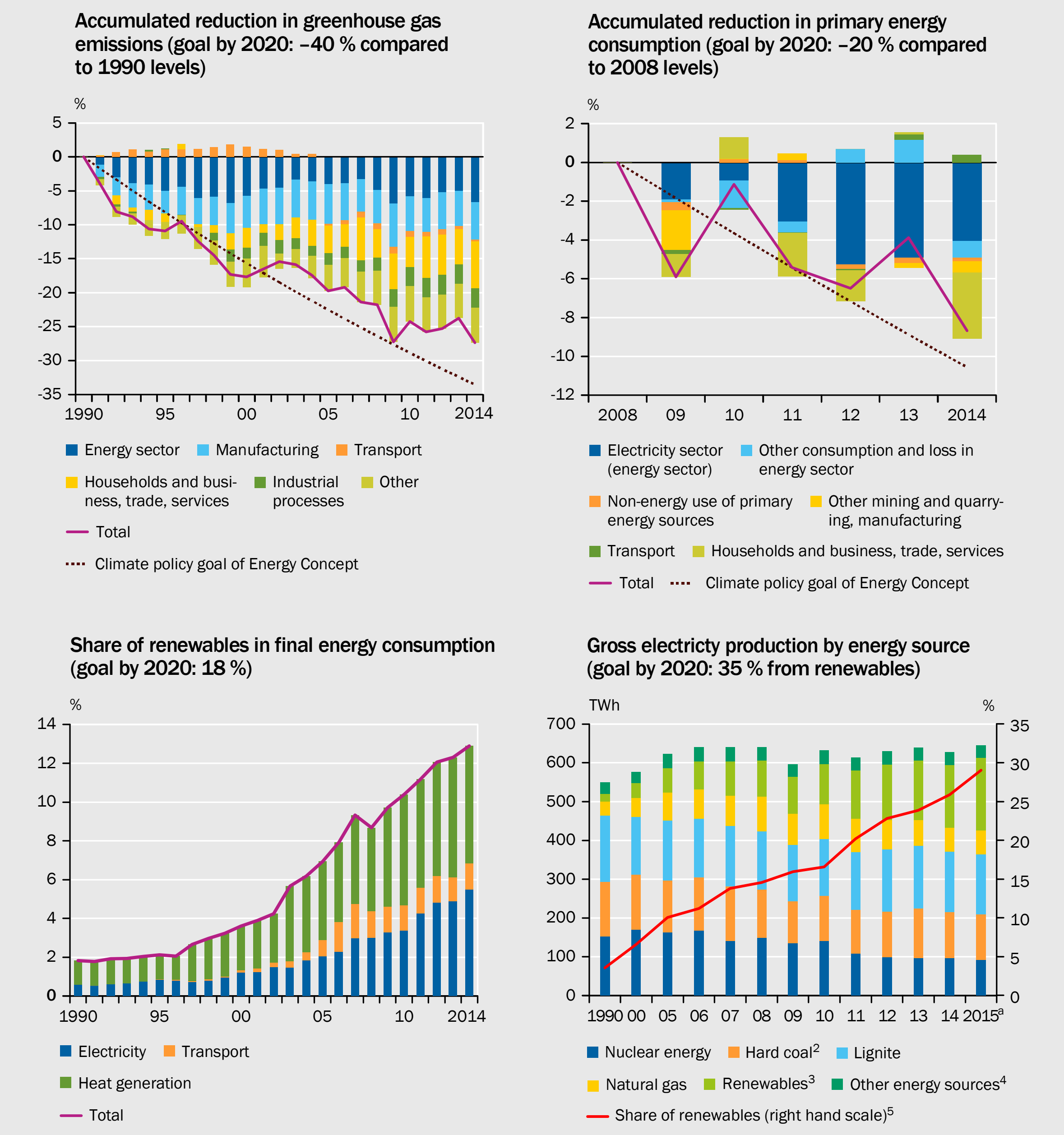
After that, emission reduction only remained on target in the year 2009 but this was the consequence of the deep recession following the global financial crisis. ↘ CHART 120 TOP LEFT Overall, emission reduction through to the year 2015 stood at slightly more than 27 %, thereby falling short of the target by 6 percentage points.

872. In the year 2015 the majority of **greenhouse gas emissions** were caused by the energy sector with around 38 %. Here, the growth contribution to the reduction in total greenhouse gases has been around 7 percentage points since the year 1990, but development has been stagnant since the year 1999. The transport sector was the second biggest greenhouse gas emitter with 18 %. Despite large tax burdens and emission regulations for car manufacturers, there

has been no decline in emissions in this sector since the year 1990. Other significant emitters are the manufacturing industry as well as private households and the combined sector of commerce, trade and services, each with 14 %. It has been possible to considerably reduce greenhouse gas emissions here.

873. In response to the anticipated failure to meet its goal (climate protection gap), the Federal Government adopted additional measures in December 2014 with the **2020 Climate Action Plan** (Aktionsprogramm Klimaschutz 2020). This plan comprises over 100 individual measures that are directed at the various

↘ CHART 120
Climate and energy policy goals of the 2010 Energy Concept



1 – Diffuse emissions from fuels; agriculture, land use change and forestry; waste; military and other minor sources. 2 – 5.6 TWh higher in 2013 compared with official statistics. Subsequent correction in 2015 was no longer regarded in official statistics for 2013. 3 – Hydropower, windpower, biomass, photovoltaic, geothermal, household waste. 4 – Including petroleum products. 5 – In relation to total gross electricity generation. a – Preliminary data, some estimated; as of August 2016.

Sources: AGEB, AGEE, BMU, BMWi, Federal Government, UBA sectors. Concrete contributions to the reduction in greenhouse gases were defined for the central policy measures.

874. **Primary energy consumption** is another objective set out in the Energy Concept. ↘ CHART 120 TOP RIGHT In addition to final energy consumption, primary energy consumption comprises energy losses during the energy conversion and the non-energy consumption of primary energy sources. The core objective is to reduce primary energy consumption by 20 % in the year 2020 compared to the level of the year 2008. In 2014, however, the reduction was only just below 9 %. Furthermore, this percentage must in fact be interpreted optimistically as the mild winter in the year 2014 had a dampening effect on energy consumption.

Standing at 27 %, the combined sector of households, commerce, trade and services accounted for the largest level of primary energy consumption in the year 2014. This is followed by the electricity sector with 24 %, the transport sector with 20 % and manufacturing with 19 %. There were significant savings in the electricity sector, while energy consumption in the transport sector merely stagnated.

875. The ambitious goal to increase **energy efficiency** (final energy) by an annual average of 2.1 % did not remain on target in recent years. Final energy efficiency increased by roughly 1.6 % per annum in the period from 2008 to 2014. To meet the target, the Federal Government in its **National Action Plan on Energy Efficiency (Nationaler Aktionsplan Energieeffizienz, NAPE)** again adopted a multitude of measures directed at all sectors.

876. The second core goal of increasing the **share of renewable energy** in gross energy consumption to 18 % in the year 2020 will likely be achieved in the heating and electricity sector. ↘ CHART 120 BOTTOM LEFT However, the share of renewables in the transport sector has declined in recent years. For example, having peaked in the year 2007 the share of biofuels in total fuel consumption has declined as a result of the repeal of tax privileges for pure biofuels.

The lower-level goal of increasing the share of **electricity production derived from renewable energy sources** in gross electricity consumption is expected to be significantly exceeded. ↘ CHART 120 BOTTOM RIGHT However, the trade-off is a sharp increase in electricity costs, lack of integration into the power grids and a significant increase in volatility and regionality. Therefore the latest developments in the electricity market are discussed in more detail in Section III.

3. Climate policy assessment

877. While the specific objectives of the Energy Concept are merely supposed to provide long-term orientation for the economy, recent history has shown time and again that the Federal Government is certainly willing to take counter-measures if there is an imminent risk of failure to meet the targets (2015 Annual Report Item 87). The catalogue of targets therefore carries the risk of **economic fine-tuning** and creates considerable regulatory uncertainty, particularly in the electricity generation sector.

878. On the whole, the Energy Concept together with the national action plans have the distinct hallmarks of a **planned economy**. An attempt is made to achieve a range of individual goals with primarily technology-specific measures in various areas. This political fine-tuning is obviously based on the premise that the behaviour of market players can be planned very precisely through the selection of individual instruments. For example, the 2050 Climate Plan currently under discussion seeks to specifically change the heating systems in apartments, the choice of drive type for modes of transport, and even the eating habits of citizens and much more.

The criticism expressed by the German Council of Economic Experts is explicitly not directed at the top-level political goals, particularly the need to reduce greenhouse gas emissions as a result of ongoing climate change. Withdrawal from nuclear energy is also a given starting point of the analysis. However, the **point of the steering goals** is **not** altogether **clear** from an economic perspective, as these additional constraints only place an additional burden on the energy transition and make it unnecessarily more expensive.

879. The plethora of measures and the accompanying sharp increase in costs **adversely affect public acceptance** for this project which concerns society as a whole. This is confirmed by a study conducted by the RWI (Andor et al., 2016) which discovered in a representative survey that while 88 % of the population are in favour of support for renewable energy, the willingness to pay for it declined. In addition, the measures are likely to have had a negative impact on the investment and production activities of energy-intensive businesses. ↘ BOX 30 If the system is not changed, it will only be possible to deliver on the goals of the 2010 Energy Concept by creating new subsidies. This will ratchet up the cost of the energy transition even further and the constant intervention in market processes can jeopardise Germany's position as a place to do business.

In addition, the Federal Government's fine-tuning of the energy transition is based on the misjudgement that all sectors absolutely must make a significant contribution to the reduction of greenhouse gases. As the costs of emissions prevention should be considered instead, the German Council of Economic Experts is **against a climate policy that is sector- and technology-specific** and in favour of a whole-of-system approach where all technologies and sectors are considered.

880. The report on pollutant prevention through renewables presents one particular example of the misjudgements that arise when the **interactions** of climate policy measures are not considered. The Federal Ministry for Economics and Energy (BMWi) puts the emissions prevented through the use of renewable energy in the year 2015 at around 167.5 million tonnes of CO_2 equivalent (BMWi, 2015b), with the electricity sector accounting for some 122.1 million tonnes (roughly 37 % of total greenhouse gas emissions in the electricity sector in the year 2015). However, the allegedly high impact of pollutant prevention is put into perspective when one considers that greenhouse gas emissions in the energy sector are capped across Europe by the EU-ETS.

This produces two effects. For one, the 122.1 million tonnes of CO_2 equivalent were not saved in the form of CO_2 emissions because the EU-ETS allowance price was not zero in the year 2015 and the allowances were therefore used for other CO_2-heavy purposes. Secondly, renewable energy had a dampening effect on the EU-ETS allowance price. Coupled with the global market prices for fossils fuels, such as coal or natural gas, that have been falling since the year 2011, this has made fossil fuels very cost-effective once again.

↘ BOX 30

The importance of energy costs on production and investment activity

The influence of energy costs on German industry is controversially debated. While industry representatives argue that the current energy prices jeopardise Germany as a place to do business, the German Advisory Council on the Environment believes this to be an exaggeration (SRU, 2016). **International competitiveness** with regard to energy costs is determined by several factors. On the one hand, the role of electricity costs for German industry is prominently debated. The Renewable Energy Sources Act (EEG) granted exceptions for particularly electricity-intensive businesses competing in the international arena. As a result of the exceptions, it is even likely that the businesses concerned have seen their electricity costs go down, as the price for electricity on the exchange has fallen owing to the increasing feed-in of renewable energy and the EEG surcharge largely does not apply for electricity-intensive businesses. ↘ CHART 123 RIGHT Nevertheless, there is considerable uncertainty surrounding regulations for electricity-intensive businesses as the existence of these exceptions is repeatedly called into question.

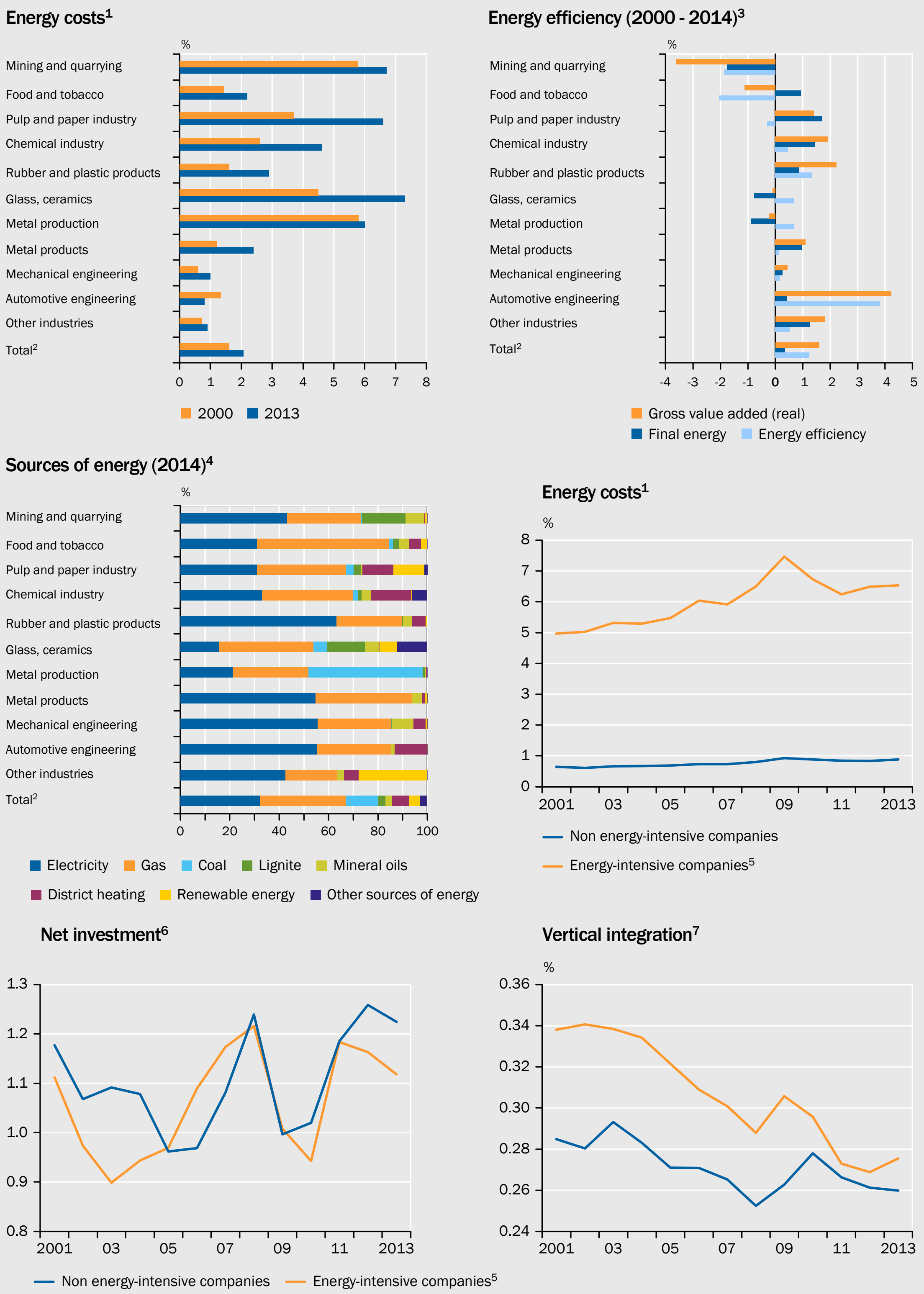
On the other hand, energy costs comprise costs for other sources of energy such as natural gas, coal and mineral oil. **International developments in commodity prices** therefore play a huge role for the businesses. For example, the shale gas boom in the United States has considerably improved the field conditions for energy-intensive US businesses. In addition, there is the problem of carbon leakage (Aichele and Felbermayr, 2011, 2015). If countries make different climate policy efforts (e.g. participation in emissions trading), this can result in the shifting of carbon emissions through international trade. Ultimately, the upshot of this is that energy-intensive production sectors move offshore to the country with less stringent climate regulations.

At first glance, energy costs would appear to play a more minor role in German industry with regard to production and investment decisions in the **manufacturing sector**. For example, the share of energy costs in the gross production value (energy cost share) was only 2 % in the year 2013. ↘ CHART 121 TOP LEFT These are the direct energy costs. Indirect energy costs contained in intermediate goods are not considered. With regard to this last point, Löschel et al. (2015) reveal that the significance of indirect energy costs compared with direct energy costs has increased since the mid-2000s. The gross production value is essentially equivalent to the turnover of the businesses. However, the low share of direct energy costs should not detract from the fact that there is a high degree of heterogeneity between the individual economic sectors and businesses. This heterogeneity also applies to the energy mix in the individual economic sectors. ↘ CHART 121 CENTRE LEFT

In an aggregate analysis, energy costs in the year 2013 were far more important in the **chemical industry** with a proportion of 4.6 % of total costs than in machinery and vehicles manufacture, for example, with figures of 1.0 % and 0.8 % respectively. In addition, the share of energy costs in the chemical industry has increased by two percentage points since the year 2000. From the data it is not possible to ascertain to what extent the cost increase was caused by higher electricity costs or other sources of energy. Other energy-intensive industries include metal production, the paper industry, mining and the glass industry along with quarrying.

↘ CHART 121

Analysis of energy costs development



1 – Share in gross production value. 2 – Mining and quarrying, manufacturing sector. 3 – Relation of real gross value added to final energy consumption; annual average change. 4 – Share in final energy consumption. 5 – Companies with an average share of the energy costs of the gross production value of at least 2.3 %. 6 – Relation of gross investment to depreciation. 7 – Share of gross value added in production value excluding energy costs.

Source: BMWi, energy balances, survey on investment and cost structure among businesses in the manufacturing sector

The aggregate analysis, however, reveals the weakness that all businesses in a single industry are regarded as being equally energy-intensive. However, there can be profound differences within the sectors. A more precise **analysis with business data** can be performed on the basis of the microdata from the survey of cost structures and investment in the manufacturing industry. The microdata are from roughly 41,000 businesses, with information available on the total costs of energy, fixed capital formation, gross value added and the production value for the years spanning 2001 to 2013. With these data, it is possible to distinguish between energy-intensive and less energy-intensive businesses on the basis of the share of energy costs in the production value. Once this value has been determined, the average share of energy costs over time can be identified for each business.

Energy costs are an important location factor. It turns out that the top 10 % of energy-intensive businesses in the German manufacturing sector spend at least 4.8 % of their production value on energy. Energy costs account for a higher share in the overall costs than interest on borrowings on the average of all businesses in the manufacturing sector. This is true for all the years between 2001 and 2013. Hereinafter, energy-intensive businesses are defined as having an average proportion of energy costs of at least 2.3 %. This value is the mean value across all businesses. The energy costs of less energy-intensive businesses amounted to less than 1 % of the production value on average in the year 2013 and were largely constant. The costs for energy-intensive businesses stood at around 6.5 % on average and have increased by 1.5 percentage points since the year 2001. ↘ CHART 121 CENTRE RIGHT

In response to the higher energy costs, the businesses can try to take measures to increase their **energy efficiency** (energy productivity). At aggregate level, however, it becomes apparent that the energy-intensive sectors of the economy have only achieved a below-average reduction in their energy consumption in relation to the value added. ↘ CHART 121 TOP RIGHT While the energy efficiency of the manufacturing sector and of mining and quarrying increased by an annual average of slightly more than 1 % between 2000 and 2014, improvements in the energy-intensive sectors of the economy were not as high. This is in stark contrast to the automotive engineering sector which can boast a 3.8 % improvement in energy efficiency on a yearly average.

However, energy-intensive businesses seem to have found another way of reducing the burden of energy costs. Business data reveal a **significant decrease in the vertical integration of manufacturing** compared with less energy-intensive businesses in recent years. ↘ CHART 121 BOTTOM RIGHT Offshoring of energy-intensive production stages to another country may have played a role here. Coupled with the decline in the vertical integration of manufacturing, the investment activity of energy-intensive businesses was less than that of other businesses in the years between 2001 and 2013. On average, gross investment was 6 % above depreciation in the considered period. The figure was 10 % in the case of less energy-intensive businesses. ↘ CHART 121 BOTTOM LEFT However, this is a descriptive analysis that does not allow for causal statements. Nonetheless, the results do indicate that the increasing energy prices of recent years served as a dampening effect on the investment and production activity of German industry.

881. Instead of concentrating on these fine-tuning goals, the Federal Government should bring the international dimension of climate policy to the fore and make a long-term commitment to the **EU-ETS as a guiding instrument**. Up to now, the EU-ETS has only considered around half the greenhouse gas emissions of the participating countries. To effectively reduce emissions it should also be extended to the transport sector, private households and the industries exempted thus far. National support instruments and subsidies could be dropped.

The wide variety of instruments to attain the steering goals requires **enormous knowledge on the part of policy-makers**. They must know in what sectors the costs of greenhouse gas emissions abatement are the lowest. They must create long-term projections and also factor in action to circumvent special measures. However, the individual economic actors probably do not have much incentive to make this information available. The advantage of the EU-ETS or a carbon tax is that the goals can be reached using these instruments without this knowledge base, leaving it up to households and businesses to decide where they want to save energy or greenhouse gas emissions.

III. LESSONS FROM THE ELECTRICITY MARKET

882. So far, the implementation of the energy transition has been virtually synonymous with subsidising renewable energy in the production of electricity through the Renewable Energy Sources Act (EEG). As is clear from the overall evaluation of the goals of the Energy Concept and the attainment of these goals in the past five years, this support instrument has indeed proven **very effective**: it led to a previously unexpected expansion of electricity generation capacities using wind and solar power. But it was also **spectacularly inefficient** given that the costs of this support have literally skyrocketed without the electricity sector having made a serious contribution to cutting greenhouse gas emissions.

The developments in the electricity market make it clear how wrong it would be to split the task of organising energy policy into an "electricity transition", a "mobility transition" and a "heating transition" and to pursue these individual transition goals with small-scale sector-specific and technology-specific measures. Instead, the energy transition should take a holistic approach and maximise the benefits of the division of labour.

1. Technology mix in electricity generation

883. The Federal Government's Energy Concept focuses on the electricity market, and specifically on the expansion of **electricity production** deriving from renewable energy. Its share in gross electricity consumption has increased significantly in the past five years, climbing 14.6 percentage points to 31.6 %; therefore Germany will in all likelihood exceed its target of a 35 % share by 2020, as articulated in the Energy Concept. ↘ CHART 120 BOTTOM RIGHT To slow down this development, the Federal Government introduced deployment corridors for individual technologies with the 2014 Renewable Energy Sources Act.

884. In the GCEE's view, the primary issue is not that the overarching target will be exceeded but rather the **support given to specific technologies** - such as photovoltaics - which is motivated by industry policy. Direct support for individual renewable technologies might, perhaps, be economically justified in the early stages of their development as support for technical progress, which would be

driven by learning curve effects (spillover effects). However, if one third of electricity production is already derived from renewables, these technologies stopped being niche technologies long ago and in truth would already need to face competition without technology-specific support.

885. If, nonetheless, the decision is made to stick with the direct support of renewable technologies in the hope of additional learning curve effects, optimum support - which should only be granted to match the level of the externality - should be directed at the **installed capacity** of these technologies and not at their electricity production (Andor and Voss, 2016). This is because technological progress also only refers to the production and installation of capacities. Furthermore, support for electricity production in the form of fixed feed-in tariffs is the wrong approach as far as incentives are concerned. This is consistent with studies on the feed-in tariffs under the Renewable Energy Sources Act in Germany that indicate that these tariffs do not have a distinct, general effect of driving innovation (Wangler, 2013; Böhringer et al., 2013; EFI, 2014).

886. The strong expansion of renewable electricity production, is accompanied by insufficient progress has been made in the **grid and storage infrastructure**. The transportation of wind power from the north to the south of Germany is particularly problematic. However, the south's need for electricity will increase significantly, and will need to be satiated by other regions. By the end of the year 2019, the reduction in electricity generation capacity from expected plant closures will exceed the capacity being added by plants currently under construction, creating a capacity shortfall of 2.4 GW (Federal Network Agency, 2016a).

Grid expansion is, however, being constantly delayed by complex approval procedures and opposition from the local population. Using underground cabling instead would be very costly and would additionally drive up grid charges.

887. As a result of the **increase in volatile electricity generation** deriving from renewables and the planned decommissioning of power plants suitable for covering the base load, flexible electricity demand that responds to the volatile supply of electricity, for example, and better storage capacities are becoming increasingly important (acatech et al., 2015b; Elsner et al., 2015). The 2017 Renewable Energy Sources Act largely gets rid of the double EEG surcharge for stored electricity. However, investment in storage systems will be too low as long as the market participants are not directly confronted with a highly volatile electricity price. Greater flexibility in electricity demand through the use of smart grids is an alternative to electricity storage. ↘ BOX 31

888. In the absence of more flexible electricity demand and better storage capacities, we could expect more and more periods of excess electricity production in the years ahead. Forecasts suggest that the number of hours with **negative electricity prices** will exceed 1,000 per year by 2022 (Götz, 2014). A higher EEG surcharge would be the outcome.

In addition, the economically inefficient scenario arises in which renewable energy plants with zero marginal costs are taken from the grid when electricity prices are negative while expensive production with conventional power plants continues because they are expensive to start up and shut down. If current electricity market prices were passed on to end customers, price swings would reflect production volatility and thereby create market incentives for more flexible demand side, storage and load management.

↘ BOX 31

Smart Grids

As the large-scale storage of electricity has not been possible so far, a central feature of the electricity market is that electricity production must match a corresponding demand for electricity at all times. This generally does not need to be the case for goods markets. Electricity production particularly from wind and solar energy is **by its very nature volatile** and only rarely coincides with demand peaks. The need to physically balance electricity production and consumption therefore becomes all the more complex with increasing market penetration of renewable energy. Smart grids can therefore play a pivotal role in the energy transition.

Intuitively a **smart grid** is understood as a mechanism that efficiently brings into line the electricity demand, production and storage of multiple private households (or businesses). This is accomplished by evaluating a wide range of data using information and communication technology. The aim of smart grids, therefore, is to reconcile the geographical and temporal differences in electricity production and consumption. They could help reduce the need for grid expansion and storage systems (Alipour 2016) as the otherwise customary peaks in demand can be avoided in many cases. With electricity demand responding flexibly to fluctuations in production, less power generation capacity would be needed in times of demand peaks and less grid capacity for transport peaks.

Large-scale IT-assisted metering, communication and control systems are needed to make smart grids possible. First, metering systems are used to capture data on behaviour of consumers. These data are then analysed and communicated to the control system which is responsible for making appropriate adjustments to the power demand and the storage needs of a household. In June 2016, the Federal Government adopted the **Act on the Digitisation of the Energy Transition** and with it mapped the course for the gradual installation of smart meters. In contrast to most EU Member States, Germany does not require all electricity consumers to have a smart meter; instead the requirement will initially only apply to larger consumers and generation plants.

The volume of investment in smart grid technologies already tripled to €3 billion between the years 2010 and 2014 (Covrig et al., 2014). Starting in the year 2017, blueprints for wider implementation will be developed in Germany over the course of four years as part of five large-scale **smart grid demonstration projects** involving over 200 businesses (SINTEG programme of the Federal Ministry of Economics and Technology). The projects have a total investment volume of roughly €600 million and cover a large area of Germany, with "C/sells" spanning the states of Baden-Württemberg, Bavaria and Hesse; "Designetz" spanning North Rhine-Westphalia, Rhineland-Palatinate and Saarland; "enera" covering Lower Saxony; "NEW 4.0" covering Hamburg and Schleswig-Holstein; and "WindNODE" addressing east Germany and Berlin. The main barrier to the nationwide rollout of smart grids is, however, less the restructuring of the grid and more the need to fit households and businesses with suitable systems.

889. While the share of renewable energy in gross electricity production has increased, the shares of nuclear energy and natural gas have fallen (minus eight percentage points and minus five percentage points respectively). However, the share of **coal and lignite** stayed the same with a combined share of roughly 42 %. ↘ CHART 120 BOTTOM RIGHT The high share of coal-fired power plants is primari-

ly due to the fact that coal is currently the cheapest technology owing to the low carbon price (EU-ETS allowance price). This persistently high share of coal is one of the main reasons why greenhouse gas emissions in the energy sector have not declined further since the year 2009. ↘ CHART 120 TOP LEFT

890. To still be able to deliver on the goals of the energy transition, particularly the reduction in greenhouse gas emissions, public debate on **coal phase-out** has since got underway. The German Council of Economic Experts however urges the Federal Government not to once again use industry policy to intervene in the energy sector and instead let the technologies compete with one another within the European emissions trading system (acatech et al., 2015a). Then market signals would dictate which power stations should be the first to be shut down. Under the ETS, it is immaterial from a climate policy perspective whether this turns out to be coal-fired power stations or not.

The maintenance or even expansion of **reserve capacities** to balance output fluctuations of renewable power plants - also a hotly debated topic - is not necessary. This balance can be achieved through the better integration of the European electricity market, smart grid expansion and the advances in the research of new technologies. ↘ ITEM 887 FF. The German Council of Economic Experts reiterates its opposition to the introduction of capacity markets (2014 Annual Report Item 38; 2013 Annual Report Item 798).

2. Revision of the Renewable Energy Sources Act: costs still too high

891. **Total compensation payments under the Renewable Energy Sources Act** to the producers of electricity from renewable sources climbed to €27.3 billion in the year 2015. ↘ CHART 122 TOP LEFT However, the electricity suppliers do not pass on the total amount as the EEG surcharge to the consumers and businesses obliged to pay since the market value of the electricity supported by the Renewable Energy Sources Act is deducted beforehand. These differential costs amounted to around €22 billion in the year 2015 (BMWi, 2016). Average compensation from the EEG for one unit of electricity produced rose from 8.5 cent/kWh in the year 2000 to 17 cent/kWh in the year 2015.

This increase in compensation is primarily attributable to the change in the supported renewable energy technology mix over time. ↘ CHART 122 TOP RIGHT For example, the share of photovoltaics in total renewable energy has increased significantly. Support for this technology went hand in hand with a guaranteed high rate of compensation. ↘ CHART 122 BOTTOM RIGHT

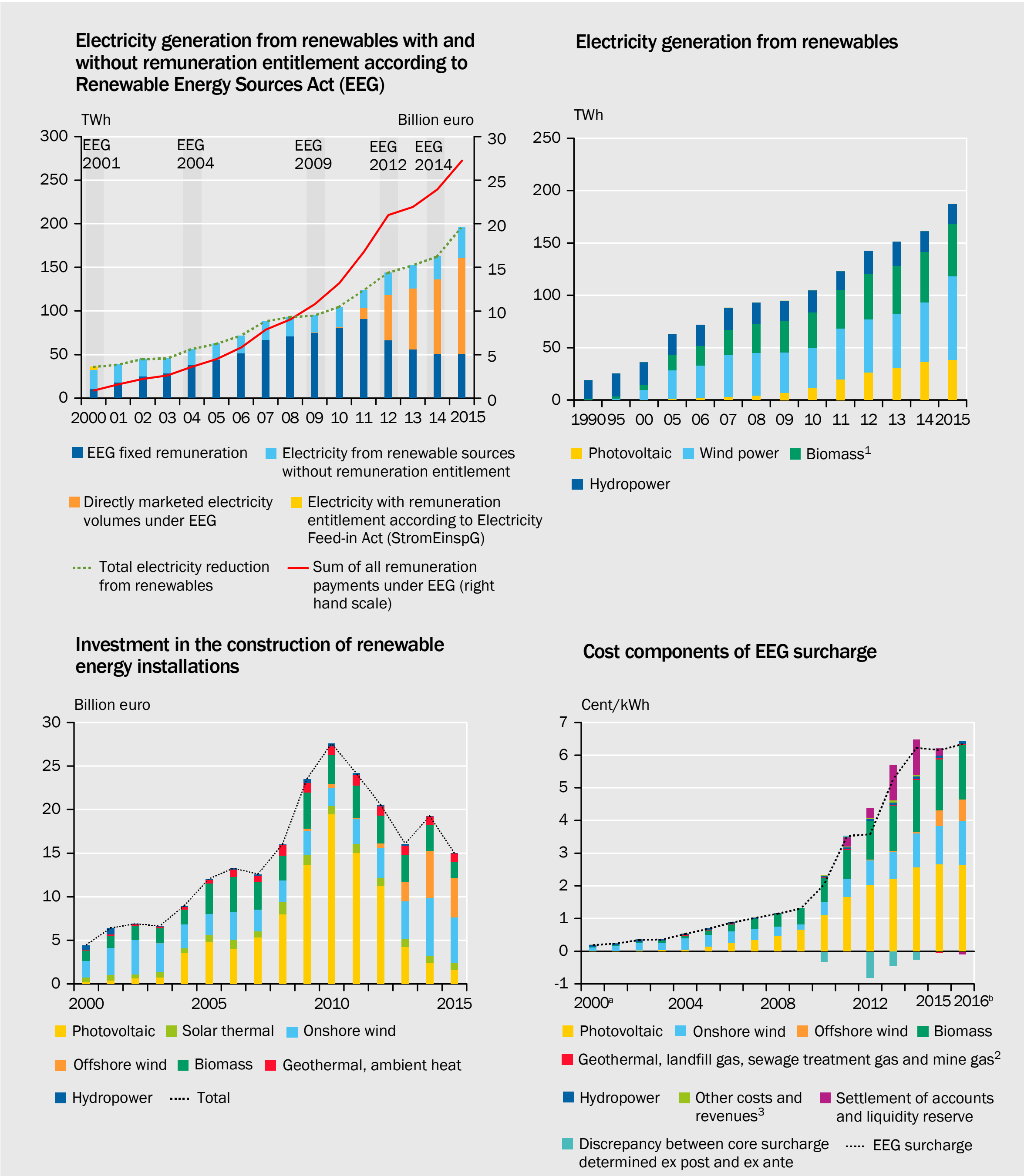
892. Policy-makers responded too late with **lower remuneration** to the cost increases witnessed around the year 2010 as a result of the sharp growth in investment in photovoltaic installations ↘ CHART 122 BOTTOM LEFT. And now there is a risk of a similarly late response with respect to offshore wind. Electricity generation deriving from offshore wind has increased almost nine-fold in the past three years, growing from 0.9 TWh to 8.3 TWh. With an electricity production share

of only 1.3 %, offshore wind was already responsible for 8 % of the differential costs in the year 2015.

893. There has been no further increase in **electricity prices** for private households and industry since the year 2013. ↘ CHART 123 This can be put down to two effects: For one, the drop in commodity prices and increasing volumes of renewable

↘ CHART 122

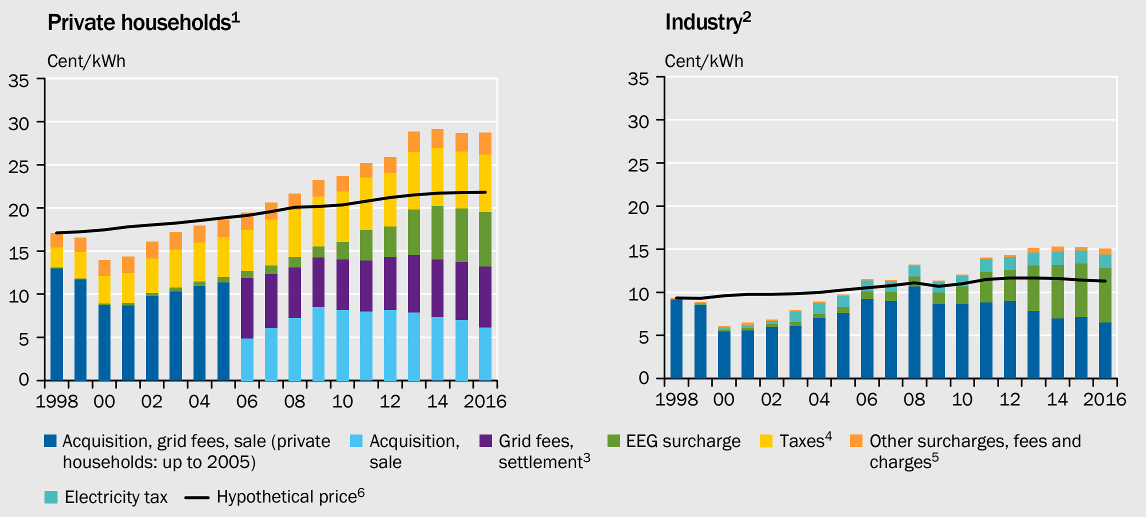
Electricity market and renewables in Germany



1 – Including biogenic share of waste. 2 – Landfill gas, sewage treatment gas and mine gas listed separately for first time in 2004. 3 – A.o. costs for listing and trading connection, interest charges, EEG bonus, retrofitting costs for 50.2 Hz problem and revenue for privileged final consumption, revenue from offshore capacity auctions and revenue according to Section 103 (6) of the Renewable Energy Sources Act in connection with Section 75 of the Renewable Energy Sources Act. a – short year: April 1, 2000- December 31, 2000. b – Forecast of transmission system operators (TSOs) in accordance with the Balancing Mechanism Ordinance and based on scientific reports.

Sources: BMWi, AGEE-Stat working group on renewable energy statistics, BDEW 2014, Federal Network Agency 2013, TSO 2015a, TSO 2015b, TSO 2015c, TSO 2015d and own calculations

↘ CHART 123
Electricity prices for private households and industrial customers



1 – Annual consumption of 3,500 kWh. 2 – Supply at medium voltage level: purchase 100 kW/1,600h to 4,000 kW/5,000h. 3 – Including metering and meter operation. 4 – VAT and electricity tax. 5 – Concessions fee, CHP surcharge, surcharge under Section 19 of the Electricity Grid Fee Ordinance and surcharge for interruptible loads. 6 – Own calculations: For private households: 1998 electricity price projected forward with the development of the consumer price index. For industry: 1998 electricity price projected forward with the development of producer prices for industrial products excluding electricity, gas and district heating.

Source: BDEW

electricity prevented any further increase in the price of electricity. Renewable energy is offered on the electricity market at a low marginal cost and therefore forces out conventional electricity producers that have a higher price (merit order effect). Secondly, the again increasing EEG surcharge prevented a drop in the electricity price, resulting from the lower price on the exchange for electricity.

894. A further increase in electricity prices can be expected in the future. This is because power grid operators can be expected to increase the grid charges if the Federal Government sticks by its current policy. Here the problems of the grid infrastructure in the context of volatile electricity production derived from renewables are becoming more and more apparent. The increasing costs are an indicator that renewable energy plants will receive payment in the future even if they are not in use as generation peaks do not necessarily coincide with a similarly high level of demand. This reflects delays in grid expansion between the north and south of the country and limited export possibilities to neighbouring countries such as Austria and Poland.

In all, it can be stated that a high degree of intervention in the generation capacity of power plants is needed to prevent an excess load on the power grids (redispatch measures). Furthermore, the costs of additional investment in the expansion of the power grids will lead to an increase in grid fees, albeit on a far smaller scale than redispatch measures (TenneT, 2016).

895. The **2017 Revision of the Renewable Energy Sources Act** introduces public tender procedures and auctions for the supported volumes of offshore and onshore wind as well as photovoltaics (PV) and biomass. ↘ BOX 32 These auctioning systems seek to markedly reduce the costs of support for renewable energy.

First pilots for rounds of auctions for PV took place in the years 2015 and 2016. A total of 500 MW and 125 MW were auctioned in the years 2015 and 2016 respectively with average accepted prices of 9.17 ct/kWh (15 April, 2015), 8.49 ct/kWh (1 August, 2015), 8 ct/kWh (1 December, 2015),7.41 ct/KWh (1 April, 2016) and 7.25 ct/kWh (1 August, 2016).

These values were below the previous funding rates of 9.02 ct/kWh (Federal Network Agency, 2016b). International experience also suggests that there is potential for cost reduction. The introduction of auctions in Brazil, China, the United Kingdom and Italy, for example, resulted in considerably lower remuneration rates.

896. In the opinion of the German Council of Economic Experts, the introduction of auctioning systems is a **correct step** towards better cost efficiency. In addition, it welcomes the initial small steps towards the technology-neutral organisation of the auctions. The GCEE has consistently called for more market elements in the promotion of renewable energy (2009 Annual Report Item 366 ff.). However, these auctioning systems have come far too late given the high payment commitments already made for existing installations.

Furthermore, the correct response to the explosion in costs witnessed for years in connection with the Renewable Energy Sources Act would have been to better synchronise the pace of expansion of renewables with the expansion rate of grids and storage systems. If policy-makers could not bring themselves to abandon national support instruments in favour of European trade with emission allowances, then this support should at least be **technology neutral**. This is the only way to bring about the urgently needed competition among the technologies (2014 Annual Report Item 36). Instead, in the 2017 Renewable Energy Sources Act policy-makers set the capacity volumes to be auctioned for the individual technologies, and in so doing are squandering potential for further cost reductions.

↘ BOX 32

Key elements of the 2017 Revision of the Renewable Energy Sources Act (EEG 2017)

The 2017 Renewable Energy Sources Act (EEG 2017) changes funding for four renewable technologies - onshore wind, offshore wind, photovoltaics and biomass - to a system based on **technology-specific auctions.** The remaining technologies (hydro power, geothermal) and certain facilities will remain in the system of fixed remuneration rates. The "flexible cap" rules therefore continue to apply particularly for small photovoltaic installations under 750 KiloWatt (kW), which accounted for up to 60 % of existing capacities for this technology in the last three years, or for small biogas installations with capacities less than 150 kW. Simply put, the "flexible cap" is a mechanism by which the remuneration rates of the individual technologies for new installations are adjusted downwards if certain expansion targets are exceeded (2014 Annual Report, Box 4).

The **capacity volumes to be auctioned** are set in advance in the EEG 2017 and the deployment corridor corresponds more or less to that of the previous 2014 Renewable Energy Sources Act. To stay within the corridor, the volumes for auction are adjusted annually such that if deployment falls outside the corridor one year the volume for auction is increased or decreased accordingly the following year. This can happen, for example, if projects agreed to in the auctions do not materialise or if the level of expansion of technologies that are not funded through the auction system - such as small PV installations - was too high. For the 2018-2020 period, the EEG 2017 also makes provisions for a small percentage of the volumes for auction (approx. 12 %) to be dedicated to combined auctioning procedures for onshore wind and photovoltaics, as well as technology-neutral innovation auctioning systems for pilot projects.

To reduce the costs associated with **grid congestion**, the Federal Network Agency will identify areas with choke points in the grid, known as grid expansion areas. In these areas, a limit is placed on the permitted additional capacity for onshore wind. In addition, the first steps are taken towards sector coupling. If the load on the grids is too high, not only can generation facilities be shut down (redispatch), as was previously the case, but now the excess electricity can be used in the heating sector using power-to-heat systems for example. The plant operators are compensated for this.

Since the introduction of the Renewable Energy Sources Act the amount of the feed-in-tariff for onshore wind depends on the geographical location. What is known as the **reference yield model** attempts to establish a level playing field across Germany. The basic intention is to relieve the strain on the still inadequate grid infrastructure by providing less or more funding respectively for wind-derived electricity at sites with favourable and less favourable conditions. The 2017 Renewable Energy Sources Act simplifies this model but essentially retains it. Plant operators for a period of 20 years receive a constant rate of remuneration, which is pegged to the quality of the site. The stakeholders bid on a remuneration rate for a 100 % reference site. Depending on the quality of the site, the rate of remuneration is then multiplied by a correction factor of between 0.79 (over 150 % of the reference site) and 1.29 (below 70 %). Therefore installations in windier sites get a lower remuneration rate than installations in less windy places.

The German Council of Economic Experts deems the reference yield model to be **inefficient**. Instead, the actual problems of grid expansion, such as political disputes (north-south power line) and lengthy approval procedures, should be addressed.

897. The 2017 Renewable Energy Sources Act sticks by the deployment corridor for renewable energy and there is nothing to prevent an excess share of renewable energy in gross electricity production in the future. ↘ BOX 32 While a similar increase in the share of renewables in electricity production would have been possible with the **quota model** preferred by the German Council of Economic Experts or with technology-neutral auctioning systems, the costs would be lower because preference would be given to the most efficient technologies (2011 Annual Report Items 435 ff.; 2012 Annual Report Item 502; 2014 Annual Report Item 36).

With a technology-neutral system, the odds that photovoltaics or offshore wind power would be funded would be low. Funding for both these technologies through the 2017 Renewable Energy Sources Act ultimately boils down to industrial policy more than anything else. However, there was no reason to expect a more far-reaching reform of the Renewable Energy Sources Act given the huge pressure from various lobby groups and parties benefitting from the current system.

3. The potential of sector coupling

898. Recently efforts have been stepped up to use electricity from renewable sources to cover the energy needs in other sectors, such as industry, transport or households. For one, this **sector coupling** seeks to create new ways to address increasingly volatile electricity generation, such as by using new storage technologies and smart grids. ↘ BOX 31 Furthermore, by using new technologies it might be possible to replace the power generated from fossil fuels such as oil or coal with electricity derived from renewables. This applies in particular to the transport sector, which has primarily relied on fossil fuels up to now.

899. Other sectors must indeed be involved if the ambitious goal of reducing greenhouse gas emissions by 80 % to 95 % until the year 2050 ought to be achieved. Concentrating exclusively on the energy sector would not be enough since this sector was only responsible for 45 % of all greenhouse gas emissions in the year 2014. However, Germany's **energy policy** has so far viewed the individual sectors of electricity, heating and transport in isolation and adopted a large number of separate measures, particularly requirements, for each individual sector.

900. Even today we can point to several examples that clearly demonstrate how **sector coupling** works and the **potential** it offers. In addition to using electric cars that are powered by renewable electricity, in many cases sector coupling refers to the ability to convert energy from electricity to other energy carrier using what are termed "power-to-X technologies". These technologies comprise the conversion of electricity

– to heat (power-to-heat),
– to hydrogen or methane (power-to-gas)
– or to liquid fuels (power-to-liquid).

The energy carriers resulting from the conversion of electricity can, in turn, be used directly or be stored. In this way, power-to-X technologies can additionally contribute to flexibilising the supply of energy. Furthermore, different applications could be interconnected. For example, electric cars can equally be used as a method of transport and as an electricity storage medium whenever they are not on the road (vehicle-to-grid). ↘ BOX 31 However, many of the ideas for sector coupling **are not yet mature enough** for **mass production.** For example, power-to-X technologies tend to be characterized by high energy losses during the power conversion process.

In addition, there is currently little economic incentive in the heating and transport sector to switch from fossil fuels to electricity. This is a prime example of the sometimes **unintended side-effects** that sector-specific support can have on other sectors. Since the EEG surcharge, grid charges and an electricity/energy tax drive up the price of electricity, it is far more expensive to run an electrical heat pump than to generate heat with natural gas and heating oil, which are essentially unaffected by these cost components. Furthermore, it is still much more costly to use an electric car in the transport sector than a car that runs on diesel or petrol (Fraunhofer IWES and Fraunhofer IBP, 2015).

901. In terms of economic policy, therefore, the question is how to provide efficient support for these new technologies. Past experience shows that policy-makers prefer to rely on **subsidy-based solutions**. For example, in its attempt to promote the electrification of the transport sector the Federal Government introduced incentive premiums ("eco-bonus") of up to €4,000 for the purchase of hybrid and electric cars (up to a list price of €60,000) and a tax bonus for electric cars. While the support scheme hopes to boost electric car purchases and put at least 300,000 additional electric cars on the road, only 4,451 applications had been made in the first three months of the scheme (1 July-30 September 2016), (BAFA, 2016).

902. In contrast, the German Council of Economic Experts believes that **direct research funding** should generally be given priority over a subsidy-based solution. While learning curves and decreasing average costs as a result of the higher demand can be cited as factors encouraging innovation when these technologies are promoted through subsidies, the same political-economy problems that occur with the promotion of renewable energy through the Renewable Energy Sources Act also occur here: once a funding mechanism motivated by industrial policy has become established it is extremely difficult to break away from it again.

Furthermore, it is debatable whether the eco-bonus actually helps German carmakers, which lobbied very hard for the scheme, become more competitive in the electric car sector. These doubts are fuelled not least by the fact that 47 % of the applications between July and September 2016 for the "eco-bonus" were submitted for foreign-made hybrid and electric cars (BAFA, 2016).

903. Above all, we are once again faced with the problem that policy-makers cannot reliably predict which technologies can make the biggest contribution to reducing greenhouse gas emissions. The best way to resolve this **information problem** is to allow the market to decide and expose all sectors combined to the technology-neutral incentive effects of emissions trading.

In this way, not only could the electrification of other sectors contribute to the reduction in greenhouse gases but **sector coupling in the broader sense** could also be pursued. Not least, private stakeholders can reduce final energy consumption (energy efficiency) in the mobility sector, for instance, by changing their behaviour patterns. Up to now, this potential for price-induced changes in behaviour has been largely untapped.

IV. CONCLUSION: AIM FOR GREATER DIVISION OF LABOUR

904. The Paris climate summit could constitute a milestone in efforts to tackle global climate change with a **globally coordinated climate policy**. Germany will **chair the G20** in the year 2017**.** In this capacity, the Federal Government has

the opportunity to work towards an agreement on an efficient implementation mechanism to follow on from the national commitments to reduce greenhouse gas emissions. In principle, two approaches can be pursued to deliver this reduction whilst ensuring the least possible loss of value added worldwide: a global emissions trading system and a global emissions tax.

Limiting climate change by effectively reducing greenhouse gas emissions is a gargantuan task. It would be foolish and very probably futile to pursue smaller-scale national or even regional strategies instead of a globally coordinated approach that leverages the benefits of the **international division of labour** and relies on market signals to resolve information issues.

905. The goal of forging a global alliance for the introduction of a global solution of this kind conflicts with the strong desire for economic development among emerging and developing countries. This goal can therefore only be achieved if a simultaneous agreement is reached on **global burden-sharing** that is sufficiently attractive for these countries. A global emissions trading system or a global emissions tax can be complement accordingly in this context. This could be achieved through an appropriate allocation of emission permits at the start or through suitable rules surrounding access to funds in the Global Climate Partnership Fund which has already been agreed.

The problems of efficient emissions reduction and of sharing the resulting burden can therefore be approached as discrete concepts and resolved separately. On the long term, therefore, there is no justification to limit climate policy to purely national approaches of the energy transition: the best opportunity to reframe global climate protection is now.

906. In contrast, Germany's current national energy transition is **expensive and inefficient** since it chiefly relies on subsidies and requirements instead of market mechanisms. Furthermore, it is not immediately apparent how it should slot into a globally coordinated approach to climate policy. If the primary objective of the energy transition really is Germany's contribution to global climate protection and if, above all, the restructuring of German (industrial) society is not to be pursued as an objective in itself, then there are far superior ways to achieve this goal.

The overriding goal of a consistent and significant reduction in greenhouse gas emissions should not be called into question here. However, in keeping with considerations at the global level, an economically efficient national climate policy should be based on the advantages of the division of labour and the use of market signals to resolve information problems.

907. In the opinion of the German Council of Economic Experts, the best solution would be to include **all sectors** of final energy consumption **in the EU emissions trading system** in addition to the energy sector and to improve the functioning of the system on the basis of experience gathered thus far. The emissions trading system would then ensure that - in Europe at least - emissions are reduced where the costs of greenhouse gas abatement are the lowest.

Furthermore, ideally all technology-specific and sector-specific support measures and support measures limited to a specific region (including the promotion of renewable energy) should be abandoned. However, this will likely prove to be difficult considering the massive opposition from those benefitting from the current system in Germany. Therefore, we should **at least aim for** a support system for renewable energy that is **technology-neutral, sector-neutral** and **transregional** instead of the funding policy currently in place.

A differing opinion

908. One member of the German Council of Economic Experts, Peter Bofinger, has a different opinion regarding the views presented in this chapter.

909. The majority of Council members finds the Renewable Energy Sources Act (EEG) to be **"spectacularly inefficient"** given that "the costs associated with this support have literally skyrocketed without the electricity sector having made a serious contribution to cutting greenhouse gas emissions".

It justifies this argument by stating that pollutant prevention through the use of renewable energy has negative repercussions for the ETS market.

"For one, the 122.1 million tonnes of CO_2 equivalent were not saved in the form of CO_2 emissions because the EU-ETS allowance price was not zero in the year 2015 and the allowances were therefore used for other CO_2-heavy purposes. Secondly, renewable energy had a dampening effect on the EU-ETS allowance price. Coupled with the global market prices for fossils fuels, such as coal or natural gas, that have been falling since the year 2011, this has made fossil fuels very cost-effective once again."

910. This argument fails to recognise the fact that the EU-ETS is already characterised by a **considerable overabundance of allowances**, which the European Commission (2016) puts at about 2 billion CO_2 equivalents. The Commission identifies unfavourable economic developments and the ability to generate allowances by investing in energy in emerging and developing countries as the primary reasons for this development. From this angle, the influence of the reduction in CO_2 demand through German climate policy is comparatively low. In addition, through its **back-loading** policy in the years 2014 to 2016 the European Commission has reduced the cap by 900 million allowances. One could therefore argue that this also removed the amount of German pollutant prevention from the market.

The majority is even in favour of intervention to reduce the number of excess allowances in order to stabilise the price signal deriving from emissions trading. ↘ ITEM 33 FF.

911. Contrary to the majority opinion, the EU-ETS and the promotion of renewable energy through the Renewable Energy Sources Act are generally **not incompatible**. When setting the cap for emissions under the EU-ETS, which will decrease significantly over time, the funding measures implemented with the Renewable Energy Sources Act and practised in other countries, and the targets formulated by the European Commission itself for the expansion of renewables, are already being factored in.

Therefore, problems with the interaction of the two instruments only arise if there is an **unexpected expansion** in support through feed-in tariffs. However, this issue should not play a major role in the future with the increasing use of auction systems. In this way, the European Commission can take full account of Germany's contribution to emissions prevention when setting the targets. If this is not done adequately, this is proof of the inefficiency of the EU-ETS and not of the inefficiency of the Renewable Energy Sources Act.

912. Furthermore, the efficiency of the Renewable Energy Sources Act should be appraised in a larger, target-specific context. There is broad consensus that we need to **largely decarbonise** by the middle of this century. In terms of this target, the Renewable Energy Sources Act has managed to greatly increase the production of energy from renewable sources and spectacularly drive down the costs of electricity generation. Given the global success of renewable energy, one can indeed attest that while German policy-makers perhaps did not have a "vast amount of knowledge" they did have adequate knowledge when they decided to invest massively in the promotion of renewable energy.

913. Besides, there is little evidence to argue that investment decisions of the market players, taken alone, would deliver fundamental changes to the energy policy of a country. For example, nuclear energy only became competitive with large-scale support from the government.

Had we not introduced the Renewable Energy Sources Act and only relied on the EU-ETS, we would not have witnessed a similar level of investment in renewable energy given the huge surplus of allowances that would also have occurred in the absence of the emission reductions through renewables, and the correspondingly low allowance price.

914. In any case, even a far higher allowance price does not guarantee sufficient incentive for investment. Sonnenschein (2016) identifies the following problems with an energy policy that is based solely on the ETS:

- It is unable to take account of **positive externalities** resulting from the fact that social gains from research and development in the field of renewable energy are greater than private gains. Investment in renewable energy is therefore too low.
- Energy markets are often not fully liberalised and **oligopolistic structures** present barriers to access in energy generation and distribution.
- Technologies with the lowest avoidance costs emerge primarily, thereby preventing the cost degression of technologies that are more costly but that are

needed to achieve long-term energy targets. Delays in the use of such technologies result in higher costs over the longer term.

- The large fluctuations in allowance prices and periodic changes of the allowance cap creates a **high degree of uncertainty for investors**. This is particularly problematic given the high fixed costs and the very long investment period for renewable energy. The "clear, reliable long-term incentives" for market players, as demanded by the majority, are therefore provided by the Renewable Energy Sources Act and not by the EU-ETS.
- The emissions cap is a **policy variable** to a large extent. Therefore the price signals from carbon allowances have been too low thus far to make investment in renewable energy attractive.

915. The finding that the **prices in the emissions trading systems** are generally too low to deliver incentive for investment in renewables is confirmed by a recent OECD study (2016). The study looks at the experience of 41 countries that either have carbon trading systems or levy an emissions tax. The OECD identifies a gap between the effective carbon price and the price of €30 per tonne of CO_2, which is considered to be the minimum price needed from an ecological perspective. The gap is zero at a carbon price of €30 and is 100 % at a carbon price of zero. Currently the actual gap is 80 %.

916. There is no evidence to support the majority opinion that the quota model preferred by the German Council of Economic Experts or technology-neutral auctions would have delivered a similar increase in the share of renewables in electricity generation but at a lower cost as priority would be given to the most efficient technologies. In any case, the UK experience with the quota model ("renewables standard") in the period 2002-2009 demonstrates that it was not possible to reach the quantity targets with this approach (Bofinger, 2013).

917. Finally, the demand that German energy and environmental policy should recognise that global climate change mitigation - and not national industrial policy - is its top objective cannot be supported. This again reveals the fundamental lack of understanding of the interaction between the Renewable Energy Sources Act and the EU-ETS.

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