H2 VOR ORT

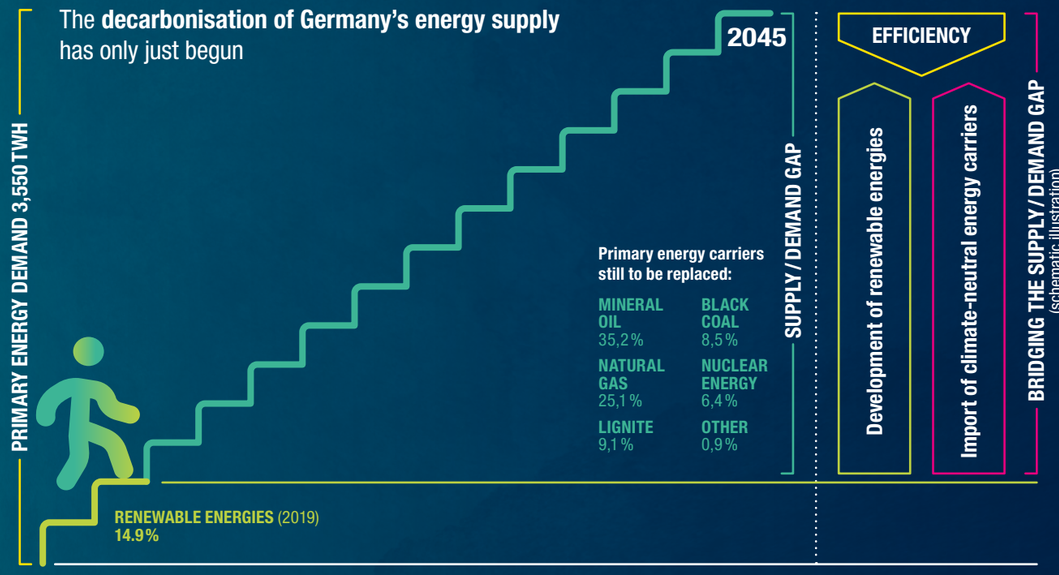
Molecules & Electrons: Transitioning to a Safe, Net Zero Energy System by 2045

The target is clear: Germany intends to hit net zero by 2045. 85 % of our energy still needs to be decarbonised – net zero gases are an indispensable part of achieving this goal. But precisely how much energy is required to get there, and how will it be supplied? This publication of H2vorOrt answers these and other questions.

3,000 terawatt-hours still need to become climate-neutral

When talking about energy consumption, a distinction is usually made between primary and final energy consumption. Both terms relate to the demand for energy, but they refer to different points in time regarding its consumption. Primary energy is the available, useable energy content of a naturally occurring energy carrier, while the final energy content is the amount of energy that is ultimately available for use. According to this logic, primary energy carriers are energy carriers that have not yet been converted like, for instance, crude oil and natural gas, but also solar, wind and hydropower. In other words, the term “primary energy” describes the inherent natural power of these energy sources. However, this energy must be converted by e. g. turbines, photovoltaic cells, or condensing boilers before it can be used, and it is frequently transmitted over long distances after the conversion process. All these steps require energy in their turn, which is why a certain amount of the primary energy content is lost during the energy conversion and transmission phases. The final energy content is the energy content minus the conversion and transmission losses; it is the part of the primary energy content that is ultimately available to consumers. The energy consumption for Germany clearly illustrates the importance of distinguishing between primary and final energy content.

Making hydrogen usable for everyone via the gas distribution networks

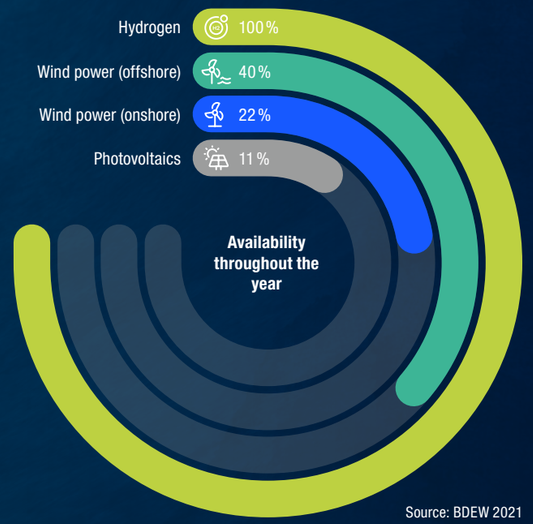


Source: AG Energiebilanzen e.V. 2021

In 2020, 3,550 TWh of primary energy consumption were required to meet Germany’s demand of approximately 2,500 TWh of final energy consumption. This is about 27 times the amount of energy generated by all wind power plants in Germany in one year. Last year, 15 % or 500 TWh of the primary energy demand was met by energy produced from renewable sources, i.e. in a net zero way. However, 100 % of the energy must be generated without producing CO_2 emissions if Germany is to achieve its net zero target by 2045. In other words, 85 % or about 3,000 TWh of the primary energy still need to be replaced by energy from climate neutral sources or, if and where possible, saved by efficiency gains. This is equivalent to the amount of energy consumed by Spain, Portugal, and the Netherlands together in 2019.[1]

Germany already produces almost 50 % of its electricity from renewable sources. How does this square with the fact that 85 % of the energy still needs to be generated without producing emissions? The answer is that electricity, or energy in the form of electrons, accounts for about 500 TWh or only 20 % of Germany’s total energy consumption, whereas the remaining 80 % of the demand is met by molecules in the form of energy carriers like oil, gas, or biomass. Especially the German heating sector, which in 2019 accounted for over 50 % or 1,330 TWh of the final energy consumption, receives most of its energy supply in the form of molecules. Net zero gases like hydrogen are a natural option to swiftly advance the ongoing decarbonisation of the molecules that are used in Germany. The gas infrastructure can carry gas composed of up to 100 % of these molecules and can thus help to drastically reduce CO_2 emissions in the short term.

The supply of energy must be secure and reliable around the clock, independent of the weather: **Hydrogen can be used flexibly at all times.**



Source: BDEW 2021

[1] https://www.statista.com/statistics/332520/primary-energy-consumption-in-selected-countries-in-europe

Electrons and molecules together ensure a secure and reliable supply…

One of the key challenges at both the national and the global level is the constantly increasing demand for energy in spite of efficiency improvements. At the same time greenhouse gas emissions must be cut and the secure and reliable supply of energy must be ensured. In Germany, this challenge is further compounded by the fact that the guaranteed power generation capacity is declining in the wake of the phase-out of nuclear energy and coal, and by the highly volatile weather-dependent generation of power from most renewable sources.

Net zero gases like hydrogen or biomethane can solve this key issue of the energy transition process because – in contrast to electricity – they can be stored over long periods of time and carried over long distances without major losses. In other words, the continuity of supply does not depend on the time and place of production. In Germany, energy consumption is particularly high in the winter, when houses need to be heated and streets and buildings must be illuminated for many hours, with the monthly gas consumption increasing threefold in comparison to the summer months. During these times, the German gas networks can be used to reliably supply Germany with energy in the form of net zero gases.

…and lower CO_2 emissions

What is more, a combination of molecules and electrons helps to cut CO_2 emissions that cannot be avoided by an energy supply based solely on electrons. This is because the effort and cost involved in electrifying end consumer appliances may entail further delays in decarbonisation.

For instance, net zero gases can markedly accelerate the CO_2 reduction process in the building sector by decoupling the achievement of climate goals from the renovation rate of the existing building stock. Except for new buildings, the installation of an electrical heat pump almost always requires a costly renovation of a building's energy supply installations. In Germany, however, the annual renovation rate of existing building stock is as low as 1.1, and even if it were to increase twofold to an ambitious 2 percent, it would still take 50 years to fully decarbonise the heat market. However, only 24 years remain until the deadline of 2045 is reached.

Net zero gases for a resilient and economically efficient energy system

Looking at the energy system as a whole, it becomes clear that the parallel use of electricity and net zero gases makes the entire system more resilient. The use of two independent networks for the provision of energy helps avert the risk of being dependent on a single energy carrier and, what is more, reliably ensures continued supply should one energy carrier be compromised.

An unbeatable team: **Net zero electrons and molecules**

Combining net zero electrons and molecules is preferable to relying on a purely electrical energy system also from a consumers' perspective. The physical properties of electricity make it impossible to transmit power without energy losses, so that while it is technically possible to carry electricity over long distances, it does not make much sense from the point of view of energy and economic efficiency. The existing gas infrastructure can be used for the transmission of net zero gases – an economically efficient solution that also helps save a lot of time. The provision of energy in the form of electrons and molecules thus also contributes to optimizing the ongoing development of the network infrastructure.

Germany currently imports about 75 percent of its primary energy. The import rate will continue to be high in the future as well, since the production of renewables is considerably cheaper in other countries. The power-and-gas market is already a well-functioning common European market that reliably ensures Germany's energy supply and will continue to do so in a net zero future. At the same time, there is enormous global potential for producing net zero gases that can be offered worldwide because they are easy to transmit. This does not only pave the way for the further diversification of the supply of energy imports to Germany and Europe but also creates global competition with a positive impact on pricing.

One example is the energy partnership agreement between Germany and Ukraine that intends to tap the potential for importing green hydrogen in the short term. Portugal, too, is considered one of the most promising states when it comes to exporting large quantities of green hydrogen – it boasts one of the lowest production costs of green power, and the Portuguese government vigorously pushes the development of electrolysis plants. The country plans to produce and export green hydrogen on an industrial scale as early as in 2022.

A recent market survey among long-distance gas network operators that was undertaken in preparation of the 2022/23 network development plan showed that German businesses reckon with a domestic electrolysis capacity of more than 21 gigawatts. This is equivalent to an annual injection quantity of 196 TWh of hydrogen, which would suffice to meet the annual energy demand of the federal states Rhineland-Palatinate and Schleswig-Holstein[2]. Germany currently discusses numerous instruments such as, for instance, the definition of a green gas target, the establishment of a blending ratio for green gases, a swifter increase of the price for CO_2 and the introduction of a European levy on the CO_2 content of imports, with the intention to ensure a quick realization of these hydrogen production capacities and boost the German hydrogen market. At any rate, however, additional large quantities of electric power from renewable sources will be required; consequently, it is important to define distinctly more ambitious development targets for renewables for 2030 and beyond and make key decisions that help to implement the hydrogen strategy.

Why do we need hydrogen to meet the climate protection targets and maintain a safe and reliable supply of energy at the same time?

- Germany requires large quantities of CO_2-neutral energy.
- This energy must be available at all times.
- The existing infrastructure can be used for supplying buildings with hydrogen without costly and time-consuming renovation, and thus contributes to lowering emissions.
- The use of two independent networks for the provision of electric power and gas makes the energy system more resilient and prevents unilateral dependence on imports.

About H2vorOrt

The "H2vorOrt" initiative is a collaboration of 37 distribution grid operators of the Deutscher Verein des Gas- und Wasserfaches (DVGW) working with the Verband kommunaler Unternehmen (German Association of Local Public Utilities, VKU), whose joint objective is to turn more than 500,000 km of gas distribution infrastructure into a net zero system. The project partners have joined forces to investigate the issue of how to implement a regional, reliable supply of net zero gases across the Federal Republic of Germany in concrete terms. Hydrogen in particular can play a crucial role in achieving all climate goals without compromising economic efficiency.

[2] https://www.lak-energiebilanzen.de/eingabe-dynamisch/?a=e400