STUDY
Energieperspektiven 2030 – Welche Maßnahmen zur Transformation des deutschen Energiesystems müssen bis 2030 umgesetzt werden, was muss bis 2030 vorbereitet sein?
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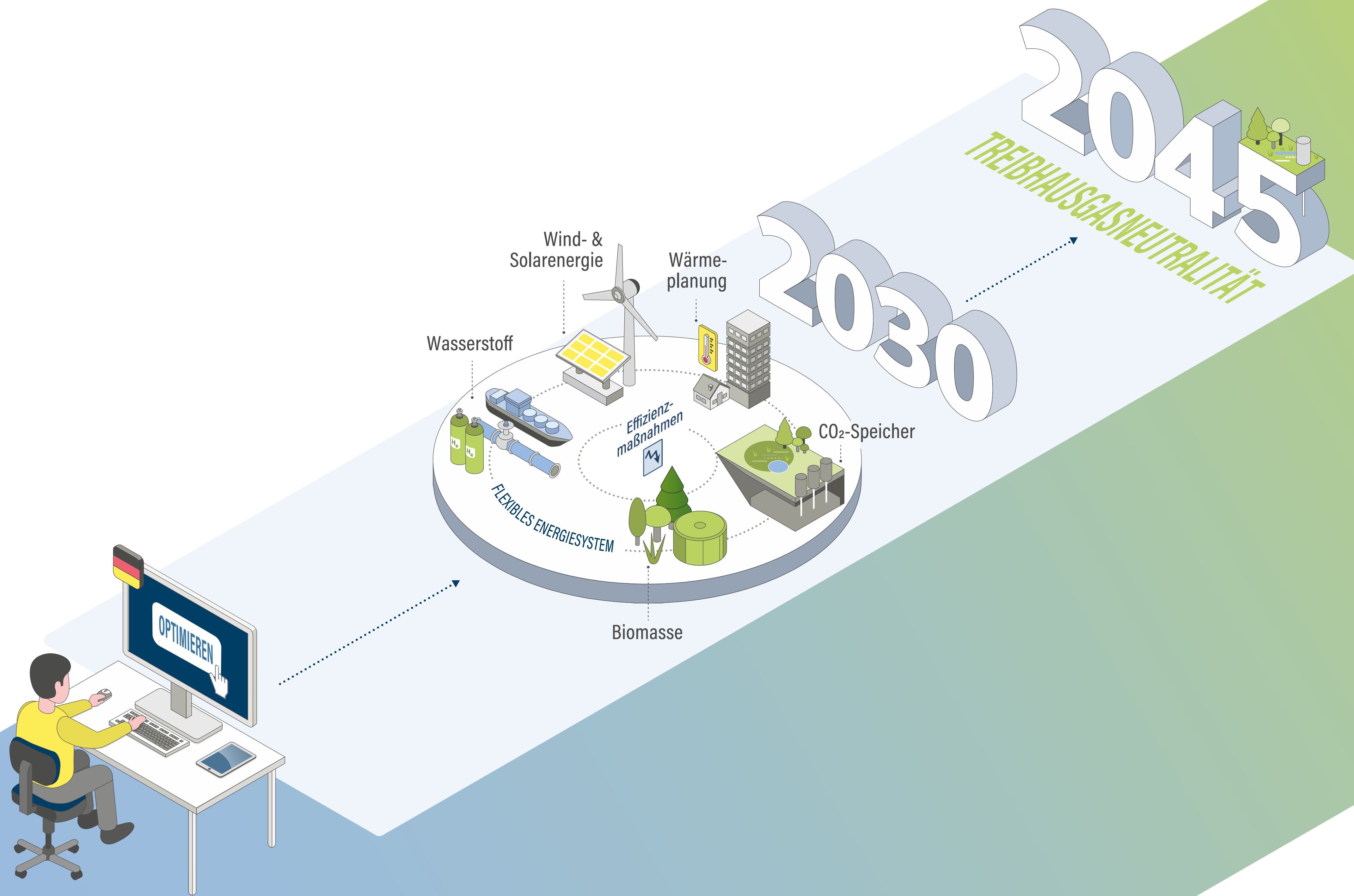
ENERGYPERSPECTIVES 2030

What measures must be implemented before 2030 for the transformation of the German energy system and what preparations are necessary?



INSTITUTE OF TECHNO-ECONOMIC SYSTEMS ANALYSIS (IEK-3)

ENERGYPERSPECTIVES 2030

This study looks at where things stand and what measures must be taken by 2030 to keep Germany on track for becoming climate neutral by 2045.

Systems analysts from Forschungszentrum Jülich developed their own computer models for the study. These enable a scientifically founded analysis of cost-effective strategies and measures aiming to achieve greenhouse gas reduction targets. Using the models, the German energy supply with its generation pathways and all of its interactions can be analysed in hourly resolution. The computer models provide information on the energy system as a whole with integrated energy sector coupling. This includes relevant energy carriers (electricity, natural gas, hydrogen, and heat) as well as the generation technologies and the demand for them. This allows all factors to be balanced and the cost optimum for the energy system to be determined.

The study focuses on the year 2030 on the road towards net zero in 2045. This contrasts with the two previous analyses conducted by the institute, which took 2045 or 2050 as the target. What must be done by 2030 to achieve climate neutrality by 2045? What strategies will work and where are additional measures necessary? What general conditions may need to be changed?

Our analyses show

1. that it is **still possible to become climate neutral** by 2045 – from both a technical and an economic perspective.
2. that **important measures must be implemented and decisions made by 2030** if net zero is to become reality in 2045.
3. that **biomass** will become an important **substitute for fossil energy carriers** by 2030 and that it will take on an additional, decisive role from 2040 onwards in terms of producing **negative emissions**.

[1] Cost-efficient and climate-friendly transformation strategies for the German energy system until the year 2050 (2019)
Strategies for a greenhouse gas-neutral energy supply by the year 2045 (2021)

Road map for net zero

If the targets of the German Federal Climate Change Act (KSG) are to be achieved, comprehensive measures need to be in place by 2030 in all sectors. In addition, it is essential that the groundwork be laid before 2030 for subsequent steps so that the goal of becoming climate neutral by 2045 can actually be achieved.

Implementation of energy-efficiency measures

Increasing energy efficiency in all sectors is a cornerstone of a net-zero energy supply. Compared to 2008 levels, around 15 % of the final energy demand can be reduced cost-efficiently by 2030. This figure will rise to 25 % by 2045. The increasing electrification in all sectors will see an increase in energy efficiency. Despite this, electricity consumption will increase by 2030 by 25 % to 640 TWh and by 2045 by 150 % to 1275 TWh, compared to levels in 2019 before the coronavirus pandemic.

The aim of the recently enacted German Energy Efficiency Act (EnEfG) is to decrease final energy demand by 2045 by 45 % compared to levels in 2008. Taking continued economic and population growth as a given, this will only be possible if additional cost-driving measures are implemented compared to the cost-optimization scenario. In the model, the energy efficiency target can be achieved through a range of cost-optimization measures given a negative annual growth of 1 %. It is more important to focus on providing renewable energy than on an absolute limit for final energy demand.

Flexibility of the energy system

The phasing out of coal and nuclear power plants means that alternative, flexible power plants must be constructed to provide electricity during periods when little renewable energy can be fed in. By 2030, this will primarily involve the construction of hydrogen-fuelled gas-fired power plants with an output of around 6 GW. Long-term storage capacities are just as important. Storage is important to compensate for seasonal fluctuations in solar and wind energy and during cold "dunkelflauten" This function will be fulfilled predominantly by hydrogen storage. At least some of the existing, geological, natural gas reservoirs need to be prepared before 2030 for the storage of hydrogen. In addition, from a macroeconomic perspective, the flexible operation of technologies for sector coupling (e.g. electrolyzers and heat pumps) will be important in future. These technologies will be decisive for the appropriate use of the erratic supply of power from renewable energy.

Wind and solar energy

The replacement of fossil energy carriers will lead to an increasing electrification of the German energy supply in all sectors. This in turn will cause a 25 % increase in electricity consumption to 640 TWh by 2030. Converting the German power supply to CO2-free, renewable power production is therefore one of the basic key requirements associated with achieving net zero. The scale of the required expansion coupled with the remaining short time we have to react means that photovoltaics and wind energy capacities must be increased to 700 GW.

In terms of minimizing costs, the model calculates high annual expansion rates until 2030 of at least 8 GW for onshore wind power and 17 GW for photovoltaics. The installation of offshore wind power plants will also be hugely important because they offer almost twice the full-load hours of onshore wind power plants. The installation of new offshore wind power plants is necessary to increase capacity by at least 3 GW every year until 2045.

This represents a two- to fourfold increase compared to today's annual expansion rates of around 2 GW for wind power and around 8 GW for photovoltaics.

Heat planning

Heat pumps represent the most cost-efficient heating technology, and by 2030, they will cover around 21 % of space heating demand. In the model, this share will rise to more than 80 % by 2045. To operate heat pumps as efficiently as possible, heat storage in buildings and heat networks must be massively expanded.

Just as important for Germany's transition to renewable heating is the expansive refurbishment of existing buildings with an average refurbishment rate of 1.8 % per year. From a techno-economic perspective, buildings should be refurbished before heat generators, such as gas and oil boilers, are replaced with heat pumps. This should be taken into account in the incentives. If building envelopes cannot be refurbished, the efficiency of heat pumps can be increased by replacing the radiators, turning heat pumps into cost-effective heating technologies in such instances too.

Hydrogen

Important decisions will have to be made before 2030 to cover the demand for hydrogen of 80 TWh (equating to 2.4 million tonnes). This demand will increase rapidly from 2035 onwards and reach 480 TWh in 2045. Under the constraint of cost optimization, the model requires a ramping up of domestic electrolysis capacity to 6 GW in 2030. This would cover 30 % of the German hydrogen demand, leaving 70 % to be imported. The necessary import pathways and capacities have yet to be established. Temporarily, blue hydrogen and hydrogen in the form of ammonia could be imported as suitable options to cover the German hydrogen demand. To achieve a climate-neutral energy system in 2045, importing green hydrogen via pipelines from neighbouring European countries and North Africa is a cheaper option. Dependencies on long-term, suboptimal import pathways must therefore be avoided.

In addition, the framework conditions for the construction of hydrogen-powered gas turbines must be created right now, because in 2045, up to 90 GW of installed turbine capacity will be required to ensure a secure power supply during low feed-in periods.

Biomass

By 2030, close to 14 % of primary energy use will be covered by biomass, making it an important pillar of the future energy supply. This figure will rise to 20 % by 2045. To ensure that sufficient biomass is available, the as yet untapped potential of biogenic waste and residual materials must be harnessed, and the areas of land currently used for the cultivation of energy crops must be expanded before 2030. By beginning now, sufficient areas would be available for the cultivation of energy crops without competing with the food chain. Biomass will play a particularly important role in process heat generation during the industry transformation from 2030 onwards. Close to 20 % of the industrial energy demand will be covered by biomass.

CO2 storage

Climate neutrality will be impossible without CO2 capture and the permanent storage of CO2. This is due to unavoidable emissions from material production (e.g. cement production) as well as to emissions that are difficult to avoid or can only be avoided at high cost. In 2045, 71 million tonnes of CO2 in the form of residual emissions will have to be compensated for under the constraint of cost optimization by an equal amount of negative emissions. Suitable geological reservoirs must be identified before 2030 for the storage of captured CO2 and the legal framework must be established for the permanent storage of CO2. To ensure that these negative emissions are available in 2045, 58 million tonnes of CO2 will have to be captured from biomass power plants and 39 million tonnes CO2 will have to be removed directly from the atmosphere. At the moment, there are no incentives in place for this.