Federal Ministry
for Economic Affairs
and Climate Action

IN FOCUS

# SECTOR COUPLING: ELECTRICITY FOR HEAT & TRANSPORT

**We need to improve energy efficiency and use more renewable energies in our efforts to decarbonise the heating and transport sectors. Sector coupling is progressing due to the increased use of renewable electricity in these sectors.**

**Sector coupling** (Source: TjasArt)

While the share of gross electricity consumption covered by renewable energies had already reached 46.2% in 2022, massive efforts are still required in the heating and transport sectors if our climate targets are to come within reach. In the heating and transport sectors, the share of renewables is only 17.4% and 6.8% respectively, and the rates of increase have been very slow. In order to accelerate the energy transition, in addition to improved energy efficiency and the direct use of renewable energies, we also need successful sector coupling, for example a much greater share of electric mobility in transport and electrically operated heat pumps for heating.

### Sector coupling contributes to energy transition goals

Certain sectors can only be efficiently decarbonised through the use of renewables, which will make a significant contribution to achieving our energy transition goals. The German Federal Government has therefore made a clear commitment to sector coupling. The use of renewable electricity needs to become economically viable for sector coupling; to achieve this, we must strengthen and expand our electricity grids. This commitment is also in line with the goal of EU countries to make sector coupling a key priority of their energy policy.

If the electricity required for sector coupling is to be used as efficiently as possible, its use should be as direct as possible. The combination of renewable energies and the electrification of sectors is increasingly reducing the use of fossil fuels, thereby contributing to decarbonisation and increasing efficiency across the economy. Heat pumps and district heating, which for example can deliver heat from large heat pumps through pipes into houses, will play an important role in the energy transition of the heating sector. In road transport, battery-electric vehicles in particular will replace fossil fuels. In the future, the operation of heat pumps or the charging of electric cars should largely

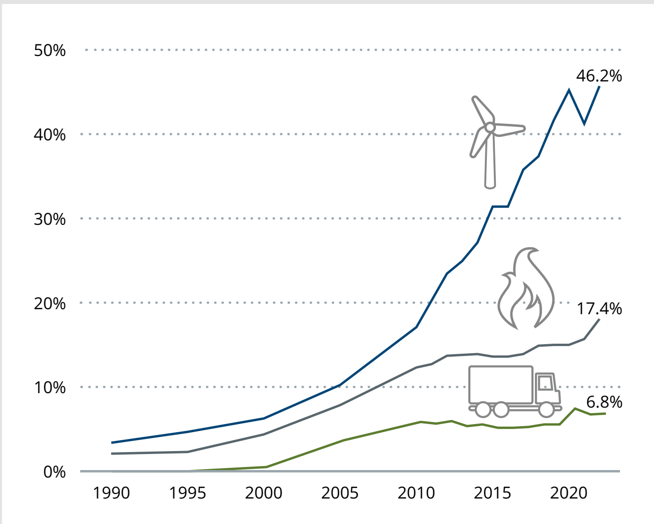



**Figure 1: Share of renewable energy in the electricity, heat and transport sectors** (Source: Based on data of the Renewable Energy Statistics Working Group from the Federal Environment Agency)

depend on the availability of renewable electricity. This will help to balance demand and supply at all times and to integrate high proportions of weather-dependent renewable energies into the system.

### Rapid market ramp-up for green hydrogen

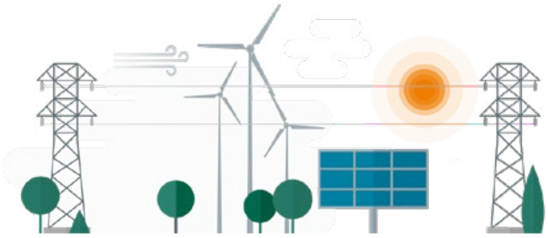
The energy transition will not be successful if we rely solely on renewables and electrification. We will still need gaseous sources of energy. Renewable electricity can be used to produce gaseous energy sources such as hydrogen – or liquid fuels such as synthetic kerosene ('power-to-gas/liquid'). Heavy industry, aviation and shipping remain dependent on these synthetic fuels because of their higher energy density and storage capacity. If the electricity comes from renewable energies and the required carbon source is sustainable, i.e. fulfils the relevant requirements, these energy sources are considered climate neutral. Although the additional conversion step means energy is lost and the efficiency drops, hydrogen and power-to-gas/liquid technology can still play an important role in the energy transition due to their wide range of potential uses. This is one reason why the Federal Government decided on a National Hydrogen Strategy in 2020. It was revised in 2023, and the expansion target for electrolysers was doubled from the previous target to 10 GW by 2030. In addition to the domestic production of green hydrogen, imports will play an important role in meeting future demand.

## IN BRIEF

**What sector coupling technologies are there?**
The best-known examples of sector coupling technologies are battery-powered electric cars and electric heat pumps. They use the electricity directly to drive the motor or tap ambient heat for heating. Electric heat pumps are considered particularly energy efficient because they can generate several kWh of heat using one kilowatt hour of electricity in conjunction with ambient heat. Power-to-gas technology uses electricity to produce a gas such as hydrogen through electrolysis. The hydrogen can be further processed with carbon-containing gases such as $CO_2$ to produce synthetic fuels. Power-to-heat systems, on the other hand, work like heat exchanger heaters and convert electricity into warm water.

**What is the significance of sector coupling for the integration of weather-dependent renewable energies?**
The generation of electricity from wind turbines and photovoltaics depends on weather conditions and the time of day. As the share of these technologies in electricity generation increases, the importance of flexible demand increases, too. This means that electricity can be consumed, especially if large amounts of electricity are generated from renewable sources. Sector coupling ensures that more flexible consumers are available. Electric cars and heat pumps can stagger their electricity consumption over time and electrolysers can produce hydrogen when renewable energy is available in abundance. This is good for the energy system and for consumers, because electricity is cheap when large amounts of it are being generated.

**How does sector coupling contribute to security of supply?**
In the future, sector coupling will ensure that energy demand can be met sustainably at all times. By producing hydrogen using electrolysers, renewable energy can be stored in the long term and then converted back into electricity using hydrogen power plants at times when there is little wind and PV generation. This ensures supply even at times when only little electricity can be generated from renewable energies.



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