

Cross-Sectoral Energy Demand Prediction for Germany with a 100% Renewable Energy Production in 2050

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Abstract : The structure of the world's energy systems has changed significantly over the past years. One of the most important challenges in the 21st century in Germany (and also worldwide) is the energy transition. This transition aims to comply with the recent international climate agreements from the United Nations Climate Change Conference (COP21) to ensure sustainable energy supply with minimal use of fossil fuels. Germany aims for complete decarbonization of the energy sector by 2050 according to the federal climate protection plan. One of the stipulations of the Renewable Energy Sources Act 2017 for the expansion of energy production from renewable sources in Germany is that they cover at least 80% of the electricity requirement in 2050; The Gross end energy consumption is targeted for at least 60%. This means that by 2050, the energy supply system would have to be almost completely converted to renewable energy. An essential basis for the development of such a sustainable energy supply from 100% renewable energies is to predict the energy requirement by 2050. This study presents two scenarios for the final energy demand in Germany in 2050. In the first scenario, the targets for energy efficiency increase and demand reduction are set very ambitiously. To build a comparison basis, the second scenario provides results with less ambitious assumptions. For this purpose, first, the relevant framework conditions (following CUTEK 2016) were examined, such as the predicted population development and economic growth, which were in the past a significant driver for the increase in energy demand. Also, the potential for energy demand reduction and efficiency increase (on the demand side) was investigated. In particular, current and future technological developments in energy consumption sectors and possible options for energy substitution (namely the electrification rate in the transport sector and the building renovation rate) were included. Here, in addition to the traditional electricity sector, the areas of heat, and fuel-based consumptions in different sectors such as households, commercial, industrial and transport are taken into account, supporting the idea that for a 100% supply from renewable energies, the areas currently based on (fossil) fuels must be almost completely be electricity-based by 2050. The results show that in the very ambitious scenario a final energy demand of 1,362 TWh/a is required, which is composed of 818 TWh/a electricity, 229 TWh/a ambient heat for electric heat pumps and approx. 315 TWh/a non-electric energy (raw materials for non-electrifiable processes). In the less ambitious scenario, in which the targets are not fully achieved by 2050, the final energy demand will need a higher electricity part of almost 1,138 TWh/a (from the total: 1,682 TWh/a). It has also been estimated that 50% of the electricity revenue must be saved to compensate for fluctuations in the daily and annual flows. Due to conversion and storage losses (about 50%), this would mean that the electricity requirement for the very ambitious scenario would increase to 1,227 TWh / a.

Keywords : energy demand, energy transition, German Energiewende, 100% renewable energy production

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