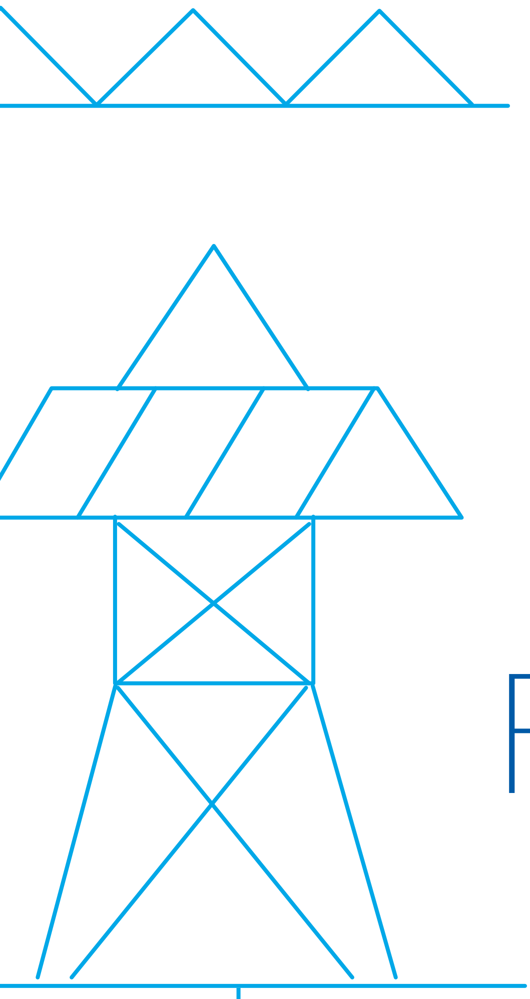
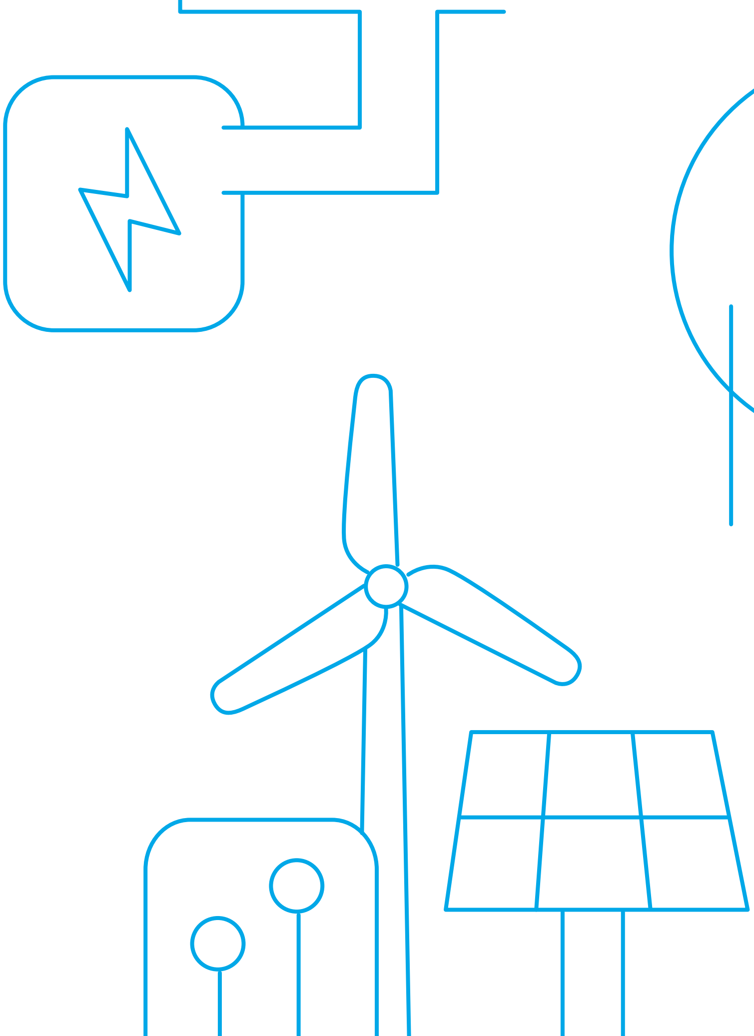
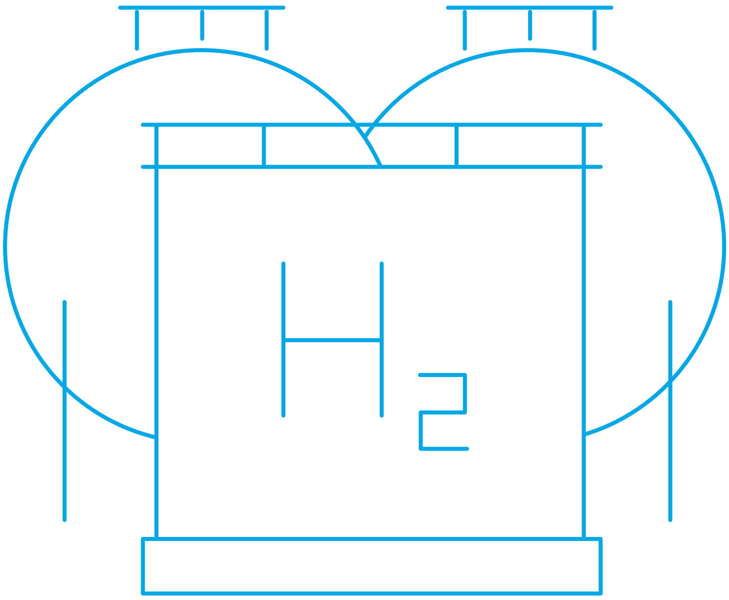


IN FOCUS

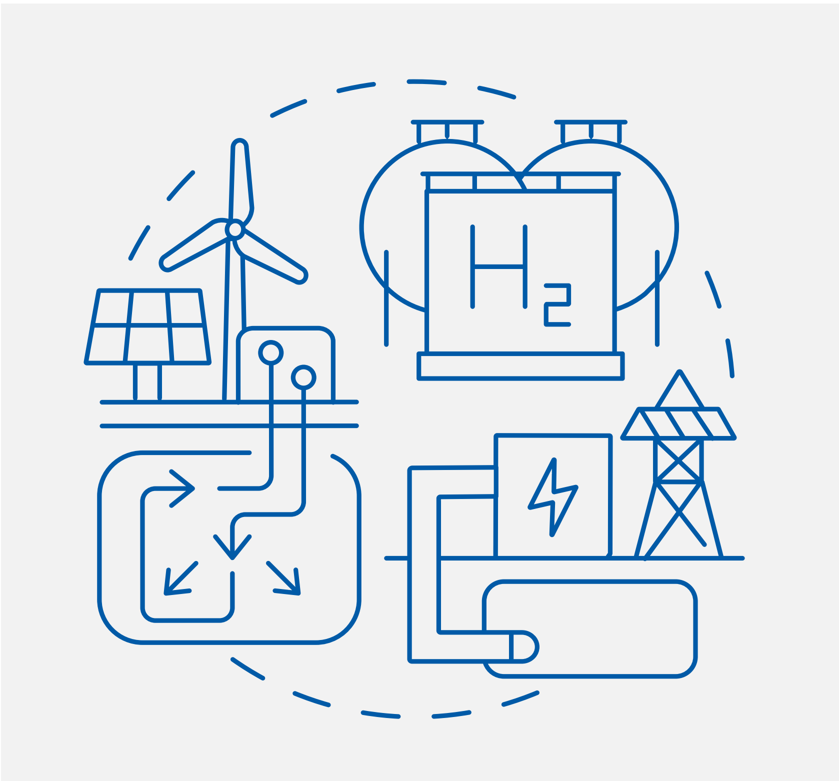
STRATEGIES FOR A SAFE AND CO2-FREE ENERGY SUPPLY





DREES & SOMMER

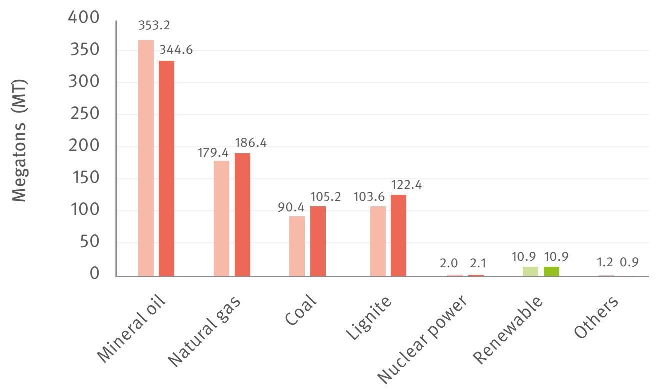
Our energy supply and our industrial processes are still based on coal, oil and gas. It is imperative that our civilization becomes one that no longer produces CO2 emissions. To achieve this, we must optimize every sector – with green electricity and the help of hydrogen. This transformation that is now ahead of us is at least as important as the previous three industrial revolutions. And the issue of supply reliability that the war in Ukraine and its virtually unforeseeable consequences have raised has given this transformation an additional dimension.



Our Current Position

By phasing out the nuclear power plants – which is certainly expedient in the long term but painful in the short term – Germany has put itself under extreme pressure in comparison with some of its neighbors. Our greenhouse gas emissions are thus increasing again, after a significant decrease in the previous year. In 2021, approximately 772 million tons of greenhouse gases ended up in the atmosphere. The waste disposal industry is not included in this figure. This is around 32 million tons more than in 2020.

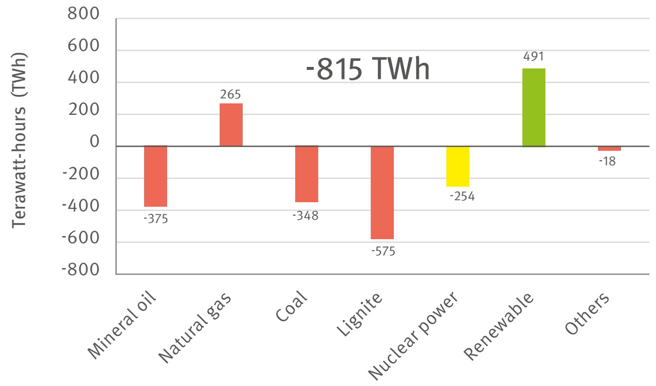
CO2 emissions in Germany in 2020 and 2021



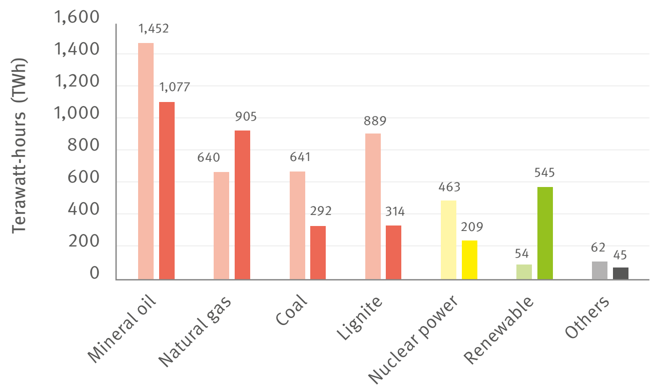
An increase in the previous year was seen in the energy sector in particular, which recorded a rise of 27 million tons of CO2 equivalents. This is linked to a higher demand for electricity. To meet this need, Germany increasingly turned to coal because the gas prices were on the rise and the generation of electricity from renewable energy sources stagnated as a result of poor wind conditions.

And if the supply of Russian gas was to stop – for whatever reason – Germany would have an enormous problem. And not only with the CO2 emissions but with the energy supply in general! The energy consumption in our country has reduced by 815 TWh since 1990. Most notably, coal burning, which has a particularly high carbon impact, decreased sharply, whereas natural gas and renewable energies recorded an increase. This was generally a positive development, a step in the right direction, but one that did not go anywhere near far enough. We simply did not do enough, and we are now paying the price.

Change to the proportions of primary energies, from 1990 to 2022



Development of primary energies, from 1990 and 2021



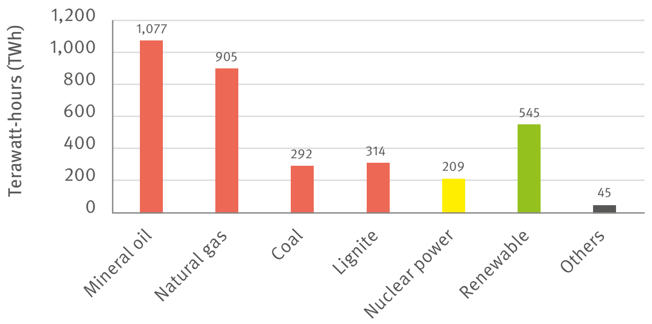
There is no other option than to significantly raise the pace at which we develop renewable energies. Germany must manage to expand its present capacities many times over in order to increase the proportion of renewable energies used for electricity generation to 80 percent by 2030. An impasse such as that seen in the past few years must no longer be allowed to happen.

Furthermore, the Russian war of aggression in Ukraine has dramatically brought to light how closely security and energy supply are linked. We can no longer afford to ignore this fact. It is thus imperative to quickly remove all the obstacles that stand in the way of more wind and solar power. The faster departure from fossil energy sources must include all segments – from industrial production, through the buildings sector, to mobility and agriculture. Keeping a balance in terms of social considerations is key.

We have to alter our mindset and use all the technological know-how with an open mind to further the turnaround in climate policy.

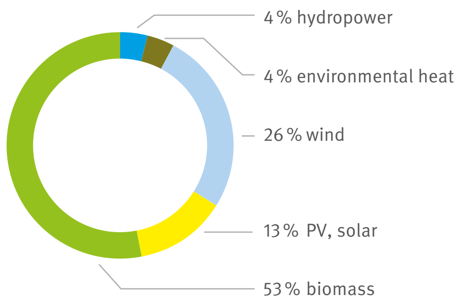
At the moment, fossil energies still dominate, but the proportion of natural gas has increased somewhat in comparison. Overall, the mix of primary energy in 2021 is as follows.

Primary energies in Germany in 2021



On the positive side, renewable energies now account for 16 percent of the total primary energy requirement. While this is a good achievement, the following graphic shows the massive task we are faced with if we want to replace fossil fuels entirely.

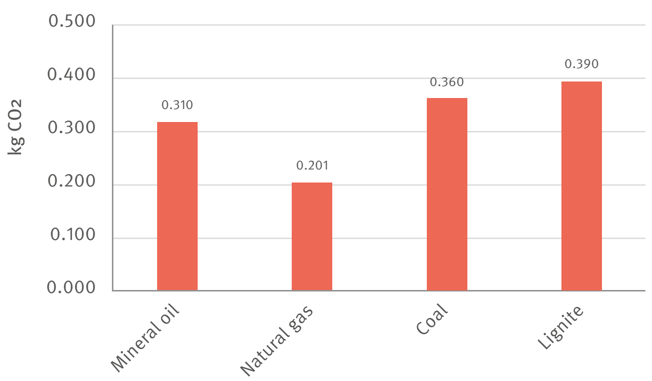
Proportion of renewable energies



As, when we look at the renewable energies more closely, it becomes clear that our overall problem is much bigger – we cannot substantially increase the proportions of biomass and hydropower without causing damage to the environment in other ways. All we thus have left are wind power and photovoltaic systems, which together only account for just under 40 percent of the renewable energies. Twelve times the amount of wind and solar electricity would be needed to replace the fossil fuels completely, not even taking into account the phasing out of the remaining nuclear power plants.

This has given rise to the idea of massively increasing the proportion of natural gas as an interim solution, rather than using mineral oil and coal. As can be seen in the following graphic, the CO_2 emissions per kilowatt hour are significantly lower with natural gas than with mineral oil and, in particular, coal.

CO_2 emissions per kWh



The war in Ukraine has now made these considerations extremely uncertain or even obsolete. Politicians are therefore desperately looking for ways of at least partly replacing Russian gas with alternative solutions as quickly as possible. In addition to increasing the supply of gas from Norway, another option is to source liquefied natural gas (LNG) from countries on the Arabian Peninsula, such as Qatar and the United Arab Emirates. On the other hand, environmental reasons mean that importing LNG from the fracking plants in the USA does not appear to make much sense – but this will presumably be no obstacle.

And one thing must not be forgotten; natural gas is and always will be a fossil fuel and it can – in whatever form – only be an interim solution. Therefore, in an extremely short space of time, hydrogen has become an essential driving force behind the turnaround in climate policy, in addition to power generation using wind and solar energy.

Due to the high costs, the production of hydrogen in Germany will be mainly limited to its function of storing surplus electricity from the increasingly large electricity production peaks related to wind energy and PV systems. Production from surplus heat from industry is also feasible. This hydrogen could be directly added to the natural gas without liquefaction.

However, our own options for hydrogen production are limited. The picture is completely different near to large solar power stations in Southern Europe, North Africa and on the Arabian Peninsula. In these regions, there are double the number of hours of sunshine and almost double the amount of solar insolation as in Germany. There, electricity can be produced at a price that makes the production of hydrogen, including liquefaction, absolutely competitive.

The planned new German LNG terminals could thus have twofold use: as storage facilities for the liquefied gas and as the receiving ports for the hydrogen that has been liquefied in the aforementioned regions.

Totally irrespective of this, the hydrogen in question could also be used to produce methanol (for synthetic fuels) and ammonia, which could reach us via the same transportation infrastructures as the mineral oil.

There is no longer time to discuss obvious solutions again and again in interminable political debates. People of action are needed. Engineers and planners from all fields. Plant constructors from the chemical and petrochemical industries. The energy sector. The key players from the construction industry. They must all work together with the politicians to lay down the framework in just a very short space of time. Even if the situation with Russia was to eventually stabilize again, the energy transformation is needed in the long term in any case.

Alongside the emissions, the energy prices in particular are also currently increasing, which should actually speed up the transition. But conversions take time. And, in the short term at least, still higher gas prices or even supply shortages have the opposite effect. They do not make climate protection simpler; they put it at risk. As, should a lack of natural gas cause gaps in the electricity supply, the use of coal-fired power plants will inevitably increase. For example, as early as January, the coal imports in the European Union rose by more than 56 percent compared with the previous year.

And many people will be asking themselves whether the aforementioned activities will mean we will see a green economic miracle for all or rather a nasty surprise with de-industrialization and a massive loss of wealth for a large proportion of the population.

How many protesters will take to the streets to challenge all the plans or reject them totally from the outset? It is going to be very interesting.

Optimization of the Sectors

The German Federal Government is aiming for complete decarbonization of the energy supply by 2045. By 2030, the emissions, caused by the energy industry, are to have been reduced to 175 million tons of CO_2 equivalents. The most important aspects are phasing out coal-fired power generation, a massive expansion of renewable energies in the areas of electricity, heat and transport and an increase in energy efficiency.

The cure-all is electrical energy, but there is one drawback – the fluctuating production of electricity when generated by the wind and the sun. We have to tap into other sources of energy that, one the one hand, store surplus electricity and also convert it into usable forms of energy for the consumer sectors. The electricity-based and CO_2-free generation of green hydrogen is an indispensable step for the long-term storage of surplus electricity. Wind turbines should not be switched off just because a consumer cannot be found for the power from time to time.

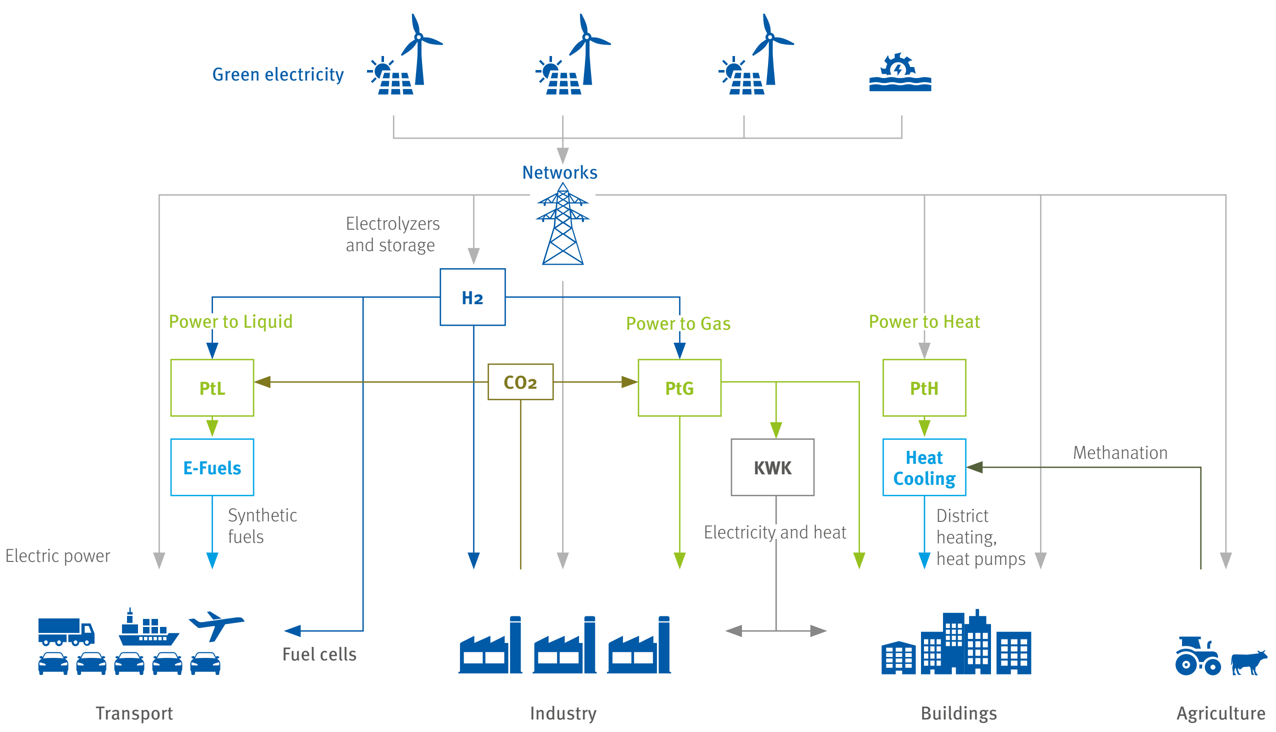
Hydrogen can either be used directly or converted into other forms of energy via power-to-x processes. This includes the following.

Power-to-gas (PtG): The green hydrogen can save significant amounts of CO_2 in the steel and chemical industries or be used for fuel cells in the transport sector – as well as for combined heat and power generation (CHP). It makes the decentral and highly-efficient production of electricity and heat CO_2-free.

Power-to-liquids (PtL): Methanol and synthetic fuels, such as dimethyl ester and kerosene, can also be produced on the basis of hydrogen and added CO_2. These e-fuels can then specifically reduce the use of fossil fuels in the transport sector.

Power-to-heat (PtH): The use of electricity can play an additional part in decarbonization in the heating market through the use of simple heating elements in district heating systems or the integration of heat pumps.

A complete energy system, always based on GREEN ELECTRICITY, is thus created.



Energy strategy of the future

The Energy Sector

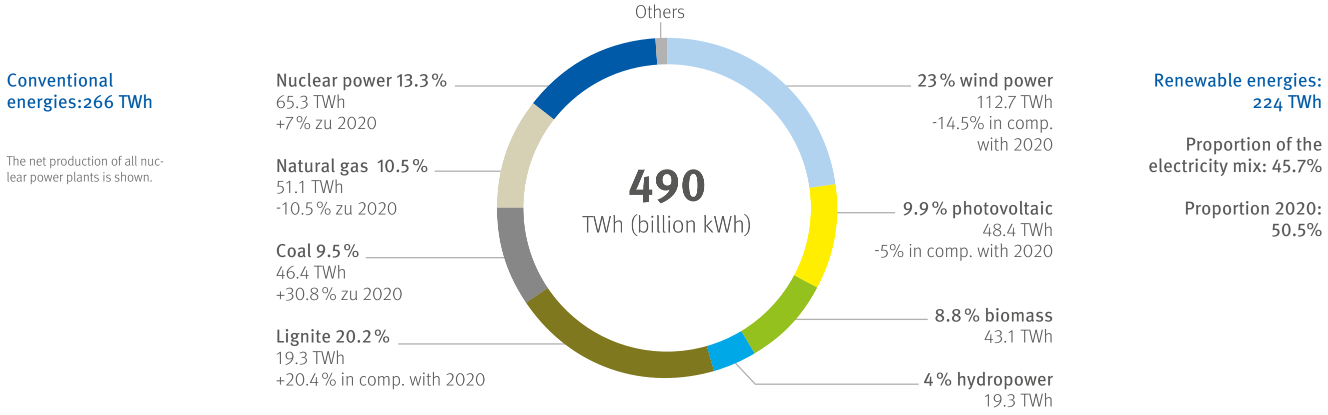
The transformation of energy generation results in a massive surge in electricity demand of other sectors. This increase is even greater as some of the fossil fuels in the consumer branches cannot be replaced by electricity at all – but by the electricity-intensive production of hydrogen or hydrogen-based energy sources, such as methane or e-fuels. By 2030, the generating power of the solar sector is thus to more than double, from approximately 45 gigawatts today to 98 gigawatts in Germany. The generating power of onshore wind energy is to increase from approximately 53 GW in 2019 to between 67 and 71 GW, and the offshore sector is to rise from 6 GW to 20 GW.

Electricity Production

The transformation in the consumption sectors only makes sense if all the electricity comes from renewable energy. Sufficient quantities of green electricity are the basic requirement for electric vehicles, heat pumps, industrial processes and the production of green hydrogen.

Large increases are mainly possible in the wind energy (offshore and onshore) and photovoltaic sectors. Hydropower plants and biomass facilities provide a continual supply of electricity but the opportunities to expand them are comparatively limited.

Even if the electricity consumption of currently 490 TWh did not change in the next few years, the proportion of electricity from wind power and photovoltaic systems would have to more than double. However, the electricity consumption is set to increase. It will also double by 2030/2035; by 2040, net electricity generation with renewable energies of more than 1,000 TWh will probably be needed, which is 4.5 times the proportion of electricity that is generated from wind power and photovoltaic systems today. In Germany, an extensive increase in generating capacities will therefore have to take place by 2045, depending on the level of imports. The speed at which this is carried out must be approximately three times as fast. The best way to achieve this is with incentives for the general public and for companies.



Electricity mix in Germany 2021 (Fraunhofer ISE 2021)

Wind and Solar Parks
In Germany, wind parks (onshore and offshore) and solar parks will have to generate the greatest amount of electricity. But smaller, decentral systems are also important if there are enough of them.

An example of this is agrivoltaic systems on farmed fields. In 2021, the agriculture sector still used 14 percent of its area for energy crops. If farmers grow rape on a one hectare field, they produce approximately 1,800 liters of biodiesel per year. Energy content: 17,640 kWh. In the same area, a photovoltaic system can generate approximately 1,000,000 kWh of solar electricity per year – more than 55 times more. And insect-friendly wildflower meadows, pastures and vegetables flourish in the shade of the solar modules.

Solar-paneled roofs with digitally controlled energy storage are an important source of electricity and also play an important part in sector coupling with electric cars and heat pumps.

Undeveloped area PV and agrivoltaics

Photovoltaics on buildings

SuedLink north-to-south connection

Electricity Grid Expansion is needed
The significant increase in renewable energies for electricity generation and the changes in the overall power plant portfolio – especially the phasing out of nuclear power and coal in Germany – result in considerable need for modifications to the electricity transmission grid. Not only the size and types of the plants are changing but also the regional distribution of the electricity generation infrastructure.

For example, in Germany, the focal points of electricity generation are clearly moving to the north, e.g., due to the construction of new offshore wind parks in the North Sea and Baltic Sea. However, the areas of highest consumption with numerous large electricity clients are still in the south and west of the republic.

The grid expansion applies to the transmission grids, i. e., the 'electricity freeways', as well as to the distribution grids. Existing lines have to be renewed, transmission capacities in the existing grid increased and new transmission lines built. The main challenge is line availability. Local opposition often makes it more difficult to define routes. Planning and approval processes stretch out over many years.

Hydrogen – Production and Distribution

Hydrogen (H_2), as an enabler and a storage medium, is playing an important role in the energy transformation. Electricity and hydrogen are the perfect combination on the journey to a net zero economy. However, the problem of the production and/or provision of the hydrogen is still to be solved. There are three options.

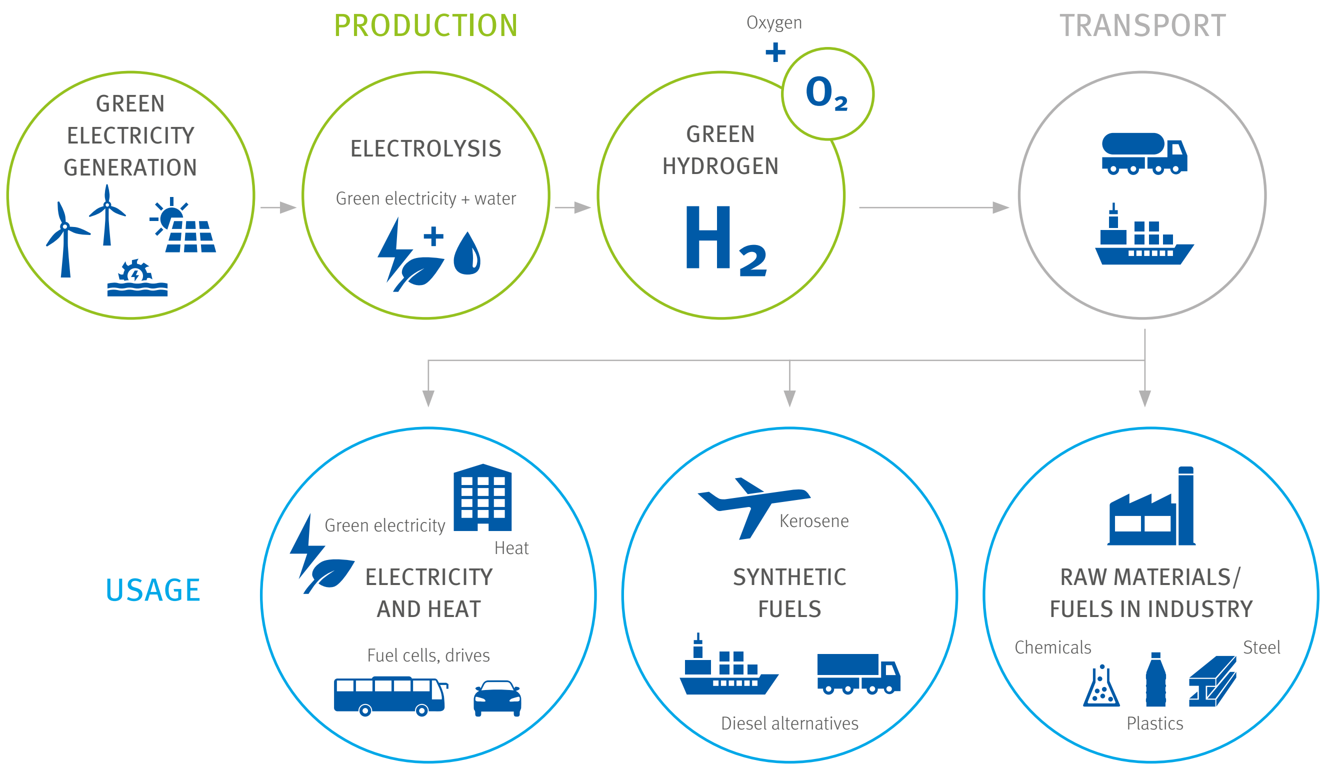
1. **Decentral production at the consumer** – While transporting the energy via the existing electricity grid results in a high load on the grid, transporting does not require any new infrastructure. Nonetheless, a high number of – usually small – electrolyzers need to be installed.

2. **Central production at the electricity producer A** – Distribution takes place via trucks or ships with high variable costs. In addition, the hydrogen must be liquefied, which requires a great deal of electricity.

3. **Central production at the electricity producer B** – Distribution takes place via the existing gas network or a new hydrogen network, resulting in high investment and fixed costs.

Electrolysis to produce green hydrogen needs a very large amount of green electricity which is too expensive and not available in the required quantities in Germany. This situation could be helped considerably by importing hydrogen and/or green methane or methanol from Southern Europe, North Africa or the Arabian Peninsula – regions with almost four times as much usable solar energy, and where hydrogen production is considerably cheaper than in Germany.

Transporting this will be achievable and expedient in the future. Methanol can be transported in the same way as mineral oil always has been; new transport channels are being created for liquefied natural gas, and LNG terminals are being constructed.



The journey of hydrogen (German Federal Ministry of Education and Research – FONA)

The Industry Sector (Basic Industry)

By 2030, the greenhouse gas emissions in industry are to be gradually reduced to 140 million tons of CO_2 equivalents – 25.5 percent less than in 2019.

Production is to become greenhouse gas neutral. This means that process-related emissions are to be avoided, and greenhouse gas neutral energy provision is to be realized. Energy consumption must decrease; energy efficiency must be improved. Increased use of renewable energies and waste heat is needed. This can be attained by optimizing material and resource usage. Higher recycling rates significantly reduce the need for primary materials. If industry wants to avoid process-related emissions entirely, it will have to fundamentally transform all its production methods. This applies in particular to the steel, cement, lime and nonferrous metals sectors, as well as to parts of the basic chemicals industry.

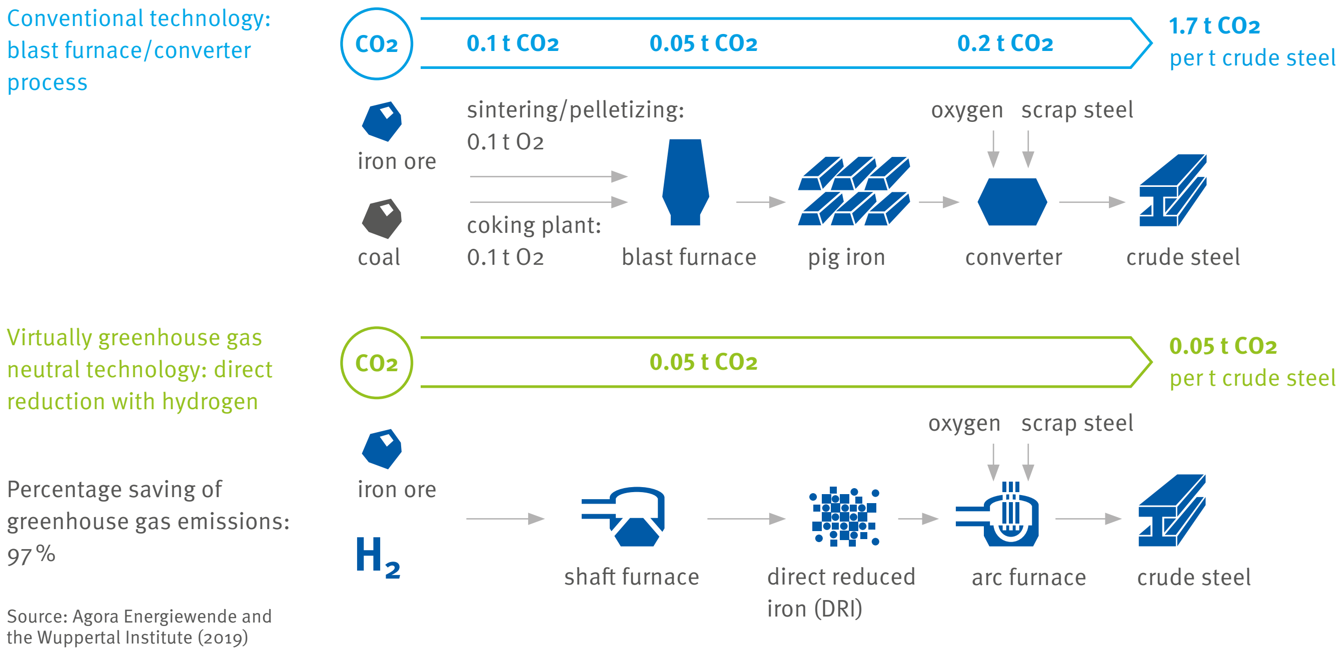
Steel Production

The main starting point in this context is the **transformation of primary steel production.** Industry is working on processes that reduce iron ore using hydrogen instead of, as is currently the case, carbon and then process it further.

The second element needed for lower CO_2 emissions is **scrap-based electric steel production**. This is a method with lower greenhouse gas emissions which is already available for approximately 30 percent of the crude steel produced. Steel and its production by-products are the starting point of numerous value chains that are based on the principles of the circular economy and can save significant amounts of CO_2, especially considering that steel can be recycled, repaired and reconditioned again and again without adversely affecting quality, and it is also durable and easy to process.

Cement Production

Concrete is the most important construction material in the world. Virtually no new building can do without it, or to be more accurate, without cement clinker, which is the most important component of this construction material. More than 4.6 billion tons of cement are used around the world every year. Its production releases a high amount of CO_2 when fossil raw materials are heated in a rotary kiln. An even larger proportion of the emissions comes from the cement itself. The limestone in the cement releases approximately 600 kilograms of CO_2 per ton produced. In total, this amounts to 2.8 billion tons of CO_2 annually.



Comparison of conventional steel production with H_2 direct reduction

The construction industry is currently aiming to use less cement, reduce the proportion of cement clinker and capture additional CO_2 in order to use or store it (CCUS – carbon capture usage and storage). However, underground storage is controversial.

Production of Petrochemicals
It is estimated that three quarters of the total mass of our solar system is hydrogen. The chemical and petrochemical sectors (or the upstream oil and gas industry) need large quantities of it. Refineries and fertilizer producers use more than three quarters of the total amount of hydrogen required by industry, above all for the production of basic chemicals such as ammonia (NH_3) and methanol. Both of these are basic chemicals that are primarily used to manufacture other products. Ammonia is mainly used for the production of fertilizers and refrigerants. After being converted to formaldehyde, methanol is used to produce colorants and drugs; it also has the potential to be deployed as a fuel made from green hydrogen.

The petrochemical industry does not use the gas much as a raw material but to remove sulfur compounds from mineral oil, natural gas and the refinery products derived from them. During hydrocracking, hydrogen helps to convert heavy and viscous residues from the mineral oil refining process into lighter components and then to produce fuels such as kerosene and diesel from them.

The transition from conventional to green hydrogen would considerably improve this industry's climate impact, as would process optimizations and the increased use of electric power for the core processes. However, both would require significant investment in the production facilities.

Other Measures
In addition to adapting their processes, industrial companies should focus on fossil fuel free heat generation when reinvesting in their production sites. Just as the district heating networks in cities are often supplied by coal or natural gas-fired heating plants, the heat supply to industrial sites is still mainly based on conventional energy sources. This has to change if we are to reach our goals.

Industrial petrochemical plant

The Transport Sector

Approximately 95 percent of the fuels used by the transport sector are still fossil fuels, mainly gasoline and diesel from mineral oil. This sector is currently responsible for 13 percent of the CO_2 emissions and 24.5 percent of the energy consumption in Germany. By 2030, the emissions are to sink by 42 percent in comparison with 2019 – with the help of better energy efficiency of all means of transport, a more pronounced transition to emission-free drives and fuels, more public or shared transport offerings, more journeys on foot and by bike and improved logistics that avoid unnecessary travel.

Technological Approaches
By 2030, Germany will need approximately 15 million cars and light commercial vehicles (LCVs) with electric drives if it is to achieve the EU fleet targets. Plug-in hybrids must have a minimum electric range of 50 to 60 kilometers. A ban on the production of combustion engines from 2032 or 2035 is under debate. It will be possible to ensure that most cars use e-fuels by 2030 with the help of imports. Heavy commercial vehicles (HCVs) are responsible for more than a quarter of the German transport-related greenhouse gas emissions. New trucks are to have an electric drive or fuel cells by 2030. Another option for long-distance travel is the hybrid trolleytruck. On freeways, it is supplied with electricity via an electrified wire; it is powered by its own electric drive on other roads. For new aircraft and heavy land-based vehicles as well, the aim is to transition to drives that use e-fuels or hydrogen.

Digital train control system

Infrastructure Measures
The core feature of a climate-neutral transport system is a well-functioning, sustainable infrastructure for ecomobility, i. e. for buses, streetcars and subways, as well as bikes and pedestrians. Local public transport systems must be attractive, low cost, fast, safe and comfortable. They need to expand their offerings and increase frequency and quality. Communication-based train control (CBTC) makes it possible to do without the usual signals, thus reducing maintenance costs. Moreover, the public transport company uses a digital train control system to increase the capacity of its routes, especially in the tunnels. This form of modernization is a trump card for the mobility transformation. This is because a CBTC system enables 'moving block' operation, whereby the trains move at braking distance instead of in fixed blocks, as is currently the case. Shorter train spacing is thus possible, allowing capacity to be increased by up to 25 percent – without expanding existing tracks and tunnels or building new ones.

The high-performance train control technology not only ensures more trains along the route but also improves interval accuracy and reliability. It facilitates better energy efficiency when travelling – savings of up to 15 percent are possible – and greater passenger comfort due to gentler acceleration and braking. This also reduces the wear on vehicles and tracks.

CBTC therefore has the potential to increase the share of rail-based local public transport in urban areas and thus to directly ensure more cleaner air in cities. Renewing outdated train control systems is not only a technical and operational necessity for transport companies, it is also indispensable in the light of future mobility requirements.

Speed Limits
General speed limits on German roads are viewed as rapidly achievable and as a low cost and effective means of helping to reduce greenhouse gas emissions, other pollutants and noise. However, it will be difficult to find a generally acceptable compromise. In principle, a digital solution that ensures a constant flow of traffic is needed in this case as well, alongside expedient upper limits.

The Construction and Buildings Sector

According to a United Nations environment report, the construction and buildings sector has record levels of greenhouse gas emissions; it is lagging behind in terms of the goals of the Paris Agreement on Climate Change. The sector is actually moving farther away from the stipulations.

Energy Consumption during Construction Phase – Gray Energy
New buildings in Germany have a very high energy standard that, in conjunction with modern heating systems, allows them to be run with either very little or even no CO_2. However, the construction phase and not just the utilization phase is relevant. 'Gray energy' is involved in the construction of every new building; it is used when raw materials are produced, for the production of cement, steel and aluminum, for manufacturing construction elements and for the erection of the building.

A study of an apartment building revealed that its construction consumed almost 85 percent of the gray energy. Naturally, this proportion significantly changes with a technically equipped office building or an industrial site, where technology prevails.

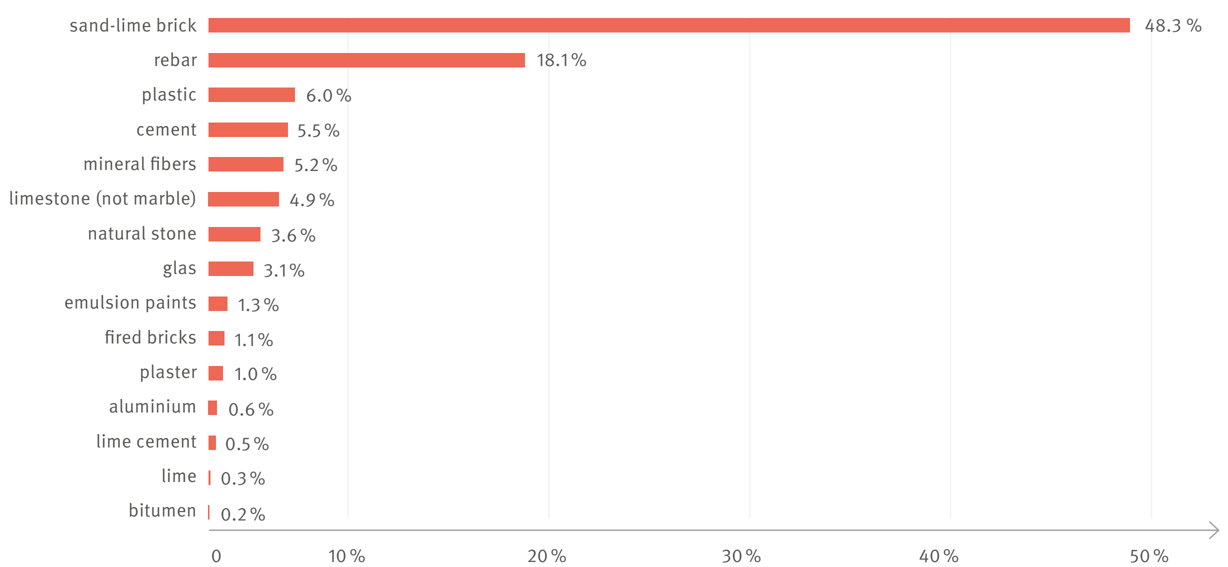
Recent studies assume that gray energy represents more than 50 percent of the primary energy consumption of the building's entire life cycle – long before the approximately 50 years of service life of the real estate. The only solution is a systematic expansion of the circular economy during construction.

Many stakeholders, such as suppliers of façade systems or windows or producers of recycled aggregate, are already making significant efforts in line with the Cradle to Cradle® (C2C) principle. However, many more parties must follow this example. However, the most efficient method to save CO_2 is building with wood. With CO_2, water and the sun, wood is produced environmentally friendly by nature. Besides, oxygen is produced! In wood, a climatic-effective CO_2-storage takes place over the whole lifecycle. With the use of wood with the building is also referred to as a carbon sink, since wood is the only building material can store carbon.

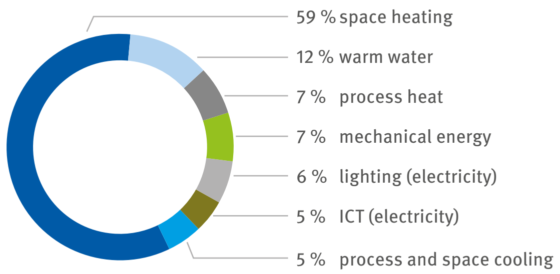
Drees & Sommer has been working intensively on building ecology since the 1990s. As a link between investors, clients, architects and product manufacturers, Drees & Sommer implements Cradle to Cradle innovations in planning, construction and operation. This results in buildings with outstanding interior quality, which at the same time ensure that the value of the properties will be maintained in the long term.

To expand these activities, Drees & Sommer acquired a majority stake in EPEA GmbH in 2019. Since its founded in 1987 by Prof. Dr. Michael Braungart, it has become an international innovation partner for environmentally products, processes, buildings, and urban districts.

Energy consumption for the construction elements

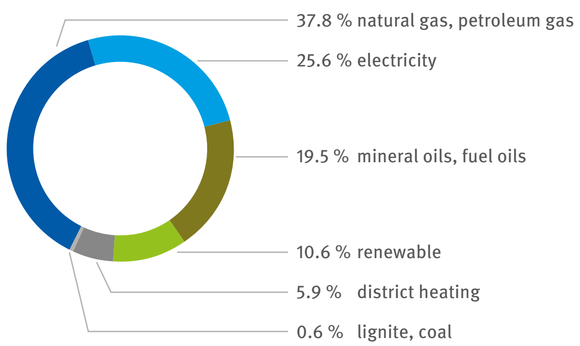


Consumer Energy
There are more than 21.7 million buildings in Germany. Around 19 million of them house residential units, of which approximately 12.5 million were built before the first German Thermal Insulation Regulation (Wärmeschutzverordnung) in 1979. Heating accounts for approximately 60 percent of the energy consumption in the buildings sector. Another 24 percent is related to various types of heat and cooling systems. While households mainly need warm water and process heat (such as for washing machines and dishwashers), the commercial sector also requires process cooling.



Final energy consumption, building utilization
(Source: BMWi – Federal Ministry for Economic Affairs and Energy, 2020)

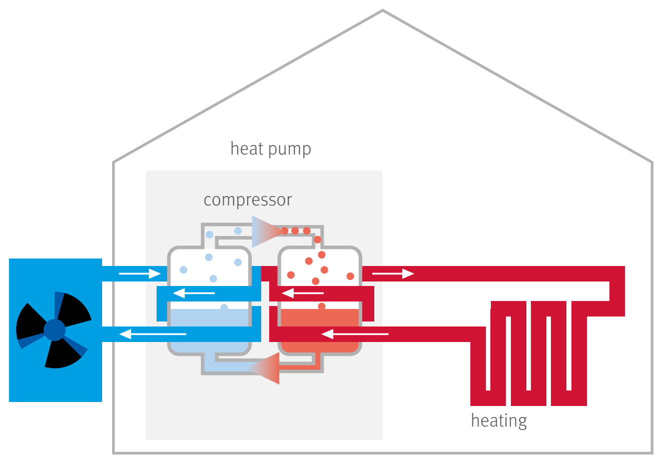
At more than 80 percent, most of the emissions in the buildings sector result from burning fossil fuels. This includes an increasing use of wood-fired heating systems. While wood is a renewable raw material, it should not be burned. When burned, wood not only releases the stored CO_2 but also a considerable amount of fine particulate matter. The impact on the air is much worse than with oil heating. And it takes 30 to 40 years before the amount of wood that has been burned grows back.



Energy sources, building utilization
(Source: BMWi – Federal Ministry for Economic Affairs and Energy, 2020)

Wood has to be used for construction elements or as fertilizer – including in the form of chippings, sawdust and bark. For this reason, all wood-fired heating systems, including those that use pellets, should be banned as soon as possible. The only sensible way to shape the future of heating and cooling is to base it on electric heat pumps coupled with solar heating, geothermal energy and ambient air or waste air sources.

To reduce the energy requirement, it is imperative that substantial retrofitting of existing systems is prescribed and subsidized. First and foremost, this involves insulating roofs, walls and windows, together with intelligent ventilation without any loss of heat.



Mode of operation of a heat pump

The Agriculture Sector

By 2030, the greenhouse gas emissions of the agriculture sector are to decrease by 15 percent in comparison with 2019. One measure is to reduce surplus nitrogen by using less nitrogenous fertilizer and thus to ensure a more sustainable and resource-efficient approach to foodstuffs. More stringent requirements for fertilizing are also important for water conservation. An expansion of the ecological farming segment is therefore to be aimed for; the German Federal Government spends € 36 million annually in subsidies for this purpose.

The Need for Sector Coupling

The production of electricity from renewable energies fluctuates, as it depends on the strength of the wind and the hours of sunshine. Also, electricity cannot be stored in large quantities. In order that the future system can function despite this, ‘sector coupling’, which ensures that no energy is lost throughout the entire system, is needed. For this purpose lots of decentral energy consumption and generation units must be systematically linked together.

Here is an example to illustrate how it works. During a strong wind all the wind turbines are able to produce a large amount of electricity. But the grid cannot carry it because the consumption is low, and the pumped-storage plants are full. What happens without sector coupling? The operator must shut down some of its wind turbines, even though the harvesting conditions are ideal. Whereas with sector coupling mechanisms, such as power-to-gas, which convert the surplus electricity into the storable energy source hydrogen by means of electrolysis, come into play.

The Coupling Sectors

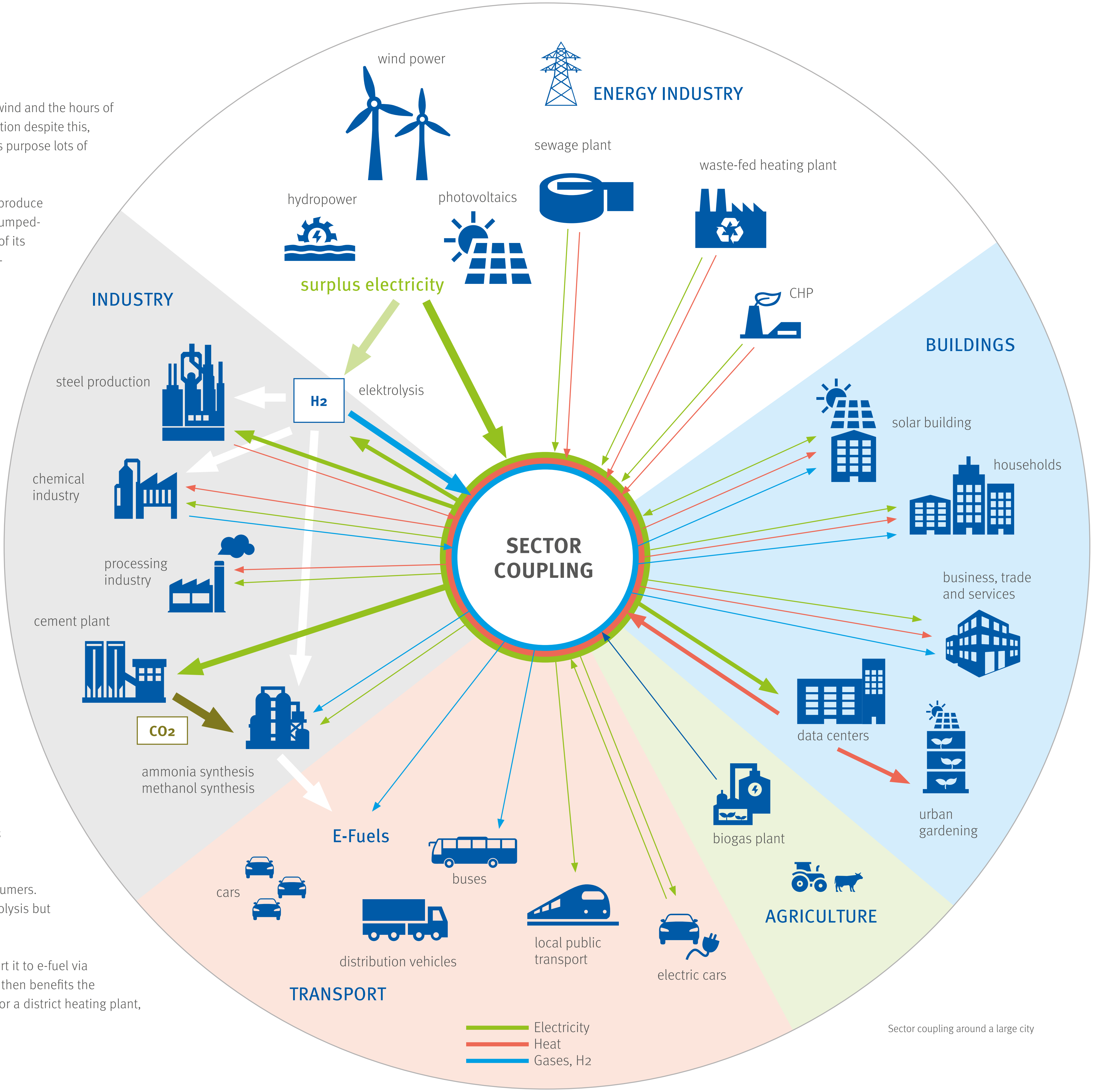
The coupled sectors are primarily electricity, heating and transport. Industry, commerce, trade and services as well as private households are integrated as consumer groups. Generating a large, fluctuating amount of electricity involves a comprehensive system change. The dependency on the weather means that much too much or much too little electricity is often available. This problem grows with the proportion of electricity produced from renewable energies, which is to amount to 40 to 45 percent by 2025 (2015: 30 percent). Today, billions of euros are already being spent each year on energy balancing or redispatch measures to ensure that the grid remains stable if too much electricity from renewable sources is produced. If we do nothing to counteract this, the trend will continue to grow.

Currently, conventional power plants still primarily control mechanisms that balance electricity generation from renewable energies with the electricity requirement. As this will no longer be possible within the framework of decarbonization, sector coupling must take over. It comes hand in hand with further efficiency and CO_2 reduction potential. Cell-like structures, such as urban districts, are suitable for this strategy, as it brings together various stakeholders and facilitates a wide variety of interactions. Existing infrastructures are not unnecessary, they are indispensable. We need to integrate them economically and intelligently. For example, the existing gas and heating network infrastructures can carry large amounts of energy and therefore make it available for efficient and climate-friendly use within the sectors. They can also provide temporary storage.

The illustration shows the wide variety of coupling options provided by the electricity, heat/cooling and gas/H_2 energy sources. A combined energy offering from these three energy sources is created; it can be supplied in different directions depending on availability and needs.

The renewable energies (except for geothermal heating) usually supply electricity to almost all consumers. If there is a surplus supply of electricity, it cannot only be converted to hydrogen by means of electrolysis but can also be used to charge electric cars or batteries in buildings via a digitalized system.

The virtually CO_2-free production of steel is possible using the hydrogen. Another option is to convert it to e-fuel via a process involving ammonia or methanol synthesis using the CO_2 produced in cement plants. This then benefits the transport sector. The waste heat from a data center can be networked with an urban gardening site or a district heating plant, for example. All these are just a few of a wide range of options.

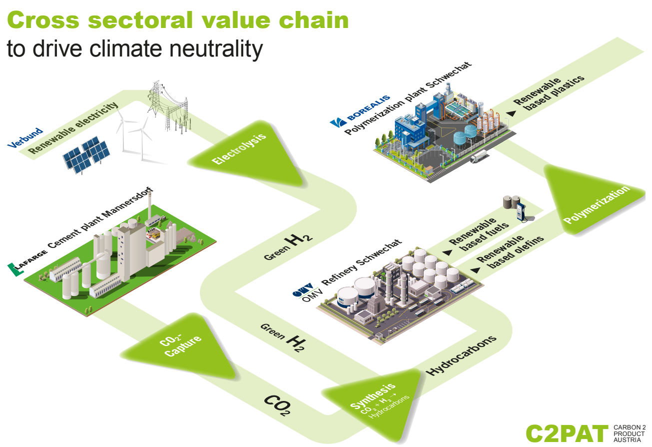


Sector coupling around a large city

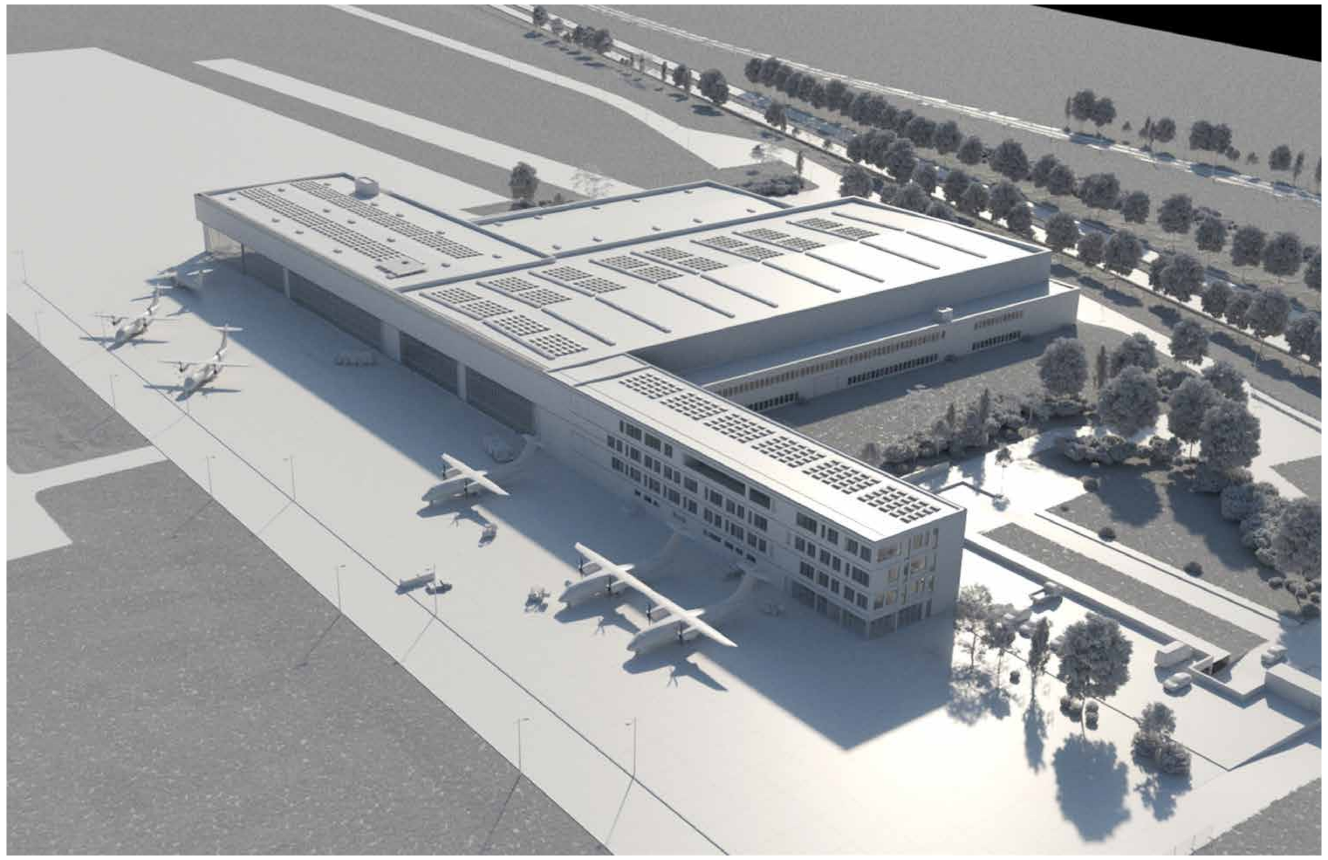
Examples of Sector Coupling

Cement industry

The industrial companies Lafarge (cement), OMV (mineral oil and natural gas), Verbund (electricity) and Borealis (chemicals) are working on a partnership focusing on production with less impact on the environment. Together, they aim to have built a plant that will capture and use CO2 on an industrial scale by 2030. The plant will be designed to capture CO2 from the cement production process and enable the production of plastics, olefins and fuels on the basis of renewable raw materials. The partners are thus striving to create a cross-sector value chain in order to expedite climate neutrality, the circular economy and innovation. According to the industrial companies, the success of the joint project will greatly depend on whether politicians manage to set up the necessary financial and regulatory framework at both European and national level.



Source: C2PAT Decarbonization infographic



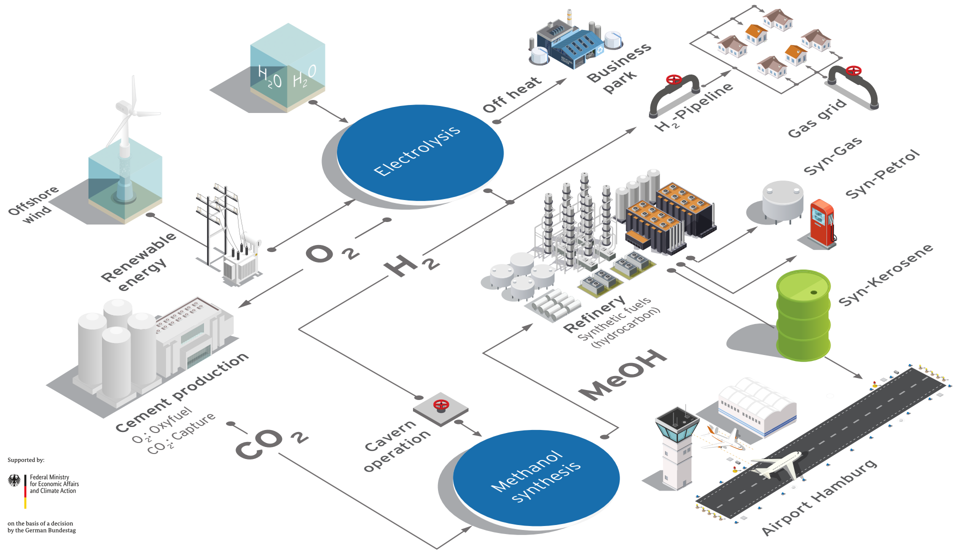
Source: Deutsche Aircraft

Westküste100 Energy Transformation

This project focuses on the sustainable production of hydrogen and research into storage and transportation technologies for hydrogen, including trials on an industrial scale.

To achieve this, Westküste100 produces extremely climate-friendly green hydrogen by means of electrolysis using energy from offshore wind parks. At the Heide refinery, an integrated 30-megawatt electrolysis system is being set up that breaks the water down into its basic components: hydrogen and oxygen. The resulting waste heat (also known as process heat) is fed into an existing and extended heating network and later, for example, is supplied to a business park. Westküste100 feeds the hydrogen into the gas network or makes it available for the production of methanol. A research team at the Lägerdorf cement plant benefits from the oxygen.

They are studying how emissions can be reduced by the production of clinker. Even the small amount of remaining CO2 that is inevitably produced by all burning processes is to be utilized as a raw material. The idea is to use the carbon dioxide from local cement production to produce synthetic hydrocarbons.



Industrial scale green hydrogen and decarbonization

Source: westkueste100.de

Climate-friendly regional air transport begins with sustainable production processes

As a new German aircraft manufacturer, Deutsche Aircraft is pursuing a strategy of enabling climate-neutral flight operations in the short term rather than waiting to implement climate-friendly technologies.

In addition to the pre-development of future aircraft concepts based on a hydrogen fuel cell system, the company is currently focusing on making the next aircraft – the D328eco™ – suitable for so-called PtL (Power to Liquid) fuel. PtL is also based on hydrogen as the basic energy source, but is chemically very similar to fossil kerosene and can therefore be used operationally more quickly. To optimize the carbon footprint, Deutsche Aircraft is working closely with energy suppliers and fuel manufacturers to ensure the scalability of PtL technology and to help driving its expansion. At the same time, work continues to minimize energy and thus fuel consumption by implementing the latest aircraft and engine technologies.

Deutsche Aircraft also attaches great importance to sustainable energy supply and environmental compatibility in the production of the D328eco™. Among other things, Drees & Sommer is supporting Deutsche Aircraft with project management and planning services for the design of the state-of-the-art final assembly line at Leipzig/Halle Airport.

What will the Obstacles be?

We will only manage to achieve the transformation that is required across all sectors if business, politicians and society as a whole work hard together. Above all, we must speed up the pace of the transformation significantly. The many challenges associated with this require well-coordinated packages of measures and higher-level political supervision that creates incentives and a clear general framework – by means of subsidies and suitable regulations.

However, speeding up the journey to climate neutrality also means that we have to scale better than we have previously done, for example in production processes. In the field of hydrogen production, the task will be to create more standardized electrolysis capacities in shorter spaces of time. Otherwise, our goals will remain unattainable.

As the capacities of drilling companies are scarce, we need geothermal plants for climate neutral heat supply. Tapping into underground heat sources more intensively than we have previously done is only possible if new companies with experience of industrial production and standardized processes join this market segment.

Another major obstacle which is also linked to uncertainty is the state of the solar industry in Germany. The German solar industry was once a leading light. But this was ten years ago. Between 2012 and 2015, the solar industry in Germany was phased out due to the reduction or discontinuation of the subsidies; most of it relocated to China. Only a few small companies were able to maintain a basic level of production.

There is now a new company in Bitterfeld. One company in the face of the numerous established competitors in China – this is not enough. However, the solar industry as a whole is a major segment in Germany: mounting frames, solar cells, solar modules, inverters and storage batteries. More is happening in this context. As far as skilled staff is concerned, the situation looks very bleak. There is a dramatic shortage of skilled staff. If you order a solar system today, it will take weeks or even months before someone arrives to attach it to your roof. The picture is the same in the plant construction field. There are supply shortages for materials and a lack of skilled staff. Whether it be planning and approval processes or implementing projects – everything is delayed when there are not enough qualified workers. The difficulties can only be remedied by means of structural changes.

Approval processes for new electricity lines or onshore wind parks must proceed much more quickly; this will only be achieved by significant intervention into current legislation. Change demands a highly increased awareness of energy consumption and the use of resources. This awareness has long been developing – 'thanks' to increasing costs for CO_2 emissions resulting from conventional energy generation. Their rising prices create opportunities for more climate-friendly technologies, which in turn become less expensive due to the wider demand and the resultant improved scaling. The laws of the marketplace take effect quickly and encourage the fast spread of more climate-friendly applications.

Almost every location for wind turbines or the route of power lines is disputed due to different interests. There is (still) no overriding interest for an energy supply from renewable energies.

Summary

And one thing is clear. We will only achieve the energy transformation and thus the CO_2 reduction if we exploit all the options related to the networking of a CO_2-free energy industry without any technological limitations. At Drees & Sommer, we propose a three-stage strategy.

2022 – 2030
Approval and subsidies (not linked to a specific technology) for all CO_2 reduction options – in particular, the production of e-fuels in suitable regions.

2031 – 2040
Concentration on the further development of the approaches with the best cost/benefit ratio

From 2041
Transition to a well-regulated 'green society' across all sectors with firmly established processes for avoiding CO_2, plus a reliable supply of green energy.

To enable us to achieve these goals, we need to discuss and communicate in an open, targeted way and without being slowed up by special interest groups. Considerable investment and subsidies will be needed to adapt the energy industry to renewable energies and to promote CO_2-free processes in all sectors.

Enormous changes are ahead of us, in the fields of plant and building construction and operation in particular. Without the systematic introduction of the circular economy (C2C), all the efforts on the part of the construction industry will come to nothing. Successful decarbonization in the transport sector is first and foremost based on the expansion of the electricity infrastructure. If those in power accept the import of synthetic fuels in the initial stages, this will have a great impact in terms of the vehicle fleet.

However, the essential factor is the digital networking of energy production and distribution all the way to private homes and electric cars in the interests of successful sector coupling.

DREES & SOMMER SERVICES FOR SECTOR OPTIMIZATION AND SECTOR COUPLING

Cross-sector services
- Factory planning for the production of stacks, electrolyzers and fuel cells
- Drawing up innovative concepts for a sustainable heat supply
- Design, planning and project management for the use of fuel cells and electrolyzers
- EPCM/GCM for production plants for battery and cell production

Services in the transport sector
- System planning and energy design for mobility hubs
- Planning and project management for charging infrastructure

Services in the energy sector
- Project management and process consultation services for electricity, gas and H_2 line projects
- Project management for geothermal power plants
- Contract management and general support for power plant conversions (fuel switching)
- Consultancy services in connection with organization, processes and BIM for network expansion projects

Services in the real estate sector
- Planning and project management for decentral heat networks in districts
- Project management and general planning for buildings and urban districts

Drees & Sommer's current projects are not only related to German locations but also to the sites in Europe. Projects for the large-scale production of renewable energies and in connection with the production of hydrogen and synthetic fuels are also planned outside of Europe.

IMPRINT

Drees & Sommer operates internationally, and its clients benefit from its global presence. At 51 offices, our experts support both German and international companies from a range of industries in the realization of their projects. In addition, Drees & Sommer has temporary project offices all over the world – wherever you currently need us.

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