Expert Commission on the Energy of the Future Monitoring Process

Statement on the Sixth Monitoring Report of the Federal Government for 2016

Berlin · Münster · Stuttgart, June 2018

- Prof. Dr Andreas Löschel (Chair)
- 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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Statement

0 Foreword

1. These comments by the Expert Commission on the Energy of the Future Monitoring Process refer to the Sixth Monitoring Report of the Federal Government for reference year 2016. The monitoring process serves to review the progress made on attaining the goals of the Federal Government's Energy Concept "for an environmentally sound, reliable and affordable energy supply" of September 2010 and the implementation status of the relevant measures, so that fine-tuning can take place where necessary. To this end, the Federal Government appointed an independent Expert Commission in October 2011 consisting of four energy scientists; they are tasked with evaluating and commenting on the monitoring reports to be produced by the ministries each year and the progress reports submitted every three years. The focus of the monitoring reports is on providing a facts-based overview of the energy transition, whilst the progress reports contain a more wide-ranging analytical element and can propose action to overcome barriers to reaching the goals.

2. The Sixth Monitoring Report and the comments on it are outside the usual schedule. Firstly, according to the agreed schedule, both documents were to be presented to the Federal Cabinet by 15 December 2017 (cf. Bundestag Printed Paper 18/6781). However, there were unusually time-consuming coalition negotiations in autumn 2017, and this also delayed the compilation of the Monitoring Report. For this reason, the Expert Commission decided in October 2017 to publish a separate brief commentary on the status and key fields of the energy transition. Secondly, the schedule provided for a progress report rather than the monitoring report that has now been presented. Since a progress report not only documents the status of implementation of the energy transition, but also should contain an outlook for the future development and propose what may be far-reaching measures, the Federal Government decided that these explicitly forward looking messages should be contained in the future, seventh monitoring report, which is to be integrated into the second progress report.

3. These comments by the Expert Commission refer to the draft of the Sixth Monitoring Report, which was provided to us by the Federal Ministry for Economic Affairs and Energy on 12 June 2018. At that time, the report was still being coordinated among the ministries. We are grateful to the Federal Ministry for Economic Affairs and Energy for endeavouring to provide the report as quickly as possible.

4. As part of the monitoring process, numerous meetings took place with representatives of the Federal Ministry for Economic Affairs and Energy, the Federal Network Agency and the Federal Environment Agency. In April 2017, the chair of the Expert Commission attended the Bundestag Committee on Economic Affairs and Energy, and in May 2017 he was invited as an expert to the public hearing on the Federal Government's draft "Second Act amending the Energy and Electricity Duty Act". In July 2017 there was a separate meeting between the Expert Commission and representatives of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety and the Federal Ministry of Transport and Digital Infrastructure. This meeting focused mainly on the climate and energy targets for 2030 and on the questions from the Expert Commission. The discussions this year were supported by the provision of many current studies undertaken on behalf of the Federal Government. Mention should be made here of the discussions relating to the study on "the impact of the measures of the Federal Government within the target architecture for the restructuring of the energy supply" with the consortium undertaking the study (July and November 2017). Also, in October 2017, the Federal Ministry for Economic Affairs and Energy organised a workshop with the National Regulatory Control Council to determine the costs of the energy transition, in which the Expert Commission presented its views. Our thanks go to all our interlocutors, and particularly those in the ministries and federal authorities, for the constructive cooperation.

5. The questions and issues raised during the monitoring process are addressed in these comments. A particular focus is placed this year on the EU Governance Regulation, which will set the course in the next decade up to 2030 for the national and European monitoring of the energy transitions. In this context, we are particularly grateful to Matthias Duwe (Ecologic Institut) and Dr Severin Fischer (ETH Zürich), who fed their expertise on the European processes into a joint workshop with the Expert Commission (March 2018). With regard to the chapter on start-ups, we are grateful to Prof. Dr Orestis Terzidis and his assistant Markus Lau. On the basis of their work, the Expert Commission makes a proposal for the future development of monitoring of start-ups in the energy sector.

6. Furthermore, the chair of the Expert Commission was a member of the "Energy Transition Research Forum" at the Federal Ministry of Education and Research and of the board of the academy project "Energy Systems of the Future" of the Leopoldina National Academy of Sciences, the Union of German Academies of Sciences, and acatech. At present, the Expert Commission is also examining the possibilities for international monitoring of the energy transitions in various countries.

7. The Expert Commission could not have produced these comments without the outstanding dedication of their academic assistants. For this reason, our sincere thanks go to Oliver Kaltenegger, Martin Baikowski, Laura Klockenbusch and Dr Jörg Lingens of Westfälische Wilhelms-Universität Münster, Lars Dittmar, Lisa Marina Koch and Dr Fernando Oster of the Energy Systems Department of TU Berlin, Maike Schmidt and Dr Tobias Buchmann of the ZSW, Stuttgart, and Andreas Prahl of the Ecologic Institut, Berlin.

8. Any errors or omissions in these comments are the sole responsibility of the undersigned.

Berlin, Münster, Stuttgart, 27 June 2018

Georg Erdmann

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Summary of the statement

Statement on the Sixth Monitoring Report of the Federal Government

Status of the energy transition

1. The Federal Government set itself a long-term energy policy strategy with ambitious goals in its Energy Concept of September 2010 and the decision in August 2011 to phase out nuclear power. Accordingly, a large number of important projects for the energy transition have been realised in recent years. These include the National Action Plan on Energy Efficiency (NAPE), the funding of electric mobility, and recently the move to auctions for the funding of the expansion of renewable energy and the further development of the electricity market design. The coalition agreement addresses the main fields of action, albeit in an abstract manner which generally lacks specific measures.

2. In order to document the implementation of the Energy Concept and the progress achieved, the Federal Government publishes a facts-based monitoring report each late autumn, as well as a progress report every three years containing an in-depth analysis of the developments and measures. Since 2011, the Federal Government has been advised in this process by an independent commission consisting of four energy experts. The Expert Commission on the Energy of the Future Monitoring Process presents annual comments on the progress made on the energy transition which are attached to the Federal Government's monitoring reports on the energy transition and forwarded to the Cabinet and the Bundestag.

3. Due to the time-consuming formation of the government, the Sixth Monitoring Report is being presented behind schedule. However, the Expert Commission did publish a separate brief commentary on the status and key fields of the energy transition in autumn 2017 (EWK, 2017). The Sixth Monitoring Report by the Federal Government and these comments refer to 2016, even if many facts are already available for 2017. A progress report should rapidly be produced to close this gap and to formulate an outlook for the energy transition with viable measures which are capable of meeting the targets. The current Monitoring Report provides a realistic assessment of the successes, and also of the difficulties, in the implementation of the energy transition. There should now soon be a deeper analysis of the causes of foreseeable failures to meet certain energy transition targets and – building on this – proposals to counter these failures. This will provide a logical development of the Energy Concept.

4. The current, facts-based overview of the status of the implementation of the energy transition shows a considerable need for action in order to meet some of the energy transition targets. Not all areas of the energy transition are making the desired progress. It is true that the nuclear phase-out is progressing well, but the overarching goal of the energy transition, to cut greenhouse-gas emissions, will probably be missed by quite a margin up to 2020. The Expert Commission has been pointing out this anticipated gap for several years now. In this context, the Expert Commission believes that positive mention should be made of two measures by the Federal Government: Firstly, the coalition agreement has announced a Climate Change Mitigation Act in which a long-term target corridor in compliance with the Paris Climate Agreement is now to be rapidly set. Secondly, the Federal Government is now working on the details of the phase-out of coal-fired electricity generation, and has set up the "Growth, Structural Change and Regional Development Commission" for this purpose.

5. The expansion of renewable energy remains on track, driven particularly by the dynamic development of renewables-based electricity generation. However, good progress on the renewables contrasts with considerable

deficiencies in improving energy efficiency. The developments in the transport sector in particular are going in the wrong direction, in terms of both energy consumption and greenhouse gas emissions.

6. The picture is also mixed with regard to the qualitative dimension of the Federal Government's Energy Concept. Taking electricity imports into consideration, security of supply does not appear to pose a problem in the coming years. However, the expansion of the grid has been falling further and further behind the targets in recent years. The energy transition is currently affordable, and this is reflected in a renewed drop in the proportion of economic output accounted for by end-user spending on electricity. However, this development should continue to be closely monitored, since the stabilisation of overall expenditure is likely to be only temporary. In the view of the Expert Commission, public acceptance of the energy transition, which is so important, does not exist unreservedly.

7. The views of the Expert Commission differ in some aspects from those of the Federal Government, particularly regarding the development of greenhouse gas emissions, final energy productivity, the increase in the proportion of renewable energy in the consumption of heat, and (particularly looking to the future) security of supply. These are areas in which the Expert Commission arrives at a more sceptical view than the Federal Government.

The energy transition traffic light

8. For the purpose of its assessment, the Expert Commission is deploying an energy transition traffic light. Using seven key indicators and various supplementary indicators, this provides a robust depiction. The colour of the traffic light shows whether the attainment of the target by 2020 – or 2022 in the case of the nuclear phase-out – is likely (green) or unlikely (red). The colour amber is used to mark indicators for targets where it is not certain at present that they will be attained (cf. Table 1 for an overview of all indicators, and Table 2 for a detailed breakdown of each indicator).

9. With regard to allocation to the three categories, the Expert Commission uses the statistical concept of prediction intervals. If the politically determined target figure for 2020 lies within the prediction interval, this means that the target is likely to be attained if the current trend continues, at least in statistical terms. If the target is likely to be overfulfilled or missed, the figures will lie outside the interval. Measures that have recently been implemented or become effective and are thus not reflected in past data are fed in in the form of expert assessments where no quantitative and robust analysis of the effect is available. In this way, the energy transition traffic light combines the strengths of an objective, statistical facts-based methods with the expertise of the Expert Commission.

10. It looks highly likely that the climate target for 2020 will be missed by a large margin. In this regard, the Expert Commission has for years been flagging up the risk of a substantial failure to meet the target. This is now also being conceded by the Federal Government: both the Sixth Monitoring Report and the Federal Government's 2017 Climate Action Report assume that the reduction in greenhouse gas emissions against 1990 will only be around 32 % (excluding further measures to mitigate climate change). At the present rate of progress, it will also not be possible to attain the 2030 target, because from 2017 until 2030, annual greenhouse gas emissions would have to be cut three times more than it was the case in the years from 2000 until 2017.

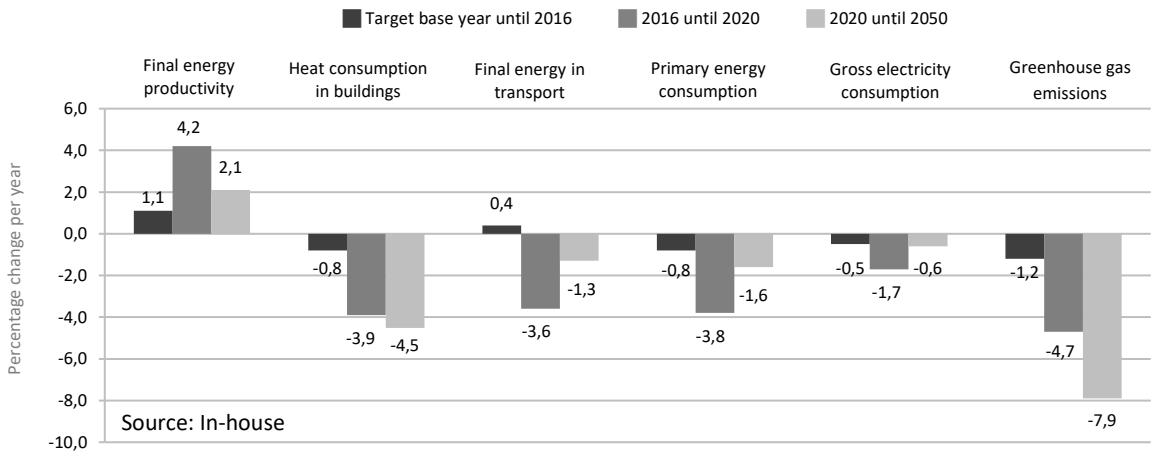
11. In the field of renewable energy, renewables-based electricity generation is the main driver of developments. However, the proportions of renewable energy vary very widely from sector to sector. Even in the auctions of funding for renewables-based electricity generation, it will not be possible to attain the desired intensity of competition in all sectors. Particular note should be taken of this against the background of the special auctions

for photovoltaic installations and onshore wind energy announced in the coalition agreement. The idea of dispensing with a funding system is also only feasible if there are substantial alterations to the electricity market design and corresponding supporting arrangements, such as carbon pricing for fossil fuels.

12. The generally positive trends in the field of renewable energy compare with an unsatisfactory development in energy efficiency. It is true that both the proportion of renewables in final energy consumption and the proportion of renewables in gross electricity consumption proceeded on track; however, the increase in final energy productivity is not going to plan, and the reduction in primary energy consumption is also lagging behind expectations. Energy productivity would have to be boosted by a factor of 4 in order to get back on track to hit the Energy Concept target by 2020. It is necessary to rapidly address the large, still untapped potential here in order to achieve significant results on energy efficiency and the renovation of buildings.

13. The transport sector is clearly missing the energy transition targets both in terms of boosting the proportion of renewables and in terms of cutting final energy consumption. Final energy consumption in the transport sector rose for the fourth year in succession; in 2016, the year-on-year rise was almost 3 %. The gap between current progress and the 2020 target equates roughly to the annual consumption of 10 to 11 million cars in Germany. The need for reductions up to 2030 amounts to nearly 70mt of CO_2 equivalents or approx. 41 %. However, the emissions from motorised individual transport are rising in view of the growing number of vehicles and the related total number of kilometres travelled, whilst the average specific energy consumption and thus also the average specific CO_2 emissions in the car fleet have been stagnating for years. Despite this, the desired measures stated in the coalition agreement are very vague. Figure 1 summarises the current trends and changes needed in order to attain specific energy transition targets.

Figure 1: Changes needed now and in future for specific energy transition targets



14. Whilst the Federal Government believes that the electricity supply is thoroughly secure, the Expert Commission certainly sees problems in security of supply. It is true that there are very few supply failures at present, but there are signs of major shortfalls in the expansion of the grid. The projects governed by the Power Grid Expansion Act currently stand at approx. 750 completed kilometres at the end of the first quarter of 2018, or around 840 kilometres behind the original schedule. In the case of expansion projects under the Federal Requirements Plan Act, the shortfall is even greater. The plan was to have 1,435 completed kilometres of powerlines at

the end of 2017, but only 150 kilometres were in place at the end of the first quarter of 2018. At present, it is still possible to remedy critical grid situations with expensive system services. Without more resolute progress on grid expansion, however, the Federal Government will be endangering its targets to increase the amount of renewable electricity generation facilities, and will be risking supply-critical situations in future.

15. In terms of total expenditure on the energy transition, the proportion of GDP accounted for by end-user spending on electricity dropped from 2.3 % in 2015 to 2.2 % in 2016. Increases in the field of state-induced (EEG surcharge, etc.) and regulated (grid fees) elements contrast with a fall in market-driven elements, resulting in an overall slight drop in expenditure of close to EUR 1 bn in 2016. A reform of fees, taxes and charges on energy is necessary, but difficult. The price system for energy needs to be more clearly oriented to the actual cause of climate change, greenhouse gas emissions, currently fails to utilise a great deal of potential for cost efficiency, runs counter to the important concept of sector coupling, and results in distorted or overlapping price signals. A lean energy price system would, as far as possible, cover all sources of greenhouse gas emissions by a generally uniform price per emitted tonne of CO_2, and would provide complementary instruments (only) for further imperfections in the market.

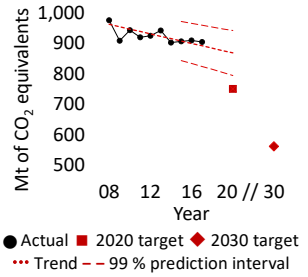
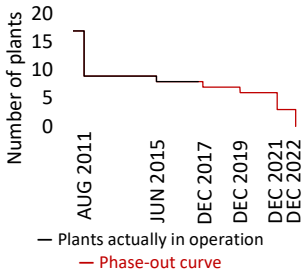
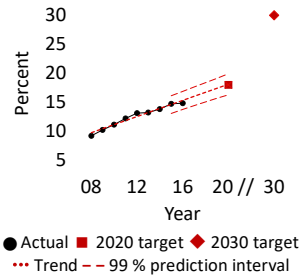
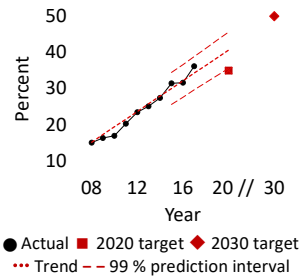
16. The summary of the overall assessment of the Expert Commission regarding the status of the energy transition in terms of attaining the 2020/2022 targets can be seen in Table 1. Table 2 provides a detailed breakdown of the developments of the specific indicators.

Table 1: Summary of the overall assessment of the Expert Commission regarding the status of the energy transition in terms of attaining the 2020/2022 targets

Dimension	Indicator	
Mitigating climate change	Reduction in greenhouse gas emissions (leading indicator or overarching target)	🔴
Phase-out of nuclear power	Operational nuclear power plants (leading indicator or overarching target)	🟢
Renewable energy	Increase in the share of renewable energy in gross final energy consumption (leading indicator)	🟢
	Increase in the share of renewable energy in gross electricity consumption	🟢
	Increase in the share of renewable energy in heat consumption	🟡
	Increase in the share of renewable energy in transport	🔴
Energy efficiency	Reduction of primary energy consumption (leading indicator)	🔴
	Final energy productivity	🔴
	Reduction in demand for heat in building sector	🟡
	Reduction in final energy consumption in transport	🔴
Security of supply	Expansion of transmission grids (leading indicator)	🔴
	Redispatch measures	🟡
	System Average Interruption Duration Index – SAIDI electricity and SAIDI gas	🟢
Affordability	End-user spending on electricity in terms of GDP (leading indicator)	🟡
	End-user spending on heating services	🟢
	End-user spending in road traffic	🟢
	Industrial electricity unit costs in the international comparison	🟡
	Residential electricity costs	🟡
Public acceptance	General approval of the goals of the energy transition (leading indicator)	🟢
	Approval of the implementation of the energy transition	🟡
	Approval on the basis of the personal impact	🔴
Target attainment: 🟢 likely 🟡 uncertain 🔴 unlikely		

Source: In-house

Table 2: Detailed breakdown of the developments of the specific indicators

<table>
<tr><td rowspan="2">Mitigating climate change</td><td rowspan="2"></td><td>Reduction in greenhouse gas emissions (leading indicator or overarching target)</td></tr>
<tr><td><u>Metric:</u> Total greenhouse gas emissions [megatonnes (Mt) of CO_2 equivalents]
<u>Target:</u> Reduction in greenhouse gas emissions of at least 40 % against 1990 by 2020 and of at least 55 % by 2030 [Energy Concept 2010]
<u>Assessment criteria:</u> Prediction interval and expert assessment
<u>Status quo 2017:</u> 905 megatonnes of CO_2 equivalents</td><td> 
</td></tr>
<tr><td rowspan="2">Phase-out of nuclear power</td><td rowspan="2"></td><td>Operational nuclear power plants (leading indicator or overarching target)</td></tr>
<tr><td><u>Metric:</u> Number of operational nuclear power plants [number of plants]
<u>Target:</u> At the latest at the end of 31 December 2017: 7 plants; 31.12.2019: 6 plants; 31.12.2021: 3 plants; 31.12.2022: 0 plants [Thirteenth Act Amending the Atomic Energy Act 2011]
<u>Assessment criteria:</u> Expert assessment
<u>Status quo 2017:</u> 7 plants</td><td> 
</td></tr>
<tr><td rowspan="4">Renewable energy</td><td rowspan="4"></td><td>Increase in the share of renewable energy in gross final energy consumption (leading indicator)</td></tr>
<tr><td><u>Metric:</u> Share of renewable energy in gross final energy consumption incl. in-house consumption for electricity and heat generation and transport and grid losses (“gross final energy consumption”) [percent]
<u>Target:</u> Increase in the proportion of renewable energy in gross final energy consumption to 18 % by 2020 and 30 % by 2030 [Energy Concept 2010]
<u>Assessment criteria:</u> Prediction interval and expert assessment
<u>Status quo 2016:</u> 14.8 %
<u>Note:</u> Green traffic light requires overfulfillment of “increase in the share of renewable energy in gross electricity consumption”</td><td> 
</td></tr>
<tr><td>Increase in the share of renewable energy in gross electricity consumption</td></tr>
<tr><td><u>Metric:</u> Proportion of renewable energy in gross electricity generation including balance of electricity traded with other countries (“gross electricity consumption”) [percent]
<u>Target:</u> Increase in the proportion of renewable energy in gross electricity consumption to at least 35 % by 2020 and at least 50 % by 2030 [Energy Concept 2010]
<u>Assessment criteria:</u> Prediction interval and expert assessment
<u>Status quo 2017:</u> 36.2 %</td><td> 
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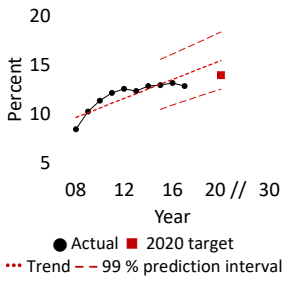
<table>
<tr><td rowspan="3">Renewable energy</td><td rowspan="3"></td><td colspan="2">Increase in the share of renewable energy in heat consumption  </td></tr>
<tr><td>Metric: Share of renewable energy in gross final energy consumption for space heat, hot water, process heat, air conditioning and process cooling [percent]
Target: Increase the share of renewable energy in heat consumption to 14 % by 2020 [Act on the Promotion of Renewable Energy in the Heat Sector 2008]
Assessment criteria: Prediction interval and expert assessment
Status quo 2017: 12.9 %
Note: Amber traffic light, since there was no increase in 2014-2017, and an increase of only 0.3 percentage points in 2012-2017</td><td> 
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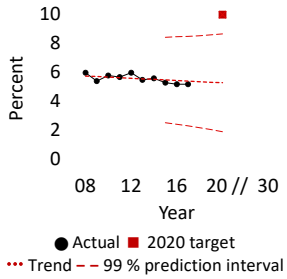
<tr><td colspan="2">Increase in the share of renewable energy in transport  </td></tr>
<tr><td>Metric: Share of renewable energy in final energy consumption in transport sector [percent]
Target: Increase the share of renewable energy in transport to 10 % by 2020 [EU Directive 2009/28/EC]
Assessment criteria: Prediction interval and expert assessment
Status quo 2017: 5.2 %</td><td> 
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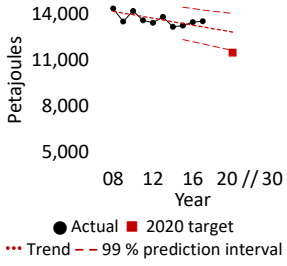
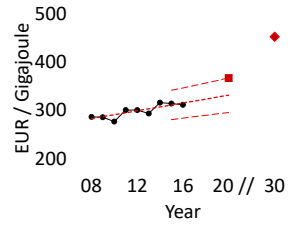
<tr><td rowspan="3">Energy efficiency</td><td rowspan="3"></td><td colspan="2">Reduction of primary energy consumption (leading indicator)  </td></tr>
<tr><td>Metric: Primary energy consumption [petajoules]
Target: Reduction in primary energy consumption by 20 % between 2008 and 2020 [Energy Concept 2010]:
Assessment criteria: Prediction interval and expert assessment
Status quo 2017: 13,550 petajoules</td><td> 
</td></tr>
<tr><td colspan="2">Final energy productivity  </td></tr>
<tr><td>Metric: Average final energy productivity per annum in period from 2008 until the current reference year defined as real GDP divided by final energy consumption [EUR / gigajoules]
Target: Average final energy productivity of 2.1 % per year in 2008-2050 period [Energy Concept 2010]
Assessment criteria: Prediction interval and expert assessment
Status quo 2016: EUR 312 / gigajoule</td><td> 
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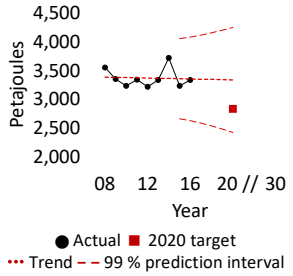
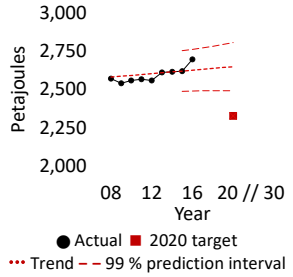
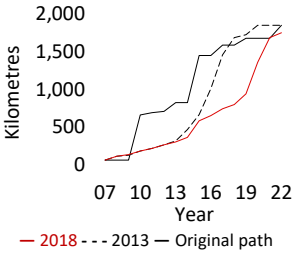
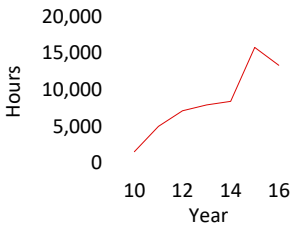
Energy efficiency		Reduction in the demand for heat in the building sector	
		Metric: Final energy consumption for space heat, hot water, air conditioning and lighting in industry, commerce and households [petajoules] Target: Reduction in demand for heat by 20 % between 2008 and 2020 [Energy Concept 2010] Assessment criteria: Prediction interval and expert assessment Status quo 2016: 3,341 petajoules (temperature-adjusted)	
		Reduction in final energy consumption in transport	
		Metric: Final energy consumption in transport [petajoules] Target: Reduction in final energy consumption in the transport sector by 10 % between 2005 and 2020 [Energy Concept 2010] Assessment criteria: Prediction interval and expert assessment Status quo 2016: 2,696 petajoules	
Security of supply		Expansion of transmission grids (leading indicator)	
		Metric: Discrepancy between planned and actual figure in transmission grid expansion [kilometres] Message: The deviation is a yardstick for security of supply in terms of the grid, with increasing deviations indicating a (future) risk to security of supply Assessment criteria: Expert assessment Status quo 2018: 1,590 kilometres (planned), 750 kilometres (actual), 840 kilometres (deviation) Note: Red traffic light derives from the assessment of the future delays in the increasing RES target	
		Redispatch measures	
		Metric: Total duration of market-based intervention in the power generation schedule [hours] Message: The deficiencies in the grid infrastructure are reflected in the overall duration of the intervention Assessment criteria: Expert assessment Status quo 2016: 13,339 hours	

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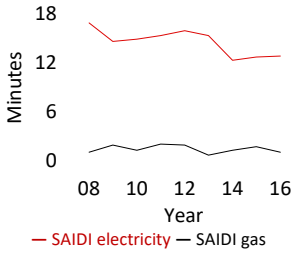
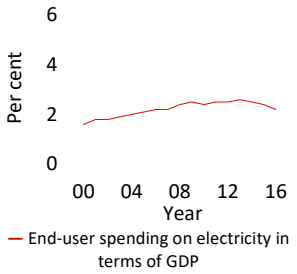
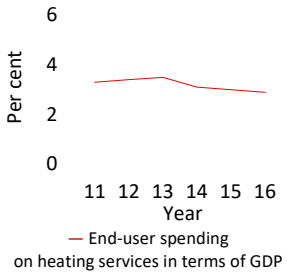
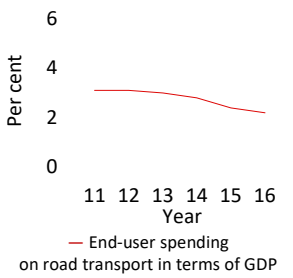
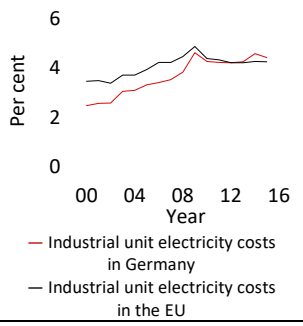
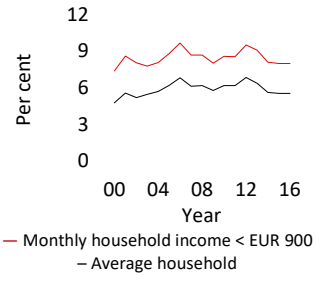
<table>
<tr><td rowspan="8">Security of supply</td><td rowspan="8"></td><td colspan="3">System Average Interruption Duration Index – SAIDI electricity and SAIDI gas  </td></tr>
<tr><td colspan="2">Metric: Failures in electricity supply and gas supply per year and customer [minutes]
Message: SAIDI electricity is a metric for electricity supply security, SAIDI gas for gas supply security; SAIDI electricity and SAIDI gas disregard scheduled interruptions and interruptions due to force majeure; SAIDI electricity only measures downtimes longer than 3 minutes, SAIDI gas measures all interruptions to the gas supply
Assessment criteria: Expert assessment
Status quo 2016: 12.8 minutes for electricity and 1.0 minutes for gas</td><td> 
</td></tr>
<tr><td colspan="3">End-user spending on electricity in terms of GDP (leading indicator)  </td></tr>
<tr><td colspan="2">Affordability metrics:
• (Aggregated) end-user spending on electricity (and for heat services and road transport) divided by GDP [percent]
• Electricity unit costs for industry defined as cost of electricity divided by value added [percent]
Message: The indicators measure the burden of energy costs
Assessment criteria: Expert assessment
Status quo 2016: 2.2 % (end-user spending on electricity in terms of GDP)</td><td> 
</td></tr>
<tr><td>End-user spending on heating services  </td><td>End-user spending on road transport  </td><td>Industrial unit electricity costs in intern. comparison  </td></tr>
<tr><td> 
</td><td> 
</td><td> 
</td></tr>
<tr><td colspan="3">Burden of energy costs on households  </td></tr>
<tr><td colspan="2">Metric: Proportion of energy spending of private households (excluding vehicle fuel) in terms of total consumer spending [percent]
Message: The indicator shows the burden of energy costs for households and draws attention to potential social effects of the energy transition; it compares the burden of energy costs for poor households with the burden on average households
Assessment criteria: Expert assessment
Status quo 2016: 8.0 % (poor households) and 5.6 % (average household)</td><td> 
</td></tr>
<tr><td>Affordability</td><td></td><td colspan="3"></td></tr>
</table>

European and international context

17. In its Monitoring Report, the Federal Government has taken an intensive look at European and international energy and climate policy, placing this part of its report at the beginning in order to signal its significance. EU energy policy is currently dominated by the negotiations on the "Clean Energy for All Europeans" package of legislation proposed by the European Commission in November 2016. On the basis of this legislation, the EU's climate and energy target architecture is to be fleshed out for the 2020-2030 period, and the European energy union is to be developed further. One major component of the package of legislation is the regulation on the governance of the energy union which, inter alia, puts key conditions in place for the development of national energy transition monitoring. Since the EU's target architecture for 2030 does not stipulate any binding national renewable energy and energy efficiency targets for 2030, the European Commission lacks the power to bring treaty infringement procedures in the case of non-compliance. Against this background, European Commission has proposed an innovative policy in the Governance Regulation: the Member States are to use integrated National Energy and Climate Plans (NECPs) and progress reports to describe their national energy and climate targets and the strategies and measures designed to attain them.

18. In this context, the Expert Commission supports the efforts made by the Federal Government to keep an eye on the harmonisation of the substance and timetable of the national and European targets and reporting requirements in order to attain a common understanding of target definitions, to better network the areas of "climate" and "energy", and to avoid duplication of effort. Since Germany is pursuing relatively far-reaching goals to expand renewable energy at national level, the Federal Government should work towards more ambitious renewable energy expansion targets at EU level. Otherwise, Germany's disproportionately great contribution could result in weaker efforts on the part of European neighbours. Furthermore, the substance of the indicators for the monitoring of the energy transition should be brought in line with the EU requirements. Here, some of the European reporting requirements necessitate new indicators, which should also be used in national monitoring. Finally, it seems worthwhile to have the European monitoring process also backed up by independent academic analysis. The setting up of a commission of experts along German, French or British lines is one feasible approach.

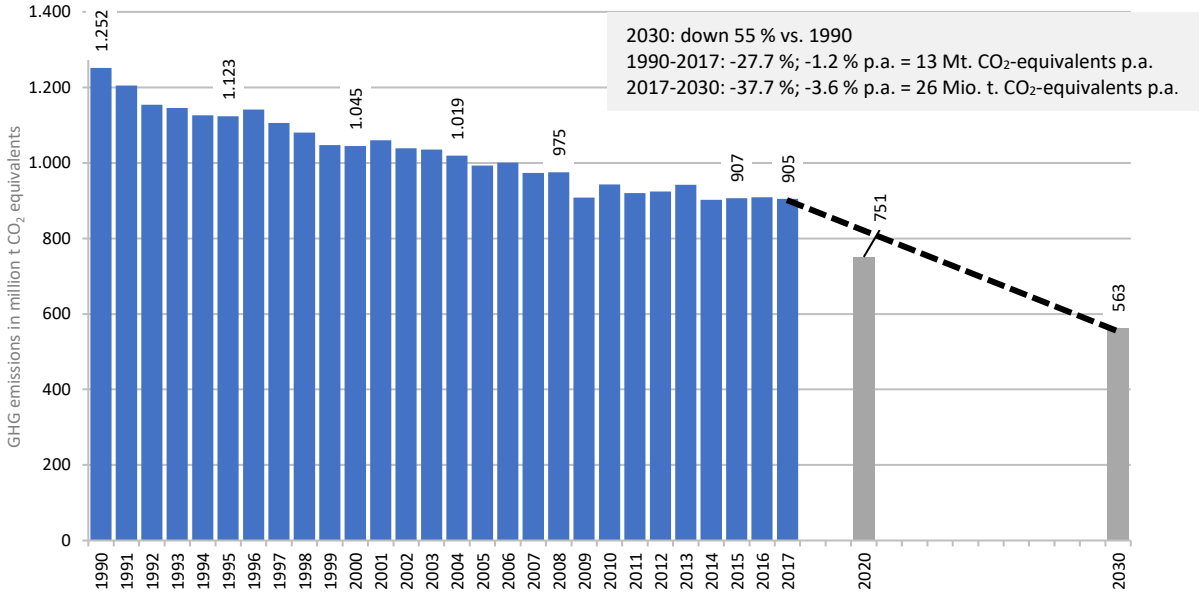
19. There is no doubt that Germany could benefit from an international monitoring process. Depending on the set of indicators used, other countries are outperforming Germany in some aspects of the energy transition. So it appears most appropriate to monitor the energy and climate policies of other countries more systematically than it has been the case and, where appropriate, to copy successful elements. The benefits of such a process are increasingly being perceived by third parties, e.g. in the G20 Hamburg Climate and Energy Action Plan for Growth. Despite the heterogeneity of the countries in terms of their current situation, ambitions and monitoring systems, academically grounded monitoring would benefit all partners if it is based on the core elements of "informing", "monitoring", "evaluating" and "sharing and learning from one another".

20. The Expert Commission takes a positive view of the reform of the European emissions trading system (ETS). In previous comments, the Expert Commission has already pointed out that mechanisms should be established to ensure that additional national emission reductions also result in genuine climate change mitigation in Europe as a whole. Thanks to this reform, there are two mechanisms which help to reduce an excess of ETS certificates: the market stability reserve and the possibility for Member States to cancel certificates when plants which are subject to the ETS, such as power stations, are closed down. At the same time, the Federal Government must ensure that appropriate measures make it possible to attain the reduction targets for the non-ETS sectors in line with the burden-sharing agreements of 14 % for 2020 and 38 % for 2030.

Greenhouse gas emissions

21. The development of greenhouse gas emissions has been deviating from the target curve for some time now (cf. Figure 2). Whilst, as an annual average in the period from 1990 to 2000, greenhouse gas emissions dropped by 1.7 %, and by approx. 1.0 % from 2000 to 2010, they only declined by 0.6 % a year between 2010 and 2016; they actually increased in 2015 and 2016. Provisional estimates suggest that the decline in 2017 was again much too small, at 0.6 %.

Figure 2: Greenhouse gas emissions in Germany from 1990 to the reduction target for 2030



Source: In-house calculations based on UBA (2018b) and BMWi/BMU (2010)

22. The Expert Commission has been flagging up for years the risk of a substantial failure to meet the 2020 target. There is a variety of causes for the foreseeable failure to attain the target: it seems clear that the impact of the numerous measures adopted by the Federal Government is limited, and that it proved impossible to roll out some highly promising measures. There is still no comprehensive concept to offset the additional CO_2 emissions associated with the nuclear energy phase-out. In addition, exogenous reasons are making it more difficult to cut emissions; the Federal Government's Sixth Monitoring Report addressed some of these: the low energy and CO_2 certificate prices offer almost no incentives for measures reducing emissions. The more expansionary economic and demographic development is tending to raise energy consumption and greenhouse gas emissions, contrary to what was expected in 2010 when the Energy Concept was adopted. Also, the balance of electricity exports, which rose to more than 50 billion kWh in 2016, impacts negatively on Germany's climate footprint.

23. In the context of the forthcoming development of a concrete strategy for the 2030 target horizon, the Federal Government should also develop an understanding of how the various causes of missed targets can be eliminated or offset in future. In view of the missed targets for 2020, the challenge of cutting greenhouse gas

emissions by 55 % by 2030 to a permissible level of no more than 563 Mt of CO_2 equivalents is already a considerable one. From 2017 to 2030, annual greenhouse gas emissions would have to be cut by approx. 26 Mt of CO_2 equivalents, or three times as much as in the years from 2000 to 2017 (approx. 8 Mt of CO_2 equivalents per year). This necessitates reduction figures which were only attained in the early 1990s when the GDR economy collapsed and during the 2008/2009 financial market crisis.

24. In view of the limited effects achieved so far on emissions reductions, the Expert Commission sees a need to review the current design of the measures, particularly in view of the large number of small-scale measures. In this context, there is the proposal for a general pricing of emissions, also in view of the need to finance existing or new funding programmes (cf. Chapter 10).

25. However, two activities initiated by the Federal Government should particularly be flagged up as positive in the view of the Expert Commission. A Climate Change Mitigation Act has been announced in the coalition agreement. The Act should be oriented to the long-term goals of the Paris Climate Agreement, according to which the rise in temperature is to be permanently restricted to below 2 degrees and net global greenhouse gas emissions need to drop to zero in the second half of the century. So far, there have been no details of the context of such an act. The Expert Commission believes that the fixing of climate targets in law – as opposed to the setting of the targets as government policy – is important because it will exercise more of a binding effect on other policy areas and planning processes. A comprehensive statutory arrangement with the establishment of effective institutions and sanction mechanisms could improve the preconditions for actually attaining the medium-term targets for 2030.

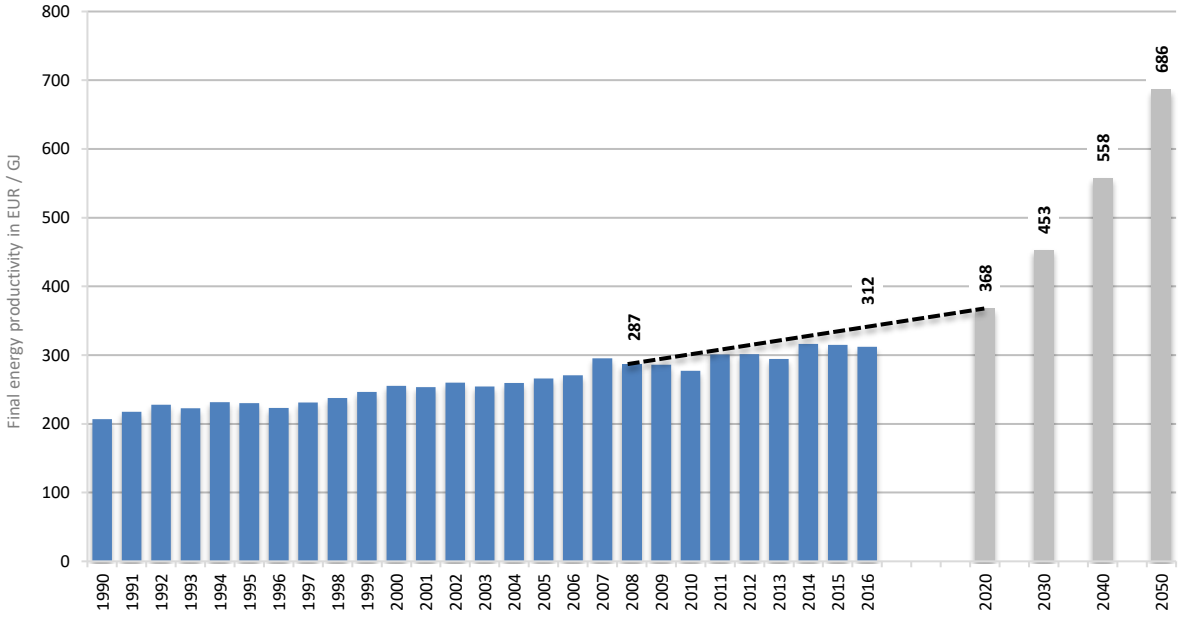
26. Secondly, the Federal Government is now working on the details of the phase-out of coal-fired electricity generation, and has set up the "Growth, Structural Change and Regional Development Commission" for this purpose. The Commission should be wished every success, not least in order to ensure public acceptance for the necessary measures. The same goes for the envisaged commissions for the transport and buildings sectors.

Energy efficiency

27. In the Federal Government's five previous monitoring reports, and in the comments from the Expert Commission, complaints were regularly made about the lack of progress on developing energy efficiency and calls were made for incentives to promote further energy efficiency. This Sixth Monitoring Report again sees no change in these messages. The goal of an increase in final energy productivity of 2.1 % per year starting in 2008 has since been missed. As an average for the years from 2008 to 2016, it improved by a mere 1 %, and in 2016 it actually declined by 0.9 % in year-on-year terms. Figure 3 shows the gap between the target curves from 2008 (target base year) until 2020 and the actual figures for final energy productivity from 2008 to 2016, a gap that has widened significantly since 2014.

28. If final energy productivity is to return to the target curve by 2020, it would have to increase by a factor of 4. The Expert Commission believes that such a development is highly improbable, since so far only the residential market has achieved a slight decline in final energy consumption, whilst it is basically flat in industry and actually tending to rise in the field of commerce, trade and services and – particularly – in transport.

Figure 3: Development of final energy productivity in Germany from 1990 to 2016, and targets up to 2050



Source: In-house calculations based on BMWi/BMU (2010), Destatis (2018e) and AGEB (2017b)

29. In the transport sector, the main causes of this are the increased number of kilometres travelled and the structure of the vehicle fleet, which the improvements in energy efficiency were unable to offset. Given the future increase in traffic assumed by the Federal Transport Infrastructure Plan, there would be a need for a drastic increase in energy efficiency in order to achieve a genuine drop in energy consumption and thus lower greenhouse gas emissions. In the view of the Expert Commission, there will also be a need for a political decision as to whether the main focus will remain on efficiency and fuel substitution, or whether there will also be a need for measures to reduce traffic.

30. Even though some progress has been made in the buildings sector, there continues to be a high untapped efficiency potential. In the view of the Expert Commission, there is a substantial need to improve the energy performance of non-residential buildings in particular. If the general goals of higher efficiency in buildings are to be attained, the Federal Government would have to substantially expand the existing funding measures in this field, such as the "CO_2 Building Renovation Programme: Non-Residential Buildings". The Expert Commission takes a more positive view of the development in residential space heating needs. However, the temperature-adjusted use of energy for space heating has scarcely fallen at all since 2009. Against this background, the Expert Commission recommends that the Federal Government analyse these weaker trends in more detail in order to counteract them. In order to achieve significant results, the Expert Commission deems it necessary to top up the funding for energy efficiency and for the retrofitting of buildings. The amount must be suited to truly mastering the major challenge of a climate-neutral building stock to be obtained in the coming 30 years. However, the focus should also be placed on residential energy consumption which does not serve space heating, since no reduction at all has taken place here so far.

31. In the Federal Government's strategy to implement the energy transition, a key role is played by the National Action Plan on Energy Efficiency (NAPE). However, the measures have so far had little impact. Monitoring of the various measures shows that most of them have a limited impact on energy consumption and emissions. Some of the estimates of the effectiveness of the measures, such as that of energy efficiency networks, seem quite questionable. The Expert Commission welcomes the efforts to monitor the measures, but repeats its recommendation to review the reduction effects and to undertake a more comprehensive evaluation of the measures, taking into account the commission's recommendations on the monitoring of the NAPE.

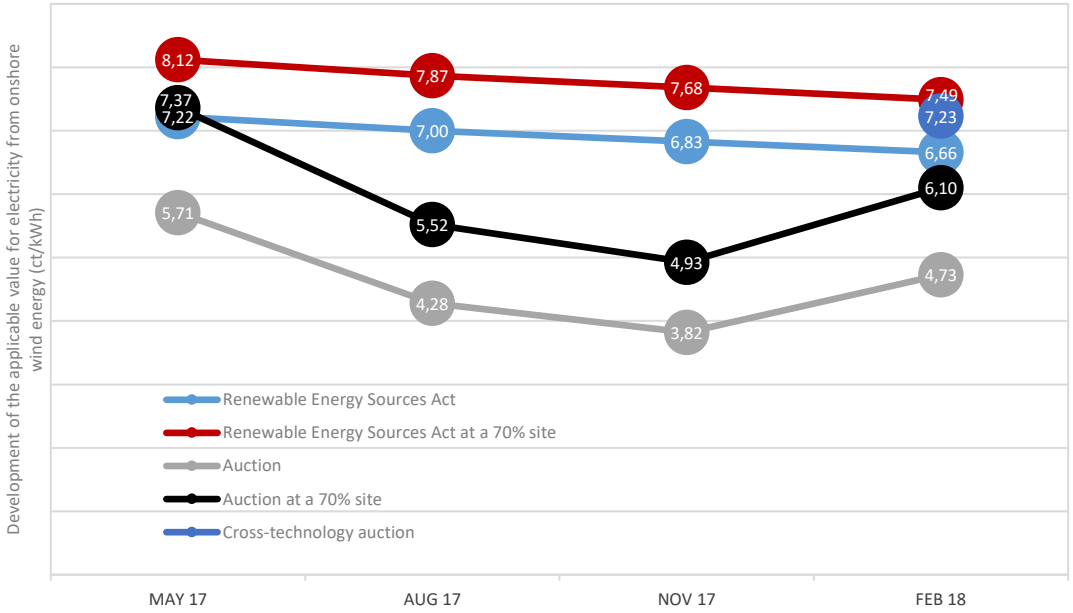
32. The Expert Commission would like to point out that there should be a fundamental rethink of the design of the measures in order to adequately address major challenges of the energy transition and the rather limited effects of the energy and climate policy measures seen so far and likely in the future. This should be done irrespectively of the evaluation of the NAPE contained in the Federal Government's current Monitoring Report and the energy-saving and emissions-reducing measures cited for the building sector. Apart from this, the Expert Commission feels that its sceptical view of the attainment of future emission reduction targets is confirmed again by the Federal Government's 2017 Climate Action Report: according to the report, the reduction in greenhouse gas emissions from 1990 to 2020 is likely to amount to no more than 32 %, given the expansionary economic and demographic development. This entails greenhouse gas emissions of approx. 850 Mt of CO_2 equivalents, or around 100 Mt of CO_2 equivalents more than aimed at. Under these preconditions, the additional emission reduction from 2020 until 2030 will have to amount not to 188 Mt but to 288 Mt of CO_2 equivalents, i.e. almost 30 Mt of CO_2 equivalents a year.

Renewable energy

33. The expansion of renewable energy remains generally on track. However, the main reason why the proportion of gross final energy consumption covered by renewables rose only slightly in year-on-year terms in 2016, to 14.8 %, is weather-related: a lack of wind and sun meant that the proportion of gross electricity consumption covered by renewable energy rose only slightly. Since, however, the amount of installed generation capacity increased significantly in 2016 and 2017, renewables accounted for 36.2 % of gross electricity generation in 2017 (2016: 31.6 %), meaning that the Federal Government's minimum target of 35 % for 2020 was reached three years ahead of schedule. This suggests that 2017 will also have seen a further rise in the proportion of gross final energy consumption covered by renewables. The EU's 18 % target for Germany in 2020 thus continues to appear to be attainable, even if the proportions of renewable energy developed very differently in the various sectors.

34. The dynamics of the development of renewables-based electricity generation continue to be driven largely by the rules of the Renewable Energy Sources Act. The Expert Commission takes a differentiated view of the introduction of auctions in the 2017 Renewable Energy Sources Act and the developments triggered by this: it was not possible to achieve the desired intensity of competition in all sectors (cf. Figure 4). This is particularly the case with regard to the special auctions of 4 GW for both photovoltaic installations and onshore wind energy announced in the coalition agreement. In the forthcoming auctions, a lack of approved sites may result in insufficient competition, because according to the current status of the reports in the register of onshore wind energy installations, approvals have only been granted for sites with a volume of 1.2 GW.

Figure 4: Development of the applicable value for electricity from onshore wind energy installations pursuant to the Renewable Energy Sources Act



Source: In-house, based on BNetzA (2018h)

35. The Expert Commission also recommends a further-reaching analysis in terms of the citing of the cost reductions achieved, because some of the bid levels were greatly affected by special cases like the different rules for citizens' energy companies. In the field of onshore and offshore wind energy, therefore, the auction results should rather be viewed as forecast cost-reduction potential for the near future, and not as cost reductions generated by the auction system. This is also demonstrated by the first technology-neutral auction for photovoltaics and onshore wind energy, which did not produce any comparably low costs for wind energy. In the case of the offshore auctions which produced a surprise in the form of bids of 0 ct/kWh, it seems likely that this was driven by strategic considerations to secure sites and grid connection capacity. An equally important role was probably played by the expectation of technical advances in the next generation of equipment, and rising prices for electricity on the exchange following the nuclear phase-out.

36. The Expert Commission regards the 2017 Renewable Energy Sources Act as no more than a first step towards creating competition-based incentives and integrating renewables into the electricity markets, so that with time it will be possible to dispense fully with the provision of financial support. In the view of the Expert Commission, switching from price-based to quantitative steering, and competition-based setting of funding levels is not sufficient for a viable electricity market regime which takes account of the special features of (intermittent) renewable energy. In order to make a reality of the envisaged discontinuation of a funding system in the coming five years, there is a need for further changes in the electricity market design and corresponding supporting rules, such as carbon pricing for fossil fuels. In order to shape the transition, one initial possibility would be a switch from the provision of funding under the Renewable Energy Sources Act for a certain number of years

to funding for a number of full-load hours, which would result in several clear simplifications in the Act and would support competitive behaviour by the installation operators.

Electricity industry

37. According to the Monitoring Report, the Electricity Market Act adopted in July 2016 is to put the conditions in place for competition between flexible generation, flexible demand and storage. Electricity traders selling electricity to end-users are to feed in the amount sold into the grid at the same time – this is known as "balancing group commitments". Also, the Act promises to introduce "free pricing on the wholesale electricity market", which would ensure optimal investment in the required generation capacity. The new Act has now been in force for more than a year, so it is useful and necessary to pose the question in the context of energy transition monitoring as to whether and to what extent the Act is meeting the expectations placed in its adoption or whether there are at least indications of this. However, the present approach to electricity market regulation remains unsuited in several ways for an electricity sector dominated by wind and solar power. This is reflected in various areas.

38. The new regulatory framework does not offer any coherent strategy for storage. If storage is to play a significant role in the German electricity system in the medium to long term, the Federal Government would have to take appropriate steps. The Expert Commission also recommends that new pump-storage facilities should no longer be given preference over old pump-storage facilities.

39. The Expert Commission believes that the obligation to uphold balancing group commitments, with appropriate sanctions for non-compliance, is the right instrument to arrive at appropriate pricing of flexibility. However, the introduction of the capacity reserve implicitly denies the balance responsible parties the capability to ensure balanced balancing groups on a continuous basis and to contract the necessary flexibilities for this at an early stage. The introduction of the capacity reserve therefore impacts negatively on the business models based on the creation of flexibility options.

40. In addition to the establishment of the capacity reserve and the extension of the grid reserve, further reserve mechanisms under the supervision of the transmission system operators have been added. This removes a significant portion of conventional capacity from the electricity market and finances it from elsewhere. This fundamentally contradicts the concept of the energy-only market and the unbundling of grid operation and generation. At the same time, not all the reasons given for the establishment of the reserves – i.e. security of supply – are persuasive.

41. The Federal Government should therefore put a lot of effort into the establishment of a viable and coherent regulatory framework with uniform rules for all parties. In particular, this will require a reform of the taxes and charges (cf. Chapter 10). It seems likely that this cannot be tackled without the constructive participation of the Federal Finance Ministry.

42. The Expert Commission believes that the brief comments made by the Federal Government about security of supply in the electricity sector fail to reflect the importance of this issue. This is particularly the case against the background of the paradigm shift anchored in the Electricity Market Act from a national to a cross-border consideration of security of supply.

43. The comprehensive analyses by ENTSO-E and the Pentalateral Energy Forum (PLEF) find that the security of supply situation in Germany, taking into account electricity imports in the coming years, appears to be uncritical (cf. Table 3). However, the picture is less positive if one takes a cross-border view of the "PLEF" region, i.e. Germany, Austria, France, Benelux and Switzerland. In particular, the security of supply situation in France remains tense. Also, the analyses flag up the growing complexity and rising interdependencies of the European electricity systems. These interdependencies mean that national intervention in the power station fleet is likely to impact on security of supply in neighbouring systems. In view of this, the Expert Commission recommends that the debate about the phase-out of coal should include not only an examination of the impact on security of supply in our neighbouring countries, but also a consultation of the neighbouring countries on these issues.

Table 3: Selected figures on security of supply from the PLEF and MAF studies for the "penta region" countries

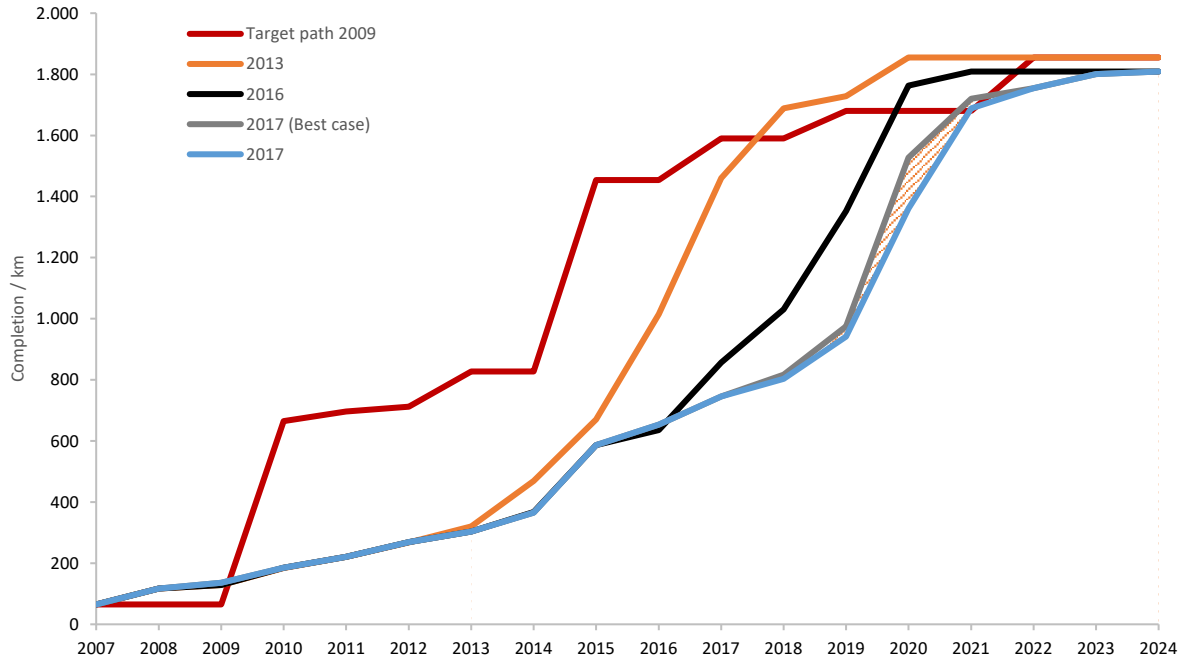
Author (year of publication)		PLEF (2015)	PLEF (2018)		MAF (2016)	MAF (2017)	
	Reference year	2020	2018/19	2023/24	2020	2020	2025
	Security standard [h/a]	**Loss of Load Expectation [h/a]**					
Belgium[1]	3.0	7.0	3.5	2.7	0.6	0.3	6.0
France	3.0	10.0	5.0	4.9	2.7	5.8	4.6
Austria	-	0.0	0.0	0.0	0.0	0.1	0.1
Switzerland	-	0.0	0.0	0.0	1.3	0.6	0.3
Netherlands	4.0	0.0	0.2	1.1	0.0	0.1	1.3
Luxembourg	-	0.0	0.0	2.6	1.5	0.7	1.7
Germany	**-**	**0.0**	**0.0**	**0.5**	**0.3**	**0.4**	**0.6**
		Assumed output of hard coal and lignite in Germany [GW]					
Lignite		17.5	18.8	16.0	18.1	16.6	11.4
Hard coal		24.6	21.8	20.1	26.3	23.2	20.9
Total		42.1	40.6	36.1	44.4	39.8	32.3
[1] 3 h/a LOLE and 95 percentile <20 h							

Source: Own calculations based on MAF (2017, 2016) und PLEF (2018, 2015)

Electricity grids

44. The Expert Commission welcomes the commitment by the government to the expansion of the grid, but again warns that the Federal Government's Monitoring Report fails to adequately depict delays. The Power Grid Expansion Act (EnLAG) and the Federal Requirements Plan Act (BBPlG) anchor the energy industry's need for the projects cited in them in law. However, recent years have seen repeated delays (cf. Figure 5). The projects governed by the Power Grid Expansion Act currently stand at approx. 750 completed kilometres at the end of the first quarter of 2018, or around 840 kilometres behind the original schedule. In the case of expansion projects under the Federal Requirements Plan Act, the shortfall is even greater. The plan was to have 1,435 completed kilometres of powerlines in 2017, but only 150 kilometres were in place at the end of the first quarter of 2018. Also, the year which the Monitoring Report cites for the completion of the major electricity highways (2025, for example for SuedLink and SuedOstLink) will be virtually impossible to achieve as things stand today.

Figure 5: Target path and gradually adjusted paths for the grid expansion according to EnLAG



Source: In-house calculations on basis of BNetzA/BKartA (2014, 2015) and BNetzA (2010, 2017c)

45. The Federal Government's Coalition Agreement raised the renewables target in the electricity sector (share of gross electricity consumption) from 50 % to 65 % by 2030. Numerous people in the grid industry believe that this step is incompatible with the current progress on grid expansion. It is impossible to stress often enough that grid expansion needs to be coordinated with the deployment of renewable electricity generation, irrespective of all the efforts to decentralise and flexibilise. Grid pricing plays an important role if there is to be a successful activation of these alternatives to grid expansion.

46. The Act on the Modernisation of the Grid Fee Structure (NEMoG), which entered into force in July 2017, unifies the grid charges at transmission system level. The Expert Commission welcomes this development, since the expansion of the transmission of electricity over long distances cannot be funded solely by the end-users in the regions with high proportions of wind energy. But there is also a substantial need for reform at distribution grid level. Generators take their decisions on investment and production without any regard for the capacity utilisation of the grid, and consumers also have virtually no incentives to adapt their consumption to the level of grid capacity utilisation. The Expert Commission believes that this circumstance could be remedied by grid charges on the generation side (entry components) and dynamisation in terms of time.

47. So far, little attention has been paid to the fact that very high feed-in of wind energy in Germany increasingly creates ring flows which result in physical congestion at the interconnectors. The smaller amount of free powerline capacity to our European neighbours reduces the quantity of electricity that can be traded on the European electricity market. Taken together, the expansion of renewable energy installations in Germany and the lack of grid expansion thus result in disintegration of the European internal market. It is understandable that

the European Commission is monitoring this with highly critical eyes and discussing potential solutions, such as the splitting up of Germany's bidding zone.

48. Even if the costs of grid congestion management (redispatch, grid reserve and renewables curtailment) did drop in 2016 assuming an objective allocation of costs, they remain at a high level compared with preceding years. The costs were cut as a result of the completion of individual grid expansion projects, improved procedures at the transmission system operators, and the smaller amount of wind energy feed-in in 2016. However, the Expert Commission points out that the costs can rise again quickly if the necessary grid expansion does not take place soon. The transmission system operators are already announcing record costs for 2017.

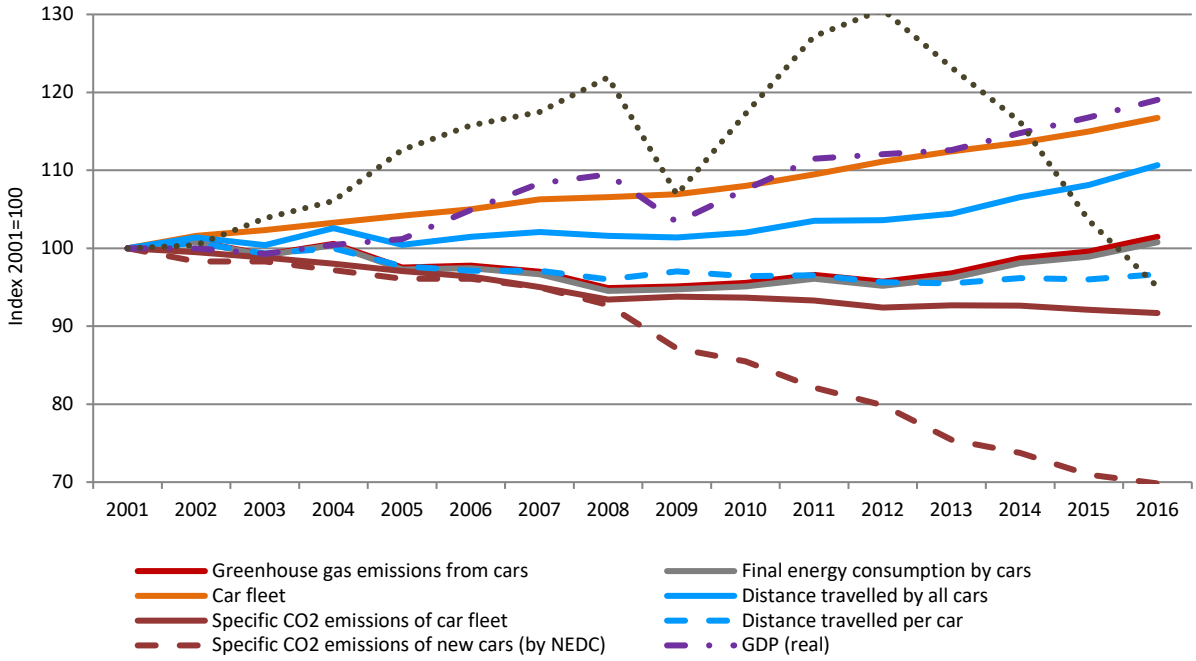
49. The Ordinance on Interruptible Loads (AbLaV) was only marginally revised and extended at the end of 2016, even though the interruptible loads are a very expensive instrument, given the small benefits. With a view to efficiency, the Federal Government should avoid such small-scale instruments.

Transport

50. Final energy consumption in the transport sector rose by almost 3 % in 2016 in year-on-year terms. This is the fourth successive rise, and runs counter to the target set for 2020. The current gap compared with the 2020 target roughly equates to the annual energy consumption of 10 to 11 million cars in Germany (approx. one quarter of the car fleet). According to the 2050 Climate Action Plan, the transport sector is to cut its emission to 98 Mt of CO_2 equivalents by 2030. Given emissions of 167 Mt of CO_2 equivalents in 2016, this implies a need to cut almost 70 Mt of CO_2 equivalents or approx. 41 %. The Coalition Agreement states that German transport policy is committed to the 2050 Climate Action Plan and the Paris Climate Agreement. However, the measures cited in the Coalition Agreement are very vague when it comes to the largest cause of energy consumption and emissions, i.e. private individual motorised transport.

51. The key drivers of the rising energy consumption and growing emissions from individual motorised transport are, firstly, the ongoing rise in the number of vehicles and the related increase in the total distance travelled. Secondly, the specific average energy consumption of the car fleet, and thus the specific average CO_2 emissions, have been flat for years (cf. Figure 6). The reasons for this include the continuing disparities between emissions in tests and on the road. The utilisation of flexibilities in the New European Driving Cycle (NEDC) have rendered the statutory limits virtually ineffective in practice. The new Worldwide Harmonised Light Vehicles Test Procedure (WLTP) will generate more realistic results, but will not close the gap with the emissions under real driving conditions. The Expert Commission calls for additional independent studies on real driving conditions so that the development of the deviations can be regularly reviewed. Policy measures should also take account of the deviations. New specific emission limits for cars, valid from 2021, are currently being negotiated at EU level, but according to the current draft by the European Commission are not sufficient to achieve the emission cuts required by the 2050 Climate Action Plan. For this reason, the Expert Commission recommends that the Federal Government calls for more ambitious CO_2 limits in future negotiations. Otherwise, the failure to cut emissions will have to be offset by additional national measures in order to attain the targets of the 2050 Climate Action Plan.

Figure 6: Total greenhouse gas emissions from fuel consumption by cars in Germany and influencing factors, 2000-2016



Source: In-house calculations based on Ecologic Institut (2017b), BMVI (2017b), ICCT (2017a), Eurostat (2018) and MVV (2018)

52. The increase in car ownership and the total distance travelled by private motorised transport offsets the effectiveness of efficiency measures. Price instruments can help to reduce rebound effects from improvements in efficiency and to internalise externalities in transport. In line with its previous comments, the Expert Commission advises the Federal Government to make progress on the far-reaching introduction of a pricing system for road use. Further to this, the Expert Commission recommends that use be made of the car tax and the tax on company cars in order to create incentives to buy smaller, lighter, more efficient and more climate-friendly vehicles and to make vehicles, which harm the climate, less attractive. Coupled with benefits in terms of CO_2 emissions, this would address other externalities like land use, emissions of particulates, and the use of resources.

53. The costs of purchasing a battery-electric lower mid-size car in 2015 were, depending on the size of the battery, between EUR 5,600 and EUR 17,700 higher than those of a comparable conventional vehicle. Despite the existence of funding instruments, the costs continue to present a barrier to the spread of electric mobility. Thus, further supportive measures are required. The investment in the distribution grid which is required for the expansion of the charging infrastructure must be tackled soon.

54. With regard to rail traffic, the Expert Commission welcomes the projects formulated in the Coalition Agreement. Comprehensive use should be made of existing potential to shift traffic to the railways. Here, a pricing of road use based on the externalities of traffic can improve the competitiveness of the railways. Against the background of the 2050 Climate Action Plan, the Federal Government should also reassess the question of the necessary investment in infrastructure and the distribution between road and rail in the Federal Transport Infrastructure Plan.

Energy prices and energy costs

55. In its comments made in response to the First Monitoring Report, the Expert Commission had recommended that the burden of energy costs be assessed on the basis of macroeconomically aggregated sets of figures and not on the basis of sectoral energy prices. The main elements of the time series for the overall electricity industry accounts are presented in Table 4. The calculations are based on the total revenues from the sale of electricity to end-users, which are determined each year by the Federal Statistical Office. The revenues include unit, capacity and transfer charges, as well as grid fees, taxes and charges (electricity taxes, concession fees, EEG surcharge, etc.), but not value-added tax. Nor do they include spending on self-supply of electricity in industrial and small scale thermal power stations.

56. The proportion of GDP accounted for by end-user spending on electricity dropped slightly from 2.3 % in 2015 to 2.2 % in 2016. A consideration of the absolute figures also shows a slight drop in spending of just under EUR 1 billion in 2016. This development yet again shows that increases in the field of state-induced (EEG surcharge, etc.) and regulated (grid fees) elements contrast with a fall in market-driven elements. The stabilisation of the total expenditure is probably only temporary in nature; in the field of grid fees in particular, increases for 2017 and 2018 are already known.

Table 4: Aggregated end-user spending on electricity

	2010	2011	2012	2013	2014	2015	2016*
Electricity sales in TWh	**478.5**	**467.4**	**461.7**	**465.0**	**447.2**	**450.8**	**448.0**
	[EUR bn]						
Total spending [1]	**60.9**	**63.6**	**64.3**	**71.0**	**70.3**	**69.5**	**68.5**
State-induced elements	**17.2**	**23.0**	**23.3**	**30.0**	**32.3**	**31.3**	**32.7**
Electricity taxes [2]	6.4	7.2	7.0	7.0	6.6	6.6	6.6
Concession fees [3]	2.1	2.2	2.1	2.1	2.0	2.0	2.0
EEG surcharge (differential costs) [4]	8.3	13.4	14.0	19.8	22.3	22.0	22.7
CHP Act [5]	0.4	0.2	0.3	0.4	0.5	0.6	1.3
Charges (Section 17F Energy Industry Act, Section 18 AbLaV) [6]	-	-	-	0.7	0.8	0.0	0.2
State-regulated elements	**16.9**	**17.6**	**19.0**	**21.2**	**21.4**	**21.4**	**22.3**
Grid fees: transmission system [7]	2.2	2.2	2.6	3.0	3.1	3.5	3.8
Grid fees: distribution system [8]	14.7	15.4	16.4	18.2	18.3	17.9	18.5
Market-driven elements	**26.8**	**23.1**	**22.0**	**19.8**	**16.6**	**16.8**	**13.4**
Market value EEG electricity [9]	3.5	4.4	4.8	4.2	4.1	4.7	4.3
Generation and sales [10]	23.3	18.6	17.2	15.6	12.5	12.1	9.1

* some figures provisional

Source and legend: See chapter 9.1

57. The proportion of GDP accounted for by end-user spending on heating services stood at 2.9 % in 2016. In the last three years, the absolute burden of costs basically remained stable. Lower spending on final energy sources was offset by higher spending on energy efficiency. Because of the growth of the German economy, the relative burden of costs dropped by 0.2 percentage points compared with 2014. The achievement of a virtually climate-neutral building stock is likely to result in a significant increase in end-user spending on heating services. As a consequence, there are likely to be problems of distribution amongst the affected stakeholders.

58. End-user spending on road transport fell further, but only slightly, in 2016. As in the preceding year, this fall is due to exogenous factors, e.g. the drop in average fuel prices. In terms of GDP, the relative burden of costs stands at 2.2 %, or 0.2 percentage points down in year-on-year terms. Due to the lack of clarity about how policy makers will resolve the current pressure to act in the transport sector, it is difficult to predict future developments.

59. The Expert Commission welcomes the commencement of work by the Federal Government on the national energy accounts concept. The indicators for electricity, heat and transport deliver messages about the relative development of end-user spending in these three sectors. The Expert Commission recommends that the Federal Government collect the necessary data in future and provide the necessary expertise to create the indicators. The costs and unit costs should be displayed in addition to the energy prices.

Reform of fees, taxes and charges on energy

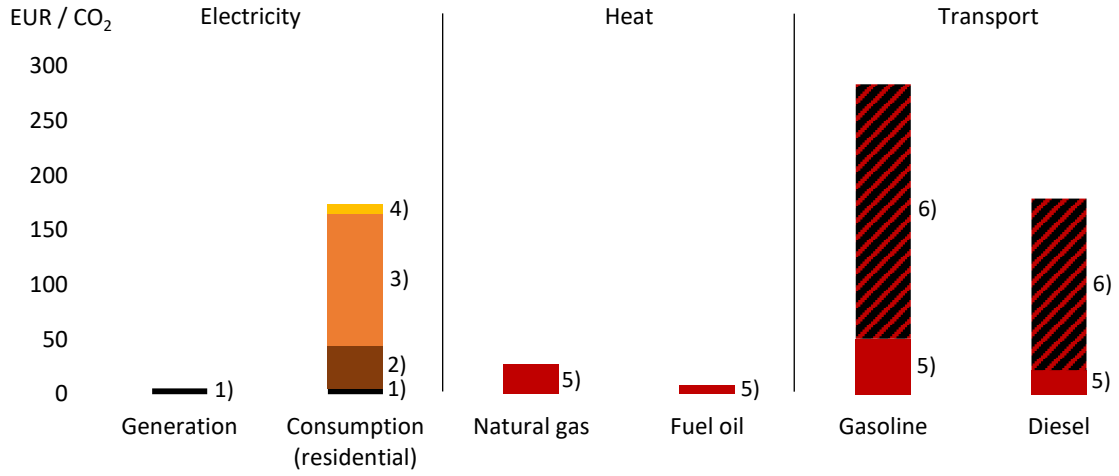
60. At present, the climate and energy policy toolkit consists of a large number of small-scale incentive systems. As an alternative, the Expert Commission advocated in its last comments a general pricing of CO_2 as a guiding policy instrument to set an economically rational, stable and long-term framework for the transformation of the energy system. The Expert Commission is thinking of a lean energy price system that would, as far as possible, cover all sources of greenhouse gas emissions by a generally uniform price per emitted tonne of CO_2. Complementary instruments are (only) required where this is justified by further imperfections in the market.

61. A comprehensive evaluation mechanism is required in order to implement the theoretical call for a carbon price signal which, as far as possible, is uniform for all sectors. At present, is it not clear which sectors face which CO_2 prices. A robust method is required for an informed proposal for a reform of fees, taxes and charges on energy. The Expert Commission offers a conceptual framework for this.

62. Initial indicative estimations of the "total CO_2 prices" in Germany show an apparent large degree of heterogeneity in CO_2 pricing between the sectors (due to the emissions trading system and energy-related charges and taxes, cf. Figure 7). This becomes particularly obvious in the comparison between electricity and heat (CO_2 price signal for electricity of 164.82 EUR / t CO_2 as opposed to 7.97 EUR / t CO_2 for fuel oil). The Expert Commission's recommendation for a general price for CO_2 works from this, and aims to level out the different price signals for emissions in different sectors. A corresponding reform can address also the low CO_2 prices for high-emission energy sources (e.g. fuel oil) which are particularly critical in terms of climate policy and which are inadequate at present to fully internalise the external costs of the emissions. There is also a considerable degree of heterogeneity within the sectors. This is particularly obvious in the German electricity sector, where the calculated CO_2 price for generation is only roughly one twentieth of the CO_2 price for consumption. In the transport sector, there is heterogeneity due to the different taxes imposed on different energy sources (e.g. gasoline versus diesel). Correcting the amount by excluding "non-climate-change-related" price components reduces the amount for gasoline, for example, from the initially calculated CO_2 price signal of 283.28 EUR / t CO_2 to 50.68 EUR / t CO_2. Such corrections must not be neglected in the future discussion of correctly registered CO_2 price

signals. As far as the Expert Commission is aware, no such adjusted calculations of this type exist at present. The example cited for the transport sector (or rather for a selection of instruments effective in this sector) is an initial example which should be developed further and transferred to other sources of CO_2 emissions.

Figure 7: „Total CO_2 prices“ in Germany 2016



1) EU ETS certificates, 2) Electricity tax, 3) EEG surcharge, 4) CHP surcharge, 5) Energy tax,
6) “Infrastructure component” and pricing of other environment effects apart from greenhouse gas emissions.

Source: In-house calculations based on Agora Energiewende (2017b)

63. The price system for energy needs to be more clearly oriented to the actual cause of climate change (greenhouse gas emissions), currently fails to utilise a great deal of potential for cost efficiency, runs counter to the important concept of sector coupling, and results in distorted and overlapping price signals. It is necessary to pay attention to other important evaluation criteria for a reform, such as a long-term orientation for market participants, aspects of the competitiveness of energy-intensive industry, regressive effects of additional CO_2 pricing, and possible remedies.

64. The quantifications of the CO_2 price signals on the basis of the monitoring evaluation framework presented show how complex a complete and correct registration of CO_2 prices is in practice. It is therefore necessary to exercise caution when formulating a comprehensive proposal for reform which moves towards the general CO_2 pricing favoured by the Expert Commission. For this reason, the Expert Commission suggests consideration of a revenue-neutral substitution of all charges on electricity by a CO_2-based supplement on the energy taxes on fossil fuels. If this proposal were realised, the electricity price could fall for the end-user; at the same time, the wholesale electricity price would be likely to rise due to the inclusion of the CO_2 prices on fuels for fossil fuel power stations. This would reduce the cost of funding renewable energy. It might be the case that certain renewables-based power generation installations could then be viable without additional funding. The market opportunities for sector coupling technologies would improve. The increasing competitiveness of low-carbon sources of energy is also likely to permit a market-driven phase out of coal/lignite without new state interventions. The danger that the self-supply will undermine the solidarity of electricity consumers would be reduced, since self-supply would no longer enjoy such a strong advantage compared with purchasing electricity from the

grid. Not least, the debate about the treatment of electricity storage facilities in terms of exemptions from electricity-specific charges would end, as these would disappear or at least be significantly reduced.

Innovation and digitalisation

65. The Federal Government's Monitoring Report provides a rather brief overview of the issue of energy research and innovation. In order to reflect the importance cited in the report of energy research as a "key for a successful energy transition", the Expert Commission recommends that future reports provide a more detailed depiction, especially as the energy transition is a driving force for innovation which offers substantial opportunities for the business sector.

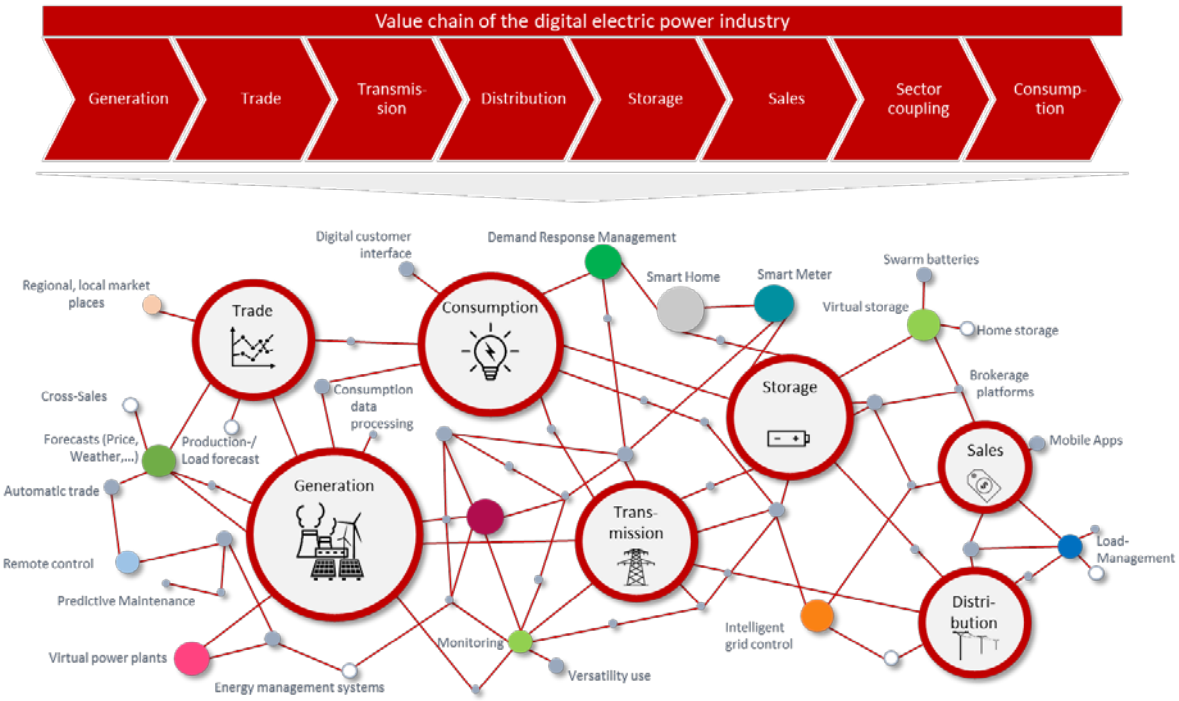
66. To start with, in addition to the public-sector spending on research and development, the report should also address spending by the private sector, which is probably about ten times higher. After all, the Federal Government's Monitoring Report rightly points out that research, development and demonstration of innovative energy technologies is primarily a task for the private sector, and that public research funding serves not least to support the innovative activities of German firms.

67. Also, it is recommended that the existing set of indicators used for the research and development phase of innovations be extended to include the diffusive phase (cost cuts, market shares, shares of global trade, etc.), and that the figures be subject to appropriate interpretation. A further aspect could be "innovation biographies", i.e. sample analyses of technologies which are of particular relevance for the energy transition. On this basis, innovation patterns capable of generalisation could be derived which show which factors generally play a key role in success or failure, e.g. regarding the policy framework for the transfer of research findings to the market.

68. Many innovations are initiated by small and medium-sized enterprises (SMEs). For this reason, the Federal Government should pay greater attention to these companies in its innovation monitoring. However, it is likely to be difficult for SMEs to develop and implement innovations in technology-intensive and capital-intensive fields. This is particularly true of high-tech start-ups – the companies which will be tomorrow's leading researchers. For this reason, the Expert Commission welcomes the Federal Government's intentions to strengthen the start-up culture and to significantly facilitate access for start-ups to research funding, particularly in the field of energy research.

69. In addition to this, a large proportion of the business models of start-ups in the energy transition are data-driven. This is linked to a transformation from linear value chains to value networks (cf. Figure 8). After all, digitalisation and decentralisation trigger changes in the market structure which are increasingly resulting in parallel (and not purely linear) interactions between the market players and transactions involving tangible and intangible factors. In order to reflect these developments, the Expert Commission submits a proposal to develop the monitoring of start-ups on the energy market. This sort of monitoring with an extended methodology offers a starting point for the answering of new questions relating to market roles, network analyses and value creation processes.

Figure 8: From value chains to value networks



Source: In-house, based on Lau und Terzidis (2017)

70. The last comments from the Expert Commission already explained that only a detailed study can provide an insight into the innovative nature of these start-ups. This detailed study is now being made possible. The database described here lists energy start-ups, giving specific information about their products and technologies, and thus makes it possible to differentiate between innovative and diffusive start-ups, i.e. those which bring new technologies or products to the market and those which tend to disseminate existing technologies and services. Irrespective of whether the energy start-ups are “innovative” or “diffusive”, the term refers to new businesses whose products, technologies and services, either as their core business or as a significant sideline, make a contribution towards environmentally friendly generation, storage and distribution of energy, improving energy efficiency, or promoting sustainable mobility. The data analysis shows that innovative start-ups are primarily tending to drive progress in the fields of the smart home and of trading/forecasting. The main driving forces for the smart home are energy management systems, automation of buildings, and monitoring of consumption. The companies working on trading/forecasting are mainly trading platforms focused on electricity roadmaps, pooling of generators/consumers, and direct marketing of energy. In contrast, the categories of the smart grid and of monitoring/demand-side management are mainly covered by diffusive start-ups.