B CORE TOPICS 2013

B 1 COORDINATING CLIMATE, ENERGY AND INNOVATION POLICIES

B 1–1 INTRODUCTION

Germany has committed itself to ambitious climate and energy goals (cf. Table 1). Here, a key policy element is climate protection, i.e. the reduction of greenhouse gas emissions. The aim is to reduce greenhouse gas emissions by 40 percent by the year 2020 and by 80 to 95 percent by the year 2050 compared with 1990 levels. Germany's climate protection goals provide the rationale not only for explicit emission reduction targets, but also for other energy policy objectives, such as the advancement of renewable energy and an increase in energy efficiency. For each of these objectives the question arises how they are justified and how they can be implemented by means of regulation.[153] A fundamental economic justification for policy objectives and regulation is market failure, i.e. a situation in which the market-based coordination of economic activities does not lead to a socially desirable allocation of goods and resources.

Success and acceptance of regulation in the climate and energy market largely depends on keeping the overall economic costs of reaching the established goals as low as possible. This means that regulation should be cost-efficient, while at the same time providing incentives for developing cost-cutting technical innovation as well as new services and business models. To accomplish this, climate and energy policy regulation should be designed in a way that is consistent with market behaviour, i.e. measures should be targeted at decentralised price mechanisms to coordinate economic activities. The use of additional innovation policy instruments can also be justified here, which leads to the fact that the regulatory areas of climate, energy and innovation policies overlap. Hence it is essential to closely coordinate policies so as to create synergies and avoid counterproductive interactions.

The following section aims to critically review the Federal Government's climate and energy policy objectives and their implementation, assess the need for supplementary innovation policies and identify coordination requirements in overlapping regulatory areas.[154] For this purpose, the areas of climate and energy policy as well as climate and energy-related innovation policies shall be analysed individually. In the next step, coordination requirements for these three policy areas will be discussed in more detail.

CLIMATE POLICY B 1–2

1. Rationale for climate policy

Climate policy goals follow a clear welfare-economic rationale since greenhouse gas emissions are associated with negative externalities (cf. Box 8). Therefore, the amount of greenhouse gas emissions exceeds the desirable amount. Climate change caused by anthropogenic greenhouse gas emissions is a global challenge that has not been mastered at international level due to the free rider problem. By setting ambitious unilateral emission reduction targets, the EU aims to take a leading role in climate protection, while also encouraging other countries – especially important emerging economies such as China and India – to commit to collaboration in climate protection in the medium term.

The EU sees itself not only as a pioneer in terms of quantitative climate protection goals, but also in implementing these in a cost-efficient way through market-conforming regulation. In this context it is

Climate and energy policy targets according to the Federal Government's energy concept TAB 01

	Climate	Renewable Energy		Energy efficiency[155]			
	Reduction of greenhouse gas emissions compared with 1990	Share of gross final energy consumption	Share of gross electricity consumption	Reduction of primary energy consumption compared with 2008	Reduction of electricity consumption compared with 2008	Increase of energy productivity in relation to final energy consumption	Reduction of final energy consumption in the area of transport compared with 2005
2020	40%	18%	35%	20%	10%	Average: 2.1% p.a.	10%
2030	55%	30%	50%	–	–		–
2040	70%	45%	65%	–	–		–
2050	80–95%	60%	80%	50%	25%		40%

Source: own depiction following Hansjürgens (2012) based on *Bundesregierung* (2010).

important to differentiate between static and dynamic regulation efficiency (cf. Box 9). The successful implementation of the Federal Government's climate and energy policy objectives – often referred to as the Energy Transition – crucially depends on keeping the financial burden as low as possible.

Unless there are market failure indications that go beyond the externality of greenhouse gas emissions, cost-efficient climate policy is characterised by a clear-cut criterion: the equalisation of the marginal abatement costs across all emission sources. If this criterion is met, emissions will be abated where it costs the least. To accomplish this, emission taxes or tradable emission certificates should be considered as market-conforming policy instruments.[156] Both instruments indicate to market participants the existence of uniform emission prices, which will lead to balanced marginal abatement costs (cf. Box 10).

2. Regulation of CO_2 emissions: analysis of the current situation

With the introduction of the European Emissions Trading System (EU ETS) in 2005, the EU launched a cost-effective market-conforming instrument to reduce CO_2 emissions of energy-intensive plants

BOX 08

Externalities of greenhouse gas emissions

Externalities are generally defined as the effects of economic activities on third parties for which no compensation is made. Greenhouse gas emissions caused by human activities lead to negative externalities. The burning of oil, coal and gas emits the greenhouse gas CO_2. Increased CO_2 levels in the atmosphere lead to an increase in CO_2 concentration, which reinforces the natural greenhouse effect and leads to a rise in the global average temperature. As a result of global warming or climate change, sea levels rise and extreme weather events occur more frequently. Negative consequences of climate change, such as floods and droughts, affect many people around the world. Since those who emit greenhouse gas do not consider these consequences in their individual decisions, more greenhouse gases are emitted than would be socially desirable.

BOX 09

Static and dynamic efficiency of emission reduction policies

Static efficiency: Static efficiency means that an emission reduction target is achieved with a given technology at the lowest possible costs. This is the case whenever the costs incurred by preventing an additional emission unit are equal for all emitters. In the regulatory practice, not only direct costs, but also transaction costs have to be taken into account. These include e.g. information and monitoring costs.

Dynamische Effizienz: The criterion of dynamic efficiency focusses on reaching an emission reduction target over time at minimal cost. The crucial point here is whether market participants are provided with sufficient incentives for investing in new technologies so as to reduce future emission reduction costs.

BOX 10

Emission taxes and emissions trading

Emission taxes: If an emission tax is in place, each emission unit will be linked to a monetary obligation. Thus the overall economic costs of emissions can be integrated into the market price mechanism. All those activities that are associated with emissions will become more expensive. In their individual cost-benefit calculus, economic players will choose their emission levels in a way that ensures that the costs and benefits of further emission units are balanced. In order to reach established emission reduction targets, emission taxes have to be continuously adapted to changing economic framework conditions.

Emissions trading: In emissions trading, certificates are issued that represent the licence to emit a specified amount of greenhouse gases. Companies will purchase certificates on the emission market, provided that the costs for the certificate are lower than the achievable revenues anticipated. If it is cheaper for a company to reduce its own emissions instead of purchasing additional certificates on the emission market, it will reduce its emissions and can thus sell certificates. This interaction of demand and supply decisions leads to a uniform emission price. As opposed to the emission taxes approach, the amount of emissions available in emissions trading is limited in absolute terms from the very start.

BOX 11

The European Emissions Trading System

In 2005, the EU launched its European Union Emissions Trading System (EU ETS), an emissions trading scheme for selected energy-intensive industries.[157] During the first two trading periods from 2005 to 2007 and from 2008 to 2012, only CO_2 emissions were included in the scheme. In the third trading period (2013 to 2020), other greenhouse gas emissions will also be subject to the emissions trading provisions. Since the start of the second period, the Clean Development Mechanism (CDM) and the Joint Implementation (JI) arrangements allow companies to purchase additional allowances through project-based emission reductions in third countries. The underlying aim is to tap low-cost emission reduction potentials outside the EU.

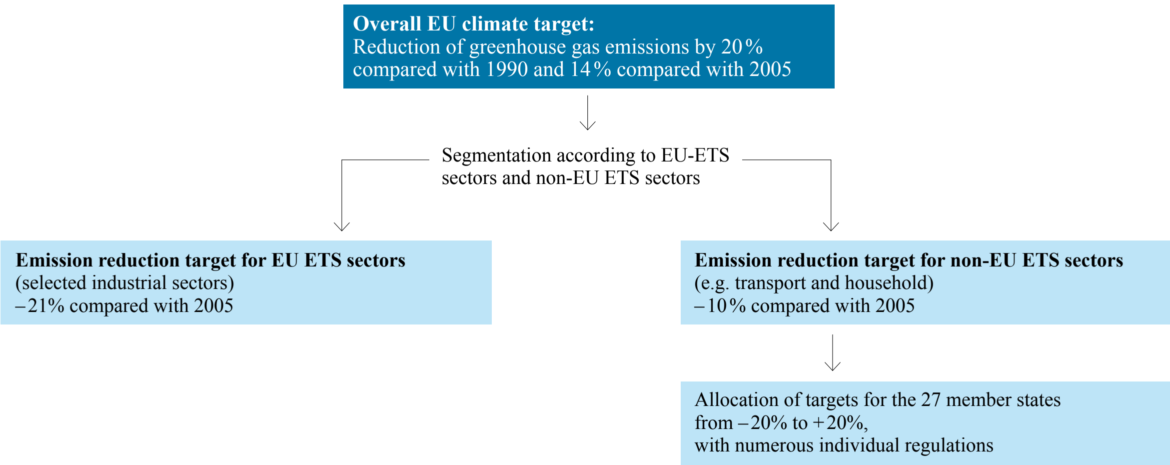
The first EU ETS trading period (2005 to 2007) was designed as a pilot phase. Due to the generous provisions of emission allowances, it was fairly non-restrictive, which led to a very low emission allowance price. In the early stages of the scheme, the EU ETS emissions budget was allocated freely to participants so as to reduce the cost burden caused by emissions trading for the respective industries, and to foster acceptance for the leading role of this European emissions trading scheme. In the third trading period, the majority of certificates will be auctioned on the stock exchange. Receipts will be allocated to the EU member states according to a fixed distribution key. Energy and trade intensive industries in particular shall continue to receive certificates gratuitously in order to protect them against major disadvantages in international competition – the rationale being that the EU is a limited economic area, while greenhouse effects are global in nature. This entails the risk that emissions are relocated counterproductively to countries that are lacking a relevant regulatory framework, an effect that is known as emission leakage.

across the EU (cf. Box 11). The introduction of the EU ETS marks the first emissions trading scheme established at an international level. Based on 2005 emission levels, the emissions budget for emissions trading will be reduced by 21 percent by 2020. The third trading period began in January 2013 and runs until December 2020. Several shortcomings of the first two trading periods (2005 to 2007 and 2008 to 2012) have been resolved or at least mitigated. Yet there is still need for further reform.

The following issues should be considered here:

– The EU ETS currently covers only about half of the EU's greenhouse gas emission sources.[158] All those emission sources that are not included in the EU ETS are subject to the supervision of the individual EU member states. In the sectors that are not covered by the scheme, member states have to achieve an average emission reduction rate of 10 percent[159] between 2005 and 2020 if the EU is to reach its overall climate target of 20 percent compared with 1990 levels (cf. Figure 1). In practice, a number of regulations is in place across all EU member states to reduce emissions beyond the EU ETS, e.g. in the transport sector and the household sector. These include efficiency

Segmentation of the EU climate target FIG 01



Source: own depiction following EU (2009).

standards for buildings, public funding for public transport, as well as energy consumption taxes and subsidies for renewable energy sources. Yet these measures are not directly linked with each other. As a result, the marginal abatement costs differ between EU ETS and non-EU ETS sectors and also between individual non-EU ETS sectors. This leads to efficiency losses, which means that climate protection at EU level is becoming more expensive than necessary.

– Prices for emission certificates in the EU ETS are well below the estimated level required to compensate for damage caused by each additional tonne of CO_2 emitted.[160] The negative externalities of greenhouse gas emissions are thus not fully internalised.

– The effectiveness of EU climate policy is further restricted by a number of energy-related subsidies that are not aligned with the overall objective of emission reduction. Subsidies for specific fossil fuels work against the objective of a cost-efficient energy mix deemed necessary according to climate protection considerations.

– The current design of the EU ETS does not provide for dynamic efficiency. In the event that emission prices fluctuate considerably and political reduction targets become uncertain over time, risk-averse players (cf. Box 12) within the EU ETS tend to rely on established prevention techniques such as the switching from coal to gas-fired power plants, while disregarding long-term desirable investments in innovative, climate-friendly technologies.

Empirical studies on the innovation effects of emissions trading suggest that the EU ETS has not had a major effect on corporate R&D decisions and the source-specific portfolio of energy suppliers – not least due to low and volatile emission prices.[161] Thus it could be shown that electricity producers primarily focussed on improving efficiency in their natural gas and coal power plants – while the EU ETS has

Risk aversion BOX 12

Investments are always associated with risks.[162] These include e.g. sales risks, customer risks and price risks, but also political risks. While risk-neutral investors exclusively focus on the expected return, risk-averse investors are willing to accept a lower expected return in exchange for a higher level of security. This is based on the consideration that a potential loss is weighted more heavily than a potential return of the same amount and probability. Wherever risks are involved, the risk-averse behaviour of market participants will result in a shortage of socially desirable private investments. The higher the risk, the more pronounced is the problem of private underinvestment.

had a limited effect on the use of renewable energy, demand-side energy savings and investments in new technologies such as carbon capture and storage technologies. The emissions trading scheme is indeed a cost-efficient way of reaching short-term, less ambitious emission reduction targets within the EU ETS. However, if these measures are not aligned with ambitious emission reduction targets, the risk of path dependencies in favour of conventional (fossil) technologies will increase, creating high abatement costs in the long term.

3. Reform concepts

In view of the existing deficits in German and European climate policies, a number of reform concepts are currently being discussed.

The efficiency of climate policy could be enhanced by including all sectors in the emissions trading system.[163] The market price mechanism would provide the countries involved with incentives to use the most favourable abatement options across all greenhouse gas emission sources, and additional costs for segmented and uncoordinated policy measures would be eliminated. In political discourse it is sometimes argued that the expansion of emissions trading to all emitting market participants would incur high transaction costs. Yet this could be avoided if regulation were applied to the early links of the value chain: transaction costs would be incurred nationally by only a few importers and producers of fossil fuels. Appropriate controls should be in place to ensure that carbon markets with only a few key players are not exposed to distorted competition caused by market power.

The EU ETS' dynamic incentive effects could be enhanced by stabilising certificate prices within a target range based on reliable estimates of long-term climate damages caused by greenhouse gas emissions. Given the low EU ETS emission prices in the past, the proposed reforms are primarily aimed at providing price support. As an effective short-term measure, certificates could be withdrawn from the market as set-asides. As regards measures with a more sustainable effect, the introduction of a price floor is currently being discussed. In the event that the market price of certificates falls below the floor, the minimum price would have the same effect as a tax. Price stability could also be enhanced by establishing a central, independent authority, which would control the supply of emission allowances in a way that would ensure that certificate prices remain within a specific corridor even in times of economic distortions.[164]

Since incentives to invest in innovative emission reduction and prevention technologies may be considerably hindered due to risk-averse behaviour and insufficient planning security on the part of companies, the German Advisory Council on the Environment (SRU) recommends developing climate goals and associated legally binding provisions at least for the period until 2030.[165]

ENERGY POLICY

1. Rationale for energy policy: renewable energy and energy efficiency

If there were no further indications of market failure besides the externalities of greenhouse gas emissions, any renewable energy and energy efficiency objectives could be deemed superfluous or even counterproductive. The reduction target for greenhouse gas emissions could be achieved using a single market-conforming regulatory instrument – such as comprehensive emissions trading – in a statically and dynamically efficient way. The balancing of marginal abatement costs would automatically create a cost-effective mix of greenhouse gas reduction options. These would include not only a stronger use of renewable energy or improvements in energy efficiency, but also innovation in climate-friendly technologies. In such a scenario, explicit renewable energy and energy efficiency targets, as stipulated in the policies of the Federal Government and the EU, would be superfluous as targets would be reached through efficient climate policy anyway, or they would be costly due to additional efforts employed. Measured against the target for greenhouse gas reduction, the energy system would in fact over-cater for renewable energy or energy efficiency.

In addition to the externalities of greenhouse gas emissions, there are other forms of market failure that call into question the dynamic efficiency of emissions trading as the sole instrument of climate policy and would justify complementary regulatory measures. These forms include knowledge spillover and adoption externalities in particular (cf. Box 13). Besides this, existing price uncertainties may provide risk-averse market participants with investment incentives that are deemed sub-optimal from an overall economic perspective.[166] This is an issue that applies to the energy sector in particular, since the energy sector is characterised by uncertainties regarding binding long-term climate and energy policy objectives and their regulatory implementation. What is more, investment needs for R&D are relatively high in the energy sector and investment cycles for energy technologies are long.

Due to knowledge spillover, adoption externalities and price uncertainties, emissions trading that focusses solely on static efficiency is not a suitable means of overcoming what is known as the carbon lock-in. Today's energy sector is dominated by fossil fuel based technologies that benefit from sunk investment costs and economies of scale. Thus, established technologies not only benefit from compatible infrastructures, but also from accumulated knowledge assets as well as social and institutional habits and structures. All of these factors result in path dependencies. Moreover, cost-reducing economies of scale and learning curve effects for new technologies can only be expected in the medium to long term.

From an industrial policy perspective it is often argued that the promotion of renewable energy and energy efficiency can improve the competitiveness of domestic industries. Yet, beyond any regulatory concerns, it remains doubtful whether the promotion of the renewable energy sector will be suited to overcompensate costs incurred by regulation, tap additional innovation benefits and implement strategic competitive advantages.

Another argument in favour of public support for renewable energy and energy efficiency improvements is Germany's dependence on imported fossil fuels: Germany heavily depends on imports from various world regions, some of them politically unstable. Moreover, limited competition in international energy markets entails the risk of unreasonably high energy prices caused by the market power of individual suppliers. Regulatory intervention to reduce import dependency may be justified whenever countermeasures by private stakeholders – such as

BOX 13

Knowledge spillover and adoption externalities

Knowledge spillover: In the field of research and innovation, externalities occur in the form of knowledge spillover. By inspecting innovative products and processes, market participants can acquire knowledge without having to bear the full costs of knowledge creation. Conversely, this means that innovators cannot privatise the full social and societal returns of their product or process development. Form a social point of view, innovators invest too little in the production of knowledge due to the fact that the private innovation returns deviate from the social innovation returns. In energy technologies, there are additional factors that complicate the situation: here, patentability is restricted due to the complexity of plants and the diversity of stakeholders involved, which makes it even more difficult to privatise R&D returns.[167]

Adoption externalities: The costs of using a technology can depend on the number of market participants that have already adopted the respective technology. Users who adopt new technologies at an early stage can provide other stakeholders with valuable information on a new technology's existence, characteristics and success factors. Additional positive effects arise whenever (production) costs can be reduced as a result of the producer's increasing experience with the technology. If third parties benefit from these effects without making adequate compensation, this is referred to as adoption externalities. Thus it is often the case that developers, manufacturers and first-time adopters of a new technology cannot obtain the full return on the knowledge they generate.[168] Adoption externalities result from interaction between technology suppliers and technology users and the feedback loop between technology and market development, which are initiated by a stakeholder's investments and can be used by other market participants without compensation.

Regulatory measures for balancing these externalities include e.g. the strengthening or creation of property rights (e.g. through patenting), direct R&D subsidies, tax benefits for knowledge production, and sales promotion.

the diversification of supply sources or energy savings – do not suffice to meet the precautionary level deemed desirable from an overall economic perspective. In practice, however, it is often difficult to determine the scope of such deviations – which may e.g. result from different discount rates or different risk preferences[169] – and to develop targeted corrective measures on the basis of sovereign provisions.

In terms of energy efficiency, market failure can also be caused by information-related issues and institutional barriers. This means that energy efficiency measures deemed profitable from an overall economic perspective are not conducted. This is particularly the case in the energy-efficient renovation of buildings: home owners and landlords have to expend in order to obtain relevant information on potential savings and energy efficient products and technologies.[170] In the face of large investment amounts and long payoff periods, risk-averse owners will refrain if a potential investment's profitability is uncertain. What is more, home owners often anticipate financing constraints – especially in cases where diverse individual measures can only be properly implemented as part of a comprehensive renovation scheme. Coordination issues may also exist between tenants and landlords, known as the landlord-tenant dilemma: tenants have an interest in keeping their rental and property payments at the lowest possible level, but have insufficient knowledge about the energy efficiency of the building. Landlords have insufficient incentives for implementing energy efficiency measures, unless they directly profit from lower energy costs or pass investment expenditures on to their tenants – on the grounds of the market situation, on legal grounds, or due to the fact that tenants are underinformed.[171]

From a climate protection perspective, the systematic expansion of the renewable energy sector and improvements in energy efficiency are often justified on the grounds that the EU ETS only covers part of the overall economy's greenhouse gas emissions. Thus, for instance, greenhouse gas emissions produced in the generation of heating energy – with the exception of heating energy generated through electricity and district heating – are not regulated by emissions trading. Obviously, by expanding European emissions trading to all emission sources, this problem could be solved cost-effectively and according to the polluter-pays principle.

2. Renewable energy

2.1 The EEG: analysis of the current situation

The expansion of the renewable energy sector in Germany is regulated by the Act on Granting Priority to Renewable Energy Sources (Renewable Energy Sources Act – EEG) (cf. Box 14). The EEG is based on the 1991 Grid Feed-In Law *(StrEG)*. It entered into force in 2000 and has since been amended several times. The EEG's main pillars are the operator's obligation to connect to the grid, the priority of electricity generated from renewable energy sources as opposed to electricity from conventional sources, as well as feed-in tariffs and optional market premiums respectively. In terms of both static and dynamic efficiency, the EEG shows serious shortcomings.

Static efficiency would be achieved if the expansion of the renewable energy sector was ensued by balancing the marginal costs of production, i.e. by ensuring that the next unit of green electricity was supplied through the cheapest generation option. In practice, however, feed-in tariffs as stipulated in the EEG vary depending on the technology used, which is the reason why marginal costs do not balance. For instance, electricity generated from solar power will achieve a much higher price than electricity generated from wind power. As a result, too much solar power is being produced. Thus the expansion target for renewable energy is not implemented based on a minimum cost technology mix. Furthermore, an unrestricted take-or-pay clause for fixed and high feed-in tariffs leads to a much greater expansion than originally planned, which is associated with substantial additional costs.

When calculating future investments, operators of plants generating electricity from renewable sources can disregard the costs of potential additional investments in the electricity grid. The EEG does not provide any incentives for minimising the overall costs of constructing and operating plants and grids. Neither does the EEG provide sufficient incentives for operators to embark on demand-driven production and to invest in storage technologies and storage technology research. Although the EEG's market premium model serves the purpose of promoting the demand-driven generation of electricity from renewable sources, the premium is optional and plant

BOX 14

Germany's Renewable Energy Sources Act (EEG)

Connection requirement for grid operators: Under the EEG, grid operators are obliged to connect installations generating electricity from renewable energy sources to their grid system.[172] Grid operators are obliged to expand their networks if necessary to secure the purchase, transmission and distribution of electricity from renewable energy sources.[173]

Prioritising electricity feed-in from renewable energy sources over electricity from conventional energy sources: The total available electricity from renewable energy sources shall be purchased, transmitted and distributed by grid operators as a matter of priority.[174] Only in exceptional cases are grid operators permitted to engage in feed-in management, that is, to reduce the feed-in power of installations generating electricity from renewable sources. This only applies if network bottlenecks are anticipated, or the safety and reliability of the electricity supply system is at risk.[175] Whenever the supply of electricity from plants generating electricity from renewable sources is reduced, plant operators are to be compensated.[176]

Feed-in tariffs: Grid operators are obliged to pay tariffs to operators of installations generating electricity from renewable energy sources.[177] This obligation also applies in cases where electricity is temporarily stored prior to being fed into the grid system.[178] Applicable tariff rates are stipulated by the EEG and may differ depending on the energy source.[179] Tariff rates are subject to a degression formula, i.e. rates decrease per year for each newly commissioned plant,[180] while rates for energy produced by a plant remain constant for a period of 20 years.[181] Grid operators are obliged to supply electricity for which tariffs are paid to the relevant transmission system operator,[182] while the latter is obliged to compensate the grid operator accordingly.[183] Transmission system operators who have to purchase electricity from renewable energy sources in quantities greater than the average share are entitled to seek compensation from other transmission system operators.[184] All transmission system operators must sell the electricity purchased on the energy exchange's spot market[185] in accordance with the requirements of the Equalisation Scheme Ordinance *(Ausgl-MechV)*.[186] To cover the shortfall resulting from the difference between the sales-generated income on the exchange and expenditures incurred by the legally binding tariffs, transmission system operators may require electricity suppliers that supply electricity to end consumers to pay a fee (EEG surcharge) for each kilowatt-hour of electricity usage.[187]

Market premium: Plant operators may dispense with the statutory feed-in tariffs and directly market electricity from renewable energy sources. Since January 2012, plant operators are entitled to charge a market premium to the grid operator.[188] For each new calendar month, plant operators can decide anew whether to make use of the statutory feed-in tariffs, or whether to sell the produced electricity directly on the day-ahead market.[189] The market premium model aims to provide incentives for a demand-oriented production of electricity from renewable energy sources.[190]

operators are free to return to feed-in tariffs each month. It is therefore to be feared that deadweight effects will occur, which could further increase the costs of the EEG.[191] Moreover, it is doubtful whether the market premium model can initiate adjustments to the feed-in system according to market prices, since the supply of electricity from renewable sources is very inelastic to price movements (with the exception of biomass-generated electricity). The lack of demand orientation in the supply of electricity from renewable energy not only increases system integration costs, but also jeopardises the security of supply. Demand-oriented energy supply is a prerequisite for achieving enhanced self-sufficiency in power supply through the use of renewable energy.

Based on the criterion of dynamic efficiency, technology-specific feed-in tariffs can be generally justified on the grounds of varying degrees of adoption externalities. Yet the EEG's technology-specific feed-in tariffs do not address technology-specific adoption externalities but rather the respective electricity production costs, which results in distorted investment incentives.

The EEG has certainly created opportunities for incremental innovations, as operators demand technologies with the best possible ratio of production costs and feed-in tariff rate per unit of electricity produced. Yet incentives provided by the EEG for developing radical technological innovations are limited, because the remuneration guaranteed by the EEG is calculated based on the average cost of the respective technology. Thus, for a potential innovator, the revenue from an (ex-post) cost-effective new technology is the same as the revenue generated through pre-existing technologies. As a consequence, it does not pay to embark on risk-involving investments in technological innovations.[192]

By means of a graded feed-in tariff system, the legislator aims to facilitate the launch of technologies that are not yet saleable. But the EEG has also failed as an industrial policy instrument,[193] a fact that currently manifests itself in the economic problems of the German solar industry. Today, the EEG is largely used as a means of promoting the import of photovoltaic modules from foreign manufacturers – instead of providing German companies with a sustainable competitive edge.[194]

But the EEG is also costly and less targeted with regard to internalising knowledge spillover occurring in the early stages of the innovation process and in the development phase of entirely new technologies. Here, the EEG primarily acts as a production subsidy for electricity rather than an R&D funding measure. In the context of the massive expansion of the renewable energy sector, R&D activities have increased in absolute terms. Yet, in relative terms, R&D activities have decreased considerably: thus the R&D ratio of the German solar power industry decreased from nearly 4 percent in 2001 to a mere 1.6 percent in 2008. Especially companies with fairly mature technologies do not feel the need to invest in research. The excessive growth of the market has indirectly lead to market entry barriers for less mature technologies, while at the same time facilitating lock-in effects in favour of established renew-able energy technologies.

The explicit promotion of renewable energy can be partially regarded as a strategy for reducing greenhouse gases. Yet, when considering the CO_2 abatement costs associated with the EEG, this regulatory instrument is by no means a cost-effective way of reducing CO_2 emissions. The macroeconomic CO_2 abatement costs differ widely depending on the renewable technology used. Also in the medium term, the respective abatement costs tend to be well above the expected CO_2 prices in emissions trading or the estimated marginal costs of climate change. The highest abatement costs occur in the photovoltaic industry, and will remain high for the decades ahead (cf. Table 2), while the lowest costs are recorded in the onshore wind energy sector, and, from 2040, the offshore sector will follow suit.

It is sometimes also argued that subsidising the renewable energy sector has a positive effect on employment, as new jobs are being created in this industry.[195] Yet the EEG's macroeconomic employment effects are not quite clear. The EEG's promotional measures are financed through higher electricity prices for companies and private households, incurred via the EEG surcharge. This results in lower consumption levels, lower investments in other areas and, ultimately, negative employment effects. Furthermore, energy policy cannot serve as a substitute for labour market strategies to reduce unemployment.

Another problem inherent in the EEG are its regressive distributional effects. Since demand for electricity is very inelastic, low-income households are burdened to a relatively higher degree than high-

TAB 02 **Estimated macroeconomic CO_2 abatement costs in euro per tonne of CO_2**

	2010	2020	2030	2040	2050
Photovoltaics	387	161	163	169	177
Wind onshore	59	42	57	55	71
Wind offshore	107	88	64	49	56
Biomass	120	116	140	148	154

Source: own depiction, based on Ifo Institute and FfE (2012).

income households.[196] This distribution effect is reinforced by the fact that high energy consuming manufacturing companies have to pay only a reduced EEG surcharge so as to remain competitive.[197] This results in an even greater cost burden for all other electricity consumers. While low-income households are more affected by the EEG surcharge than high-income households, recipients of subsidies for rooftop photovoltaic installations are benefitting from payments resulting from the EEG's provisions. As property owners, these beneficiaries tend to belong to a more affluent segment of society.[198]

2.2 Reform concepts

With regard to the promotion of renewable energy sources, several reform concepts have been brought forward.

A reform concept that remains fairly close to the existing system, is to select plants eligible for funding through a tendering procedure, while feed-in tariffs stipulated by law would continue to be paid for a specified period of time. At any rate, a tendering model could be a suitable means of monitoring the capacity expansion of individual renewable technologies. The market-based auctioning of technology-specific generation capacity would create incentives for cost efficiency. Yet it will be difficult to precisely identify technology-specific expansion targets.

This would not be the case with green certificates, a measure recently recommended by the German Council of Economic Experts (SVR, cf. Box 15) and the German Monopolies Commission[199]. To reach the overall target, the respective contributions from renewable energy technologies shall be determined cost-efficiently on the basis of a market-based price mechanism. Individual US states, as well as a number of countries, have already introduced green certificates, among them EU member states such as Great Britain, Sweden, Poland, Belgium and Italy. The Netherlands are planning to introduce green certificates in 2015.

The trading of green certificates leads to a uniform price that provides orientation for all market participants. According to this model, revenues of producers of electricity from renewable energy flow from two different sources.[201] First, compensation is made through selling electricity at market prices. Second, revenues are generated from selling green certificates. The electricity price provides a direct incentive for demand-oriented supply and investments in storage technologies. Expanding trade in green certificates to other EU member states would lead to further efficiency improvements, since the locational advantages of the different European regions could be utilised here (e.g. solar energy in southern Europe and wind energy on the North Sea coast).

BOX 15

Green certificates as proposed by the German Council of Economic Experts[200]

Newly installed plants for producing electricity from renewable energy sources shall no longer be subject to the EEG. Yet the operators' obligation to connect to the grid and the priority feed-in continues to apply. Plant operators shall sell their electricity on the electricity exchange, where they compete with producers of electricity from conventional sources, or they arrange for long-term contracts with electricity consumers. For each electricity unit generated, operators of plants producing electricity from renewable sources shall receive green certificates from their transmission system operators. These certificates will be tradable. Energy suppliers shall be required to cover a minimum quota of electricity supplied to consumers from renewable sources. This quota will increase over time. For each accounting period, energy suppliers shall be obliged to produce a certain number of green certificates. The number shall be calculated based on the minimum quota and the total amount of electricity supplied to the end consumer.

Green certificates shall be traded on the exchange market. Producers of electricity generated from renewable sources shall sell their electricity to energy suppliers. The interplay between supply and demand will result in a uniform market price. A payment scheme graded according to technology shall not be in place.

Ultimately, the trading of green certificates shall be coordinated within Europe under a harmonised procedure.

The introduction of green certificates entails the risk of high price volatility at least in the early stages, which might discourage risk-averse investors.[202] In order to mitigate price volatility, market participants should be enabled to trade across periods and on futures markets. Other countermeasures include the introduction of price corridors, as well as a guaranteed term for investors regarding their plants' certificate validity.

According to the German Council of Economic Experts, green certificates should be flanked by additional innovation support measures so as to account for knowledge spillover and adoption externalities.[203] These include e.g. the expansion of university and non-university research and the creation of attractive framework conditions for private research.

The introduction of banding multipliers in the production of green electricity could be an alternative to a strict separation of technology promotion and quantity control through green certificates.[204] This measure is based on the idea that renewable technologies with higher generation costs would receive more Renewable Energy Certificates per kilowatt hour. Certificates would also be traded on a homogeneous certificates market. However, the introduction of banding multipliers would entail the government to make discretionary decisions – similar to those related to determining EEG feed-in tariffs – on the eligibility of alternative technologies in green power generation.

3. Energy efficiency

3.1 Analysis of the current situation

At German and European levels, a number of taxes and regulations are in place to increase energy efficiency. Besides introducing energy taxes, the legislator has enacted e.g. efficiency standards in the field of building and transport, eco-design guidelines for electrical devices, as well as bans on conventional light bulbs and night storage heaters. In the field of energy efficiency, specific instruments have been developed to manage information and financing issues and the landlord-tenant dilemma (as described above). These include e.g. financial incentives (such as KfW programmes), information and advisory services (including energy certification) funded by the public sector, as well as technical regulations (Energy Saving Ordinance) and amendments to tenancy law.

Notwithstanding the usefulness of explicit energy efficiency targets, energy policy should create incentives for implementing energy-saving measures where they are at the lowest overall economic cost. The current conglomeration of rule-based and discretionary measures does not meet this requirement. Current standards and bans disregard the fact that substantial welfare losses may be incurred by restricting producers' and consumers' choices. Moreover, standards do not provide incentives for increasing energy efficiency beyond the prescribed level, which results in the fact that continuous innovation activities are not fostered.

3.2 Reform concepts

A tradable quota system could provide a possible solution for achieving cost-efficient energy savings. A quota system would balance out the marginal costs of energy saving incurred by different energy saving measures.

Quota systems as an energy-saving measure are currently being discussed in the context of the new EU-wide Energy Efficiency Directive[205]. According to this directive, which is to be transposed into national law by the spring of 2014, energy consumption of end users in all member states shall be reduced by 1.5 percent annually based on the average annual sales volume of the years 2010 to 2012. Member states may achieve this goal either through an energy savings quota for energy distributors and retail supply companies, or through alternative measures.[206] In France, Great Britain, Italy, Denmark, and the region of Flanders, quota systems for energy saving are already in place. In all of these economies, energy companies are obliged to produce prescribed energy savings and to prove their savings. Moreover, companies also receive certificates for energy saving measures implemented for their consumers. These tradable certificates serve as proof that a particular saving has been accomplished.

B 1–4 INNOVATION POLICY

1. Rationale for innovation policy

A functioning innovation system with adequate incentives is the prerequisite for reaching climate and energy policy objectives efficiently.

Various types of market failure caused by knowledge spillover and adoption externalities may occur in innovation processes. These types of market failure are particularly relevant for the climate and energy market – not least because of the industry's particularly long investment horizons and the high degree of uncertainties regarding policy developments. These reasons justify not only the promotion of research and development, but also the promotion of new technologies in terms of market entry and diffusion.

Yet, when it comes to practical implementation, innovation policy is a highly complex task. It is close to impossible to analytically deduce an efficient mix of applicable innovation policy measures. It is therefore essential to critically assess the innovation system on a regular basis through monitoring and evaluation and to adjust policy measures as necessary.

Beyond market failure caused by knowledge spillover and adoption externalities, the objectives of supply security and strategic competitive advantages for Germany's economy provide the rationale for climate and energy-related innovation policies. Furthermore, it is often argued that, in the medium term, the development of innovative, climate-friendly technologies can lead to emission reductions in countries that are lacking a stringent climate policy. This can be achieved through technology transfer, which can lead to an increase in the (global) cost efficiency of unilateral climate policies.

BOX 16

Forward-looking projects in the Federal Government's requirement area "Climate and Energy"[208]

CO_2-neutral, energy-efficient and climate-adapted cities: With this project, the Federal Government promotes the ideal of the zero-emissions city. The project addresses the energy efficiency of buildings and production facilities, the future design of sustainable mobility and the development of intelligent energy networks. With the support of the Federal Government, selected cities will be transformed into low-carbon regions by 2020. Up to EUR 560 million are earmarked for the implementation of the forward-looking project "CO_2-neutral, energy-efficient and climate-adapted cities".

Renewable biomaterials as an alternative to oil: This project aims to explore the potential of renewable resources as an alternative to oil. The project's two main objectives are to increase the use of biomass without entering into competition with the food production industry, and to establish new processes for making full use of biomass. The budget of the forward-looking project "Renewable biomaterials as an alternative to oil" will amount to approximately EUR 570 million.

Intelligent restructuring of energy supply: The Federal Government considers progress in science and research as a prerequisite for reaching climate and energy-related policy objectives. Against this background, three inter-departmental research initiatives have been launched: "Energy Storage", "Grids" and "Solar Architecture / Energy-Efficient City". The budget of EUR 3.5 billion earmarked for the implementation of the Federal Government's 6th Energy Research Programme will largely be used for this forward-looking project.

2. Analysis of the current situation

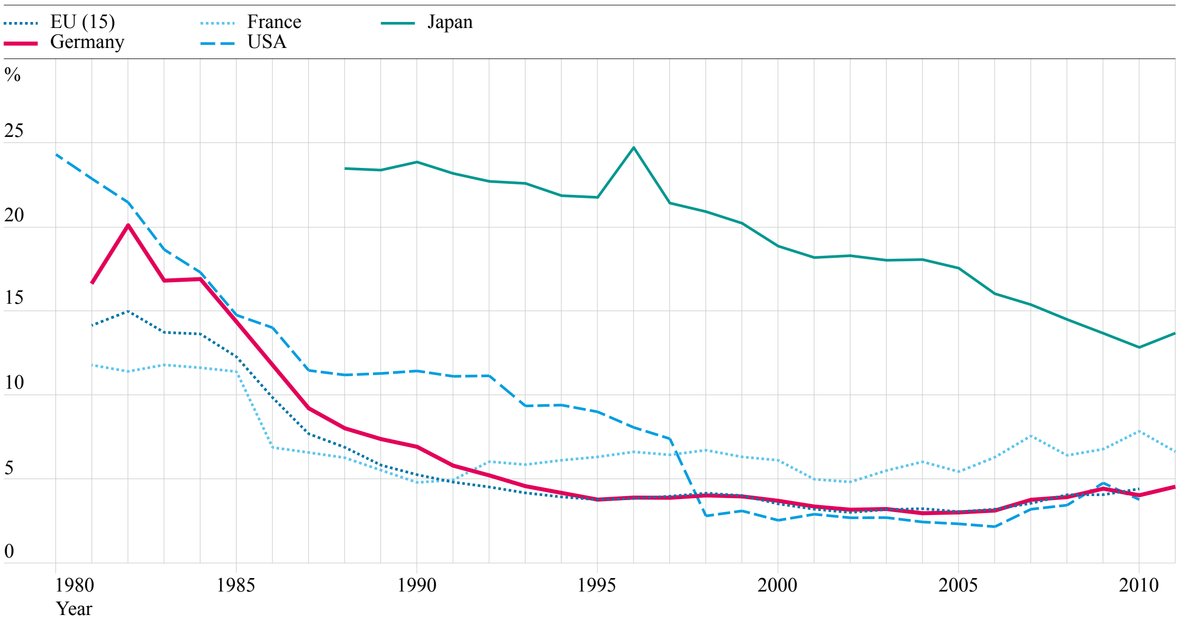
2.1 High-Tech Strategy 2020 and the 6th Energy Research Programme

The High-Tech Strategy 2020 is the Federal Government's key mechanism for coordinating the promotion of innovation across all government departments.[207] In addition to providing support measures, the High-Tech Strategy also focusses on improving framework conditions for innovation. The High-Tech strategy is based on a mission-oriented approach. It is divided into five requirement areas,[209] with "Climate and Energy" being one of these requirement areas.[210] The respective requirement area's key challenges are addressed via "forward-looking projects", and concrete objectives for scientific, technological and social developments are pursued over a period of ten to 15 years.[211] To date, three forward-looking projects have been designed for the requirement area of "Climate and Energy" (see Box 16).

With the 6th Energy Research Programme "Research for an environmentally sound, reliable and affordable energy supply", the Federal Government has established the guidelines and focal areas of its energy-related funding strategy.[212] It was adopted by the Federal Cabinet in August 2011. The programme was developed jointly by the Federal Ministry of Economics and Technology (BMWi), the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the Federal Ministry of Education and Research (BMBF), the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV), and coordinated by the BMWi. Between 2011 and 2014, the Federal Government is allocating approximately EUR 3.5 billion to the implementation of the 6th Energy Research Programme, which largely focusses on three key objectives. First and most importantly, the Research Programme aims to contribute to reaching the Federal Government's energy policy targets. This includes the priority to promote energy efficiency and the development of the renewable energy sector in a way that is cost-efficient as well as environmentally and ecologically sound. The second objective is to strengthen the position of German companies in the area of advanced energy technologies. The Research Programme's third objective is to secure technological options and to expand and improve the flexibility of energy supply in Germany. Thus, the Federal Government also regards the ongoing promotion of nuclear technology as part of an energy policy approach that is open in principle.

When compared with earlier programmes, the 5th Energy Research Programme had already a much stronger focus on renewable energy and energy efficiency. The 6th Energy Research Programme puts an additional focus on the promotion of energy storage technology and grid technology, the integration of renewable energy into the energy supply, and energy technology interaction within the overall system. For the more complex issues of energy storage and grids, interdepartmental research initiatives have

FIG 02 **Public R&D expenditures for energy research of selected countries in relation to total expenditures on civil research**

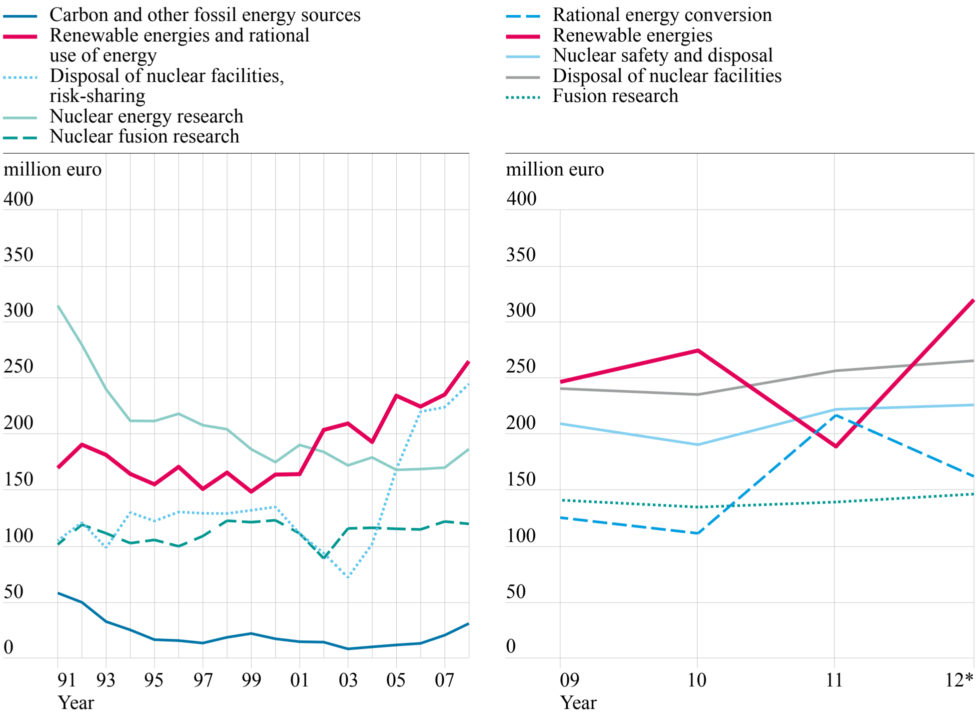


Source: own depiction based on calculations by the Ifo Institute; cf. Rave et al. (2013).

Note: R&D expenditures as GBAORD (Government budget appropriations or outlays on R&D) based on data from funding agents (including payments from foreign organisations); classification according to NABS 1992 (Nomenclature for the analysis and comparison of scientific programmes and budgets) and, for the period starting from 2007, NABS 2007; data for Japan only available from 1988.

The Federal Government's total expenditures on science, research and development in the funding priority areas of energy research and energy technologies, in million euro

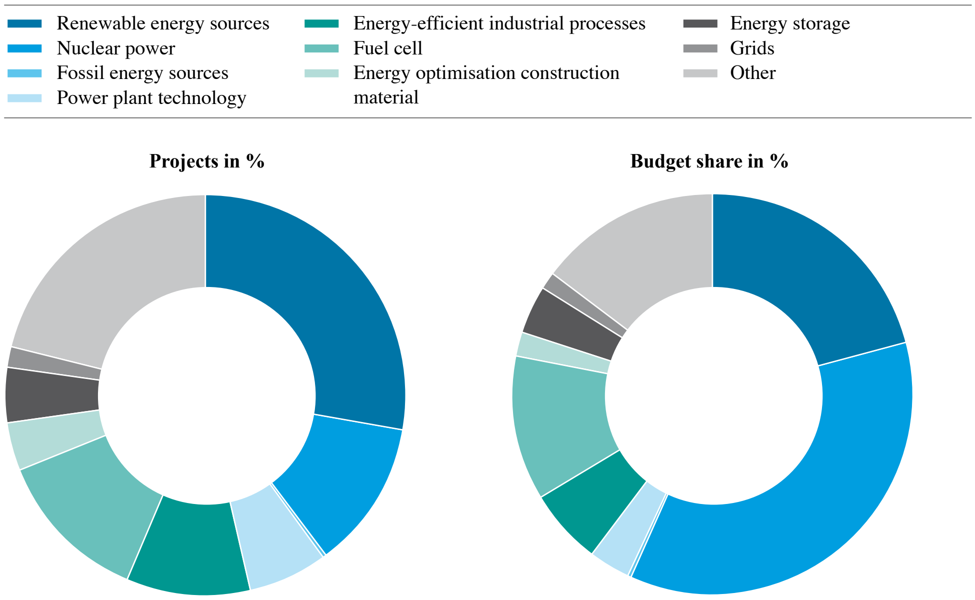
FIG 03



Until 2008: according to the Federal Government's 2005 R&D planning system. Division into support areas and funding priorities partially estimated. From 2009: according to the Federal Government's 2009 R&D planning system. 2009-2011: including investment and repayment funds without *Länder* allocations (Stimulus Package II); from 2011: including energy and climate fund. 2012: target values.
Source: own depiction based on the BMBF data portal; cf. Rave et al. (2013).

Allocation of energy-related project support by the Federal Government

FIG 04



Figures include all continuing projects as of February 2012.
Source: own depiction based on calculations by the Ifo Institute; data: *Förderdatenbank des Bundes,*[213] cf. Rave et al. (2013)

been launched. Compared with previous programmes, much lower priority has been given to fossil power plant technologies, such as technologies for carbon capture and storage. Around 18 percent of the programme's funds are being allocated to nuclear fusion research between 2011 and 2014.

In addition to the 6th Energy Research Programme, the Federal Government's High-Tech Strategy 2020 lists further lines of action, most of which have a global outlook.[214]

The Energy Research Programme does not cover research ventures in the fields of transport research, electromobility and aviation research, environmental research, housing and construction research, or research in the field of information and communication technologies – unless research addresses energy-related issues. These fields are partially covered by other requirement areas outlined in the High-Tech Strategy 2020.

2.2 Public research expenditure

In 2011, the share of public R&D spending on energy research amounted to slightly below 5 percent of the total civil research expenditure in Germany (cf. Figure 2). Yet, when compared on an international level, it should be noted that surveys on energy research are conducted differently according to country, i.e. a uniform standard does not exist. In the early 1980s, Germany was still spending up to 20 percent of civil research expenditure on energy research – which is quite remarkable, even when compared internationally. Until the early 2000s, this rate continuously dropped to approximately 3 percent, a low also in absolute terms. During this period, the Federal Government's R&D expenditure for nuclear energy research fell sharply.[215] A relative increase in research expenditure could be observed only in recent years. Energy research expenditure has also declined significantly in a number of other countries. This applies to the United States in particular, where the proportion share dropped significantly during the 1980s, and again from the mid-1990s on. In the 1980s, the share of public research expenditure of the EU-15 countries was about 2 to 3 percentage points lower than that of Germany, with figures converging over time. In Japan, where high priority is being attached to cost-intensive nuclear research, the share of energy research expenditure has been – and still is – much higher than in many other countries worldwide.

Figure 3 shows that the Federal Government's expenditure on science, research and development has increased significantly since the late 1990s, especially in the area of renewable energy. Since 2004, higher growth rates have also been recorded for research into the disposal of nuclear facilities.

An evaluation of the Federal Government's funding catalogue provides detailed information on the government's stance on funding energy-related projects. The catalogue lists the support measures provided by the Federal Ministry of Education and Research (BMBF), the Federal Ministry of Economics and Technology (BMWi), the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) and the Federal Ministry of Transport, Building and Urban Development (BMVBS) (cf. Figure 4). In the field of renewable energy, a total of 599 projects receive funds of EUR 457 million, making up 27.8 percent of energy-related projects and accounting for 20.9 percent of the total energy funding budget. Almost half of the resources will be allocated to solar energy projects, and approximately a quarter to wind energy projects. Energy storage and grids – areas that are currently widely discussed in political realms – make up only 6.3 percent of projects funded, while using only 5.3 percent of funding resources. Even though the percentage share for all energy-related projects is much lower (12 percent), a relatively large proportion (38.5 percent) of funds is allocated to nuclear research, which is owing to the large project volume in this field. Four-fifths of funds in this research area are used for research into disposal and waste management.

While expenditure on energy research has been declining for many years, which is largely attributable to diminishing research into nuclear energy, the late 1990s saw an increase in expenditure especially in the area of renewable energy.

3. Reform concepts

As regards renewable energy policies, is has often been suggested to reallocate funds from diffusion promotion to earlier phases of the innovation

Distribution of renewable energy research funding and market development funding in Germany, in million euro

TAB 03

	2008	2009	2010	2011 [f]
Total research funding [a]	222	357	375	~ 373
Research funding (federal only)	161	277	275	~ 273
Research funding (federal only, projects only)	131	220	219	~ 200
Total funding of market development	4,607	6,176	8,620	~ 12,920
Support through EEG (EEG differential cost) [b]	4,300	5,600	8,100	~ 12,400
Other support measures [c]	307	576	520	~ 520
Total research funding as a share of market development funding	4.8 %	5.8 %	4.4 %	~ 2.9 %
Federal Government's R&D project funding as a share of EEG differential cost	3.0 %	3.9 %	2.7 %	~ 1.6 %
Federal Government's R&D photovoltaics project funding as a share of EEG differential cost [d]			~ 1.5 %	~ 0.9 %
Federal Government's R&D wind energy project funding as a share of EEG differential cost for wind energy [e]			~ 1.9 %	~ 1.8 %

Source: own depiction, based on a compilation in Rave et al. (2013), in: Braun et al. (2011); BMU 2011; BMU 2012; BDWE (2012).

Notes:
[a] Project funding and institutional funding by federal and *Länder* governments; without project funding partially relating to R&D for renewable energy (2010: EUR 12 million from BMU, BMWi, BMBF each); *Länder* governments' research funding: EUR 61 million in 2008, estimated increase to EUR 80 million (2009) and EUR 100 million (2010, 2011).
[b] Differential cost: difference between the grid operator's revenue from the sale of renewable energy electricity and their expenditure in purchasing renewable energy electricity; 2011: estimates by BDEW (2012).
[c] Market incentive programme, "100,000 roofs" solar power programme (remaining expenditure), support of advice (estimated renewable energy share), export promotion, market launch of sustainable commodities (estimated renewable energy share), support programmes of the *Länder* in relation to the market development of renewable energy (approx. EUR 25 million annually); 2010: target values.
[d] EEG differential cost according to BDEW (2012): EUR 4,470 million (2010) and EUR 6,914 million (2011); R&D cash outflow according to BMU (2011, 2012) ca. EUR 65 million (2010) and EUR 60 million (2011). R&D support subject to underestimation due to attribution problems.
[e] EEG differential cost according to BDEW (2012): EUR 1,980 million (2010) and EUR 2,712 million (2011); R&D cash outflow according to BMU (2011, 2012) ca. EUR 50 million (2010) and EUR 37 million (2011). R&D support subject to underestimation due to attribution problems.
[f] Values are provisional or based on estimates respectively.

process, and to invest these funds in basic and applied research in particular.

The funding volume earmarked for market development in the area of renewable energy is 35 times greater than the total volume available for R&D funding (cf. Table 3). When comparing the funding volume of EEG-based support measures at national level with R&D project support from the Federal Government, a factor of 62 applies. Although a policy-induced market growth is also accompanied by an absolute increase in R&D activities,[216] the Expert Commission still sees a major imbalance between diffusion promotion measures and R&D support measures.

Additional basic and applied research is likely to generate considerable potential for cost reduction and innovation. Thus, according to the Fraunhofer Institute for Systems and Innovation Research (ISI), it would make sense to align research funding for photovoltaics with the entire value chain.[217] Moreover, public funding in the field of onshore wind energy should focus on concrete optimisation approaches, since this is a mature field of technology.[218] Yet in offshore wind energy research, which is still in its early development stages, specific segments should be considered to a much greater extent. These include the adaptation of wind energy plants, the development and improvement of load-bearing structures, as well as installation and maintenance concepts. As with photovoltaics, wind energy is generally characterised by a substantial need for research into smart solutions for integrating wind energy into the supply network. In addition to this, energy-related research should be coordinated more closely with research in other industries, e.g. aviation or microsystem technology.[219]

In order to assess, adjust and improve the innovation system, innovation policy has to be complemented by a continuous monitoring and evaluation process. EU countries with a highly advanced evaluation system include Denmark, Great Britain and Austria.[220] It would therefore make sense to multilaterally exchange previous findings and policy recommendations as well as methods for data collection and data analysis.

B 1–5 POLICY COORDINATION

1. Interplay between climate, energy and innovation policies

An economic evaluation of individual climate, energy and innovation policy instruments can be very complex and challenging. The task at hand is to develop theories and models for assessing if and how regulatory changes affect the behaviour of economic entities, and thus change the market outcome, as compared with a non-regulated reference situation. Where possible, the theoretical models used have to be validated on the basis of empirical work, i.e. by means of econometric or experimental studies. Although economic policy advice makes frequent use of theoretical insights, the task of analytically identifying cause-and-effect relationships is becoming more and more complex. This is aggravated by the frequent occurrence of opposite effects, which have to be evaluated based on quantitative (numerical or empirical) studies.

Economic evaluations of the isolated or combined use of climate, energy and innovation policy instruments can take the form of a descriptive study, or, as is the case in cost efficiency evaluations, a normative study. Prior to any assessment of policy interaction and policy coordination, the respective target system should be clearly established. If only one policy objective is to be pursued, such as the reduction of greenhouse gas emissions, one instrument (in this case emissions trading) usually suffices for achieving the objective efficiently. In these cases, the use of multiple instruments could be deemed either redundant or inefficient and would create the need for coordinative action, when in fact coordination is not needed in the first place. In the event that there is multiple evidence for market failure – such as greenhouse gas externalities, price uncertainties, knowledge spillover and adoption externalities – it is advisable to employ multiple instruments. Thus, emissions trading may be flanked with price corridors as a hedge against price uncertainties, and further complemented by innovation support measures for climate-friendly technologies – provided that significant knowledge spillover effects or adoption externalities are attributable to private R&D. In such a scenario, overlapping regulatory measures are inevitable, and an efficient mix of policy instruments has to take into account such economic interrelationships. Here, it is also important to closely coordinate the different policy measures across all stakeholders involved.

The EU ETS and the EEG, two key instruments of German climate and energy policy, may serve as an example for overlapping regulatory measures. As long as the objective of German climate and energy policy is confined to climate protection, the cost-effective implementation of a given emissions target can be achieved in static terms through the instrument of emissions trading. The additional promotion of renewable energy through feed-in tariffs merely leads to emissions being relocated within the EU ETS. As a result of this promotional measure, Germany's electricity industry – which, in terms of cost efficiency, has too strong a focus on the use of renewable energy – embarks on emission prevention, while "vacant" emissions are demanded elsewhere in the EU ETS. In this particular case, overlaps in regulation remain ecologically neutral but not cost-neutral. The higher proportion of renewable energy – as enforced by the EEG-based support – has the effect that the emission reduction target is achieved at unnecessarily high costs, and these costs are borne by electricity consumers.

But regulatory overlaps of the EU ETS and the EEG can also lead to other undesirable side effects. The EEG lowers the demand pressure on the supply of emission certificates, which results in price cuts for emission allowances. Plants that are most emission-intensive benefit from this, which means that, in terms of their energy mix, lignite-fired power stations for instance, are treated better than gas-fired power plants.[221] Within the framework of the EU ETS, regional carbon leakage occurs – largely to the benefit of countries that function as net importers of emission certificates and hence pay lower rates once emission prices drop, while net exporters lose out. Innovation incentives for climate-friendly production technologies derived from emissions trading are diminished by falling allowance prices. On a similar note, it is often argued that the promotion of renewable energy outside the EU ETS can contribute to emission reduction – e.g. in the area of heat generation. Yet, this hypothesis does not hold true: when analysing emission abatement costs, it turns out that the costs incurred by renewable energy, and photovoltaics in particular, are much higher than the prices of EU ETS certificates.

The same weaknesses can be observed with regard to climate protection targets that are complemented by additional energy efficiency provisions. Again, emissions within the EU ETS remain unaffected, while costs are increasing due to the fact that abatement costs are not balanced across different emission sources. As a result, climate protection becomes more expensive than necessary. Judged from this point of view, overlapping regulation for the sake of enhancing energy efficiency (such as the Eco-Design Directive for energy-using products) can be deemed counterproductive. While the emissions trading system creates incentives to compete for cost-efficient prevention measures, the Eco-Design Directive restricts the choice of products and forces manufacturers to modify their products, which leads to additional costs for producers and to welfare losses for consumers (cf. Box 17).

The Expert Commission is also sceptical concerning the introduction of energy or emission taxes as a climate protection measure to flank comprehensive emissions trading. From an ecological perspective, additional emission taxes within the EU ETS would simply evaporate – or at least this will be the case as long as allowance prices continue to be positive as a result of the EU ETS provisions. In the case of a sole emission tax, allowance prices would simply be reduced in line with the applicable tax rate. If tax rates differ between EU countries, or if national taxes do not refer to emission levels alone, this will result in multiple regulation requirements, which will incur additional costs.[222]

BOX 17

Counterproductive overlapping of emissions trading and energy efficiency measures

Example 1: The ban on conventional light bulbs
The ban on conventional incandescent light bulbs has led to a decline in the demand for electricity. As a result, the amount of CO_2 emissions caused by electricity generation is reduced. Yet the emission levels of the EU ETS sectors are not reduced. The electricity generating companies' lower demand for certificates leads to lower prices and thus to an increased demand for emission allowances from other EU ETS sectors. This means that CO_2 emissions are merely relocated. At the same time, the ban has limited the freedom of households to choose their type of lamps according to their own preferences.

Example 2: The ban on night storage heaters
The ban on night storage heaters has led to a decrease in full-load hours e.g. for base load plants operating on brown coal. This means that the respective plants produce less CO_2 emissions. On the part of base load plant operators, the demand for certificates decreases. As a result, certificates are becoming cheaper, and demand from other EU ETS sectors is increasing. CO_2 amounts emitted by the EU ETS remain stable. Outside the EU ETS, additional emissions are caused, as night storage heaters are replaced by oil and gas heaters. Moreover, home owners are restricted in their freedom to choose heaters according to their preferences.

If further objectives such as the advancement of renewable energy or energy efficiency improvements are to be justified, the stakeholders involved need to broaden their one-dimensional perspective on climate protection. The "extra costs" generated by overlapping regulatory policies could then, under the command of a reasonable mix of instruments, be overcompensated with the benefits from the pursuit of additional objectives.

As regards climate protection strategies, an emissions trading scheme with a price corridor will create incentives for innovation that are largely dynamically efficient. In the field of innovation policy, measures to internalise knowledge spillover should continue to focus on basic and applied research, while diffusion promotion should be applied where adoption externalities occur. From a theoretical point of view, there are indeed reasons to question the EEG's suitability as an innovation policy instrument.

Only very few empirical studies exist on the interaction effects between targeted innovation, climate and energy policy instruments. This also applies to the EEG. This research gap should be closed by means of systematic evaluation research activities.

2. Institutional aspects

Over the last 20 years, Germany has been exposed to increasing overlaps in environmental and energy policy issues and legislative initiatives at its institutional level. This poses a potential for conflict between the Environment and the Economics Department in particular. The latter is in charge of Germany's energy policy.

Already in the 1970s, a period that marked the beginning of an independent environmental policy in Germany, a rivalry developed between environmental concerns and the interests of energy and environmentally intensive industries affected by regulation. Existing conflicts of interest were aggravated with the increasing pressure to adopt a more stringent climate policy, and the call to promote renewable energy and energy efficiency not only as a complementary source, but also as development goals in the transformation of the energy system. The implementation of far-reaching energy policies, among them the EU ETS and the EEG, were pushed forward by the Environment Department and monitored very critically by the Economics Department.[223] Due to the scope and complexity of the issues concerned, an increasing number of other federal ministries had to be integrated into the coordination process.

Currently, ministerial responsibilities for climate and energy policies are scattered across several departments.[224] The area of power supply systems for instance is coordinated not only by the Federal Ministry of Economics and Technology (BMWi), but also by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Federal Ministry of Education and Research (BMBF).[225]

In the context of implementing the 6th Energy Research Programme, the BMWi is responsible for application-oriented project funding of R&D in the field of non-nuclear energy research (excluding renewables) and nuclear safety and repository research. In the field of renewable energy (excluding bioenergy), the BMU is in charge of application-oriented project support, while the BMELV is responsible for application-oriented project funding of R&D in the field of bioenergy. With but a few exceptions, institutional funding in the energy sector – which includes funding of the Helmholtz Association in particular – falls into the remit of the BMBF. The BMBF also supports project-oriented research on fundamental issues in the areas of energy efficiency, renewable energy, nuclear safety, waste management, radiation, fusion and precautionary research, as well as the training of experts and young scientists. Finally, the BMVBS is in charge of traffic research projects that are not included in the 6th Energy Research Programme, as well as research in construction and housing.

When analysing Germany's current institutional framework conditions, a range of issues can be instantly highlighted. Judged from an outside perspective, the federal ministries' public image and communication is inconsistent. Collaboration between the Federal Government and the *Länder* governments, each of which have their own approach to energy policy, is insufficient. The expansion of high-voltage lines, which has become necessary due to the increase in electricity from renewable energy, may serve as an example for the complexity of the coordination process involved.

Existing coordinative problems could be solved based on procedural or structural approaches. Procedural approaches address administrative coordination within the participatory process, while structural approaches primarily address the departmental layout. Thus, for instance, various stakeholders have called for establishing an Energy Ministry in Germany.[226] Denmark and Britain are among those countries that have already established such a ministry.[227] Advocates believe that a central ministry would enhance the visibility of issues arising in the context of mastering the complex challenges of the Energy Transition. Critics point to potential interdepartmental coordination problems, which would arise e.g. from conflicting objectives between nature conservation and the promotion of renewable energy.[228]

B 1–6 RECOMMENDATIONS FOR ACTION

Climate policy

The cost efficiency of EU climate policy should be increased by expanding European emissions trading to all emission sources. To improve innovation incentives created by the EU ETS, the Expert Commission recommends enhancing planning security for all companies involved. This should be implemented by means of binding emission reduction targets until at least 2030. In addition to this, minimum prices for emission allowances should be introduced.

Energy policy

In addition to the target of reducing greenhouse gas emissions, there are further energy-related policy objectives. These include the development of renewable energy and an increase in energy efficiency. These objectives can be justified by such factors as competitive advantages, the creation of "green" jobs and energy security. From a welfare economic perspective, these factors should be critically reviewed. Provided that explicit goals for developing the renewable energy sector and for increasing energy efficiency can be justified in terms of welfare policy, objectives should be implemented in the most efficient way. With regard to the renewable energy sector, the Expert Commission agrees with the recommendations of the German Council of Economic Experts and the German Monopolies Commission to introduce green certificates. An increase in energy efficiency should be implemented by introducing an energy saving quota. Especially in the building sector, which is characterised by major obstacles such as information asymmetries and the landlord-tenant dilemma, the quota system should be flanked by further measures. These include e.g. standardisation, saving regulations and financial incentives for energy-saving redevelopment. In addition to this, property, contract, planning, approval and tenancy law should be amended, and building regulations should be adapted.

Innovation policy

The issue of knowledge spillover effects in the field of R&D makes it necessary to support basic and applied research, e.g. by means of direct subsidies and R&D tax credits. Energy-related applied research should focus on key technological challenges associated with the Energy Transition, such as the development of new or improved renewable energy products and processes, storage and transmission technologies, as well as energy efficiency technologies in construction and transport.

Carbon capture and storage as a technological approach to climate protection should be researched and carefully assessed with regard to the opportunities and risks associated. In this context, demonstration projects should be implemented, with the purpose of developing and testing new technologies. A premature verdict for or against a specific technology should be avoided.

In the view of the Expert Commission, renewable energy policy is characterised by a drastic imbalance between diffusion promotion and the promotion of R&D. The Expert Commission recommends correcting this imbalance in favour of R&D funding.

While energy and climate policy measures can have a considerable impact on innovation incentives, only little empirical evidence has been provided to date. As a consequence, policy measures have to be evaluated on a regular basis and according to the latest scientific methods. Regular evaluations would enable the stakeholders involved to reliably assess overlaps in the regulatory fields of climate, energy and innovation policy.

Coordination

The fragmentation of responsibilities for energy research in Germany is quite bizarre, and responsibilities relating to the implementation of the Energy Transition are scattered widely. The Expert Commission reiterates[229] the need to coordinate and consolidate energy-related policies more closely. The pooling of competencies through the creation of an Energy Ministry is a much debated approach that has been adopted by a number of countries. Yet, in the view of the Expert Commission, this measure is not necessarily best suited for solving existing coordination issues. Even under the umbrella of one government department, contradictory assessments may persist and frictions may continue to occur and, conversely, constructive ways of collaborating may also be established across departmental boundaries. The launch of a national platform could be a viable alternative to one integrated Energy Ministry with full responsibility for the Energy Transition. Such a platform would comprise not only the relevant federal ministries, but also representatives of the *Länder* governments and key companies. Again, stringent management by the Federal Chancellery would be the prerequisite for successfully coordinating climate, energy and innovation policies.

Unnecessary coordinative efforts in the realms of climate, energy and innovation policies can only be prevented if solely those objectives are pursued that can be justified on the grounds of market failure. In the event that several objectives exist, these objectives have to be prioritised, which will facilitate clear recommendations for action. As regards regulation overlapping, ex-ante studies should be conducted to identify potential synergies and counterproductive effects. In order to prevent policy failure, policy initiatives of the EU, the Federal Government, several ministries and the *Länder* have to be coordinated more closely.