Expert commission on the “Energy of the future” monitoring process

Statement on the second monitoring report by the German government for 2012

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- Prof. Dr. Georg Erdmann
- Prof. Dr. Frithjof Staiß
- Dr. Hans-Joachim Ziesing

Summary

ENERGY OF THE FUTURE

Commission on the monitoring process

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Content

Summary

The monitoring process as an element of the German "Energiewende"

The German government's September 2010 Energy Concept is a long-term strategy setting out ambitious targets for German energy policy. After the reactor disaster in Fukushima, Japan, in June 2011 the phase-out of nuclear power was enshrined in law in an all-party consensus, rendering this system of targets yet more ambitious.

This document contains the statement of the expert commission on the "Energy of the future" monitoring process on the second monitoring report published by the German government. As for the first statement issued in December 2012, this statement aims to examine and assess the German government's monitoring report from a scientific perspective. As a result of the change in government and the reorganisation of the ministries this entailed, the process of compiling the monitoring report and our statement was delayed. Issuing our statement was also made more difficult by the fact that the draft monitoring report was not available until March 2014. This meant it was not possible to examine all parts of the German government's monitoring report in depth. However, this year as well, the relevant developments, targets and measures have been analysed extensively. The focus of our attention here is on the issues:

- the monitoring process as an element of the Energiewende,
- the phase-out of nuclear energy and development of greenhouse gas emissions,
- initiatives in the field of energy efficiency,
- development of renewable energy sources,
- development of supply security,
- economic viability of the energy supply
- innovation impetus provided by the Energiewende.

As part of this process, this report puts information provided in the Germangovernment's monitoring report into context and adds to these, if the expert commission felt that areas of considerable importance needed to be examined more thoroughly (for instance innovation impetus). In line with our mandate, our re-

port does not make any predictive statements if this means using mod-els, nor does it provide a substantiated evaluation of measures. We do, however, examine the probable impacts of the energy and environmental policy decisions made in terms of the prospects for target attainment in order to identify relevant areas of action. Like the monitoring report itself, this opinion is based on 2012 as the year under review although as a result of the time of publication, the information already available for 2013 has also been taken into account.

The monitoring process is an important element in transforming Germany's energy system. The German government's first monitoring reports served in particular to develop a framework for this new task, to identify suitable indicators and to state the necessary data on which to base this. The scaffold for the long-term support of the Energiewende has now been erected to a large extent and will be developed further step by step over the years to come. The monitoring has now moved into a new phase from the expert commission's perspective. The fact-focused monitoring describing indicators and how they have changed has reached a stage at which we believe it is now possible for the monitoring process to support the Energiewende by adopting a more problem-oriented approach.

The focus of the German government's monitoring reports should therefore go beyond presenting indicators and describing changes to them and aim more to **analyse and evaluate the developments observed**. Here it is necessary to depict the changes in the various dimensions of the Energiewende in the period under review in an impartial way. Especially if indicators point to individual developments falling behind the trajectory for target attainment, problems must be stated clearly, causes analysed in depth and conclusions drawn as to what political action must be taken. Only then can the relevant fields of action be identified and the political priorities be defined as the Ener- giewende progresses. The German government's monitoring reports can then – also beyond the progress reports which only have to be published every three years – evolve into an even more important instrument of analysis for the German government.

To make the progress of the Energiewende measurable and as such a guide for the course of action to take, clear targets must be defined and in the event of

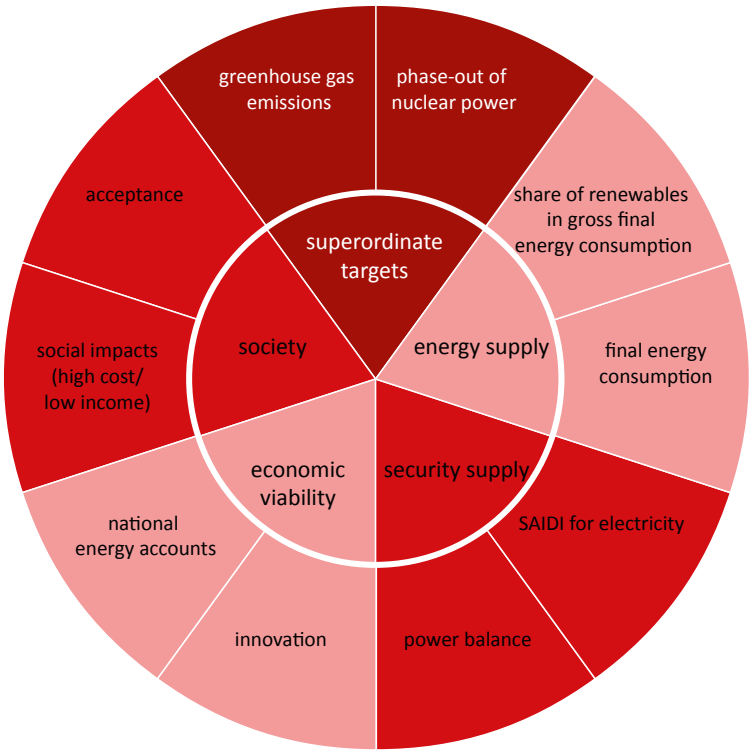
conflicting targets, priorities must be set. The Energy Concept and the subsequent decisions taken by the German government provide an extensive list of targets to transform Germany’s energy system. Officially, these targets are all equally important. But from our point of view they are not all of equal significance. The expert commission firmly believes that the Energiewende is defined by two superordinate targets: lowering greenhouse gas emissions by at least 80 % by 2050 and phasing out the use of nuclear power by the end of 2022. These superordinate targets are shored up by various sub-targets and implemented using political measures. The sub-targets and measures should in turn be adjustable flexibly, always bearing in mind that this must not compromise the attainment of the superordinate targets. We recommend the German government and the parliament turn their attention to **prioritising the Energiewende targets** accordingly.

In the “Energy of the future” monitoring process, a complex package of political aims and objectives has to be mapped and evaluated with the help of indicators. This type of framework improves continuity, planning certainty and the comparability of the monitoring process over the course of time. When defining this system of indicators, lead indicators enable the developments of the Energiewende in its various dimensions to be measured with the aid of just a few key figures. The system of indicators thus guides the course of action to be taken. Secondly, the lead indicators are backed up by a broad system of indicators providing the information base.

Whilst the German government uses only indicators which are linked to a quantitative target in the Energy Concept as lead indicators, the expert commission recommends a broader approach which also takes into account the non-quantitative aims of security of supply, economic viability and environmental soundness – beyond greenhouse gas emissions – of the energy supply as well as the acceptance and societal impact of the Energiewende. For the “Energy of the future” monitoring process, we propose the use of ten **lead indicators** for five different dimensions of the Energiewende. They render more compact the list of the German government’s lead indicators and add non-quantified dimensions of the Energy Concept to this. The lead indicators are shown in the figure below and encompass greenhouse gas emissions, the phase-out of nuclear power, the share of renewables in gross final energy consumption, final energy

consumption, System Average Interruption Duration Index (SAIDI) for electricity, the power balance, innovation, National Energy Accounts, social impacts on the basis of the "high cost/low income" approach and acceptance.

Figure: Lead indicators for the "Energy of the future" monitoring process



In addition to the German government and the expert commission, other stakeholders are participating in the discussion on monitoring the Energiewende with their own indicator systems. These stakeholders mostly also suggest the use of an aggregated perspective through lead or aggregate indicators based largely on the energy policy triangle of "security of supply, economic viability, environmental soundness" but also encompassing dimensions beyond this. It is to be welcomed that various different organisations acting independently of each other wish to support the process of transforming Germany's energy system, as this shows after all that the Energiewende with all its opportunities and challenges has arrived in society. For the monitoring process this is an important addition. Furthermore, the information base is being expanded constantly by the complementarity of these initiatives. From our point of view this is an extremely positive development.

With regard to the **availability and quality of underlying data**, the expert commission renews its recommendation from its statement on the first monitoring report in 2012 for a fundamental revision of the Energy Statistics Act (Energiestatistikgesetz) to improve the data on which energy statistics are based and in order to be able to make adjustments flexibly as structures change. Here, it is also a matter of simplifying the legal process governing the ordering of energy-related statistics by enacting appropriate ordinances, expanding the reporting groups, opening up opportunities to use administrative data, but also of conducting regular and representative random sample data surveys. Improvements to the data on which energy statistics are based are also necessary above all with regard to the collection of energy-related data for the buildings sector and for the very diffuse sector of trade, commerce and services.

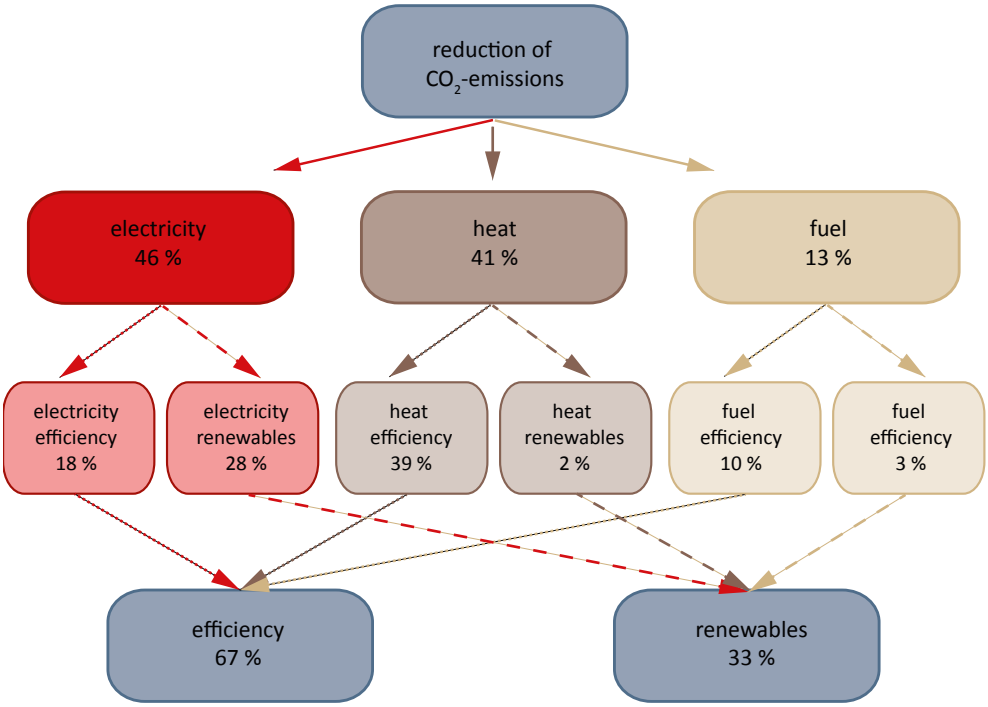
The phase-out of nuclear energy and development of greenhouse gas emissions

The **path towards phasing out nuclear energy** is set forth in law. The expert commission welcomes the affirmation of this objective in the coalition agreement. To avoid friction, the utmost must be done to ensure that the requisite transmission capacities and/or substitute capacities in particular for the south of Germany are available on time. In terms of greenhouse gas emissions, the development over the last two years allows the conclusion that Germany is currently not on course to meet its targets. The German government also notes this in this year’s monitoring report and states that with the current measures it seems that the target of **reducing greenhouse gas emissions** by 40 % by 2020 will be clearly missed with an expected drop of just 35 %. In light of this, the statement made in the monitoring report that “the transformation of Germany’s energy system is making headway” is certainly debatable in its generality from the point of view of the expert commission. For the greenhouse gas target for 2020 – which was also reaffirmed in the coalition agreement – to still be met, hence forth the annual average reduction in emissions would have to be twice as high as for the period from 2008 to 2012. A rise in emissions – as seen in 2012 and 2013 – should not be simply accepted.

Given the few years remaining until 2020, it will only be possible to stop the target from being missed if **additional energy and climate policy measures** are

implemented as promptly as possible. In the view of the expert commission what will be crucial on this front will be to create incentives through the appropriate framework conditions to improve energy efficiency and to gear the structure of electricity generation more towards renewables and other low emission energy sources. Here it is also important to take into account that irrespective of the restructuring of electricity generation required any way, there is also the zero-emissions electricity which will be lost with the shutdown of the nuclear power plants and which will have to be replaced. Our assessment of the **areas requiring action of electricity, heat and fuel, energy efficiency and renewables** to reduce CO_2 emissions based on the targets of the Energy Concept is presented in the figure below.

Figure: Reduction of energy-related CO_2 emissions according to the areas of action for the period 2010 to 2020



The largest individual contributions are from efficiency improvements or **lowering the energy requirement for heat as well as the expansion of renewable electricity generation**. Overall, this would mean that energy efficiency would

have to make twice as high a contribution as renewable energies. The expert commission welcomes the statement in the coalition agreement that the German government will "take the requisite measures in all these areas of action". Whilst the expert commission recognises the need to revise the EEG swiftly, this should not lead to further delays in the implementation of the other, equally necessary measures.

In addition to extra incentives for raising energy efficiency, also by means of regulatory as well as financial, fiscal and pricing policy, the German government should be involved equally actively in the structural **reform of the European emissions trading scheme**, so that this – as correctly described by the German government – "key climate protection instrument for the energy and industrial sector in Europe" in the future can once again fulfil its important steering functionand send out scarcity signals. In terms of its approval of "backloading" the German government should verify if it is legally possible to return the relevant allowances not in the current trading period but instead to wait until the period starting in 2020.[1] In conjunction with this, the expert commission welcomes the proposals made by the European Commission in the 2030 climate and energy package on 22 January 2014 and the joint initiative between the Federal Republic of Germany and Great Britain, France and Italy to set the pan-European emissions reduction target at at least 40 % by 2030 (which does after all mean a doubling of the target for 2020).

The simple fact that almost half of all German greenhouse gas emissions are subject to this system demonstrates the need for Germany's active involvement in the structural reform of emissions trading. In the opinion of the expert commission this also means, however, that the German government will have to actively promote the efforts to lower emissions in the **sectors outside of the emissions trading system**, which are largely subject to national provisions. This in particular concerns the area of buildings with its continued high potential for greater efficiency.

1 The German government could also possibly buy up emissions rights itself and then put them on hold. This however would have to be done in considerable volumes in order to achieve significant impacts on a pan-European scale.

A reformed emissions trading system would also make an important contribution to revitalising the Energy and Climate Fund – which is funded by the proceeds from emissions trading auctions – as an important instrument for funding climate protection measures and to combat the counterproductive trend in terms of climate protection policy towards more coal-based power generation, which has developed due to the more favourable competitive environment compared to natural gas power plants, for instance, as a result of the lower certificate and coal prices on the one hand and high natural gas prices on the other.

Initiatives in the area of energy efficiency

Along with renewables, energy efficiency is one of the strategic elements in attaining the climate protection targets. In this context, the expert commission welcomes the clearly positive attitude in the coalition agreement towards increasing energy efficiency, although the statements on this are not very concrete and there is no information on how this is to be funded. Here, the expert commission still sees a considerable need for more specific information, which it has to be said is also lacking in the present monitoring report.

It is true that there have been numerous measures contributing to improving energy efficiency in Germany for many years now, in particular, standard-setting, regulatory measures, investment promotion schemes, measures to provide pricing impetus and advice and labelling schemes. It is also clear, however, that the form they have taken to date means that one cannot expect them to have the impacts required for a successful Energiewende and the ambitious targets this entails. This also holds true for the – as it is, only very few – measures decided on since the adoption of the Energy Concept in 2010 and after the 2011 revision.

The table below illustrates in summary form that on a great deal of points, energy efficiency will still have to be increased considerably compared to the development to date if the targets aspired to are still to be met. In light of this, the expert commission feels it must conclude that the development of energy efficiency to date is lagging behind the rates of increase required to achieve the targets. The expert commission therefore welcomes the decision in the coalition agreement for the German government to conduct regular efficiency monitor-

ing. This should also include an examination of the effectiveness of the measures taken to improve energy efficiency and possible rebound effects.

Table: Previous and future changes required to attain various Energy Concept targets

	empirical period		future changes to aid target attainment	
	1990–2012 or 1990–2013	2008–2012 or 2008–2013	2012–2020 or 2013–2020	2020–2050
	average annual changes in %			
greenhouse gas emissions[1)]	-1.3	-1.1	-2.8	-3.6/-7.9[3)]
primary energy consumption (PEC)[2)]	-0.2	-1.3	-2.6	-1.6
primary energy productivity [2)]	1.9	1.7	3.0	2.5
gross electricity consumption [2)]	0.3	-0.7	-1.0	-0.6
electricity consumption productivity [2)]	1.1	1.4	1.6	1.5
final energy consumption productivity [1)]	1.8	1.1	2.6	2.1
final energy consumption for space heating (households only) [1)]	-0.7	-2.9	-1.3	-4.5
final energy consumption for transport [1)]	0.3	-0.1[4)]	-1.2	-1.3
CHP electricity [1)]	2.3-3.2[5)]	1.6-3.1	3.6-4.5	
[1)] reference year 2012, [2)] reference year 2013, [3)] reduction in emissions, [4)] 2005-2012, [5)] 2003–2012				

But one of the prerequisites for meaningful monitoring is first and foremost a **uniform understanding of terms**. In the view of the expert commission this means inter alia clarifying certain terms named in the Energy Concept and interpreted differently by the different ministries and departments, notably the terms "heat requirement" and "modernisation rate". Whilst on the one hand the reduction of the amount of heat required is defined as a reduction of non-renewable primary energy with reference to the Energy Saving Ordinance (Energieeinsparverordnung - EnEV) and accordingly every additional contribution by renewables is recorded as an energy saving, the energy contribution of renewable energy sources has to count in full towards primary energy in compliance with international standards. This is a significant difference, as counting renewables practically as "saved energy" means that the building efficiency target is considerably less ambitious than the requirement to reduce primary energy needs – including renewables. A uniform and specific definition is also needed swiftly for the "modernisation rate", which is to be doubled according to the German government's Energy Concept. A positive aspect to underline is that the use of temperature-adjusted figures in the monitoring report now allows for better interpretation of the efficiency indicators used.

The expert commission already pointed out the urgent **need for action to improve energy efficiency** in its statement last year. The first priority should be efficiency measures in the building sector. The aim of an **almost climate-neutral building stock** by 2050 requires action to be taken soon given the long capital lockup entailed. Whilst it is true that the specific final energy consumption for space heating has been lowered noticeably over the last few years, the remaining efficiency potential is still far from being exhausted. The success of the Energiewende will not be possible unless the building sector makes an appropriate contribution and the requisite investments are encouraged. Here, the expert commission considers two components to be equally necessary to attain the targets. First, the German government must decide soon on the design of financial support measures for building modernisation, ensuring they are compatible with the targets and second, a stricter Energy Savings Ordinance is required – also for new buildings. At the same time, it should be examined whether the efficiency requirements for existing buildings have to be increased as well.

The second priority is the transport sector, where the **reduction trends in energy consumption for transport** initially to be seen after 1999 have practically come to a standstill since 2005. Against the backdrop of the explicit targets to lower transport-related energy consumption, the transport sector should not – as is the case in the coalition agreement – be dealt with largely only in terms of infrastructural aspects. There is no doubt that the implementation of the targets for the transport sector requires further-reaching measures in terms of traffic-avoidance strategies and strategies to change the modal split. But what is also required are incentives for new, more energy-efficient engines and new low or zero emission fuels beyond the biofuels used to date. The expert commission welcomes the Mobility and Fuel Strategy (Mobilitäts- und Kraftstoffstrategie – MKS) of the German government. The Mobility and Fuel Strategy – which is a "learning strategy" – no doubt makes sense, but it should go hand in hand with the implementation of the requisite political measures only briefly outlined in this strategy to date.

When assessing political energy efficiency programmes, possible **rebound effects** should be taken into account as part of a comprehensive impact assessment in the view of the expert commission. Including rebound effects ensures a more realistic assessment of actual savings and as such provides an important

foundation for political decision makers because in the worst case, a measure which initially seems beneficial may prove to have an unfavourable cost-benefit ratio after taking rebound effects into account. As the rebound effect can have a negative impact on the effectiveness of minimum energy efficiency standards, instruments should be used which do not promote this effect when endeavouring to increase energy efficiency. This includes pricing instruments in particular. For instance a tax would increase the costs of using the energy service and thus creates monetary incentives to save energy without leading to direct or indirect rebound effects. An emissions trading system in which the absolute amount of input is regulated also does not leave any room for rebound effects to develop.

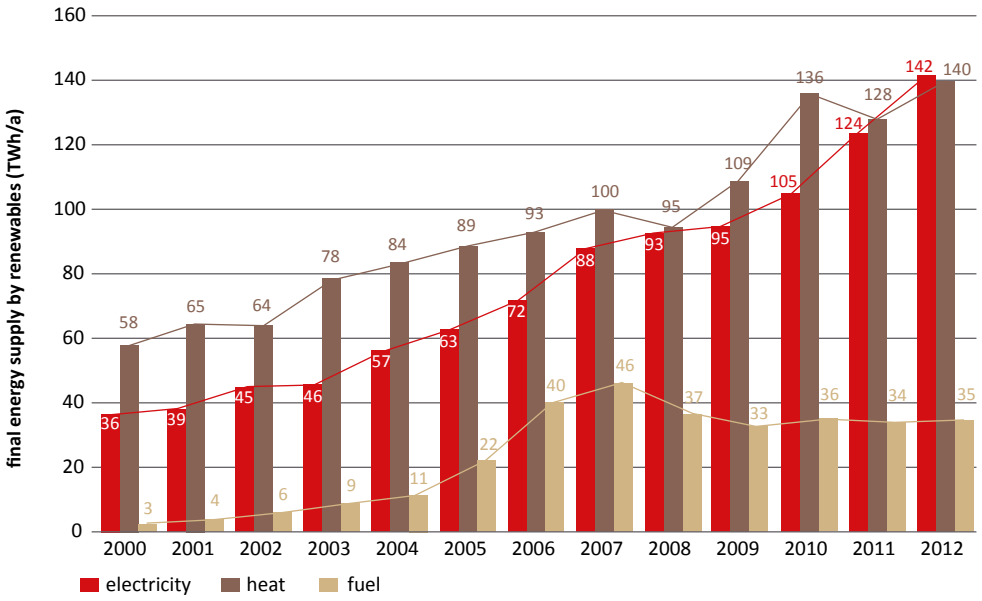
Development of renewable energy sources

Renewables developed positively again in 2012 so that the ambitious target of raising the **share of renewables in gross final energy consumption** by 2020 from today's figure of 12.5 % to 18 % still appears to be attainable. But it cannot be taken for granted that the target will be met either. As a result of the target being set as a relative target, the absolute level of energy provision from renewables required to meet the target also indirectly depends on how final energy consumption develops. If the efficiency progress aspired to and the resulting reduction in consumption do not materialise, renewables will have to expand at a considerably higher absolute level. Whether this compensatory effect will be equally achievable in all areas (electricity, heat and fuels) is doubtful.

As already seen in 2011, in 2012 the expansion in the electricity sector is the driving force behind the development of renewables. In 2012, renewables had a share of 23.5 % in gross electricity consumption and thus made the largest contribution for all three sectors of electricity, heat and fuels for the first time (see below). With this positive development, the political debate surrounding the Energiewende and the resulting costs is now focussing on the issue of financial support pursuant to the **Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz- EEG)**. The EEG surcharge to be paid by the end users of electricity rose to 5.28 ct/kWh in 2013 and 6.24 ct/kWh in 2014. This year only around 40 % of this increase is directly attributable to the expansion of renewable elec-

tricity generation. The large drop in the wholesale price of electricity and the extension of exemptions for electricity-intensive industries also caused the surcharge to rise, to cite just two influencing factors. Nonetheless, the total amount underscores the need for a reform of the EEG.

Figure: Development of the gross final energy supplied by renewables by sector



In the process of reforming the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz -EEG) the German government not only has to focus on cost efficiency and compatibility with the EU internal market, but also has to ensure that the **expansion trajectory of renewable electricity generation required for target attainment** is maintained. The precise design has to be developed to correspond to the current development phase of renewable electricity generation – the phase of beginning market integration. Measures must be selected to ensure that a continuous transition to full market integration is possible. Whether or to what extent and when the direct marketing already practiced and/or a changed electricity market design will be conducive to target attainment remains to be examined. Regarding the upcoming revision of the law, the expert commission wishes to draw attention to the following point – setting

fixed expansion corridors and thus upper limits makes expansion of renewable electricity generation beyond these considerably more difficult. It may mean that it will no longer be possible to **offset any other unmet targets** in other areas with regard to the German climate protection targets by means of higher contributions from renewable electricity generation. Given the in-creased challenges faced in attaining the German climate protection target in 2020, the expert commission believes it is necessary to pursue an expansion trajectory at the upper end of the corridor.

In the heat sector, in terms of the target of covering a share of 14 % of final energy consumption for heating and cooling by 2020, the expansion of renewables is within the target corridor – statistically speaking. It is to be welcomed that thanks to the Renewable Energies Heat Act (Erneuerbare-Energien-Wärmegesetz – EEWärmeG) renewable sources are now highly rated for the energy supply of new buildings. At the same time, thanks to the market incentives scheme for renewable heat, numerous individual measures targeting the building stock and district heat are being promoted which enable flexibilisation of the heat market and better integration of the energy system as a whole.

Leveraging **the potential for using renewables in the building stock** remains problematic on the other hand. Out of approximately half a million heating replacements per year more than 90 % are based mainly on fossil fuels, which in turn means the provision of heat to these buildings is now defined up until 2030 and even beyond to a large extent. The longer this remains unchanged, the more difficult the path towards a climate-neutral stock of buildings becomes. As the German government has spoken out against a nationwide obligation to use renewable heat in existing buildings in the coalition agreement, the existing financial incentive instruments should be bolstered. Tax breaks for investments would be one possibility here too.

In the transport sector renewable fuels accounted for 5.7 % in 2012, meaning that once again the 6.25 % quota set forth in the Biofuels Quotas Act was not attained. In addition to the dominant fuels biodiesel and bioethanol, the application of biomethane meant that for the first time a second-generation biofuel was used – although its significance is still very low, as it accounted for only 1 % of total biofuel supply. The expert commission therefore recommends prompt

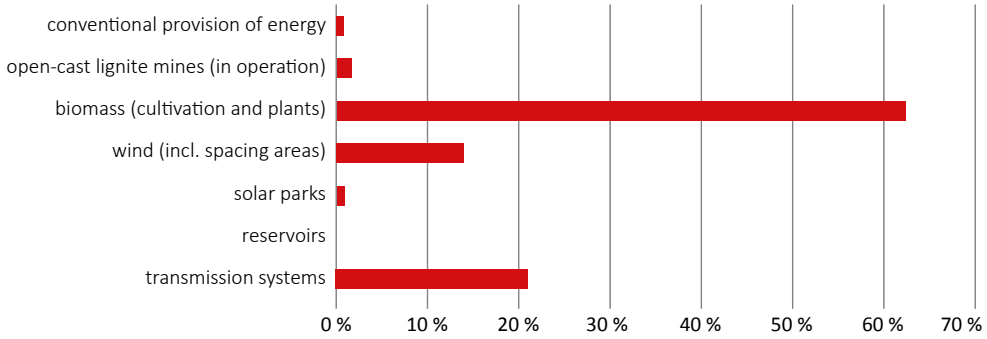
and considerable intensification of the activities to **develop alternative renewable fuels**. Suitable instruments should also be used to create incentives for their introduction. Analyses on the use of the limited-potential **resource of biomass** in terms of its optimum use in sustainable energy systems of the future are still lacking. The expert commission believes urgent action is needed here, also as part of the upcoming EEG reform.

Environmental impacts of the energy system

The environmental soundness of the energy supply is one of the fundamental prerequisites for sustainable development in Germany and plays a crucial role in the acceptance of the Energiewende. What it comes down to finally is whether the quantitatively formulated targets of the Energy Concept can be attained without serious impacts on the environmental development set out in non-quantitative terms, or whether there are indications of conflicts here, which might give cause to make adjustments. The expert commission therefore once again suggests including indicators to describe the environmental impacts in the German government's monitoring process.

The expert commission assumes that alongside climate protection, the Energiewende will lead to a positive impact on the environment in the areas of air pollutants, radioactive contamination, the use of resources and the consumption of water. The **area required by the energy system** is already high today and there is every indication that it will continue to rise. In 2012 the energy system took up almost 10 % of land in Germany. From 2011 to 2012 land take rose by around 0.4 percentage points, mainly due to continually increasing energy crop cultivation, the expansion of wind power and solar parks, and as a result of new transmission lines. Energy crop cultivation saw the largest absolute growth in land take and in 2012 used the largest area of land by far (62 %) (see figure). Energy-related land take should be monitored over the long-term as part of the monitoring process.

Figure: Land take for the provision and distribution of energy in 2012 in Germany



Land take not adjusted for overlapping, for instance spacing areas surrounding wind energy power plants also used for energy crop cultivation; conventional energy supply includes power and heating plants as well as refineries and petrol stations.

The monitoring process should also track environmental impacts of newly emerging energy technologies, such as fracking or energy-saving light bulbs. Fracking, for instance, is linked to risks for the environment and humans, especially when carried out in the vicinity of drinking water reserves. The chemicals and gases used can migrate underground to other areas such as drinking water reservoirs. Furthermore, fracking can be linked to a host of emissions such as dusts, diesel exhaust fumes, volatile organic compounds and methane.

Another energy-related environmental aspect is the safe final storage of radioactive waste in Germany. To move the discussion forward, the German government brought into force the Location Selection Act (Standortauswahlgesetz – StandAG). In accordance with this Act, which is characterised by a high degree of transparency, participation and openness, the location selection procedure is to be completed by 2031. To support the discussions, the monitoring report by the German government should quantify the existent and new quantities of highly radioactive waste according to the required containment periods (including waste from the roll back of the nuclear power plants) and the temporary storage thereof in order to ensure greater transparency here too.

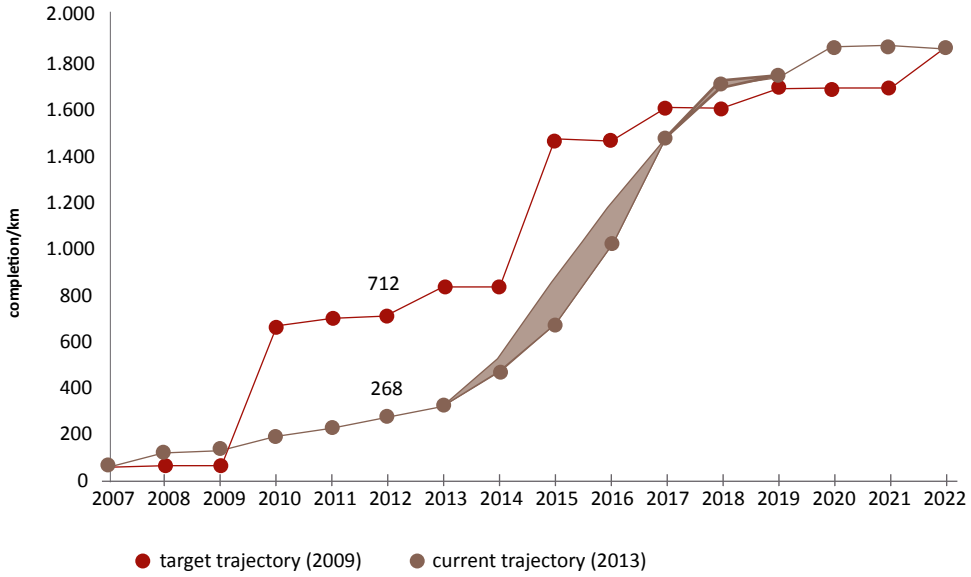
Development of supply security

The security of the energy supply can be described aptly along the value chain from primary energy, conversion, transport and distribution to the final consumer.

The expert commission calls for the remaining reliably available capacity as a result of the power balance to be used to measure the **long-term security of electricity supply.** It is true that there are still some analytical unclarities and practical problems when it comes to calculating this indicator. But these problems can be solved by developing suitable standard calculation rules based on the preliminary work done by the European Network of Transmission System Operators for Electricity (ENTSO-E) and collecting the data required for quantification. Even if these calculations are still of a preliminary nature today, there is currently **no general capacity shortage** recognisable in Germany in the field of electricity generation. However, with the planned shutdown of the remaining nuclear power plants south of the River Main the risk of a **local capcatiy shortage** arises. During winter, as well, there can be strained situations when the electrical consumption loadreaches its annual peak and the supply of renewables is low at times. In the area of backup gas power plants, at this time of the year there is also competition between the heat and electricity sectors as the primary energy source of natural gas is also used for heating.

The foreseeable supply shortages in southern Germany are exacerbated by the **backlogs in the expansion of the transmission systems**. Originally, by 2012 the aim was to already have 712 km of the transmission systems planned under the Energy Line Expansion Act (Energieleitungsausbaugesetz – EnLAG) completed. The delays also mean adapting the original expansion trajectory, as illustrated in the figure below taking into account various scenarios. Also given the urgency, compliance with this modified transmission system expansion should be very carefully monitored.

Figure: Originally planned and actual trajectory towards the grid expansion target pursuant to EnLAG



The System Average Interruption Duration Index (SAIDI) continues to indicate a very comfortable situation when it comes to the **short-term security of the electricity supply**. However, as a result of the increasingly frequent re-dispatch intervention by the transmission system operators and the problem of power cuts of less than 3 minutes still not being recorded in the statistics in Germany, we must caution against being overly unworried. The short-term security of supply is less comfortable than the SAIDI suggests. Even shorter disruptions are suspected of entailing macroeconomic losses.

Whilst bottlenecks in the gas transmission system in February 2012 led to the **gas supply** of power plants being interrupted and to negative impacts on the reliability of the electricity transmission systems, these types of risks have now been lowered by the commissioning of three new storage facilities and two new pipelines (Sannerz-Rimpar pipeline between Hesse and Bavaria and the Gazelle pipeline through the Czech Republic from Saxony to Bavaria) and thus improving the long-term security of supply in the area of natural gas. The **reliability of imports** does not constitute an acute threat either in the view of the expert commission, as possible disruptions in the area of imports are mirrored by econom-

ic losses in earnings by the exporting countries. An appropriate indicator can be established by calculating relative market shares. Here one has to compare the market share of the German sales market from the point of view of the exporting country (e.g. Russia) with the import share of this exporting country from Germany's point of view. The larger the quotient the less critical the supply risk to Germany by importing from the exporting country in question.

Economic viability of the energy supply

The expert commission has further developed its approach for evaluating the **affordability of the energy supply** inter alia using nationally aggregated final user expenditure on energy. To be able to properly assess the evolution of the costs of the energy supply and the additional costs incurred as a result of the Energiewende, the proposal has been made that data be collected on the annual aggregated total energy expenditure of final consumers in nominal monetary units (millions of euros) for the sectors of electricity, heat and transportation. The figures for total final consumer expenditure and the individual total expenditure components provide meaningful indications as to the economic viability of the energy supply. The expert commission explicitly welcomes the fact that the German government has adopted this approach for the area of electricity in its monitoring report. If such calculations are available for other countries, the economic viability of the energy supply can also be assessed well in terms of a broader international context. This indicative instrument leaves distribution problems – the subject of much political debate – unaddressed for the time being, also because distribution prob-lems are fundamentally diffused or easier to solve if final user expenditure does not develop disproportionally to nominal gross domestic product (GDP). As long as total expenditure tends to be proportional to GDP or rises at a low-er rate, the general affordability of energy as a whole can scarcely seriously be called into question.

In terms of nominal GDP, **final consumer spending on electricity** remained largely constant in 2012 at approximately 2.5 %. Whilst the shares spent on government-induced elements (taxes, levies and surcharges) as well as the government-regulated grid charges have increased significantly, the share accounted for by market-driven elements has decreased. This brings the expert commission once again to the conclusion that the increase in aggregate electricity

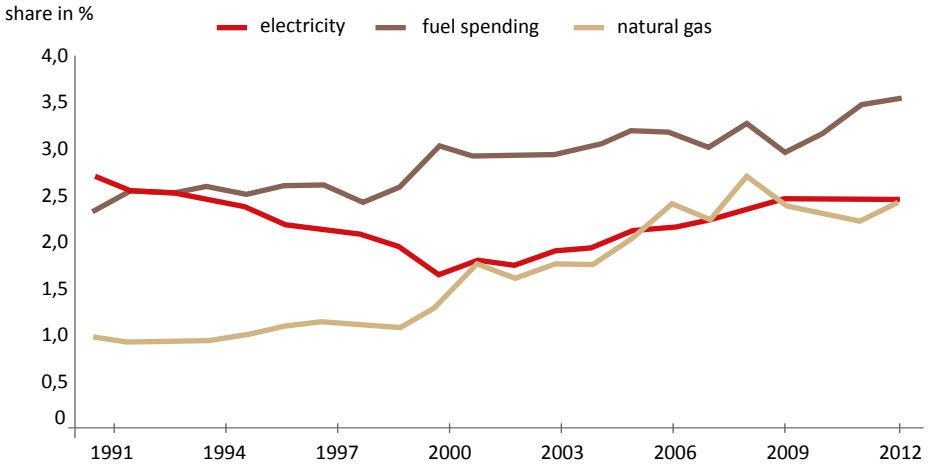
spending to date is not as dramatic as often publicly claimed. This statement relates to the past up to 2012, however. The development of electricity prices in 2013, the prospective projects for the expansion of renewables, especially in the offshore area, the urgently required expansion of grids to link up offshore wind parks and for transmission and distribution systems, the funding of new backup power plants and storage facilities could result in increasing cost dynamics for the years to come.

Final consumer spending on natural gas depends to a large degree on the international development of gas prices and the procurement expenditure this entails. In contrast to electricity, the government-induced and regulated price components play a secondary role. Total spending, which increased by around 10 % in 2012, is thus not to be attributed to the Energiewende. In the future one can expect an at least stable development if increasing fuel costs are compensated for by efficiency improvements and thus a lower heat requirement.

Final consumer spending on fuel grew disproportionately to GDP in 2012. This is in line with the longer-term trend, interrupted only in the recession year of 2009 by a major slump in freight transport. Final consumer spending doubled between 1996 and 2012 to around 86 billion euros. The rise in total spending is mainly due to a higher international crude oil price combined with a weaker euro to US dollar exchange rate. Both developments can more or less not be influenced at all by energy policy measures by the German government. It is still not possible to provide any quantitative information on **final consumer spending on heat services**.

The calculations of the aggregate final consumer spending figures are currently still suffering from of incomplete or imprecise statistical foundations. For instance, the costs connected to auto-generation of electricity are not sufficiently recorded in the statistics. There is also a lack of reliable data on the additional costs of efficiency measures in the area of heat. Over the last few years, these types of efficiency measures have been able to lower energy bills, particularly in the heat market, but the final consumer spending figures for heat services would be incorrect if the additional costs this entailed were ignored. Here there is still a need for research, including at a conceptional level.

Figure: Share of final consumer spending on electricity, fuel and natural gas in gross domestic product



In addition to total spending on energy, **distributional impacts of energy costs** must also be taken into account. This concerns, for instance, the distribution of the surcharge pursuant to the EEG across final electricity consumers and in this context the special equalisation scheme for energy-intensive industry. Irrespective of the uncertainties regarding the exact level and development of price-lowering impacts of the merit order effect of renewables, the estimates on this open up a political framework for action in which it should be possible to adopt the EEG surcharge for all consumers without negative impacts for competitiveness.

Hypothetical household types are used to illustrate distribution problems at the level of households in the monitoring report. The expert commission believes that better indicators exist, however. A “high cost/low income“ approach is proposed for the monitoring process. This would mean that currently 10 to 12 % of households could be seen to be at risk of energy poverty. To verify these impacts, however, a consistent time sequence and further analyses are required to be able to identify whether there are developments in the wrong direction. One must also bear in mind that this problem is not solely the consequence of the Energiewende.

Innovation impetus from the Energiewende

The German government's monitoring report presents a summary of macroeconomic interdependencies under the title "Macroeconomic effects of the Energiewende", which from the expert commission's point of view still seems extremely selective and incomplete. A systematic depiction of macroeconomic interdependencies is not yet apparent. In its next report, the expert commission will examine appropriate suggestions for improvements. It will however already address one point in this year's report – the promotion of innovation.

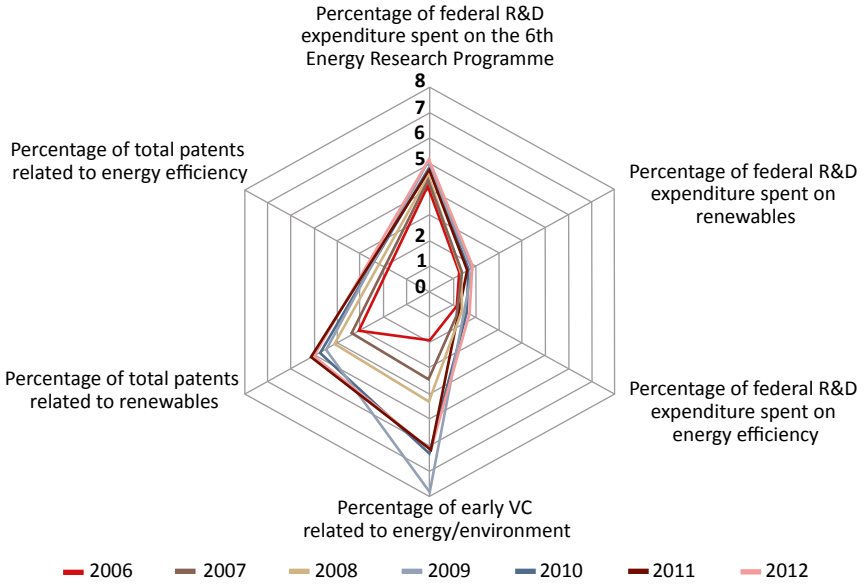
Innovation is one way of enabling a climate-friendly and secure supply of energy for the German economy at competitive prices. It is not just a matter of inventions resulting from research and development, but also the dissemination of new technologies for generating, distributing and using electricity or heat, new or evolved technologies for transmitting and storing energy, for smart grids and so on. In addition to this there are all the innovations which form the basis of these new technologies, such as those in the fields of chemicals, materials or substances technologies, which themselves do not have a direct connection to energy technologies, all the way to downstream innovation in the area of services.

A comprehensive monitoring procedure should take into account the innovation activity brought about by the Energiewende. The expert commission therefore issues the recommendation of developing an **indicator system to measure the innovation activity brought about by the Energiewende**. From our point of view the indicators currently available can scarcely do justice to the aim of measuring the innovation triggered by the Energiewende. Some fundamental considerations are helpful in compiling a system of indicators of this kind: innovation indicators can be individual indicators such as the number of patents, for instance in the area of renewable technologies or energy efficiency, spending on research and development (R&D) activities on new technologies, venture capital investments or business start-ups or several individual indicators can be aggregated into an index. Whilst the former enables a high-resolution picture of innovative activity, aggregate lead indicators can synthesise information regarding the status quo in compact form, although aggregation means subjective judgements being made as to what weighting to give to the individual indicators.

The figure below illustrates one of several possible **clusters for innovation indicators** making it possible to depict the situation at a glance and enabling comparison. The advantage over aggregation into a lead indicator is that weighting is not necessary. The indicators are treated equally, but already enable broad conclusions when looked at as a whole. In the cluster of indicators shown here, the research expenditure of the German government on the fields of "renewable energies" and "energy efficiency" during the period 2006-2012 and the provision of venture capital in the area of energy/environment are proposed as input indicators for innovation. Patent registrations are used as an example of output indicators. To make structural changes apparent, the changes in the contributions to the relevant reference figures are shown, for instance in the percentage of total R&D expenditure spent on energy-related R&D. Here it would also be conceivable – to allow international comparison for instance – to have the growth in absolute spending on energy research compared to a reference year or annual rates of change.

Energy research as a whole and also research into renewables and energy efficiency have only slightly gained in significance in the context of total research expenditure. The share of energy research expenditure at federal level rose with the 6th Energy Research Programme from 4.3 % in 2006 to 5.1 % in 2012. On the other hand, there have by all means been significant changes on several of the levels below this. Whilst the importance of research in the area of renewable energies and energy efficiency has hardly changed in terms of its significance, research into storage technologies, grid technologies and energy systems has significantly greater importance within energy research today than a few years ago. Direct comparison of these changes in the area of research expenditure to the patent registrations at the European Patent Office reveals significantly greater dynamis in the output indicator for innovation for renewables and energy efficiency. Spending on early stage VC investments in the field of energy is now slightly down again after a high increase. Company-related innovation data should – once available – also be incorporated into this picture. Furthermore, Germany's international status in the area of energy innovation should be addressed.

Figure: Example of an indicator cluster



The individual indicators selected should not be seen as exhaustive. More in-depth studies are also required to find an appropriate way to aggregate the individual indicators to produce a "lead innovation indicator" because in contrast to other lead indicators, in this case it does not make sense to use one single criterion. As aggregation also contains subjective judgements on how individual indicators should be weighted, particular care must be taken here. In particular, the basic R&D information on the Energiewende should be complemented by **additional data collection on innovation activities in particular at company level**. Only then can the impacts of the Energiewende on innovation be fully mapped. One possible solution could be a representative survey of companies across all areas of the German economy, specifically covering company innovation activities, for instance the level of R&D spending on energy research, but also the scale of product and process innovation related to energy at German industrial and service companies, for instance. The expert commission therefore recommends verifying the feasibility of a separate sur-vey or integrating this into existing surveys. A survey of this kind would be suited to recording the reaction of businesses early on to changing legal conditions and support measures in the context of the Energiewende.