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Press Release

What will the Energy Transformation Cost?

Pathways for Transforming the German Energy System by 2050

The transformation of the energy system in Germany is a declared political goal of the federal government. By 2050, greenhouse gas emissions are to be reduced by at least 80 percent under 1990 levels. This necessitates a massive reduction in energy-related CO_2 emissions, forcing a fundamental restructuring of the present energy system towards a largely carbon-free energy supply. The transformation requires major investments and will not happen of its own accord. Scientists at the Fraunhofer Institute for Solar Energy Systems ISE now presented a study which investigates the system and cost developments of the German energy system transformation in line with meeting the declared climate targets. The study covers the period starting from today up to 2050. The model-based study considers all relevant energy sectors and energy carriers to provide a detailed analysis on how Germany can achieve its climate goals through efficient energy use and renewable energy. Considering various scenarios, simulations show different, cost-optimized pathways for achieving the energy transformation.

"The scenarios differ with regard to the drive concepts used in the private and commercial mobility sector, the extent of energy retrofits in the building sector and the exact time at which coal is no longer used to generate electricity," explains the author Prof. Hans-Martin Henning, Deputy Director at Fraunhofer ISE and Professor of Technical Energy Systems at the Karlsruhe Institute of Technology (KIT). "We also consider different climate targets; for example, reducing carbon emissions 80%, 85% or 90% under 1990 levels," adds Andreas Palzer, coauthor of the study.

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Energy Mix

In all of the future scenarios, fluctuating renewable energy sources, above all photovoltaics and wind, will play a dominant role in electricity generation. The required amount of installed renewable capacity varies from 290 GW (for 80 percent reduction of CO_2 emissions) to nearly 540 GW (for 90 percent reduction) depending on the scenario. In the future energy system, photovoltaic and wind plants are supplemented by other types of electric power plants. Solar thermal systems are installed for supplying heat directly and an infrastructure is set up for providing a mix of fossil, biogenic and synthetically manufactured energy carriers in both liquid and gaseous forms. Especially in the heat sector, massive changes are to be expected in the types of technology used on the end-use side.

The new composition of energy generators requires a large amount of flexibility both in electricity generation and consumption. Beyond the established fields of application, new uses for electricity must arise in the building and mobility sectors. The increased use of electricity in these two areas implies that combustion technologies like boilers and combustion engines are to be increasingly replaced with electric powered heat pumps and motors. These units convert the final energy (electricity) more efficiently into heat or traction than the fossil fuel based combustion processes used today.

All of the scenarios foresee a rise in electricity generation and consumption and also the growing necessity to substitute fossil fuels, like gas and oil, with renewable fuels. To realize this, large area installations are required for systems which produce synthetic energy carriers from renewable electricity. Such systems would manufacture hydrogen, methane or liquid fuel using electricity generated from wind and

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photovoltaics. The installed capacity required is strongly dependent on the targeted value of energy-related carbon emissions.

The electrification of the heat supply is a prominent feature of the future energy system. In almost all of the investigated scenarios, electric heat pumps are the main technology used to supply heat for single buildings. In all of the scenarios, solar thermal systems are to cover part of the low temperature heat demand in buildings and in industry. An accelerated withdrawal from coal-generated electricity by 2040 shows a strong positive effect on successfully achieving the emission reduction targets.

Costs of the Transformation

The costs of the energy system transformation were analyzed for different scenarios with respect to the price development of fossil energy sources and the penalties on CO_2 emissions. "Assuming that the price of fossil fuels remains constant up to 2050 and the penalties on carbon emissions remain low, simulations show that the extra costs for transforming the energy system based on the least expensive scenario are about 1100 billion euros from today up to 2050. This is about 25 percent more costly than continuing to use the present energy system without changes up to 2050," explains Hans-Martin Henning. "If, however, one assumes that the prices of fossil fuels rise annually by 3%, then the cumulative total costs for carrying out the transformation and achieving the targeted 85 % reductions in energy-related CO_2 emissions are practically identical to the costs incurred by using today's energy system unchanged up to 2050."

The newest calculations confirm the first results from the "Energy Model for Germany 2050"published in 2013 by Fraunhofer ISE: After successfully completing the energy transformation in which carbon emissions have been

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reduced by 80 to 85 percent, the total annual costs for the new system are no greater than the costs needed to run Germany's energy system today, that is, 250 billion euro distributed over all end customers.

This analysis was carried out primarily by using the simulation and optimization model REMod-D (Regenerative Energy Model – Germany) developed at Fraunhofer ISE. In this model, simulations are performed on an hourly basis not only to determine the environmental compatibility and cost-effectiveness of the various scenarios but also to ensure the security of supply in all sectors hour-by-hour throughout the year.

Text of the PR and photos can be downloaded from our webpage: www.ise.fraunhofer.de

A short summary of the study is available in the English language and can be downloaded from:
www.ise.fraunhofer.de/what-will-the-energy-transformation-cost
(Full translation will be available mid January 2016)

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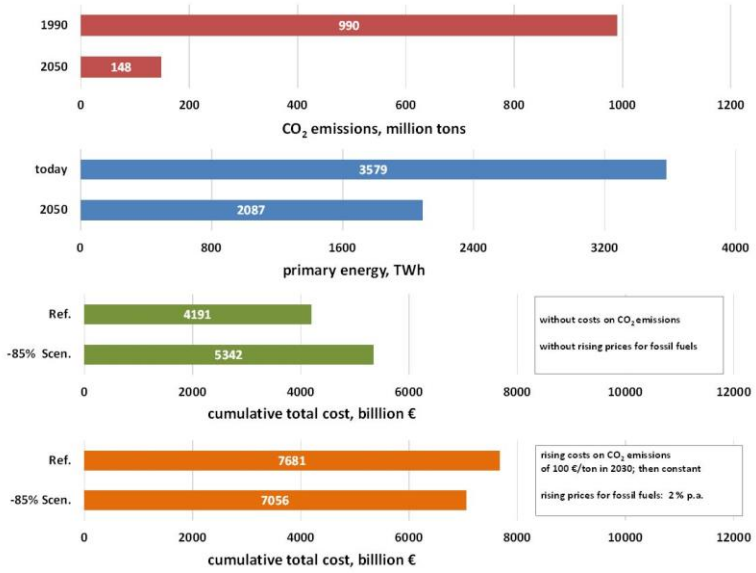

The figure summarizes the results of the analysis. i) A future energy scenario that emits 85 % less carbon emissions than 1990 levels is compared with a reference scenario, which assumes that the energy system in Germany today remains unchanged up to 2050. ii) Results show that the primary energy in the minus 85-percent scenario will drop 42 % below today's values by 2050. iii) Assuming that no penalty is imposed on CO_2 emissions and the price of fossil energy remains constant, calculations show that the cumulative total costs of the 85-%-scenario will be 27 % higher than the corresponding value of continuous use of today's system without any changes until 2050 iv) On the other hand, if the penalty for CO_2 emissions increases to €100/ton by 2030 and thereafter remains constant and given that fossil fuel prices increase annually by 2 percent, then the total cumulative costs of today's energy system (Reference) are 8 % higher than for carrying out the minus 85-percent scenario up to 2050. ©Fraunhofer ISE

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