Integrated Energy Transition

dena German Energy Agency

dena Study Integrated Energy Transition

Executive Summary

The dena study combines energy industry analyses with a comprehensive discourse

The dena Study Integrated Energy Transition develops and compares transformation paths for the energy system in Germany to achieve the climate policy targets of the German government by 2050. It outlines paths using an innovative, cross-sectoral scenario approach. At the same time, it builds on the deep industry knowledge of more than 60 study partners from all relevant sectors as well as on the continuous exchange with key players from politics, society and science. The aim is to review and supplement energy industry analyses with assessments of implementation challenges and social issues.

With increased efforts in all sectors, the Paris targets can be achieved

Generally speaking, it is possible to reduce greenhouse gas emissions by 80 per cent as well as by 95 per cent by 2050. However, this requires significantly more far-reaching measures in all sectors than previously planned with a high degree of commitment from all participants, an appropriate political framework, as well as a public discussion on the distribution of the costs of the energy transition. It's not enough to simply keep doing what we are doing. Even rigorously pursuing current developments, such as expanding renewable energy, would only reduce greenhouse gas emissions by 62 per cent by the year 2050. Since the possible transformation paths and associated reduction of greenhouse gases in the sectors already clearly differ in 2030 and the upper edge of the corridor requires very far-reaching strategies, a decision on the climate protection targets sought must be made in this legislative period. This is the only way to foster the development and widespread market introduction of the necessary new technologies in the individual sectors in a timely manner.

A broad mix of energy sources enables more cost-effective and robust transformation paths

The transformation paths explored in the dena study assuming a broad mix of technologies and energy sources are under the assumptions made more cost-effective by up to €600 billion until 2050 than those that focus more heavily on electricitybased applications. The use of existing energy infrastructures in their diversity allows these transformation paths more flexible approaches to solutions paths, such as capitalising on technological developments by 2050 that cannot yet be foreseen.

The expansion and integration of renewable energies must be accelerated

Until 2050, an expansion of renewable power generation capacities averaging up to 8.5 gigawatts annually (GW/a) is required. In order to make this possible, the existing expansion corridor must be enlarged and availability of the necessary land areas has to be ensured by the federal states. The further development of the market design and grid regulation is the basis for optimally integrating renewable energys into the system on a regional and national level.

Synthetic renewable energy carriers complement energy efficiency and the expansion of renewable power generation

The reduction of final energy consumption through comprehensive energy efficiency efforts in all sectors (efficiency gains in industry alone 26 to 33 per cent until 2050) as well as the expansion of renewable energy are two key facts to achieve the climate targets. The third decisive factor is the use of synthetic renewable energy carriers, most of which are imported into Germany. In 2050, these energy carriers will cover between 150 and 900 TWh/a in all areas of application where cutting emissions by

using renewable electricity directly is either impossible or very difficult. At the same time, these 'Green Power Fuels' close gaps that could arise in the future due to implementation obstacles (such as acceptance for new wind turbines).

A reliable planning horizon turns the necessary structural change into an opportunity to modernise

In addition to the much-discussed changes in the coal industry, the structural change associated with the transformation will also affect many other sectors and industries in the future. For example, ambitious climate targets might fundamentally change the highly integrated value-added network of the basic chemical material industry. In the automotive industry, the change in propulsion technologies will not only affect the major vehicle manufacturers, but also a large number of small and medium-sized suppliers.

It therefore requires a political framework that provides longterm reliable incentives for reducing carbon emissions and enables a marketbased innovative optimisation across sector boundaries that is open to a range of technologies. The necessary policy decisions on energy infrastructures must be made in good time, to, for example, further develop the gas infrastructure or to build an infrastructure for hybrid trolley trucks.

Building stock and energy sector require the highest investments

A successful energy transition will require continued high investments by all building owners over the next three decades when it comes to refurbishing their building stock, along with increasing the refurbishment rate from 1.0 to at least 1.4 per cent.Stimulating and consolidating this investment dynamics requires a carefully selected mix of incentive-focussed instruments, which emphasise stimulus over compulsory regulations, must be constantly reviewed and, if necessary, adapted.

Extensive balancing effects within Germany and the European integrated grid will be required for an efficient electricity system with very high proportions of renewable energy sources. In order to achieve this, investments must be made in the transmission and distribution grids beyond the existing network development plan by 2030. In addition to the continuous expansion of renewable power generation, new investments in gas-fired power plants are needed in alignment with neighbouring European countries. They ensure security of supply when the guaranteed capacity from nuclear power plants is no longer available and the guaranteed capacity from coal-fired power plants is only available to a limited extent.

The energy transition in transport is based on several pillars

The electrification of propulsion technologies is a major driver of the energy transition in the transport sector – but it is not alone. A major factor is the reduction of the specific energy consumption of transport in order to reduce total energy consumption and significantly increase the proportion of renewable energy in the transport sector. Electricity as well as gaseous and liquid fuels must be 100 per cent based on renewable energy sources in the future. At the same time, new mobility strategies are needed to curb the further increase in traffic and, at best, reduce traffic altogether. Overall, the transport, energy and IT infrastructures must be planned in a much more integrated manner across the sectors and the fee and taxation systems must be aligned with the energy transition targets.

A successful energy transition is embedded in international developments

A sustainable energy system in Germany requires balancing possibilities of a further-developed common European electricity market, an international trade for synthetic renewable energy carriers (Power Fuels) and a further decrease in cost of key energy transition technologies due to global demand.

The energy transition can only succeed if it is also a success in terms of industrial and economic policy. On the one hand, this requires instruments to protect German industry from competitive disadvantages due to German climate protection requirements (carbon leakage protection), which are higher than in other countries, and international agreements for global trade. On the other hand, the growing global demand for energy transition technologies also offers export opportunities for the German companies.

Leeway to make decisions and participation promote social acceptance

The next phase of the energy transition will affect citizens more than today – through distribution issues of energy transition costs as well as structural changes and how they affect each person's own working and living environment. They are challenged to muster the necessary private investments as well as to accept and accelerate the changes with energy applications, such as in the field of mobility. Politicians now face the task of continuously tracking and highlighting the opportunities of the large-scale energy transition project. Citizens themselves need sufficient leeway to take action as well as participate and design options for their investment decisions.

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