Executive Summary

Impact of governmental policy measures within the target architecture of the German energy transition

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Executive Summary

With the First Progress Report on the Energy Transition, the development of the Energy Transition in Germany with its corresponding goals and targets was structured into different sectors and categories. Furthermore, the targets were subdivided into a hierarchical structure of strategic and steering levels. The restructuring of targets is generally called the Target Architecture of the Energy Transition. In this study, the impact of policy measures within the Target Architecture and their interaction in the achievement of the energy- and climate-related targets is analysed. The achievement of the targets and an optimisation of the Energy Transition is analysed against this backdrop. In doing so, the key criteria cost efficiency and system integration are utilized to identify possible corridors and flexibilities in the determination of steering targets.

Impact of policy measures in the Target Architecture

The development of a comprehensive dataset containing data of individual impacts per policy measure is providing the main basis of the analysis. Impact data for policy measures are mainly based on data from currently available studies, which are collected and brought on a common basis. In cases where there was no data available, own calculations are included. Because the underlying studies show differences in the assessment of individual impacts per measure, values for possible variations of impacts are calculated and values which are most likely from a current perspective are estimated as well. In doing so, relevant uncertainties (e.g. concerning the time of the implementation of policy measures or different estimations on the effectiveness of policy measures) are included in the analysis. Thus, additional conclusions on the robustness in the achievement of the targets are possible, taking into consideration interactions between the targets. The calculations are continuously updated during the project to reflect most information based on impact assessments in the data. Furthermore, an enforcement of existing policy measure is taken into account for the time range up to 2020.

Based on this work, outcomes per policy measure are adjusted for overlaps. This enables the aggregation of individual impacts per measure in the sectors of the Target Architecture. The achievement of steering targets for one sector can have favourable or adverse effects for another sector. Therefore, interactions between the steering targets of the Target Architecture (e.g. between electricity consumption from RES and the target for reducing final energy consumption in the transport sector) are taken into account and are quantified in detail. Furthermore, the achievement of goals on the superior strategic level of the Target Architecture and an analysis of the effects of efficiency measures and measures to

promote the development of renewable energies in the electricity sector is conducted.

In a subsequent step, the aggregated impact of policy measures on the steering level, on the strategical level and concerning the policy goals are compared with the existing energy- and climate-related targets in Germany for the year 2020. An existing reference-scenario based on the „Contrafactual Scenario“ developed in the project “Makroökonomische Effekte der Energiewende” is serving as a basis for this analysis. The scenario is adjusted for the impact of policy measures until 2005 and 2008 respectively, to fit the requirements of this study. Moreover, the scenario is adjusted upwards based on current projections on the development of population and economic performance in the years up to 2020.

In the following, results on the achievement of targets in the year 2020 and corresponding uncertainties are described.

Steering targets

- Based on the calculations, the reduction of gross electricity consumption will reach minus 5,5 % in 2020 (compared to 2008). Taking into account uncertainties in the impacts of policy measures, possible values for the reduction range from minus 3,1 % to minus 7,9 %. Based on these results, the achievement of the corresponding steering target seems unlikely from a current perspective.

- The target for the share of renewable energies in gross electricity consumption will most probably be exceeded in 2020. Based on the calculations, the share will reach 41,8 % in 2020 (with an uncertainty range between 39,2 % and 44,0 %). Compared to those results, the Energiekonzept set a target for 2020 of at least 35 %.

- The reduction of final energy consumption for heating purposes will reach minus 12,5 % in 2020 (compared to 2008, with an uncertainty range between minus 11,5 % and minus 15,8 %). Based on these results, the achievement of the corresponding steering target of minus 20 % seems unlikely from a current perspective.

- The target for the share of renewable energies in heating will most probably be achieved in 2020. Based on the calculations, the share will reach 15,0 % in 2020 (with an uncertainty range between 14,5 % and 16,3 %). Compared to that, the Energiekonzept set a target for 2020 of 14 %.

- Based on the calculations, final energy consumption in transport will reach plus 4,6 % in 2020 (compared to 2005, with an uncertainty range between minus 0,6 % and plus 5,3 %). Based on these results, the achievement of the corresponding steering target of minus 10 % seems highly unlikely from a current perspective.

- The target for the share of renewable energies in the transport sector will most probably not be achieved in 2020. Based on the calculations, the share will reach 5,4 % in 2020 (with an uncertainty range between 5,4 % and 6,8 %). Compared to that, the EU-target for 2020 was set at 10 %.

Core objectives

- The superior core objective for the share of renewable energies in gross final energy consumption is within reach for the year 2020. The main reason for that are high shares of renewable energies in electricity generation and heating. Based on the calculations, the share will reach 18,4 % in 2020 (with an uncertainty range between 17,7 % and 20,0 %). Compared to that, the target is set at 18 %.

- The core objective for the reduction of primary energy consumption is unlikely to be reached in 2020. Based on the calculations, the reduction of final energy consumption for heat will reach minus 11,4 % in 2020 (compared to 2008, with an uncertainty range between minus 10,2 % and minus 13,6 %). Compared to that, the target for 2020 was set at minus 20 %

Policy goals

- Based on the results on the strategic level and on the steering level of the Target Architecture, the policy goal for the reduction of GHG-emissions will not be reached in 2020. Based on the calculations, the reduction of energy-related GHG-emissions will reach minus 28,5 % in 2020 (compared with 1990). Taking into consideration total GHG-emissions, the reduction will reach minus 31,3 % in 2020 (compared with 1990, with an uncertainty range between minus 30,3 % and minus 33,6 %). Compared to that, the target for 2020 was set at minus 40 %.

Conclusions on the achievement of targets for 2020

With regard to the impact of policy measures in the Target Architecture and its corresponding goals (mainly based on the Energiekonzept) for 2020, the following conclusions can be drawn:

- The development of a database energy- and climate-related measures, based on currently available studies and impact assessments, offers a comprehensive view on the impact of these measures. Own calculations and estimations on the impact of policy measures are only necessary in few cases.

- In the calculation of the aggregated impact of policy measures on the targets of the Energy Transition, overlaps between measures and sectors must be taken into consideration to avoid double counting. Furthermore, interactions between the sectors of the Target Architecture and other effects inside the sectors are of high importance and have to be considered in the calculation of the targets.

- Targets for the reduction of energy consumption are addressed by a large range of policy measures, which is mainly due to the diversity of stakeholders and various barriers to investment. Existing steering targets for the reduction of energy consumption are unlikely to be met in 2020. While the reduction of electricity consumption will only just fall short of the target, targets for the reduction of energy consumption for heating and in the transport sector will be missed by a large margin.

- Targets for the development of renewable energies are addressed by a small number of policy measures with relatively high impacts per measure. Steering targets for the share of renewables will mostly be met in 2020 and in some cases exceeded considerably. Compared to that, the EU-target for renewable shares in the transport sector is unlikely to be met in 2020. The core objective of total energy consumption covered by renewables within reach for the year 2020, which is mainly due to high shares of renewables in the electricity sector and in heating.

- Adverse effects on electricity markets (mainly because of low market prices in Germany and high net-exports) must be taken into consideration in the calculation of total effects of efficiency measures and measures for the promotion of renewables on the superior levels of the Target Architecture. These interdependencies make it considerably more difficult to reach the superior policy goals and core objectives in 2020.

- The superior policy goal to reduce GHG-emissions is unlikely to be achieved in 2020. Main reasons for this result are the failure to achieve energy reduction targets in all sectors, the failure to reach renewables targets in some sectors as well as adverse effects in the electricity markets, which are partly caused by weak superior measures in the electricity sector.

- Furthermore, uncertainties in the impact assessment of energy- and climate related measures are displayed in the results. Ranges of uncertainty comprise minima and maxima of impacts per measure and sector. However, conclusions concerning the likelihood of the achievement of sectoral targets are mainly stable with regard to the ranges of uncertainty derived in the analysis.

- Besides uncertainties concerning the impact of policy measures, further uncertainties regarding the achievement of energy- and climate-related targets exist for the year 2020. These include population and economic growth, the development of energy- and CO_2-prices, as well as uncertainties in the interactions in electricity markets in particular. These uncertainties are estimated to lead to a range from higher GHG-emissions of around 35 Mt to lower GHG-emissions of around 40 Mt in 2020 (compared to the general results of the study). Thus, even under the assumption of optimistic framework conditions concerning the achievement of climate targets, the achievement of the target to reduce GHG-emissions seems unlikely from a current perspective. On the contrary, in the case of high population growth and economic growth as well as low energy- and CO_2-prices the gap is estimated to increase considerably.

- Reinforcements of current policy measures are estimated to have only marginal impacts in the achievement of the targets, even if fast implementation and optimal design are considered. Main reasons for that are the lack of political realizability on the national level (e.g. policy measures on the EU-level) in the short run, delays in the realization of policy measures because of long investment cycles in the energy system and uncertainties in the exploitation of financial support measures.

Variations of the steering goals

For 2030, different combinations and prioritizations of sectoral steering goals are possible. In the context of a variation of the targets, different values of steering goals are defined for the year

2030. In doing so, a reference case (based on the Energiekonzept) and six further variations of steering targets are analysed.

Steering targets are varied within the sectors of electricity, heating/buildings and transport (intrasectoral) and between the sectors (intersectoral). Currently developed energy scenarios serve as a basis for this analysis. The different options for steering goals are set to strive for the overall reduction of GHG-emissions. Based on the key criteria cost efficiency and system integration as well as additional criteria comprising social acceptance, long term-orientation and technical restrictions, an assessment of options for the variation of steering goals is developed.

Based on the analysis, the following conclusions can be drawn:

- Achieving the superior energy- and climate-related goals in the year 2030 requires significant contributions from all sectors.

- Variations in the specification of quantitative targets exist between and within the sectors of the Target Architecture. However, different variations of targets lead to different challenges in the sectors.

- Focusing on energy-efficiency measures in the short- and mid-term will enhance the achievement of targets, especially with regard to system integration and cost efficiency criteria. Improvements in the efficiency of electricity demand reduce peak load in the power system as well as the volatility of electricity demand and therefore enhance system integration in the power system. Additional policy measures in the transport sector and in the industrial sector have the potential to result in efficiency improvements at relatively low costs. However, the realisation of efficiency improvements is hindered by inertia in investment cycles of buildings, machines and vehicles. Therefore, efficiency measures must be implemented in time to result in relevant energy savings in the short- and mid-term and adequate policy instruments must be implemented to reduce barriers to investment.

- The development of renewable energies can make significant contributions in the achievement of the energy- and climate-related targets for 2030, especially in the power sector. High shares of renewables in the power sector can be transferred for heating purposes and to the transport sector if sector integration (i.e. the electrification of heating and transport) is developed in parallel. System integration, especially due to the variability of renewable energy sources in power generation, is estimated to be the main challenge in this context. Therefore, flexibility of power

generation and power demand must be increased. Furthermore, challenges in the coordination with efficiency measures, the availability of infrastructure, and questions on the acceptance of such measures should be addressed in time. The development of renewable energies tends to lead to higher total costs in 2030. However, further technological improvements in renewable energies have the potential to reduce costs significantly.

- Sector integration in heating and transport (especially heat pumps, power-to-heat in district heating and electric vehicles) can contribute to the achievement of the targets for 2030. This is mainly due to high efficiencies of these applications and thus, the reduction of energy consumption as well as the transformation of high shares of renewables from the power sector to other sectors. Challenges may arise in the integration of additional power consumers until 2030 if these applications are utilised in an inflexible manner, which causes higher peak load and higher volatility of electricity demand in the power system. Therefore, policy measures to increase the flexibility of new applications of electricity are of significant importance. Furthermore, electrification of heating and transport may lead to higher total costs up to 2030 but are also hard to predict from a current perspective due to the possible effects of technological learning.

- Steering targets with a strong focus on specific sectors tend to have negative impacts based on the selected criteria. For example, focusing on the power sector until 2030 tends to have negative impacts on cost, social acceptance and long-term orientation and requires rapid and comprehensive modifications in the power sector (e.g. infrastructure and flexibility measures) to allow for large shares of renewable energies to be integrated in the short- and mid-term.

- It should be considered that, concerning evaluations based on the cost criteria, uncertainties in the development of future technological learning of specific technologies (e.g. renewables, sector integration, batteries) and future energy prices can have a relevant impact on the results. Furthermore, low total costs in the energy system do not have to indicate low costs from an individual perspective. This potentially hampers the implementation and impact of policy measures. Finally, additional second round effects in the economic system are not considered in this study.

- Challenges in the field of system integration tend to increase up to 2030 in any case. However, minor improvements of energy efficiency and high shares of renewable

energies at the same time tend to increase these challenges.

- Social acceptance of the Energy Transition and long-term orientation are challenges which are notoriously hard to quantify, but of significant importance for the transition until 2030. Technical restrictions tend to have a lower importance for the period until 2030 but increase in importance for the long-term development until 2050.

- The achievement of (national) targets to reduce GHG-emissions is significantly facilitated by the strengthening of superior policy instruments which do not focus on specific sectors. The impact of energy efficiency measures and of the development of renewable energies on GHG-emissions tends to be only partly realised otherwise, because conventional thermal generation can only be reduced to some extent.

As the results of this study show, the pathway for the achievement of energy- and climate related targets for 2030 will exhibit new challenges for the energy system. However, certain combinations of strategies and targets per sector (e.g. a strong focus on specific sectors and less ambitious targets for the reduction of energy demand) tend to increase challenges and must be seen critically from a current perspective. Remaining challenges need to be addressed with policy measures in time, to create an environment where energy- and climate-related targets will be met in a cost-efficient way, securing system integration and taking into account other challenges, e.g. social acceptance, long-term orientation and technical constraints. These challenges comprise, for example, the realisation of reductions in energy demand and increasing flexibility in electricity generation and electricity demand in time, policy instruments to develop renewable energies in a cost-efficient way, increasing acceptance for modifications in infrastructures and addressing individual barriers to investment.