SIXTH CHAPTER

Energy policy: Effective Energy Transition only in the European Context

The key points at a glance

The German government's energy policy guidelines have undergone a profound change over the past 14 months. In September of 2010, the government enacted a comprehensive Energy Concept featuring a number of **climate policy goals** that extend both existing and new renewable energy targets to 2050. Originally, a central component of this concept was to extend the operating time of nuclear power plants, which were seen as a bridge technology in the era of renewable energies. After the nuclear disaster in Fukushima, however, the government made an abrupt **U-turn** by mandating the complete phase out of nuclear energy by 2022. As a consequence, an entirely different system of energy supply must be established. The current energy policy deliberations mark just the beginning of this process, with its successful completion still a distant goal.

The implementation of the Energy Concept and the withdrawal of the extension of nuclear power will primarily impact the German **electricity market**, which has already experienced important changes in recent years owing to the liberalization of the European market and the financially supported development of renewable energies. Both developments have led to a decoupling of regional power generation and power consumption, requiring a significant **expansion of the transmission network** beyond the modest expansion that has occurred thus far. Overall, the integration of renewables into the power grid poses the biggest hurdle in implementing the energy transition.

The technology mix of electricity generation in Germany is now strongly influenced by **renewable energies**. Their further expansion in accordance with the objectives of the Energy Concept is a technological and financial challenge that can only be achieved with strict adherence to the principle of **cost efficiency** and the concerted exploitation of scale effects. To this end, the European dimension of the energy transition must be brought into sharper focus, so that the plants producing electricity from renewable energy sources are built in those locations where the best topographic and climatic conditions exist, as in the case of photovoltaics in Southern Europe.

The Council of Economic Experts therefore recommends that the national promotion of renewable energies is first converted into a **quantity or quota system** in the form of green power certificates so as to ensure a support regime that is technology-neutral. In a second step, this support system should be integrated with that of other Member States that have already implemented or are planning quota systems. In the long run, this would foster the standardization of support schemes in the European Union.

The switch to quota systems would uncouple the promotion of technological innovation from the promotion of renewable energies. While capacity-building is fostered by the quota system, the promotion of technology should proceed separately according to economic principles and innovation-oriented instruments.

I. The Energy Concept and Nuclear Phase Out

364. In June 2011, following the Fukushima nuclear catastrophe the previous March, the German government introduced a package of laws that would accelerate the energy transition. The focal point of this so-called Energy Package is the implementation of measures that were articulated in the **Energy Concept**, which was passed by the federal government on September 28, 2010. This document maps out the contours of a comprehensive strategy by which the generation of electricity in Germany would shift primarily to renewable energies by the year 2050. A central component of the Energy Concept was originally to extend the operation of nuclear power plants by an average of 12 years. This extension was one of the first measures implemented under the Energy Concept, but it was subsequently repealed following the Fukushima disaster under the framework of the Energy Package.

The withdrawal of the nuclear extension marked a turning-point in the long running debate on the peaceful use of atomic energy. With the enactment of a comprehensive plan to restructure energy supply, a cornerstone of which is the complete phase out of nuclear power within the coming decade, it has become clear that there is **no turning back** on the question of atomic energy. Moreover, the fact that the climate goals set out in the Energy Concept have not been revised despite the nuclear phase out only punctuates the seriousness of efforts to fashion a comprehensive energy transition. The future will require a completely new system of energy provision, particularly as regards the integration of renewable energies.

The Energy Concept of the German Government

365. The government's Energy Concept comprises a suite of **climate targets** and expansionary goals for renewable energies, as well as a bundle of **legal changes** for fostering this expansion. The concept brings together an array of federal laws and policy packages that promote climate protection by setting caps on greenhouse gas emissions and by stipulating goals for the development of technologies and energy sources. The Energy Concept also partially amends existing goals and extends them to the year 2050. In some cases this involves integrating guidelines of the European Commission into national policies.

366. The government's Energy Concept thereby affirms the goal already set out in the Integrated Energy and Climate Package (IECP) of 2007, which aims to reduce **greenhouse gases** by 40% of their level in 1990 by 2020. The Energy Concept additionally contains goals for the reduction of energy consumption and the promotion of environmental technologies. Specifically, the goals set for 2020 in the Renewable Energy Directive of the European Union were carried forward to the year 2050. Accordingly, the **share of renewable energies in gross energy consumption** should increase from the current level of 11% to 60% by 2050.

Based on Germany's Integrated Energy and Climate Package goal of increasing **the share of renewable energies in gross electricity consumption** from the current level of 17% to 35% in 2020, the share should increase further to 80% according to the Energy Concept. Furthermore, relative to 2008, **electricity consumption** should decrease 10% by 2020 and 25% by

2050. Reduction goals are likewise specified for total primary energy consumption and for final energy consumption in the transport sector (Table 24).

Table 24

Climate and energy policy goals of the federal government's Energy Concept

	Initial value	Predetermined targets			
	2010	2020	2030	2040	2050
Changes (%):					
Greenhouse gas emissions compared to 1990	– 23	– 40	– 55	– 70	– 80
Primary consumption of energy compared to 2008	– 1	– 20	.	.	– 50
Consumption of electricity compared to 2008	– 2	– 10	.	.	– 25
Final consumption of energy in transport sector compared to 20(	– 1	– 10	.	.	– 40
Shares in %:					
Renewable energies in gross final consumption of energy	*11*	*18*	*30*	*45*	*60*
Electricity generation from renewable energies in gross consumption of electricity	*17*	*35*	*50*	*65*	*80*

Sources: AGEB, AGEE, BMU, Federal Government, UBA

367. The guidelines set out by the government are intended to be indicative; they serve to orient stakeholders with an expected development path. As a comparison with the already reached reductions in emissions and the expansion of renewables illustrates, at issue are **extremely ambitious objectives**, which, given the current structure of energy provision and consumption, take us into unchartered territory. In light of their inherent volatility, the reliance on renewable energies to guarantee a high degree of energy security represents a particularly daunting challenge.

The government wants to regularly measure progress in reaching the goals on the basis of a scientifically-founded review. This **Monitoring Report** will be prepared on a yearly basis by the BMWi and BMU with the participation of other concerned agencies and, following adoption by the cabinet, will be submitted to the German Bundestag and the Bundesrat (the lower and upper houses of parliament, respectively). The first Monitoring Report covering 2011will be prepared by the end of next year. In addition, a **Progress Report** will be prepared every three years. In order to better identify trends, the first Progress Report in 2014 will be based on a data base encompassing several years. A commission of energy experts has been set up to provide scientific oversight of the monitoring process.

368. Among the concrete measures contained in the Energy Concept is an amended version of the **Renewable Energy Law** (EEG). The measures contained therein should improve the cost efficiency of the promotion of renewable energies, encourage system integration, and increase the transparency of the law. To this end, the introduction of a so-called market premium is planned, which will provide incentives for electricity feed-ins in periods of high demand in order to facilitate the system integration of renewable energies. Fundamental changes to the compensation structure of the EEG are not planned in the Energy Concept.

Beyond this, the Energy Concept stipulates a range of **changes in administrative** law that will dismantle barriers to the expansion of renewable energies and expedite the approval process, particularly as regards off-shore wind energy and network expansion.

369. In order to reach climate protection goals at low cost, a key component of the Energy Concept was an **extension of the operational period of nuclear power plants** by an average of twelve years. This extension was passed by the Bundestag on October 28, 2010. To siphon off a portion of the resulting profits, a **nuclear fuel tax** was simultaneously introduced that was to generate an additional €2.3 Bn in revenue yearly for the federal budget. In addition, a portion of the revenues from the auction of emission certificates would go to the newly established **Special Fund for Energy and Climate**, which finances the promotion of innovative technologies for the generation, storage, distribution, and use of energy.

370. Following the catastrophe at the Japanese reactor in Fukushima on March 11, 2011, however, the government made an abrupt **U-turn** in its atomic energy policy. Just days later on March 14, the decision was made to undertake a comprehensive security test of all 17 German nuclear power plants. At first, the seven oldest plants were shut down for a period of three months in a so-called moratorium. In June 2011 the government then resolved to expedite the repeal of the nuclear extension that had been part of the Energy Concept; by 2022 the use of atomic energy was to be ended. The other components of the Energy Concept remained unchanged.

371. In reaching this resolution the government relied on the recommendations of the ad hoc Ethics Commission for Secure Energy Supply. This Commission concluded that a nuclear phase-out was necessary for ethical reasons and was technologically feasible. The point of departure of the Commission's deliberations was the impression that the question of the basic role of nuclear energy in meeting the country's energy needs was fundamentally about **societal values**. According to this line of thinking, the reactor catastrophe in Japan necessitated a new appraisal of the risks associated with atomic energy, irrespective of the fact that these risks had objectively not changed (Ethics Commission). The recommendation of the Ethics Commission to irrevocably phase out nuclear power within a decade was based on a weighting of economic efficiency, social cohesion, and ecological tolerance, which together constitute indispensable elements of **sustainable economic activity** (Expertise 2010).

372. The changes in the Atomic Energy Law that were associated with the repeal of the nuclear extension were introduced with six additional laws to support the measures of the Energy Concept that were enacted on June 30, 2011. Referred to by the government as the **Energy Package**, these seven laws most notably contain the repeal of the nuclear extension in addition to an amendment to the EEG to promote the system integration of renewable energies and simplify the compensation scheme. In addition, the package contains an array of changes in administrative law to prevent companies from hoarding approvals for wind energy projects (see Box).

The draft of the Thirteenth Law on the Amendment of the Atomic Energy Law was supported by virtually all parties in the Bundestag. The only party to completely oppose the draft was DIE LINKE. The Bundesrat debated the package of laws on July 8, 2011. With the exception of a law on the tax-deductible energy-saving renovation of residential buildings, all of the laws were passed.

Box 14

The Energy Package of the German Government

The term "Energy Package" refers to a set of seven laws that were negotiated by the German Bundestag on June 30, 2011 and by the Bundesrat on July 8, 2011. With the exception of the Thirteenth Law on the Amendment of the Atomic Energy Law, the other six laws are intended to contribute to the implementation of the Energy Concept, enacted by the government in September 2010. The relevant details are found in the following laws:

The **Thirteenth Law on the Amendment of the Atomic Energy Law** repeals the extension in the operation of nuclear power plants, which had been enacted only recently by the German Bundestag on October 28, 2010. The law ends the use of nuclear energy for the commercial generation of electricity by the end of 2022. All nuclear power plants are thereby subject to a binding termination of their entitlement to maintain power operations. The seven nuclear plants that are subject to a moratorium and the Krümmel Reactor, which was disconnected due to numerous incidences, will not be reconnected to the grid. Depending on how the operators of nuclear plants made use of the opportunities to transfer the remaining operation time that where specified in the Atomic Energy Law of 2002, it may be the case that the last plant is closed before 2022.

With the **Law on the New Regulations for the Promotion of Electricity Generation from Renewable Energies (EEG Amendment 2012)**, the government aims to: (1) improve the cost efficiency of the promotion of renewable energies; (2) promote the market- and system integration of renewable energies; and (3) contribute to the simplification and transparency of the EEG. The EEG amendment essentially maintains the already existing compensation structures, but in some respects these structures were vastly simplified. The system service bonus for on-shore wind energy was extended to 31.12.2014 (formerly limited to 31.12.2013) for new installations and to 31.12.2015 for existing installations. To promote market- and system integration, an **optional market premium** and a **flexibility premium** were included in the law, features intended to provide additional incentives to feed-in electricity when demand is high. At the same time, the threshold for claiming an exception from the EEG-specified contribution for manufacturing firms was lowered considerably.

The **Law Strengthening Climate-friendly Development in Cities and Counties** includes a climate protection clause in the building code specifying that building plans should contribute to "climate protection, in particular through climate-friendly urban development." The law furthermore makes it easier to deploy and use photovoltaic panels, including on buildings. To support repowering – the substitution of old installations with high performance ones – building plans can specify that wind energy installations are only allowed when other wind energy installations are dismantled.

The **Draft Law on Tax Deductible Energy-saving Renovations in Residential Buildings** envisions that the deduction for additional construction on residential buildings built before 1995 increases from 2-2.5% of expenditures to 10%.The yearly burden of the law on public budgets would have reached €1.5 Bn, of which more than half would have been borne by the states (Länder) and counties. The Bundesrat has therefore withheld ratification thus far.

The **First Law on the Amendment of Marine Regulations** aims to reduce hoarding of approvals for off-shore projects and to bundle such approvals. The necessity of this law is evidenced by the fact that at the moment 25 off-shore wind parks have been approved but only three have been built.
The **Law on Measures to Accelerate the Extension of the Electricity Network** aims to accelerate the expansion of maximum- and high voltage level electricity networks. Under the auspices of the Federal Network Agency, the law introduces a uniform planning process for electricity transmission lines having trans-regional relevance.

The **Law Revising Energy and Economic Regulations** addresses primarily changes to the Energy Industry Act that will revise planning requirements for transmission networks. This law guarantees for the first time a coordinated, joint network expansion plan of all transmission lines and transmission system operators. It additionally involves the state via the Federal Network Agency in all stages of requirements planning.

The shortened period of the nuclear phase out removes the expectation that revenues will accrue from the additional profits of nuclear power plant operators. A portion of these revenues was originally intended for the “Energy and Climate Fund.” Revenues from the tax on nuclear fuel will likewise shrink. To compensate for the reduced revenue, the revised law that establishes the “Energy and Climate Fund” designates all revenues obtained from the auctioning of emission certificates for the fund. It was originally planned that only revenues exceeding the first €900 million obtained from auctioning would be used for this purpose.

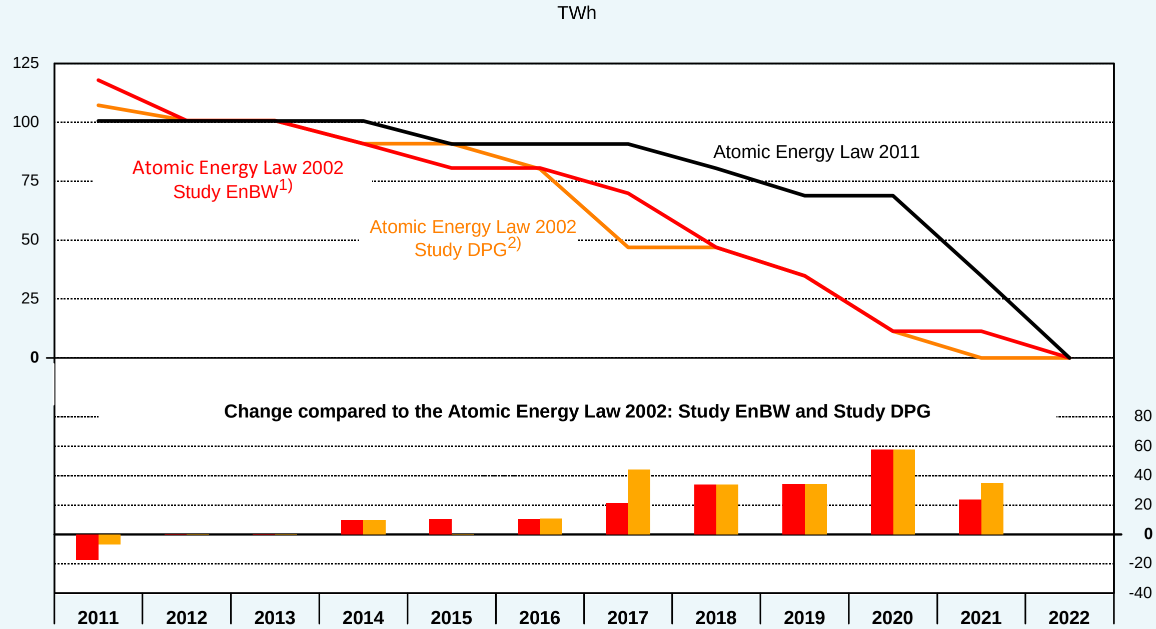
Nuclear phase out

373. The repeal of the nuclear extension has effectively set policy back on the same **exit path** it was on before the beginning of the legislative period. Based on the average gross electricity generation of the past three years, the revised amendment for the Atomic Energy Law is likely to lead in 2012 to a modest decrease of gross electricity generation from nuclear power relative to that set in the Atomic Energy Law of 2002. In the time period from 2012 to 2022 the nuclear phase out will proceed more slowly than foreseen in the phase out resolution of the former red-green government coalition. Although the last nuclear power plant will go offline in 2022, until that time there will be a few plants in operation longer than would have been expected under the Atomic Energy Law of 2002.

Nevertheless, it is important to recognize that under the Atomic Energy Law of 2002 plant operators had significantly more opportunities for transferring **residual electricity**, which complicates an appraisal of the original exit path. But even when alternative exit paths are considered that are consistent with the Atomic Energy Law of 2002, the basic tendency is unaltered: The exit path set by the amendments to the Atomic Energy Law in 2011largely correspond by and large to the effective exit path set at the beginning of the legislature period (Chart 54).

Chart 54

Expected gross generation of electricity from nuclear power plants



1) EnBW study, December 2006.– 2) Study of the German Physical Society (DPG), September 2005.

Sources: Atomic Energy Law, DPG, EnBW and own calculations

374. According to various studies, the extension of the operating time by an average of 12 years in the period from 2015 to 2030 would have led to a decrease in the wholesale price of electricity by 0.4ct/kWh to 2.5ct/kWh. The gross domestic product in this period would have been 0.1% to 0.6% higher than under the currently effective exit path (Box 15). Cumulatively, these differences amount to upwards of €120 Bn. (IER/RWI/ZEW, 2010). By contrast, the repeal of the nuclear extension can be expected to lead to a modest decrease in production potential over a transitional period, which may have already been partially realized through the shutdown of plants under the moratorium in the second quarter of 2011.

Box 15

Costs of the Nuclear Phase Out

In the run-up to the passing of the Energy Concept in September 2010, several studies were produced that analyzed possible long term development paths of German energy provision under alternative assumptions regarding the operation period of nuclear power plants and the development of energy demand, raw materials prices, and population growth.

Some of these studies can be used to estimate how the planned nuclear extension would impact electricity prices and gross domestic product. As specified in the original Energy Concept, the average extension period encompasses 12 years, which would correspond to a termination of the last nuclear plant in the period from 2035 to 2038. Other studies can be drawn upon that contain an **exit scenario** corresponding approximately to that foreseen in the Atomic Energy Law of 2002, which calls for Germany's nuclear reactors to be taken offline by the beginning of the 2020s. So long as the differences in these scenarios are primarily limited to the operation time of the nuclear power plants, then the latter scenario can be used as a baseline. The effects of an **operational extension** on electricity prices can then be calculated from the difference in prices between the extension scenario and the baseline. The same principle can be used to calculate the effects on gross domestic product. Because the nuclear phase out specified in the amendment to the Atomic Energy Law from 2011 sets essentially the same course as the Atomic Energy Law from 2002, the efficiency gains calculated from a nuclear extension mirror the estimated costs of the nuclear phase out.

In total there are five studies that consider the exit paths having the above described characteristics and that explicitly identify the electricity price under the alternative scenarios (enervis energy advisors, 2011; EWI/GWS/Prognos, 2011; IER, 2011; IER/RWI/ZEW, 2010; PIK and University of Leipzig, 2011). All of the studies estimate the electricity price for the alternative scenarios using an electricity market model that reflects the German power capacities at the level of power plant units. The studies take into account the variable cost of the power plants (per unit fuel costs, utilization rate, costs for emissions certificates) and the plant-specific start-up and shutdown costs (Kondziella et al., 2011; Ellersdorfer et al., 2008).

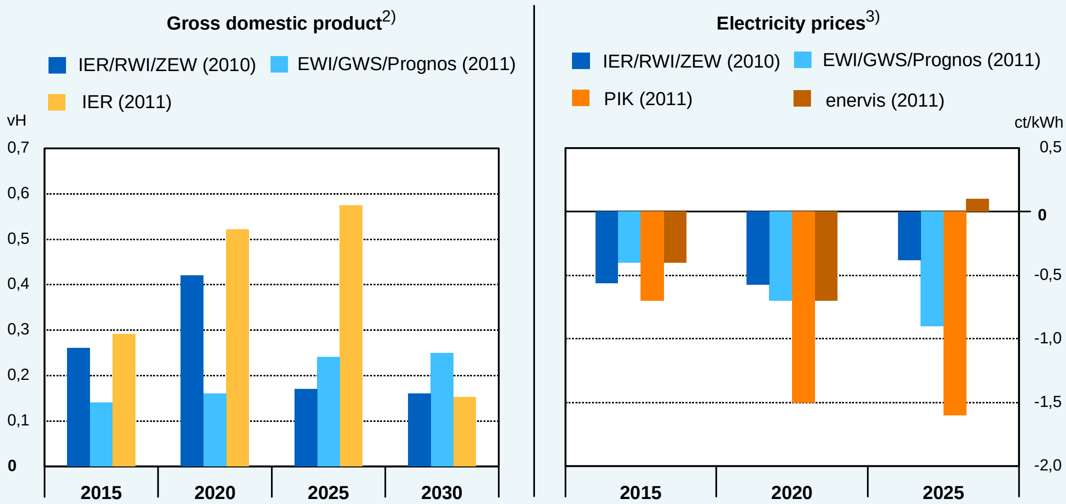
To study the economic effects of a changed power generation structure, some of the studies couple the electricity market model with a macroeconomic model. This usually involves employing an estimable general equilibrium model that models, for example, the economic effects of higher electricity prices on private consumer expenditures, on the gross value added within individual sectors of the economy, and on the investment needs arising from the substitution of nuclear power plants.

In spite of differences in methods and in assumptions pertaining to the exact exit path, the studies reach similar conclusions regarding the effects of a nuclear extension on the wholesale price for electricity and on gross domestic product. In the considered studies, the electricity price is

Chart 55

Effects of a nuclear power extension compared to the Atomic Energy Law 2002

Deviations from the phase-out path in the Atomic Energy Law 2002[1)]



1) The phase-out path from the Atomic Energy Law 2002 is compared with a nuclear extension having an average of 12 years.– 2) The changes in gross domestic product were calculated from a comparison of the following scenarios: EWI/GWS/Prognos (2011): phase-out scenario (base) and energy scenario LZV; IER/RWI/ZEW (2010): reference forecast (base) and variant Rb; IER (2011): Atomic Energy Law 2002 (base) and EKO 2010.– 3) The changes in price were calculated from a comparison of the following scenarios: enervis (2011): phase-out 2020 (base) and slow phase-out; EWI/GWS/Prognos (2011): phase-out scenario (base) and energy scenario LZV; IER/RWI/ZEW (2010): reference forecast (base) and variant Rb; PIK (2011): phase-out 2022 (base) and phase-out 2038.

0.4ct/kWh to 2.5ct/kWh lower in the extension scenario than in the baseline scenario for the years 2015 to 2030. Relative to the projected trajectory of the wholesale price, this corresponds to a reduction of 10% to 30%. The gross domestic product is 0.1% to 0.6% lower in the extension scenario than in the baseline scenario (Chart 55).

375. Although the permanent and simultaneous shutdown of plants under the moratorium resulted in a modest decrease in generation capacity relative to the original exit decision, the resulting decrease of upwards of 5000 MW from this unannounced event was nevertheless unprecedented. In extreme weather situations such as cold spells, when a malfunction in a transformer or power plant occurs (a so-called n-1 case), the stability of the network can be pushed to its limits. The Federal Network Agency assumes that such a situation would barely be manageable by the transmission network operator using available intervention instruments (Bundesnetzagentur, 2011). Nevertheless, the Federal Network Agency also points out that even before the moratorium, the system stability of the transmission network on days with heavy wind could only be guaranteed with extensive interventions from the network operators (Bundesnetzagentur, 2011). This situation makes clear the magnitude of the challenge posed by the fundamental restructuring of the energy system in the coming years, particularly given the growing share of inherently volatile electricity generated from renewable energies.

The Energy Transition as a Societal Challenge

376. The developments in energy policy for the year 2011 transform the long-term climate goals of the government from an abstract, decades-long task into a concrete societal challenge. The success of this project will depend on the path taken **in the coming year**, including both its achievements and its failures. The mere proclamation of a medium-term goal to completely phase out nuclear power and the setting of a long-term goal to restructure the system of energy supply is still far from being synonymous with their attainment.

Several obstacles – including barely avoidable conflicts of interest, technical and economic problems, and challenges in innovation – will arise on the road to completing the nuclear phase out within a decade, requiring a formidable societal commitment to overcome. In particular, the costs arising from the conversion of the system of energy provision will repeatedly have to be weighed against the foregone allocation of societal resources to **competing uses**. Only then can democratic legitimization for the endeavor be secured.

377. That said, the entry into a comprehensive energy transition also brings major opportunities. Not least, the chance emerges to demonstrate that a modern industrial society can wean itself off nuclear energy without suffering major welfare losses. Beyond this, the end of the controversial debate surrounding the use of nuclear energy will create a certain level of planning security for the affected actors, even when some of them may have wished for a different outcome. Conversely, a failure of the energy transition would do a disservice to Germany's role as an exemplar in demonstrating the path away from nuclear energy. The country can therefore not afford such a failure.

The energy transition can only succeed by recognizing not only the opportunities that would arise from such a major success, but also the **conflicts of interest** that are inextricably bundled in the process. These conflicts threaten all three elements underpinning the principle of sustainable development: economic, societal, and ecologic. From the perspective of **ecological tolerance**, for example, the massive construction of generation capacity from renewable energy and the associated requirements for network infrastructure will come into conflict with questions of environmental protection and the maintenance of natural habitats.

The energy transition will further raise challenges with respect to economic efficiency and societal cohesion. On the one hand is the premise that public resources for social goals should be allocated sparingly so as not to compromise alternative opportunities. On the other hand, one should likewise follow the premise that the costs of social goals desired by the majority should not be borne by economically disadvantaged minorities. In order to guarantee this, the course of energy policy embarked on this year should be seen as the beginning of a process, not as its successful completion.

II. Electricity Market

378. The nuclear phase out and the adoption of the Energy Package affect all areas of energy supply. This is particularly true for the electricity market, for which the shutdown of plants under the moratorium and the update of goals to expand renewable energy will have profound implications. Prior to this, the **liberalization** of the electricity market in 1998 and the political efforts beginning in 2000 to expand electricity generation from renewable energy was already responsible for crucial changes. Both measures led to a spatial decoupling of electricity generation and use, requiring an expansion of the electricity network.

The integration into the network of renewable energy capacities will alone require that the power grid is expanded by 3450 km by 2020. The costs for this network expansion will be passed through to electricity prices and will ultimately increase the price paid by consumers, which is already high owing to a range of taxes and charges, not least for the promotion of renewable energies. Even if all expectations point to the feasibility of absorbing the cost increases occurring by 2020, there will still be major political, technical, and financial challenges raised by the **integration** of renewable energies under the current plans for 2020.

1. Determinants of Wholesale Market Prices

379. Electricity is a good that is tied to the network. To deliver electricity from producers to the end consumers requires a transport- and distribution network. The average costs per kilometer of building an electricity network are higher than the costs of extending an existing network by a small amount (the marginal costs). This implies that a single network is the economically most efficient solution for transporting electricity. The electricity network therefore meets the criterion of a **natural monopoly**, creating a concentration of market power within the electricity market that requires the continuous intervention of the state to counter.

380. Until the 1990s, the electricity market in Germany was comprised of several regional monopolies consisting primarily of vertically integrated companies. These companies operated the generating plant for electricity, they maintained control over the distribution and transport networks, and they handled delivery to the end customers. During this time there was hardly any competition between the electricity suppliers. Electricity customers had to obtain electricity either from a **local regional monopolist** or produce it themselves, which paid off only for companies with a very high electricity demand. Price setting was very strongly oriented to the average costs of the regional producers.

In the 1990s policy-makers sought opportunities to open the electricity markets to competition. The liberalization of the electricity was also advanced by the European Commission, which in 1992 submitted a draft directive on establishing a competively organized internal market for electricity generation. This draft resulted in the EU Electricity Market Directive, which came into effect on February 19, 1997. In 1998 this directive was incorporated into German law, which opened the way for competition on the local electricity market.

381. With the liberalization of the electricity market, the generation, transmission, and distribution of electricity has to be divided into three separate economic activities. Being a natural monopoly, the network level must comply with an ex-ante regulation. Although the market liberalization is intended to create more competition in the energy sector, competition in electricity generation was for a long period not completely evolved (Monopolkommision, 2007). Instead, an **oligopolistic structure** consisting of four major electricity producers emerged, each operating within the geographic confines of their own customer base (Wolter and Reuter, 2005). Price formation since that time is no longer based on the average-cost calculation of territorial monopolists. Instead, a uniform wholesale price is determined on the electricity stock exchange through the interplay of supply and demand.

Electricity demand

382. In 2009, 512 bn kilowatt hours (kWh) of electricity were consumed in Germany. Of that, almost half, 45%, was consumed by industry, 27% by households, 23% by commerce, trade, and services, 3% by the transport sector (in which to date electricity for trains has played the exclusive role), and 2% by the agricultural sector (BDEW, 2010). If one only considers industry and commerce, it becomes clear that at least 70% of electricity consumption is for **economic activities**, thereby making a more or less direct contribution to maintaining the standard of living.

The demand for electricity – referred to in the technical terminology as the load – undergoes strong daily and seasonal fluctuations. Demand peaks occur around midday on workdays and in the late afternoon and evening. The demand profile is flatter on weekends and is overall subject to less movement. Because of the difficulties associated with the storage of electricity, the strong **fluctuations** in the load pose a substantial challenge to electricity providers. There must therefore be a virtually continuous correspondence between the quantity of electric energy supplied and demanded.

383. In general, the response of electricity demand to changes in electricity prices is restrained. Nevertheless, it is important to distinguish here between **adaptive behavior** in the short run and long run. In the short run, household customers have only limited flexibility to adjust their demand to increasing electricity prices because their endowment of electric appliances cannot be readily altered. With continuously high prices over the long run, however, households can substitute their appliances for more energy efficient models. Empirical studies therefore regularly identify higher price elasticities of demand for electricity in the long run.

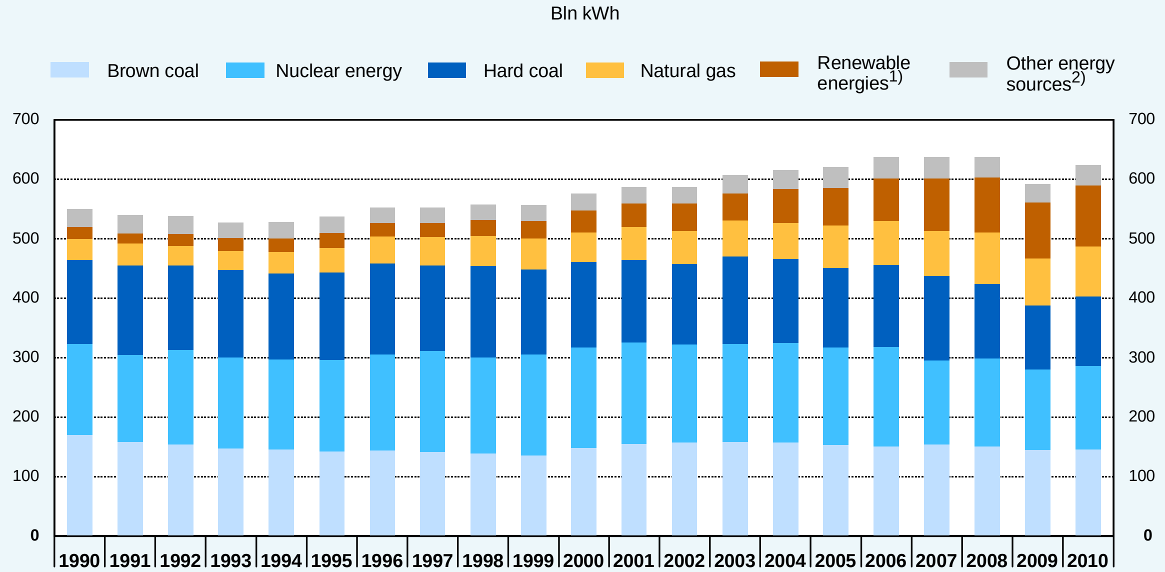
In a meta analysis of 36 studies of household electricity demand, Espey and Espey (2004) find an average short run elasticity of -0.35 and an average long run elasticity of -0.85. In the long run, a 1% increase in the electricity price therefore leads to a 0.85% decrease in electricity demand.

Electricity supply

384. Various technologies are employed for electricity generation in Germany. With 145.9 bn. kWh, brown coal comprised the largest share of electricity generation in 2010, corresponding to 23.4% of the 624.1 bn. kWh in total electricity generation. This was followed by atomic energy with 140.6 bn. kWh (22.5%), hard coal with 117.4 bn kWh (18.8%), renewable energies with 102.3 bn. kWh (16.4%), and natural gas with 83.7 bn. kWh (13.4%). Of particular significance is the increase in electricity generation from renewable energies, whose share in the period between 1990 and 2010 rose sharply (Chart 56). Given the slight decline in electricity generation from coal and nuclear energy, the overall increase in electricity generation by 13.5% between 1990 and 2010 was thus mainly accounted for by renewable energies and natural gas.

Chart 56

Gross electricity generation in Germany by energy source



1) Water power, wind power, biomass, photovoltaic, geothermal energy, domestic waste.– 2) Other energy sources including mineral oil products.

Source: AG Energiebilanzen e.V.

Over the short term, this mix of energy sources can be regarded as largely stable because electricity producers will attempt to meet electricity demand with the existing **fleet of plants**. Over the longer term, however, changes in the energy mix may transpire as plants reach their maximum operating time or due to legal changes that force plants to go offline.

385. Electricity generation in Germany is primarily dominated by four regionally separated providers, which may hinder the market entry of more productive electricity providers. The supply behavior of the already established electricity providers can, however, be approximately captured through models that assume that firms price their product based on the **short run marginal costs** (Ellersdorfer et al., 2008). Marginal costs are those arising from the production of an additional unit of electricity supply. On the electricity market, the marginal costs correspond largely to the variable costs. They incorporate the unit fuel costs and the price for emissions certificates, among other elements. The variable costs are additionally influenced by the capacity utilization of the plant.

386. The so-called **merit order** refers to an ascending ranking of generating facilities according to the marginal cost of each facility over the short term. Usually such a ranking reveals a clear ordering based on the employed technology. The merit order indicates the sequence in which plants are used in a fully competitive market to meet the daily and yearly fluctuations in demand. It thereby corresponds to the short-run supply curve. In this regard it is important to recognize that the merit order is not predetermined, but rather emerges endogenously. Plants with low marginal costs will continually be in a position to cover demand at lower prices than those ranked higher in the merit order. Low marginal-cost plants will therefore be preferred for meeting demand.

The lowest marginal cost sources of electricity generation in Germany are from hydro power, atomic energy, and brown coal. Plants with these technologies therefore enjoy a high **operational priority** owing to their cost structures and are employed to cover the so-called base load. Hard coal, natural gas, stored hydro power, as well as biomass- and biogass plants have higher marginal costs, but are appropriate for meeting fluctuation in demand. They are employed for covering the mid- and peak load. Short term peaks in demand are covered by plants that are designed to operate with frequent changes in activity. These include pumped storage power plants, gas turbines, and oil and gas plants, all of which have relatively high marginal costs.

387. Electricity generation from fossil fuels (hard coal, brown coal, natural gas) result in **greenhouse gas** emissions. Approximately half of the discharged greenhouse gases in Germany originate from the energy sector. The emission of these gases has deleterious effects on climate and the environment, resulting in negative externalties that are not incorporated in electricity prices in the absence of government intervention. The atmospheric accumulation of greenhouse gases, in particular, contributes to an increase in average global temperatures. Although the impacts from this temperature rise will be highly variable across the planet, and may even be positive in Central Europe, they are on the whole likely to result in high costs (Tol, 2010).

In the European Union, greenhouse gas emissions from energy providers and energy intensive industries are consequently limited by the **Emissions Trading Scheme**, established in 2005. Because electricity producers incorporate the opportunity costs of the certificates – that is, the forgone revenue when the producer uses the certificate for producing electricity rather than selling it – into their price setting, the Emissions Trading Scheme necessarily increases the variable costs of electricity production. This increase is all the stronger the more emission-intensive the employed technology is.

Electricity generation from renewable sources

388. Renewable energies occupy a special position in electricity generation. Because these technologies cannot currently cover their costs on the market, legal provisions provide **support** by guaranteeing them a grid connection, priority access, and a minimum purchase price, called a feed-in tariff. With grid operators legally obliged to purchase electricity supplied from renewable energy plants, they can operate independently of the merit order. The conventional fleet of plants is then left to fill whatever demand has not been already covered by the renewable energies (the residual load). In this way, the extremely high average cost that is often incurred from the generation of electricity from renewable sources is completely excluded from the determination of the whole sale price. These costs appear elsewhere; namely in the dues owed by the end customers. In the mid to long run, the share of renewable energies may under some circumstances have implications for the composition of the remaining fleet of power plants.

389. The composition of power plants can change when older plants are shut down or the operating license of nuclear power is repealed. This gives rise to the need for **substitute capacities**. Which substitute technologies are put to use depends not least on the fixed costs of the plant. These include capital costs, maintenance costs, and labor requirements. The development of the remaining collection of plants is likewise of relevance to the choice of technology. To integrate the increasing share of highly volatile electricity generation from renewable energies, it is particularly important to employ flexible power plants that can be readily powered up and turned off. Gas power plants are among the most appropriate technologies for this purpose. Given the geographic concentration of gas reserves in Russia, however, a pronounced construction in gas power plants could lead to a noticeable increase in import prices for gas.

390. There is justified concern that the increasing share of renewable energy in electricity generation and the associated decrease in the use of conventional plants would no longer guarantee the amortization of fixed costs of these plants. This circumstance would suppress investments in substitute technologies. From an economic perspective, however, it is important to additionally consider equilibrium effects on electricity prices. A decrease in the supply of electricity can lead to price increases that in turn make the installation of new capacities worthwhile. Studies of the future development of the electricity market that take into account these price effects and allow for an endogenous determination of the power plant fleet find at least a partial substitution of old power plants, albeit accompanied by an increase in imports of electricity (see box Costs of the Nuclear Phase Out).

Price formation and power trading

391. Since the liberalization of the electricity market, the wholesale price is determined on the spot- and futures market. Electricity on the **spot market** is either traded in so-called Over-The-Counter (OTC) transactions or on the electricity exchange. In the case of an OTC transaction, the trading partners reach a bilateral agreement on the price and delivery conditions of the electricity. By contrast, on the stock exchange all transactions are conducted with standardized contracts. The exchange-based electricity trade in Germany is executed on the European Energy Exchange in Leipzig. The price for electricity on the exchange, and likewise the demand, are subject to pronounced daily and seasonal fluctuations. The average price in 2010 was 4.7 ct/kWh (EEX Phelix Base) during base load periods and 5.5 ct/kWh during peak load periods (EEX Phelix Peak).

392. The wholesale price determines which power plants feed electricity into the grid, which at any given time are those plants whose variable costs are covered by the electricity price. The plant whose supply of electricity is the last to fulfill the prevailing demand is the one whose variable costs **determine the price**. Consequently, as a rule, not all plants operate continuously at full capacity. Base load plants with low variable costs deliver electricity more frequently than peak load plants. It is therefore important to distinguish between the installed capacity of a plant and its net electricity generation.

As an illustration, the share of electricity generation from brown coal and nuclear powered **base load plants** in 2009 was 47%, far exceeding their combined 26% of overall installed capacity. Conversely, wind power comprised 17% of installed capacity, but contributed only 7% to total electricity generation (BDEW, 2010). A particularly large gap is seen for electricity generated from photovoltaics, which comprised 6.5% of installed capacity in 2009 but only 1.1% of electricity generation.

393. In periods when there is an oversupply on the electricity market prices may be **negative**. This may occur, for example, when demand from industry is low and at the same time wind turbines feed large quantities of electricity into the grid. Because electricity cannot be stored in sufficiently large amounts, certain plants must be shut down when a situation of supply surpluses arises. This can be extremely expensive for base load power plants. Thus, only those plants are shut down for which the minimal costs of powering up and shutting down are incurred.

This is the reason why since September 2008 the EEX permits negative prices in the Day-ahead-auctions. In periods of negative prices electricity producers who do not enjoy preferential grid access must pay to feed electricity into the grid. In such a case the price signal ensures that the only electricity-producing plants are those for which the costs of shutting down are extremely high (Andor et al., 2010). Negative prices have emerged repeatedly on the exchange since 2008. An **extreme case** occurred on the night of October 4, 2009, when the confluence of low demand owing to a holiday and a high feed-in from wind turbines drove the electricity price down to €-500.02/MWh. It can be expected that the frequency of negative prices from overproduction will increase if the expansion of renewable energies continues rapidly apace, as planned.

2. Electricity networks, system integration, and retail prices

394. The delivery of electricity from the producer to the consumer takes place over the electricity network. The German network has a length of about 1.78 million kilometers (BDEW 2010). It consists of **four different levels** at different voltages. The maximum voltage grid, which is integrated in the European network, works with a voltage ranging from 200 kV to 380 kV and also serves as a transmission network. The large coal-, pump storage-, and nuclear power plants are connected at this level. The transmission network is additionally connected with transformers for routing to grids with lower voltage and with dome stations for routing into foreign networks.

The regional distribution networks reside within the transmission network. They function on the high- (50 k V to 150 k V) and medium (6 k V to 30 k V) voltage levels. Consumer centers or individual bulk purchasers are connected to the high voltage level. The medium voltage power grid delivers electricity to customers such as public agencies, factories, and municipal energy suppliers. The electricity from small power stations and renewable energies is also fed in on this level. On the local level, electricity is distributed over the low voltage networks, whereby the voltage provided to households ranges between 230 V to 400 V while that provided to industry ranges between 500 V and 690 V. The costs of the electricity networks are passed on in the form of **network charges** from the network operators to the end consumers, with the size of the charge depending on which network level is used. The charge is also subject to regulatory limits set by the Federal Network Agency.

Integration of renewable energies in the electricity network

395. The rapid expansion of electricity generation from renewable energies has changed the demands on the electricity network, which until now has not been designed to handle **regional disparities** in electricity generation and consumption. These disparities are particularly pronounced in parts of northern Germany, where low levels of consumption are often accompanied by a high spatial concentration of wind turbines. The integration of renewable energies in the electricity network will therefore require the expansion of the maximum voltage network so that electricity can be transported to regions of higher consumption in southern Germany.

396. The expansion requirements of the network were quantified in two studies of the German Energy Agency (dena). The first study from 2005 – the so-called **dena-Network Study I** – analyzes the effect of an increase in the share of renewable energies to 20% by 2015 on the extent to which the network would have to expand. Focusing on the effects of an increase in wind energy, both on land (onshore) and at sea (offshore), the study calculates the requisite expansion in the maximum voltage network to be 850 kilometers. The absolute additional costs for the integration of renewable energy in electricity generation are estimated at €1.6 to €2.3 bn. For electricity consumers not falling under the Hardship Regulation of the EEG (so called non-privileged consumption), this will lead to a 0.46 ct/kWh rise in the electricity price by 2015, wherein the increase of “green” electricity is already included. For a household having an average consumption of 3500 kWh, this corresponds to an additional cost burden of €16 per year. The expansion of the network is expected to increase the electricity price for privileged consumption by 0.15 ct/kWh (German Energy Agency, 2005).

397. A follow-up study from 2010, the **dena-Network Study II**, quantifies the need to expand the network given an increase in the share of renewable energy in total electricity generation to 39% by 2020. This target was selected based on the government’s Energy Concept, which foresees a 35% share of renewable energy in gross electricity consumption by 2020. The study calculates the required expansion of the maximum voltage network to be 3600 kilometers, with an associated annual cost of approximately €1 bn until 2020. Electricity prices for household customers (non-privileged consumption) would rise by 0.2 ct/kWh from higher network charges, increasing the average yearly burden on households by €7 (German Energy Agency, 2010).

398. The phase out of nuclear power plants has no direct impacts on the expansionary requirements of the electricity network (dena 2010). This is because the expansion of the network is primarily necessary for the integration of renewable energies. In this regard, the share of nuclear power in the remaining generation of electricity is irrelevant. Because the expansion of renewable energies is completely determined by its priority feed-in and legally sanctioned financial support, its expansionary path remains uninfluenced by the shut down of nuclear power plants.

399. The expansion of the electricity networks has proceeded sluggishly despite the acute urgency. Of the 24 projects identified in the dena-Network Study I and sanctioned in the Law on Expanding Energy Transmission Lines (EnLAG), there are currently only three projects that have been completed or are under construction. In total, less than 100 km of the expansionary requirements indentified in the dena-Network Study I have been completed. Among the **obstacles** hindering the network expansion are complex administrative procedures, weak public support, and the long duration of the approval process. The latter is often the result of changing responsibilities on the borders between states. As noted by the Federal Network Agency in its survey of progress with EnLAG projects, the incidence of delays is particularly high among projects that cross state borders (Deutscher Bundestag, 2011).

With the measures contained in the Energy Package, the government has substantially reformed the legal framework surrounding the expansion of the maximum- and high voltage networks. These reforms should facilitate the expansion by changes in how the expansionary requirements are determined and by introducing a national perspective in the planning of projects that cross state lines (Box 14). Whether this completely removes the existing obstacles will have to be judged based on future progress in expanding the network.

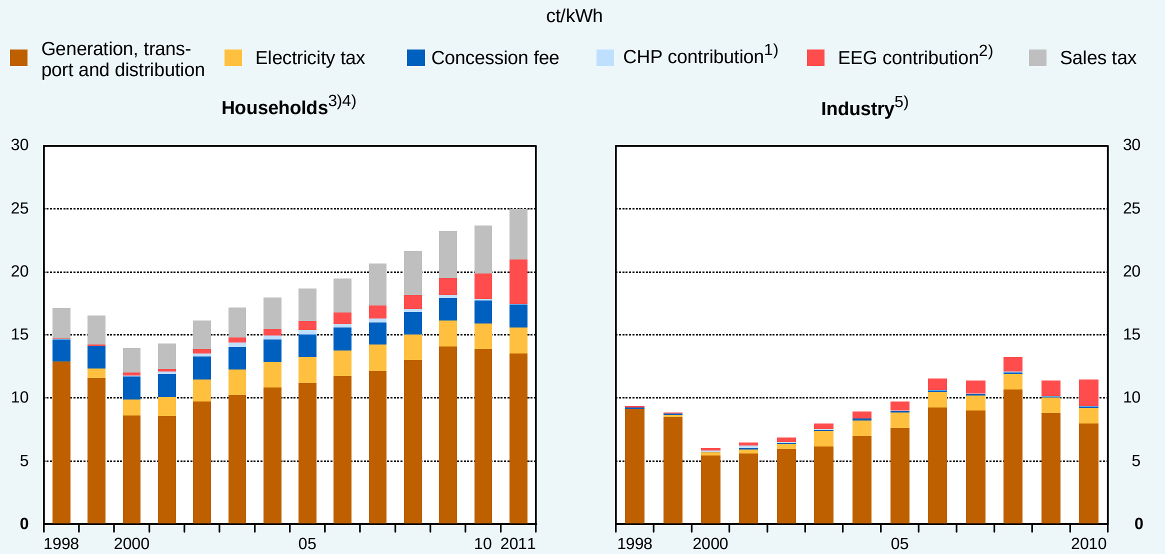
Prices for consumers

400. In addition to the increase from network charges, electricity prices for consumers will also increase as a result of various **taxes and charges**. The price paid for electricity by private households incorporates the costs for generation, transport, distribution as well as the tax on electricity, payments for financing renewable energies, licensing fees, and value added taxes. Directly following the beginning of liberalization, the price of electricity fell as expected, reflecting an attempt to guard against the threat from market entrants (Lang 1999). Since the structures on the liberalized electricity market have stabilized again, however, there is a clear upward trend in electricity prices, which can be attributed both to an increase in generation costs as well as higher taxes and charges (Chart 57).

401. The **price increase** since 2000 amounted to 79% for the average private household, with slightly less than half of the increase attributable to generation and distribution. About 43 of the 79 percentage points of the increase in the electricity price was attributable to taxes and

Chart 57

Comparison of electricity prices for households and industries



1) Combined heat and power contribution.– 2) Renewable Energy Act contribution.– 3) Base: Mid electricity consumption of 3 500 kWh (not including share of night rate).– 4) Estimation: Status as of March 2011.– 5) Medium voltage supply; minimum purchase of 100 kW/1 600 h to 400 kW/5 000 h.

Source: German Association of Energy and Water Industries

charges, whereby the largest share (23.9 percentage points) was accounted for by the promotion of renewable energy. A similar picture emerges for industrial customers, who faced an 89.1% increase in the electricity price since 2000, 42 percentage points of which was due to electricity generation. The remaining share of the price increase is primarily due to the EEG-contribution, which is responsible for 30.6 percentage points of the increase.

Currently, already 14% of the electricity price paid by consumers owes to the financial support of **renewable energies**. Without a consequent adjustment of the support system based on the principle of cost efficiency, further expansion of renewable energies to beyond 20% of electricity generation could run up against acceptance problems in the population.

402. The situation for industrial consumers is somewhat different. On the one hand, the increase in the electricity price holds the danger that the electricity-intensive parts of production migrate to locations with lower energy costs. On the whole, however, it is likely that the combined influence of the repreal of the nuclear extension and the expansion of renewable energies leaves the competitiveness of electricity-intensive industrial branches unimpaired. In the absence of scientific analysis of the uncertainties surrounding the effects of the energy transition, it is reasonable to suppose that the countervailing price-effects for industrial customers will be neutralizing.

Although the substitution of nuclear energy with power plants having higher variable costs will lead to an increase in the electricity price (see Box 15), this will be offset by downward price pressure from the expansion of renewable energies, whose marginal costs of generation are close to zero. Because firms in the electricity intensive manufacturing industries are subject to a range of exceptions with respect to the financing of renewable energies through the EEG, they are unlikely to be strongly impacted by the expected increase in the EEG-contributions.

III. Climate Policy of the European Commission

403. With the Energy Concept of 2010, the German government underlines its willingness to achieve the national renewable energy targets for 2020. Germany's Energy Concept also includes even much more ambitious renewable targets for a 30-year period beyond 2020, including an 80 % share of renewables in electricity consumption by 2050. Given the European dimension of Germany's abrupt reversal in energy politics, such a national focus, however, does not appear to be appropriate. Similarly, with its climate protection goals that are stipulated in the EU's Climate and Energy and Package, adopted in December 2008 and enacted in all Member States in June 2009, the European Union has the proud role of a **world leader** in the endeavour to mitigate global warming. From a global perspective, however, this is not an effective long-term strategy for climate protection, as the EU's unilateral mitigation strategy may reduce the incentives of Non-EU countries to implement greenhouse gas abatement measures on their own.

Irrespective of these strategic considerations regarding the EU's climate policy, the Commission would be well-advised to put an emphasis on achieving its climate policy goals at minimal cost, given the strong competition with a multitude of alternative investment opportunities of societal resources. The Commission's current strategy to leave the support of renewables within the responsibility of national governments, however, undermines the prior principle of **economic efficiency** for several reasons. First, regional and climatic advantages of particularly appropriate locations in Europe may be ignored with this national focus. Second, the cost of supporting renewables are higher than necessary due to industrial and technology policy aims that are pursued in addition to climate protection goals. A prominent example for a policy instrument that results from such a mixture of diverse policy goals is the German renewable energy support scheme EEG (Erneuerbare-Energien-Gesetz, Renewable Energy Act).

1. Basic Principles of Climate Policy

International Dimension of Climate Protection

404. The fundamental problem of any endeavour to combat climate change is that abatement cost is solely incurred by those nations that implement greenhouse gas mitigation measures, while all other nations benefit from such measures as well. Since nobody can be excluded from the benefits of mitigation, emission abatement can be characterized as a **public good.** From the logic of the theory of public goods, it can be derived that ambitious abatement efforts of one country, such as Germany, tend to lower the mitigation endeavours of other countries. Without any coordination and cooperation among countries, it is rational for a single nation to emit more greenhouse gases than would be optimal under a cooperative climate protection approach. In principle, this dilemma can only be circumvented through an international agreement that obliges all countries to coordinated abatement measures.

405. A first step in this direction was the establishment of the United Nations Framework Convention on Climate Change (UNFCCC). This convention was undersigned by the majority of countries at the Earth Summit that took place at Rio de Janeiro in 1992. It envisaged climate protection measures to reduce anthropogenic perturbations of the climate system in order to decelerate global warming. Detailed emission reduction targets, including a deadline for their achievement, were stipulated in an additional document, the well-known **Kyoto Protocol**. It entered into force on February 16, 2005, and obliges the signatory countries (also called Parties) to cut their greenhouse gas emissions until the period 2008 to 2012 by 5.2 % on average relative to the level of 1990. This overall goal breaks down into a variety of different targets for individual countries that depend on their economic development. The two largest greenhouse gas emitters, China and the U.S., however, either did not ratify the Kyoto protocol (USA) or did not accept any reduction burden (China).

For the time beyond the final round of the Kyoto Protocol, the Parties aim at initiating a **successor to the Kyoto Protocol** that should enter into force on the first of January, 2013. So far, though, the governments of the most important countries merely agreed on the so-called Copenhagen Accord, which acknowledges the goal to dampen future increases in global temperatures to 2°degrees Celsius at most in order to avoid serious anthropogenic interferences with our climate system. In this document of December 2009, developed countries (Annex I Parties to the Kyoto Protocol) would commit to emissions targets for 2020. Yet, as the Copenhagen Accord has never been approved, these targets are not legally binding. The difficulties in agreeing on a binding successor to the Kyoto Protocol illustrate the fundamental problem that results from the public good character of emission abatement.

The European Union’s Climate and Energy Package

406. Among the developed countries, only the EU Member States stipulated mandatory greenhouse gas reduction targets for the period after 2012, that is, the end of the Kyoto period, which extends from 2008 to 2012. This is all the more relevant as with the ratification of the Kyoto Protocol, the EU-15 countries already agreed on a substantial reduction of their greenhouse gas emissions by 8 % on average within the Kyoto period relative to the level of 1990. In the so-called burden sharing agreement, each Member State's individual contribution to the common reduction target of 8 % is stipulated. With a reduction goal of 21 %, Germany's contribution is by far the largest among all EU countries. In contrast, other Member States, such as Greece, are allowed to even increase their emissions until 2012, in the case of Greece by + 25 % relative to 1990.

For the period spanning from 2013 to 2020, the European climate policy is guided by the EU's climate-energy package adopted on June 25, 2009. The EU package entails the unconditional goal for 2020 to reduce the **EU's overall emissions** by 20 % relative to the level of 1990, irrespective of whether a successor to the Kyoto Protocol is established. If other developed countries were to commit themselves to similar efforts, the EU would additionally reduce its emissions and would decrease its greenhouse gas emissions by 30 % by 2020 relative to 1990.

407. In addition, the EU climate-energy package includes **technology-specific goals** in the form of targets for the increased usage of renewable energy technologies. Increasing the share of renewables in the electricity production, as well as in the transport sector, was already the aim of the EU directives on the support of electricity generation from renewable energy technologies (2001/77/EC) and on the support of biofuels (2003/30/EC). These directives envisage the increase of the shares of renewables in electricity generation by 21 % by 2010 and of biofuels in transport by 5.75 %. While the targets of both directives were indicative, the progress made by the majority of Member States to achieve these goals was rather modest. In the meanwhile, both directives were completed by the Renewables Directive (2009/28/EC) – one of the four legal acts of the EU climate package. This directive mandates an overall share of 20 % of renewable energy in the EU's gross final energy consumption by 2020, with the target for Germany being 18 %.

408. For the transport sector, there is a uniform indicative, yet not mandatory, target for all Member States to increase the share of **biofuels** in transport to 10 % by 2010. The choice of the policy instruments to reach this target is left to each Member State. Besides the aims of mitigating greenhouse gas emissions and of increasing the share of renewables, the EU climate package includes a third pillar, the increase of energy efficiency. Already in an Action Plan of 2006, the Commission aimed at reducing the annual energy consumption by 20 % by 2020 relative to 2005. Due to common target rates of 20 %, these three goals of the EU climate-energy package became well-known as the so-called 20-20-20-targets (Table 25).

Table 25

Targets of the EU-climate package (20-20-20 goals)

%

	2020
1) Change of greenhouse gas emissions compared to 1990	
If other industrial nations do not enter into a similar commitment	– 20
If other industrial nations enter into a similar commitment	– 30
2) Energy efficiency	
Reduction of total energy consumption (base year 2005)	– 20
3) Share of renewable energies in the final consumption of energy	20

409. Given the absence of any successor to the Kyoto Protocol, by implementing measures to accomplish the 20-20-20 targets, the European Union underlines its **role as world leader in climate policy**. Due to the public good character of greenhouse gas abatement, though, this should only be a temporary strategy of the EU, even though replacing carbon-intensive technologies may lead to national advantages, for instance, through the reduction of local emissions such as nitrogen oxides. Otherwise, the climate policy of major emitters of greenhouse gases would largely orient towards national, rather than global interests. Moreover, from an economic perspective, the prospects for successful negotiations on an international agreement on greenhouse gas mitigation are to be questioned, most notably, because a coordinated climate policy of the European Union decreases the willingness of other major world powers, not least the U.S., to contribute to climate protection. Such a leading role in climate policy may only be warranted if there is a substantial chance to sustainably reduce greenhouse gas emissions on a global scale.

410. Following the theory of public goods, the Commission could improve its strategic position in climate politics by integrating adaption measures into its mix of climate policies, rather than primarily focusing on mitigation measures. A clearly and globally visible change in the Commission's climate policy that explicitly adopts adaption measures on a large scale conveys the strategic advantage of implying a **credible threat** for any negotiations on a future climate protection agreement. Countries that invest in adaptation measures may reduce their own mitigation efforts on the one hand and, on the other, may strengthen the mitigation ambitions of other countries. In the end, Germany's government may potentially increase the likelihood for a global agreement by publicly demonstrating its willingness to pursue a convincing adaptation strategy (Kai Konrad), which, in fact, is part of Germany's official climate strategy (Deutsche Klimastrategie).

From these considerations, however, it does not follow that a country should entirely refrain from any mitigation measures. As evidence of the seriousness of its own efforts to contribute to an international cooperation and as a hint to the feasibility of a comprehensive turnaround in energy politics, **carefully conceived unilateral actions** may be useful indeed. Yet, the optimal level of unilateral efforts is clearly below the level that would be efficient under a global agreement on the mitigation of climate change.

411. All in all, a **balanced approach** that avoids a naive hurrying ahead in climate politics, but demonstrates courageous global responsibility, might be promising. After all, results from experimental economics indicate that people often contribute more to the provision of a public good, such as greenhouse gas abatement, than would be optimal under a pure utility maximization behaviour (Lange and Vogt, 2001). (These results, though, cannot be transferred directly to the behaviour of countries in climate politics.) Ultimately, any country has to recognize that by adopting a free-rider position, it risks its reputation in the international community. Therefore, negotiations on an international agreement on greenhouse gas abatement might be successful, even though free-riding is tempting from the perspective of individual countries, as they can save their own resources.

It is questionable, however, whether nationally or regionally limited unilateral abatement efforts can have a significant effect on climate in the long run. In the absence of any global agreement, a **strategy of moderate unilateral actions** would thus be rational. The extent of these actions should only be increased if other important countries were to commit themselves to substantial abatement measures, too. In principle, this is the strategy of the European Union, whose future abatement efforts are conditional on comparable contributions of other developed countries.

412. It is critical, though, to thoroughly examine whether the own abatement efforts significantly reduce the climate policy ambitions of other countries or even prevent them from implementing any mitigation measures. If a global agreement cannot be achieved in the near future or even if the number of countries with emissions caps does not increase notably, the European Union should **revise downward its emission reduction targets as of 2020**. In this case, the German government would be well-advised to refrain from strengthening its emission targets, as their global effectiveness would be highly questionable.

2. Implementation of Climate Policy Instruments

413. From an economic perspective, the cost of emission abatement to ensure compliance with the EU targets may be minimized by – in the economic parlance – getting the prices for emissions right. In principle, there are two possibilities, an **emissions tax** or an **emissions trading system** that includes as many economic sectors as possible. In a world without further externalities, except for environmental ones, such a trading system would ensure compliance with targets at lowest cost. By setting the emissions cap and determining the respective number of emission permits (also called certificates or allowances), the abatement intensity, as well as the required innovation activities, could be effectively triggered. There would be no need for any further climate policy instrument.

414. In practice, though, the Member States employ additional climate policy instruments that tend to increase abatement costs without guaranteeing environmental effectiveness. The Commission's energy efficiency target, for instance, aims at diminishing greenhouse gas emissions by mandating the application of less energy-intensive technologies. Frequently, these alternatives also reduce the cost of energy consumption, thereby inducing the so-called **rebound effect** that offsets part of the energy conservation intended by the efficiency improvement (Box 16). In a similar vein, while increasing the use of renewable energy technologies, the environmental effectiveness of this climate policy is modest at best due to the coexistence of the ETS. Even worse is that with uncoordinated national support schemes, a considerable potential for cost reductions through the implementation of an EU-wide support scheme cannot be exploited.

Box 16

Rebound Effect

Despite substantial efficiency increases, road traffic is one of the few sectors in the European Union (EU-15) in which the emissions of greenhouse gases, such as carbon dioxide (CO2), tend to increase. To stop this trend, in 2009 the European Commission enacted new legislation under the auspices of Regulation No. 443/2009 to reduce the per-kilometer CO2 discharge of newly registered automobiles. This regulation includes legally codified targets for the maximum allowable CO2 emissions as of 2012 and, hence, also sets limits for the fuel consumption per kilometer. Manufacturers with a fleet of new cars whose average fuel consumption exceeds the allowable emissions will have to pay heavy fines of 95 € for each additional gram and vehicle.

The Commission expects that this measure will induce considerable incentives for the development of fuel-saving technologies. Irrespective of the directive's effectiveness in increasing the fuel efficiency of automobiles, a critical issue in gauging the merits of fuel efficiency standards concerns how consumers adjust to altered unit cost of car travel. While higher fuel prices raise this cost, improved efficiency effectively reduces it, thereby stimulating the demand for car travel. In the energy economics literature, such a demand increase is referred to as the direct rebound effect, as it offsets—at least partially—the reduction in energy demand that results from an increase in efficiency.

A study by West (2004) on the mobility behaviour of U.S. households, for instance, estimates a rebound effect of 87 percent. This would imply that the actual reduction in fuel consumption due to an increase in efficiency is only 13 percent of the reduction that is theoretically possible. Other studies find substantially lower rebound effects in the car use of U.S. households (Small and van Dender, 2007). On the basis of several cross-sections of U.S. states for 1966-2001, these authors uncover rebound effects varying between 2.2 % and 15.3 %, which decrease over time. Using various estimation methods and data from the German Mobility Panel, one of the few studies on the rebound effect for the individual mobility of German households estimates quite large, but stable rebound effects in the range of 57 % and 67 % (Frondel et al., 2008). The rebound effect, however, might be so large that the energy consumption even increases as a consequence of an efficiency improvement (Wirl, 1997).

On the basis of these findings, the EU directive that demands the limitation of per-kilometer emissions of automobiles and prescribes efficiency standards for this purpose should be met with skepticism. To increase the incentives for emission abatement in the transport sector, fuel taxes should instead play an increasingly important role. Unlike fuel efficiency standards, fuel taxes directly confront motorists with the cost of driving, which not only encourages the purchase of more fuel efficient vehicles, but also has an immediate impact on driving behaviour.

EU Emissions Trading Scheme

415. The European Emissions Trading Scheme (**ETS**) sets a cap for the annually produced carbon dioxide (CO2) emissions of the EU power sector and the energy-intensive industries since the year of its launch in 2005. This cap-and-trade system rules about half of the CO2 emissions of the European Union and is, hence, its **most important climate policy instrument**. The basic idea underlying this instrument is that those companies with relatively low abatement cost cut their emissions to save emission permits and, thus, money, whereas other participants of the ETS with comparably high abatement cost may prefer buying free permits, instead of undertaking emission reduction measures.

416. Under the ETS, large emitters of CO2 must monitor and annually report their emissions, as every year they are obliged to hold an amount of **emission allowances** (also called permits or certificates) that is equivalent to their annual emissions. Among these large emitters, which are forced to participate in the ETS, are installations of the power sector, as well as industrial sectors, such as the steel, aluminium, pulp and paper, mineral oil processing and chemical industry. For each ton of CO2 for which no permit is available, a fine of €100 has to be paid.

Small installations with a capacity of less than 35 megawatt MW and annual CO2 emissions lower than 25 000 tons may be exempted from participation in the ETS. Currently, the ETS encompasses about 12 000 installations, **1 645 of which originated from Germany** in February 2011. With around 454 million tons of CO2 emissions in 2010, these installations accounted for about half of the annual CO2 emissions in Germany.

417. Emission permits can be purchased at exchanges, such as the European Energy Exchange at Leipzig, or can be traded directly among the owners of the installations integrated in the ETS. While legally based on directive 2003/87/EC, the ETS so far encompasses three trading periods that differ primarily with respect to the kind of permit allocation, i.e. grandfathering or auctioning, and the overall amount of certificates available. While the first trading period covered the years 2005 to 2007, at present, we are in the second trading period (2008-2012), with the third phase extending from 2013 to 2020.

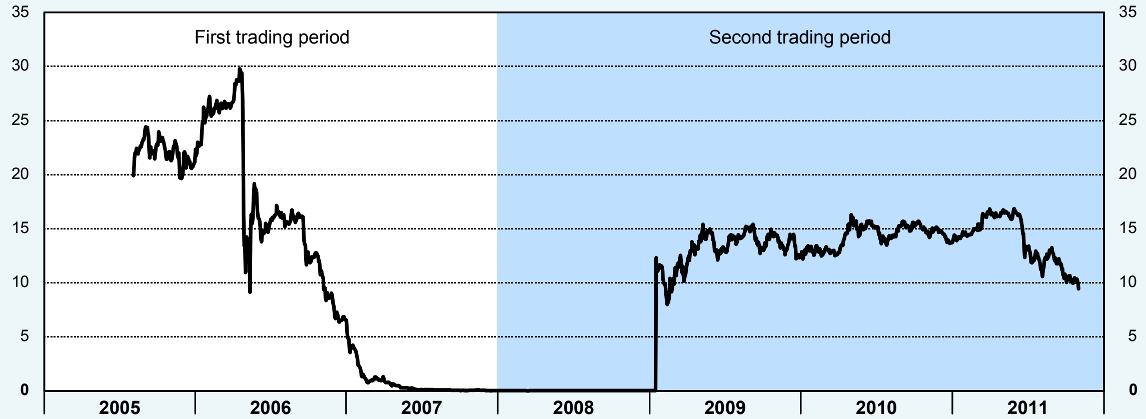
Initially, a lack of transparency on the overall number of certificates resulted in a **high volatility of permit prices**. Right after the launch of the ETS, certificate prices amounted to about €22 and rose to €30 by spring 2006. Then, it became known that numerous Member States allocated more certificates than required by their industries. Since banking of certificates between the first and the second trading period was not allowed, CO2 prices collapsed and approached zero. It was only with the beginning of the second trading period in 2008, when prices of CO2 certificates recovered and reached the level of about €15, most notably because the overall number of allowances was substantially reduced (Chart 58).

For the upcoming third period, spanning from 2013 to 2020, the ETS regime was reformed and extended by directive 2009/29/EC, which essentially implies the inclusion of the air traffic sector into the ETS and reorganizes permit allocation. Most importantly, all certificates required by the EU power sectors have to be purchased, rather than being largely grandfathered. Furthermore, there are no national allocation plans anymore: Instead, the overall **amount of certificates will be uniformly reduced** by 1.74 % per year as of 2013 in order to reach the emissions target documented in the EU climate-energy package, that is, to diminish CO2 emissions by 21 % by 2020 relative to the level of 2005.

Chart 58

Price for EU emission allowances

Euro per emission allowance for a Ton of CO_2



Source: Thomson Financial Datastream

418. For producers with marginal abatement cost clearly below the prices of certificates, the ETS provides for incentives to avoid CO2 emissions and sell superfluous permits at the market, whereas those with marginal abatement cost well above CO2 price levels tend to purchase certificates. In the end, via transferring allowances from producers with inexpensive abatement options to those with high marginal abatement cost, emissions trading implies that all producers face quite uniform marginal abatement cost. As a result, carbon emissions are ultimately cut by those producers with the lowest abatement cost. If there are no other market failures, such as information deficits or enormous investment risks that are much too high for individual agents, then emissions trading minimizes the cost of ensuring compliance with any cap.

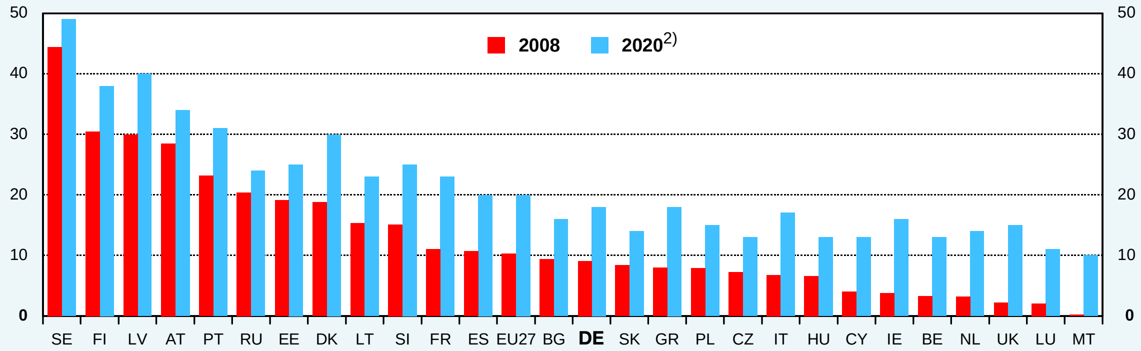
Support of Renewable Technologies in Europe

419. With the ETS, there is both an effective and efficient instrument to decrease the attractiveness of electricity generation from fossil fuels, thereby increasing the incentives for producing electricity on the basis of renewable energy technologies. In addition to the emission reductions triggered by the ETS, the Commission envisages to combat climate change by fostering the diffusion of renewable energy technologies. In fact, the Renewables Directive 2009/28/EC sets mandatory **national targets** for each Member State to increase the diffusion of renewable energy technologies. Overall, the share of renewables in the EU's final energy use shall rise to 20 % by 2020 (items 408 ff.). Germany is obliged to enlarge this share from 11 % today to 18 % in 2020 (Chart 59).

Chart 59

Renewable energies in the European Union[1)]

Share of gross final energy consumption (%)



1) SE-Sweden, FI-Finland, LV-Latvia, AT-Austria, PT-Portugal, RU-Romania, EE-Estonia, DK-Denmark, LT-Lithuania, SI-Slovenia, FR-France, ES-Spain, EU27-European Union, BG-Bulgaria, DE-Germany, SK-Slovakia, GR-Greece, PL-Poland, CZ-Czech Republik, IT-Italy, HU-Hungary, CY-Cyprus, IE-Ireland, BE-Belgium, NL-Netherlands, UK-United Kingdom, LU-Luxembourg, MT-Malta.– 2) According to the EU climate concept.

Source: EU

420. From an economic perspective, it must be asked whether an additional subsidization of renewable energy technologies can contribute to the achievement of emissions targets, given that a **binding cap** is stipulated by the ETS. In fact, the promotion of renewable energy technologies *ceteris paribus* reduces the emissions of the electricity sector so that obsolete certificates can be sold to other industry sectors that are involved in the ETS. As a result, the EEG's true effect is merely a shift, rather than a reduction, in the volume of CO2 emissions. In effect, this volume is limited by the ETS cap, irrespective of whether the production of green electricity is large or negligible. This logic led to massive criticism by energy and environmental economists (Wissenschaftlicher Beirat beim BMWi, 2004).

421. Similarly problematic is the Commission's decision to accept hardly coordinated **national support schemes**, rather than implementing an EU-wide system to foster the use of renewables. In contrast to the ETS, which allows for minimizing the overall abatement cost in Europe, a purely nationally organized diffusion of renewable energy technologies does not exploit economies of scale. Moreover, the regional distribution of renewable power capacities is inefficient, as meteorological and topographic characteristics and advantages within Europe are ignored.

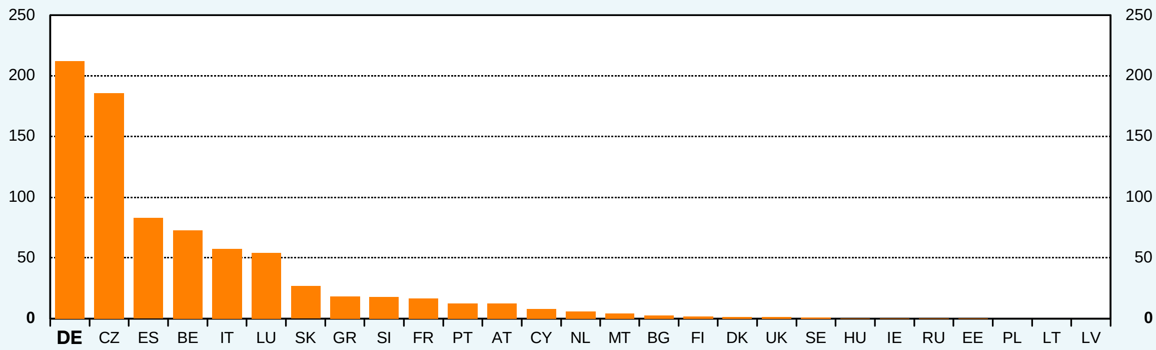
This results in the paradoxical situation that, by far, Germany experienced the globally strongest increase in photovoltaics (PV) capacities, with which **electricity** can be produced **from solar energy**, despite the fact that the average number of sunshine hours per year is much lower than in other EU countries, such as Greece, Portugal, or Spain. In both 2009 and 2010, Germany accounted for 50 % and more of the PV capacities that were newly installed in the European Union. Out of the total capacity of 29 327.7 megawatt peak (MWp) of PV capacities that were installed in 2010 in Europe, 17 370.0 MWp originiated from Germany. This corresponds to a share of almost 60 %, whereas the respective shares of much sunnier countries such as Greece and Portugal were as low as 0.7 % and 0.44 %.

Even when considering differences in population size, Germany is on top with a per-capita PV capacity of 212 Wp, being far above the European average of 58.5 Wp per inhabitant. With 18.2 and 12.3 Wp per inhabitant, respectively, Greece' and Portugal's per-capita capacities were much lower than the EU average (Chart 60). In short, these examples illustrate that there are huge **efficiency reserves** that may be exploited by improving support schemes for renewables. In particular, current support systems of many Member States deviate from the principle of cost efficiency, because they also pursue technological and industrial policy aims when supporting renewables. A prominent example is Germany's renewable support via so-called feed-in tariffs.

Chart 60

Photo voltaic capacity in the European Union in 2010[1)]

Wattpeak[2)] per inhabitant



1) DE-Germany, CZ-Czech Republic, ES-Spain, BE-Belgium, IT-Italy, LU-Luxembourg, SK-Slowakia, GR-Greece, SI-Slovenia, FR-France, PT-Portugal, AT-Austria, CY-Cyprus, NL-Netherlands, MT-Malta, BG-Bulgaria, FI-Finland, DK-Denmark, UK-United Kingdom, SE-Sweden, HU-Hungary, IE-Ireland, RU-Romania, EE-Estonia, PL-Poland, LT-Lithuania, LV-Latvia.– 2) Peak performance of solar modules under fixed standard test conditions.

Source: EurObserv'ER (2011)

Germany's Support of Renewables on the basis of the EEG

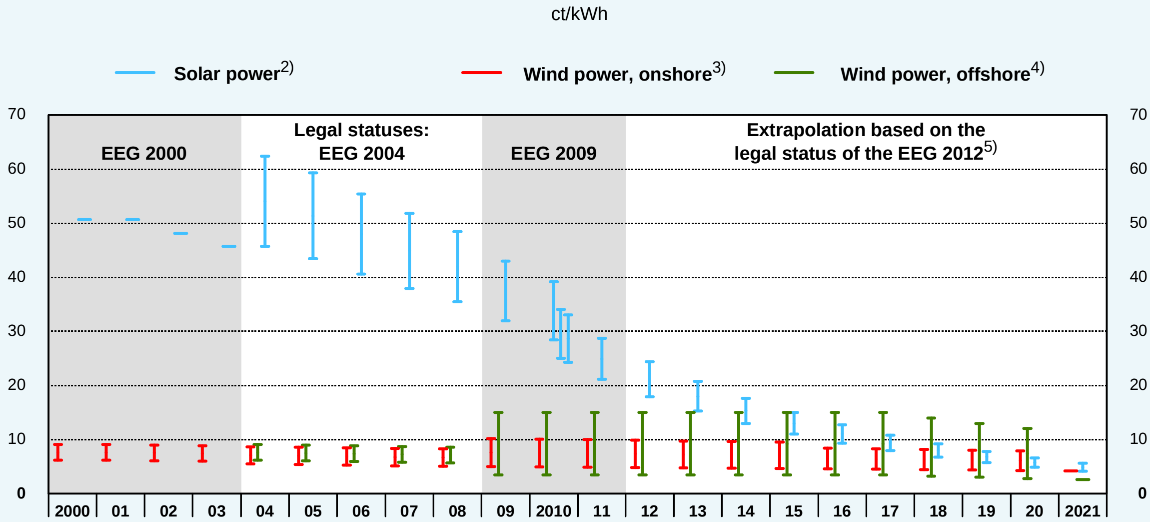
422. Electricity generation from renewable sources has been subsidized in Germany on a legal basis since 1991. Originally, this support was ruled by the Electricity Feed-in Law (Stromeinspeisungsgesetz). Under this law, utilities were obliged to accept and remunerate the feed-in of "green" electricity at 90 percent of the retail rate of electricity, considerably exceeding the cost of conventional electricity generation. This law was replaced in 2000 by the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG), which has been amended and adjusted again and again since then. The EEG's central aim is the promotion of technologies for the production of electricity from renewable energy in order to reach the national renewable targets determined by politics. It is fiercely criticized from the perspective of both environmental and innovation economics, but particularly due to the huge cost that have to be borne by electricity consumers.

423. At present, the majority of alternative technologies to produce green electricity are not competitive (Chart 61). To nevertheless reach the national targets for the electricity generation from renewable technologies, power grid operators are obliged by the EEG to give priority both to the grid connection of installations for electricity generation from renewable technologies (§ 5 EEG-2012) and to the feed-in of green electricity into the grid (feed-in priority,

Einspeisevorrang, § 8 EEG-2012). Owners of such installations are guaranteed a minimum remuneration for up to twenty years (feed-in tariff, **Einspeisevergütung)** for each kilowatt hour (kWh) of green electricity produced. Feed-in tariffs decrease annually for capacities to be newly installed, by a predetermined percentage (**Degression**). Subsidization via EEG is limited to a range of known technologies: electricity generation from water power, biomass, wind and solar power (photovoltaics), as well as from geothermal power and methane gas originating from coal mines, sewage treatment, and waste deposits.

Chart 61

Bandwidth of the compensation rate for electricity input for selected energy sources according to the EEG in the period 2000 to 2021[1)]



1) Law for the priority of renewable energies (Erneuerbare-Energien-Gesetz – EEG) from March, 29th 2000 as well as amendments from December, 22nd 2003; July, 21st 2004; October, 25th 2008; August, 11th 2010 and June, 30th 2011. Compensation rates only valid for new plants.– 2) Free standing panels including other panels as well as panels on walls and rooftops of buildings with a performance up to 30 kW.– 3) Base compensation and initial compensation including systemservice bonus and repowering bonus.– 4) Base compensation and initial compensation including quick start bonus.– 5) Without considering the degression from 2013.

As the EEG aims at supporting currently uncompetitive technologies with different degrees of maturity, the feed-in tariffs vary substantially across renewable electricity generation technologies, inversely depending on their individual production cost. Via higher minimum remunerations, **less competitive technologies** generally **benefit more** than technologies that are more competitive. Current feed-in tariffs for solar electricity generated by photovoltaics installations, for instance, range from 21 to 28.74 Cent/kWh, whereas electricity from on-shore wind power is remunerated by 8.93 Cent/kWh during the first five years after installation, and by 4.87 Cent/kWh later on. Wind power capacities in less windy areas, though, obtain the higher initial remuneration over the whole support period of 20 years.

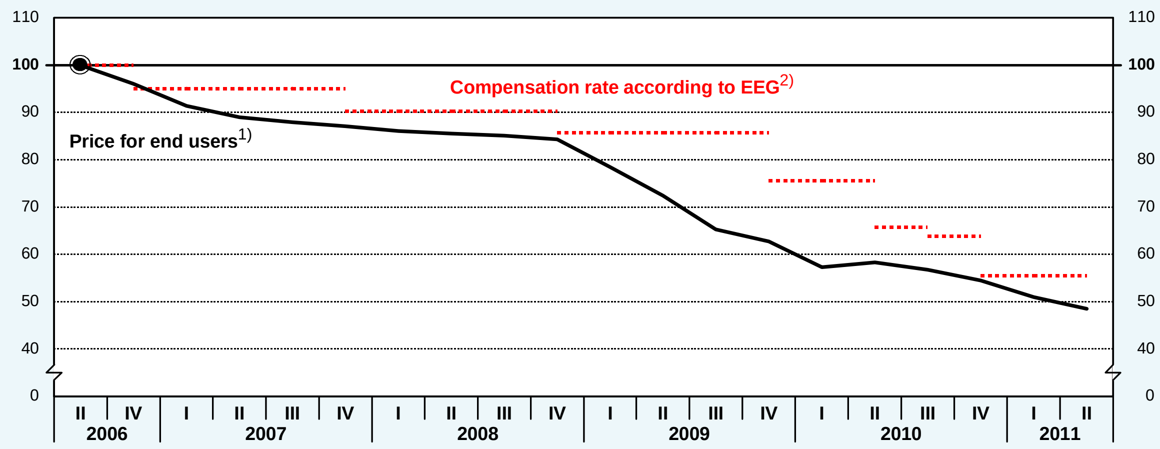
424. The EEG attempts to achieve the national targets via price incentives, rather than quota. Associated with this approach, however, is a strong demand for **information** by the regulator. Thus, grave problems come along with this policy instrument: Although the price setting is easy to administer, the extent of capacity increases is hard to manage. Sudden changes in production cost may imply substantial biases in investment calculus and, accordingly, higher than necessary cost for consumers if feed-in tariffs are not adjusted immediately. Moreover, downward adjustments of tariffs provoke lengthy and strong arguments with lobbyists, who vehemently agitate against tariff decreases (Menanteau et al., 2003).

For instance, while the average cost of photovoltaics modules with a capacity of 100 kW shrank by more than 50 % between 2006 and mid 2011, feed-in tariffs for solar electricity were not decreased accordingly (Chart 62). The discrepancy between module prices and feed-in tariffs should have been crucial for the **boom of photovoltaics** in Germany: In 2009 and 2010, installed capacity rose by 61 % and 74%, respectively. This corresponds to a triplication of capacities since 2008.

Chart 62

Price index for installed photovoltaic roof panels of up to 100 kilowatts

2nd Quarter 2006 = 100



1) Base: system price, net; source: German Solar Industry Association.– 2) Average of compensation rates for photovoltaic panels on the walls and rooftops of buildings. Performance levels up to 30 kW are from the Renewable Energy Act (EEG) from July 21st, 2004; performance levels from 30 to 100 kW are from the EEG of October 31st, 2008, including amendments from August 11th, 2010.

Furthermore, the combination of price fixing and absolute feed-in priority implies that there is no competition among producers of green electricity, but merely among manufacturers of power plants and installations. As a result, there is no incentive for producers of green electricity to orient towards market demand and to invest in electricity storage capacities. The former might be achieved through the recent introduction of an additional subsidy, the so-called market premium (Marktprämie), which provides incentives for a more demand-oriented electricity production.

425. The legally guaranteed feed-in tariffs represent, from an economic perspective, **subsidies**, irrespective of the fact that it is the electricity consumers who have to pay for them so that their payment does not need to be organized by public authorities. After all, subsidies have to be paid in all those situations in which market prices of electricity are lower than the feed-in tariffs; in fact, this holds true for the overwhelming majority of electricity generation from renewable energy technologies. The additional cost, which result from the differences in feed-in tariffs and market prices of electricity, is borne by grid owners, but ultimately passed on to consumers via a uniform contribution to net electricity prices **(EEG-Umlage)** so that this contribution for renewables also increases the value-added tax revenues of the German government.

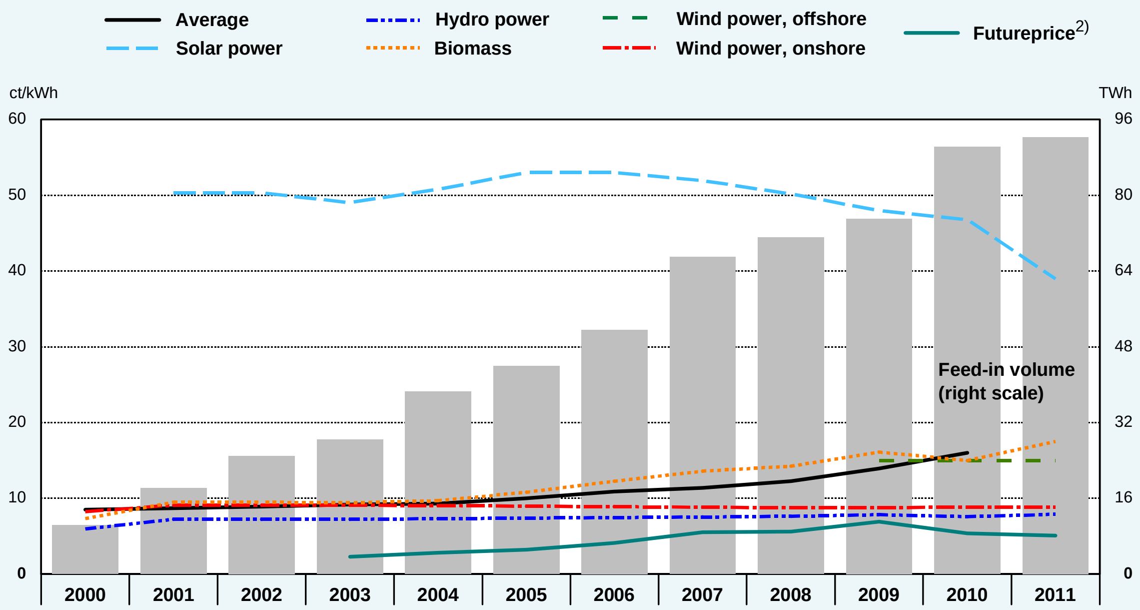
To maintain the competitiveness of energy-intensive companies, there are **exceptions** for such companies. With the most recent amendment of the EEG, which enters into force in 2012, the number of favoured companies has been increased. Eligible are those companies whose electricity cost share in gross value added is at least 14 % (15 % so far) and whose purchased amount of electricity exceeds 1 GWh (10 GWh so far). For each kWh of electricity consumption that exceeds the threshold of 1 GWh, the renewables contribution is just 10 % of the general contribution; if a company's electricity consumption exceeds 10 GWh, its renewables contribution amounts to only 1 % of the general contribution for each kWh exceeding this threshold and for an electricity consumption higher than 100 GWh the respective renewables contribution is limited to 0.05 Cent/kWh.

This exemption clause distorts the cost structures across the companies of the manufacturing sector. In addition, this exemption substantially increases the burden of private consumers and other sectors of the German economy. Presumably, this exemption rule privileges an electricity consumption of about 75 GWh in 2011; this amounts to about 16 % of the overall electricity consumption and more than 36 % of the electricity consumption of the manufacturing sector (EEG Erfahrungsbericht 2011). Without this exemption clause, the general renewables contribution would have been lower at 2.96 Cent/kWh, rather than amounting to 3.53 Cent/kWh in 2011. An additional problem is that the current support scheme in the form of a (predominantly) uniform add-on to net electricity prices has a **strong regressive** impact on private households: Due to low income elasticities of their electricity consumption, private households with low incomes suffer more from the renewable contribution than those with high incomes. This distributional aspect will be exacerbated if the renewables contribution rises due to increasing renewable shares in the future. Not least, the median of the willingness-to-pay for a share of 18 % of renewables in the electricity mix is estimated at 1.27 Cent/kWh, which is much lower than the current renewable contribution of 3.53 Cent/kWh (Grösche und Schröder, 2011).

426. Average feed-in tariffs (in Cent/kWh) rose substantially in recent years, most notably due to the boom in photovoltaics, which receives the highest feed-in tariffs among all renewable energy technologies. In 2010, for instance, 38.6 % of the overall amount of feed-in tariffs of €12 bn. accounted for the support of solar electricity, while the share of photovoltaics in total electricity supported via EEG was as low as 14.5 %. As a consequence, the uniform renewable contribution increased from 0.51 Cent/kWh in 2004 to 2.05 Cent/kWh in 2010, with a dramatic jump by almost 75 % to 3.53 Cent/kWh in 2011 (Chart 63).

Chart 63

Effective feed-in compensation of electricity from renewable energies by energy source[1)]



1) For 2000: Yearbook of renewable energies of the Energy Research Foundation of Baden-Württemberg, from 2001: Federal Association of the Energy and Water industry (BDEW); preliminary values for 2011.– 2) Futureprice for the delivery year in the previous year; source: European Energy Exchange.

427. In its current form, the support scheme for renewables via EEG hurts the principle of cost efficiency. Due to its basic idea of supporting less efficient technologies by guaranteeing higher subsidies, the CO2 abatement cost vary substantially across technologies. This pushes the **overall cost of the renewables support**. This becomes particularly obvious in the case of photovoltaics, which receives by far the highest amount of subsidies given the low electricity yield. The share of renewables could be increased with much less cost if instead of enhancing the installation of photovoltaics modules the support of renewables would focus on more efficient technologies such as on-shore wind power. This strategy could be implemented by stipulating a single, technology-independent feed-in tariff for green electricity. By such a modification of the EEG, the growth of new renewable capacities would orient towards the technology's comparative cost advantages and abatement cost would be identical.

With the current support scheme that is limited to a set of technologies, the regulator takes on the role of a **forward-looking planner**, thereby attempting to identify succeeding technologies for decades in advance. Since the preferential treatment of known technologies always implies the discrimination of other technologies, there exists a significant risk that the development of so far unknown technologies may be hampered.

428. The EEG's key problem lies in the enormous cost that is associated with its success in terms of increases of the share of renewables in electricity production. While it turned out to be **very effective** with respect to capacity increases, it is **utterly inefficient** at the same time. In particular, there are huge payment obligations due to the capacities already installed, as the feed-in tariffs that were valid at the time of installation are guaranteed for 20 years. Hence, the cost caused by the EEG could not be reduced within the next couple of years even if the EEG were to be abolished at once. While this would imply an immediate installation stop, the amount of subsidies would diminish only to the extent in which capacities that were installed twenty years before would not be supported further. It is only after 20 years that the support for all capacities installed today would cease. Overall, the real net cost (relative to the expected wholesale electricity prices at the power exchange) for all photovoltaics capacities installed in Germany between 2000 and 2010 account for about 81.5 Bn €.

With the EEG amendments of 2009, 2010, and 2012, feed-in tariffs for photovoltaics were adjusted to the erosion of module prices, yet not to the same extent; despite **accelerating the reduction of feed-in tariffs**, which is closely linked to the volume of capacity increases, the recent years' photovoltaics boom implies a heavy burden for Germany's electricity consumers over the next couple of decades (Frondel et al., 2011). Presumably, the immense burden of current payment obligations, which is most likely to strongly increase further without an adequate intervention, was reason enough that even advocates of renewable energy technologies, such as the German Advisory Council on the Environment, voted for **limiting** the increase of photovoltaics capacities. Without such a limit, the reversal in Germany's energy politics will hardly be successful.

429. One might argue that the EEG's preferential treatment of less competitive renewable energy technologies could be justified by aspects of technology policy, that is, that technological progress should be enhanced, albeit this is achieved only in an indirect way via the EEG. In fact, in an extensive discussion about the ideal design of innovation policy – where the emphasis should be put on the expansion of infrastructure and an innovation competition among private actors – the German Council of Economic Experts votes for a search for innovative solutions for fundamental societal challenges, such as the complete restructuring of our energy system, through targeted **innovation interventions**. Such interventions could be reasonable if this search is conceived as a process of discovery and if public support is organized accordingly (JG 2009 item 351).

In its current form, the EEG hardly meets these preconditions. Although in principle such a broad support of a variety of technologies may allow for an eventual market success of initially uncompetitive alternatives, this support instrument is neither **limited in time**, nor is there the political will to effectively correct for obvious errors, such as the excessive subsidization of photovoltaics. Apparently, the lobby's interests are too strong. If the regulator were to consequently pursue technology policy aims, the scientific **evaluation** of the EEG's impacts should have been demanded and documented in the Renewable Energy Act from the very beginning.

430. To substantially improve the chances for a sustainable reversal in energy politics, the German government would be well-advised to smartly integrate its climate policy targets and measures into an **international context**. A more efficient European strategy for achieving the goals resulting from both international agreements and voluntary national commitments would employ support instruments that do not ignore regional advantages in wind power and climate across Europe. A nationally oriented strategy, however, minimizes the incentives for other nations, including our European partners, to adequately contribute to climate protection. Not least, the current national support scheme for renewable energy technologies does not allow for any reduction in greenhouse gas emissions. Therefore, even if one were to be prepared to ignore the criticism raised from the perspective of innovation policy, without a **fundamental reconception** of the support scheme of renewables, the ambitious national CO2 emissions targets can hardly be achieved.

IV. Necessary Decisions in Energy Policy

431. While reinforced by Germany's reversal in energy politics, the fundamental restructuring of our energy system with the aim of its wide decarbonisation is subject to **constraints**: for the transition, it is equally important to ensure energy supply security, as well as social and environmental compatibility. Given the commitment to a complete nuclear phase-out, the most important requirement is to tackle this challenge in an economically efficient way, while both financial incentives and regulatory policy absorb **substantial societal resources**. As such resources are not available for alternative investments and policy goals, such as mitigating social disparity, it is indispensable to minimize the cost of the energy transition process.

This can hardly be achieved without fundamentally reforming Germany's current support scheme for renewable energy technologies. A new support scheme is required that is more **market-oriented** and increases the incentives to exploit economies of scale; most notably, a more efficient distribution of capacities all over Europe is indispensable. A national approach, however, would not suffice to tackle this challenge. Rather, a European solution is necessary to comply with the national energy and climate goals that were stipulated by the European Commission. In particular, the Commission's renewables targets could be reached more efficiently through a **support scheme** that is **harmonized on a European scale**, for instance by establishing a quota system that is complemented by a trading scheme for so-called green certificates.

In addition, with such an instrument, one could separately tackle the aim of increasing the shares of renewables and promoting technology development. While **technology policy** may remain a national responsibility, the capacity increase of renewable technologies may be harmonized step by step by merging the national quota systems. Moreover, a challenge such as the energy transition provokes the central question of **democratic participation**. To ensure the permanent social acceptance of such an energy transition, a thorough scientific and transparent monitoring process is required.

Different Targets Require Different Instruments

432. With the ETS, there exists an **EU-wide instrument** that makes the usage of low-carbon technologies more attractive and provides for incentives to invest in R&D, with the decision of which technology is employed remaining an issue of private actors. At least in principle, this guarantees that decisions are made in an **efficient** manner. From an economic perspective, the preferred policy with which the energy transition may be accomplished consists of augmenting the number of sectors that are integrated into the ETS and to consequently cut the cap in order to stabilize prices of certificates and stimulate private investments.

433. In addition to establishing the ETS in order to comply with targets to cut greenhouse gases, the Commission mandated detailed renewable shares. To reach these renewable goals, **subsidies** are indispensable given the current technological status quo. Support schemes for renewables, however, should be designed in a way such that the goals are achieved at minimal cost. The current renewables support scheme, which has a purely national scope, does not meet this criterion and, therefore, should be replaced by a more efficient, harmonized mechanism that covers the EU as a whole.

With the German EEG, three goals are pursued: First, part of electricity production should be based on renewable energy technologies, rather than fossil fuels, so that the national targets for the shares of renewables can be reached. Second, creating a sufficiently large market for a set of renewable energy technologies shall induce technological progress of these technologies. Third, based on the mechanisms of classical industrial politics, manufacturers of allegedly future technologies are subsidized in Germany to gain and permanently defend **global market shares**. In the past, the Council of Economic Experts heavily criticized this kind of industrial politics (JG 2009 items 351 ff.). Likewise, the scientific board of the Ministery of Economics and Technology (BMWi) raised the same criticism with respect to the industrial policy motivation of the EEG (Beiratsgutachten BMWi, 2004).

434. In the meanwhile, the grave competition problems of the German solar industry demonstrate that alleged leading positions in dynamic international markets may be transient if they primarily rest on subsidies. With particular respect to the other goals, i.e. increasing the shares of renewables in electricity consumption and stimulating technological progress, the German government is well-advised to apply **target-specific instruments**. **Technology support**, in particular, should be **nationally organized** and designed according to the principles of innovation economics. After all, it is the main argument of the proponents of the current feed-in tariff scheme that quota systems lack opportunities for technology support. We believe, however, that neither feed-in tariffs nor quota systems are appropriate instruments for a successful technology policy. Consequently, this task must be tackled by employing alternative instruments. Not least, in contrast to the current support via EEG, pursuing a separate national strategy with respect to technology policy would allow for more transparency in the usage of societal resources.

Implementing a European Quota System

435. Based on the strong capacity increases realized in recent years, there are now **mass markets** for renewable energy technologies, rather than niche markets. With a share of renewables in gross electricity production of 16.4 %, a support scheme such as the EEG, which was intended to support niche technologies, is not appropriate and timely anymore. This support scheme should be replaced by a mechanism that is strictly oriented towards the principle of cost efficiency and offers the opportunity to cooperate with other European countries in order to exploit regional advantages.

436. A transition to a new, more efficient support system could be designed as follows: A first step in the direction of cost minimization would be a technology- and size-neutral design of feed-in tariffs for all renewable capacities to be newly installed. For this purpose, the multitude of **feed-in tariffs must be harmonized**, ending up with a uniform tariff level. As a result, the capacity increase of renewable technologies would take account of production cost, even though incentives for a demand-oriented electricity production would still be low. In addition, this would provide for strong incentives to install new capacities at those locations where wind and solar power is much above average levels, rather than compensating installations with regional disadvantages, as under the current support scheme.

437. In a second step, one should contemplate switching to a **quota system** that is complemented by a trading system for green certificates. Such a system would oblige electricity providers to fill a prescribed quota of green electricity in their electricity production. Electricity, however, is a homogeneous commodity that does not allow consumers to recognize by which technology it was produced. To solve this problem, producers could obtain green certificates for each unit of green electricity that they feed into the grid. At the end of a year, electricity providers would be obliged to hold a sufficient amount of green certificates, which is required for complying with the prescribed share of green electricity (Chart 64). Otherwise, they must pay fines.

Green certificates would be traded at exchanges, so that **uniform market prices** for them could be observed at any time. While the supply of green certificates is satisfied by producers of green electricity, certificate demand results from the need to hold a minimum of certificates to fill the quota. The demand for certificates, however, is not limited by the minimum quota: each electricity provider is free to over-comply, for instance in order to distinguish itself from competitors.

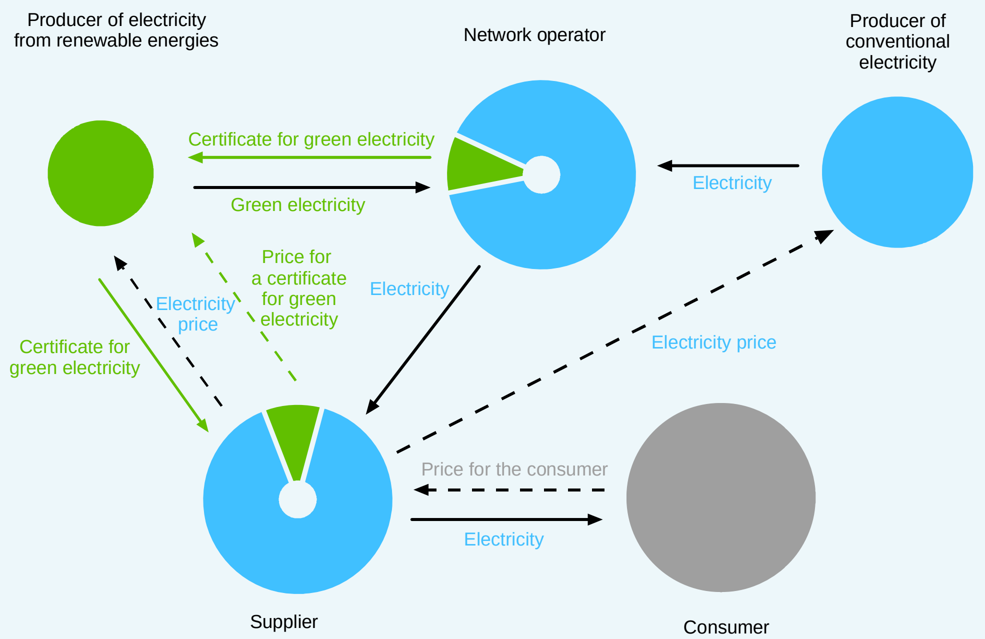
438. For producers of green electricity, there would be two major distinctions between the current support scheme and a quota system. First, in contrast to the sole **remuneration** by feed-in tariffs, there would be **two different revenue sources**: On the one hand, producers obtain revenues from selling green electricity at exchanges or from bilateral (long-term) contracts with consumers. On the other hand, another revenue source results from selling green certificates. It bears noting that such a support via green certificates would be technology-neutral, as certificate prices are the same for all technologies as opposed to the current feed-in tariffs.

Under a quota regime, producers of green electricity would employ wholesale electricity prices as a benchmark. If wholesale prices factor into their calculus to maximize profits, producers would refrain from feeding green electricity into the grid at times of negative wholesale prices. This would be an important contribution to the **integration** of renewables **into the electricity system**. Furthermore, such a regime would increase the incentives to invest in

storage capacities, which would allow producers to separate the production of green electricity from feeding it into the grid. Finally, under this regime, green electricity is always produced with the cost-minimizing technology mix.

Chart 64

Stylized operation of the market for green electricity



439. Being already installed, EEG-subsidized capacities enjoy the right of continuance; a quota system including green certificates would, hence, only affect the installation of new capacities. Future increases of green electricity shares thus would have to be transferred into a **minimum quota** and a corresponding number of green certificates. The minimum quota results from the difference between the envisaged future share and that share that prevails at the launch of the quota system. Given the government's renewable targets in terms of shares for green electricity, there would be a clear signal for all market participants that the quota will rise over time, with a detailed inter-temporal quota schedule being known from the outset. The EEG would become obsolete as a legal framework, as capacities to be newly installed would be supported by green certificates. Yet, the priority for both the grid connection of renewable technologies and for the feed-in of green electricity into the grid would be maintained. Nevertheless, in case of negative wholesale prices, there would be a disincentive for the feed-in of green electricity, so that the incentives for a demand-oriented production and feed-in will be strengthened.

440. As with feed-in tariff schemes, quota systems bear their own problems. These have to be addressed by a specifically tailored market design. First, to attenuate the volatility of green certificate prices, a banking of certificates from one period to the next should be allowed. That is, a green certificate of the current period would also be valid in the next period. Second, markets for forwards and futures for green certificates, similar to those for electricity, should be established. Third, as long as the quota system is purely national, it is reasonable to define a price ceiling for cases in which the number of green certificates available at the market is lower than required for compliance with the minimum quota. In Sweden, for instance, this price ceiling lies at 150 % of last year's average price.

It has turned out that investors' confidence in the long-term perpetuation of a support system is a central **prerequisite.** Similar to the guarantee of fixed feed-in tariffs over a period of 20 years, investors should be ensured that they are allowed to participate in the trading system for green certificates over the same period of 20 years. Likewise, the validity of certificates over the same period should be guaranteed. If the pre-defined minimum quota were to be reached, support via green certificates should be maintained another 20 years, with the minimum quota being decreased corresponding to those capacities that lose eligibility for support.

441. To reach their target shares, the majority of Member States have introduced support systems for renewables, either price- or quota-based. Only quota systems, however, are appropriate to be integrated into an EU-wide trading system for green certificates, which would represent the third and final step in our suggestion for reforming the German support system for renewables and for exploiting efficiency reserves through the regional extension of the trading system. In principle, such a system is already envisaged in Renewables Directive (2009/28/EG), as each country has specific advantages with respect to the employment of a particular kind of a variety of renewable energy technologies. For example, the transformation of solar energy into electricity is more advantageous in Mediterranean regions than in Central Europe, while the conditions for the so-called off-shore wind parks are favourable in the North and Baltic Sea. Not least, by an EU-wide system, one could better cope with the volatility of green electricity production, which is most notably due to the unreliability of wind power, than in a situation with a limited national system. A necessary pre-condition, however, would be to improve the integration of the European power grid (Roques et al., 2010).

So far, only a few Member States, such as Sweden, Poland, Belgium, and Italy, and, as of 2015, the Netherlands, employ quota systems. At least with these countries, therefore, a common emissions trading scheme with green certificates could be established. Although not all efficiency reserves could be exploited, this might initiate a **harmonized approach** that allows for successively integrating further EU countries, thereby improving its efficiency. It bears noting, though, that such a harmonization means a great challenge, as can be seen from the example of Belgium, where an attempt was made to integrate trading systems of four different regions (Verhaegen et al., 2009).

Additional Innovation and Technology Policies

442. A comprehensive economic strategy for a successful energy transition should include intelligent innovation and technology policies. Such an intelligent strategy is an open-ended **discovery process** and implies defeats and throwbacks that lead to the depreciation of the resources employed. Most notably, this strategy acknowledges that, even under an ideal design, innovation politics needs time, so that this process cannot be accelerated by deviating from the ideal design. Prescriptions for certain technological solutions by the government would be particularly counterproductive.

443. Instead, while taking into account the systemic relevance of private R&D activities, it is important that innovation policies provide for an appropriate infrastructure for science and research, both through the expansion of R&D activities at universities and non-university institutes and by creating attractive R&D conditions for private firms. To this end, research at universities and institutes should be organized by strictly taking account of three **principles:** self-responsibility, steering competences, and differentiation in performance (item 399 JG 2009). Above all, support should foster the technology-open competition for scientific **excellence**, which should be accompanied by corresponding endeavour with respect to education (items 443 ff. JG 2009). Not least, technological neutrality particularly implies that R&D efforts that support the environmentally benign use of fossil fuels should be strengthened.

444. According to the Council of Economic Experts, a comprehensive and intelligently designed innovation policy can partly be accomplished by targeted interventions and **demonstration projects**, albeit with the recognition that such interventions only represent an add-on. Not least, these interventions are only reasonable if they are embedded in a **process of learning and adjustment**, thereby requiring a clear and transparent temporal limitation of the corresponding support and a thorough evaluation of the effects that employs the standards of modern evaluation research. Most notably, such an evaluation should disentangle free-rider effects from the genuine impacts of a subsidy (JG 2009 item 403). In fact, such an evaluation is to be integrated into the monitoring process with which Germany's energy transition will be accompanied.

Ensuring Democratic Legitimacy

445. A huge challenge such as Germany's energy transition requires a close monitoring through scientific analyses and an open and transparent **public debate**. A political steering of this task must be based on a monitoring process whose duties are the comprehensive analysis and objective appraisal of potential developments and the suggestion of recommendations to adjust to altered circumstances. With the establishment of an expert committee that scientifically accompanies the progress in Germany's energy transition as of 2012, the government is essentially moving into the right direction.

An integral component of this process must be a critical judgement of the development of electricity prices and the investment decisions of private actors. Clearly, it is difficult to estimate the causal effect of the German nuclear phase-out in particular and the energy transition in general on **electricity prices**, given globally increasing cost of fossil fuels. Similarly, it is also hard to appraise to what extent price increases can be borne by various industry sectors without losing international competitiveness. Nonetheless, such a critical judgement of the development of electricity prices and their impact on potential adjustments of the energy transition is indispensable for the acceptance of the transition process.

446. Central for a successful strategy is that the public has comprehensive **information** about the consequences related to such an energy transition. This task should be addressed by education policies that enhance the transfer of technological knowledge and findings from natural sciences. In addition, for a democratic legitimacy of the energy transition, the political, sociological, and economic disciplines are called upon. Most importantly, the question of an alternative use of societal resources, in other words, the **opportunity cost** of the German energy transition has to be discussed. Otherwise, the acceptance it currently enjoys might be lost.

In this sense, the suggestions of the Ethics Commission deserve attention. For instance, the commission suggests establishing a central organization, such as a National Forum Energy Transition, in order to organize the societal debate on the energy transition. Only if a sufficient democratic participation in planning processes can be achieved, for instance in the planning of power grids and storage capacities, but also of new fossil-based power plants, can the permanent acceptance of this transition by society be expected.

Another opinion

447. A member of the Council, Peter Bofinger, does not concur with the suggestion of this chapter to convert the support for renewables under the EEG from a price-based to a quota-based system. The following presentation draws primarily on Bergek as well as Bergek and Jacobsson (Bergek 2010; Bergek and Jacobsson, 2010).

As was correctly noted by the majority of Council Members, the **basic problem of the quota system** is that it tends to promote technologies that are already ready for the market (item 435). This can be attributed to the fact that the price of the certificate is determined by the most expensive form of energy necessary to fill the quota (marginal technology). This gives rise to tremendous potential for rent-seeking on the part of suppliers, who at the outset of such a system can enter the market with established technologies. The more the quotas are increased to bring suppliers with higher costs into the market (for example off-shore wind energy), the higher will be the rents accruing to suppliers with mature technologies. Specifically, the rents will be determined by the amount of the quota, the potential of cheaper technologies, and the cost differences between the technologies. The quota system thus leads to incentives that are questionable from a regulatory viewpoint. The rewards do not flow to innovators who develop and apply relatively immature technologies, but rather to investors who bet on established technologies.

Because the majority does not want to deploy either a feed-in-tariff or quota as an instrument to promote technologies, they instead advocate “additional innovation- and technology policies.” What is left unsaid is that the EEG – for all the repeatedly mentioned problems in the area of photovoltaics – has been very successful at positioning German companies as leaders in the **market for wind turbines**. While the German market comprised only 6% of the global market in 2009, the total revenue from the production of German wind turbines, 75% of which were exported, amounted to 17.5% of worldwide revenues.

Bergek and Jacobsson attribute this policy success to the establishment of protected markets ("nursing markets" and "bridging markets"). These create incentives for the suppliers of capital equipment to enter new industries and provide resources for product-, process, and market development. The authors regard the German EEG as making an important contribution to the establishment of a "**bridge market**." In the absence of such support, a gap would emerge between the support afforded to primary research, which includes demonstration- and pilot projects, and that afforded via the quota system, which mainly favors mature technologies.

The combination of quotas and technology-neutral primary research preferred by the majority thereby gives rise not only to the danger that Germany loses its leading role as a supplier of new technologies in the energy sector, but also that the increase in quotas simultaneously increases the rents for suppliers of established technologies, which are ultimately paid by electricity consumers.

This skepticism regarding the quota system does not mean that there is no latitude for reducing the feed-in-tariffs of the EEG, particularly in the case of photovoltaics.

The argument of the majority that the EEG provides no additional **contribution to climate protection** given the binding limits on greenhouse gas emissions set by the EU-ETS is also not particularly convincing (item 415). For starters, the ETS-induced **increase in the price of electricity** from fossil fuels is in most cases **insufficient** to guarantee the cost-effectiveness of electricity from renewables (Kemfert and Diekmann, 2009). Moreover, it is both possible and politically imperative to **calibrate** emissions trading with the promotion of renewable energies, a point that is completely disregarded. In this respect, it is possible that the setting of the upper limit on emissions does not correctly anticipate and factor in the reduction in emissions from renewable energy.

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Soweit die Meinung dieses Ratsmitglieds.

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