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Energy efficiency – Small steps with a huge impact

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Renewable energy – Reaching a new era

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ENERGY TRANSITION

Project of the Century

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ENERGY TRANSITION

PROJECT OF THE CENTURY

The goal is ambitious: by 2050, Europe will be the first continent in the world to become climate-neutral. In July 2021, the European Commission launched a comprehensive package of measures to help it achieve this goal. By 2030, these measures are expected to play a key role in reducing net greenhouse gas emissions in Europe by at least 55 percent over 1990 levels.

But tremendous efforts are also being made outside Europe to reorganize both the production and utilization of energy. The objective is to minimize emissions of harmful pollutants – and thus halt global climate change.

For energy suppliers and the process industry, the energy transition brings about a far-reaching set of changes. New high-performance infrastructure and processes must be established while innovative technologies and solutions are developed and implemented. It is apparent that there are basically four approaches to becoming climate neutral:

- Increased energy efficiency
- Application of renewable energies
- Use of power-to-X technologies
- Emission capture

It is not enough for companies to focus on or even limit themselves to just one of these approaches – especially companies in the process industry. It is necessary to pursue all paths at the same time in order to ensure this project of the century is a rousing success.

"WE HAVE TO MAKE INVESTMENTS IN CLIMATE-NEUTRAL TECHNOLOGIES NOW"

Dr. Berit Erlach is Head of the "Energy Systems of the Future" (ESYS) coordination office. With the ESYS initiative, the science academies acatech – German Academy of Science and Engineering, Leopoldina and the Union of Academies provide input for the debate on the challenges and opportunities of Germany's energy transition. As part of the academy project, more than 100 experts from the fields of science and research are developing options for action to implement a secure, affordable and sustainable energy supply. The project is sponsored by the German Ministry of Education and Research (BMBF).

Dr. Erlach, how important is the process industry in achieving global climate goals?

Industry is responsible for roughly one third of global greenhouse gas emissions and therefore has a key role to play in achieving our climate goals. Production of basic materials such as steel, cement, chemicals or plastics is particularly important. To keep the increase in global temperatures to well below 2°C, preferably 1.5°C, we need to find ways of producing these basic materials in a climate-neutral process or replacing them with other materials. The EU's goal is to be climate neutral by 2050, so all industrial processes must be converted by then.

What are the most important levers for becoming climate-neutral in the process industry?

There are a total of three main levers: the first is to reduce the need for emissions-intensive basic materials. More climate-friendly materials can be used, for example, including more wood instead of steel and concrete in the construction sector. More durable products can also reduce the need for basic materials, for example when it comes to plastics. The second lever involves closing material cycles through high-quality recycling. And the third lever is a shift toward climate-neutral production processes – something that will require substantial amounts of green electricity and hydrogen by 2050.

Where do you see the biggest challenges moving forward?

I see two major challenges. First, we have to make investments in climate-neutral technologies now, because industrial plants often remain in operation for decades. Plants that are built today will still be running in 2050. Any production plant built in the next few years needs to already be climate-neutral or capable of being converted to climate-neutral operation at a later date. Right now, however, climate-neutral processes are not yet profitable on the market because CO_2 prices are still too low. Additional support from policymakers is therefore needed in the years ahead. Secondly, policymakers must provide incentives for ambitious climate protection in Europe, but at the same time prevent carbon leakage – the migration of industry to countries with less ambitious climate protection policies. In this respect, it would be a major step forward if the EU were to succeed in forging an alliance for ambitious climate protection, especially with the USA and China.

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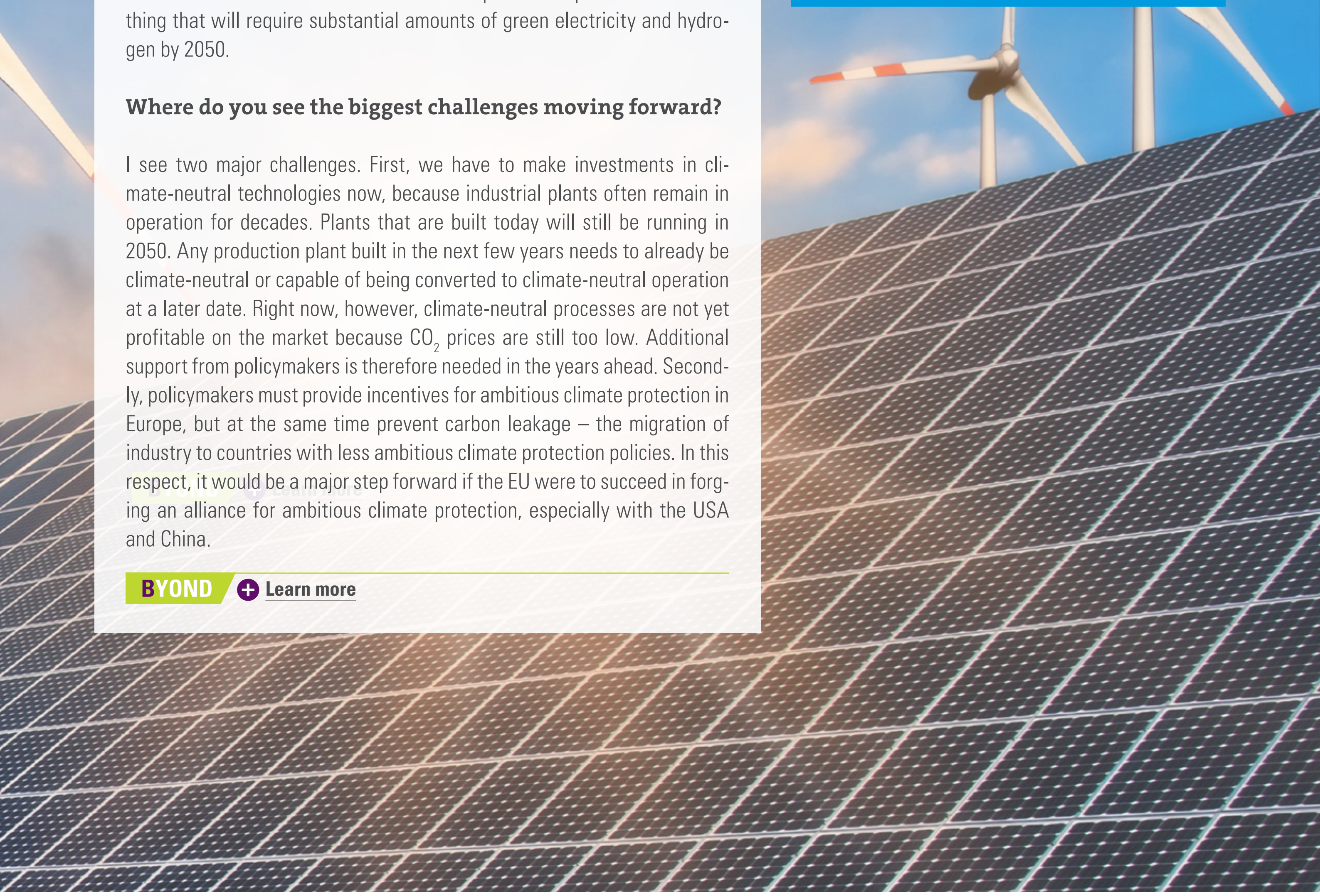


ENERGY EFFICIENCY

SMALL STEPS WITH A HUGE IMPACT

There are a lot of ways for industrial companies to become more climate-friendly and climate-neutral over the long term. The cheapest, simplest and most obvious approach is to increase energy efficiency.

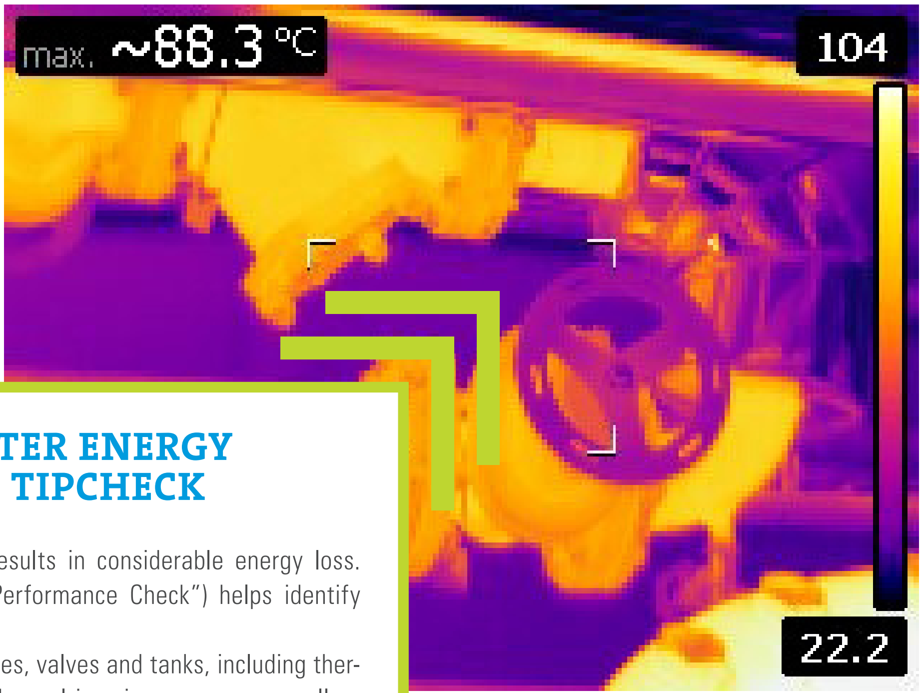
If energy is not used, there are no costs and there are no emissions. Saving energy must therefore be a top priority. "Unfortunately, however, this is not always the case", says Mark Courage, Director of Engineering at Bilfinger Tebodin in the Netherlands: "We often see operators of industrial plants looking hard at ways to use new technologies to reduce CO_2 emissions –- but they overlook the many possibilities there are to increase energy efficiency."

New technologies for energy generation and utilization receive a great deal of attention from the general public and are intensively discussed in the media and at conferences. "This is, generally speaking, also a welcome development", says Courage. "But energy efficiency measures provide many advantages over new technologies: they achieve considerable impact with relatively little effort, can be implemented much faster in most cases, are proven and necessitate far fewer changes in existing infrastructure."

There is potential in every plant

Courage also notes that many plant operators assume their plants are already highly energy-efficient or that they are too individual to benefit from efficiency solutions commonly available on the market. More often than not, however, these assumptions turn out to be wrong. "Our experience shows that with the right measure, significant amounts of energy can be saved in almost any industrial plant", Courage says. "There are a number of levers and possibilities for adjustment, and every year a range of innovations and product enhancements appear on the market that allow energy to be used even more efficiently."

Courage sees particular potential in the area of heat: "Heat is generated at many different points in an industrial plant and is still constantly being lost due to a lack of or incorrect insulation. The possibilities for reusing waste heat are also rarely fully taken advantage of – both in the plant's own processes and for transferring it to neighboring industrial plants, residential areas or district heating networks. It is here that a large number of new approaches and methods have been developed in recent years to significantly increase energy efficiency in industrial plants."



ACHIEVING GREATER ENERGY EFFICIENCY WITH TIPCHECK

Insufficient insulation regularly results in considerable energy loss. TipCheck ("Technical Insulation Performance Check") helps identify such weak points.

In the TipCheck process, all pipes, valves and tanks, including thermal bridges, are inspected with thermal imaging cameras as well as surface and moisture sensors. The data obtained is then used to calculate total heat loss.

On the basis of these findings, systematic and targeted improvement measures can be implemented with a high degree of effectiveness. These measures include re-insulation, disassembly and reassembly of the insulation and reduction of thermal bridges through the use of suitable insulation systems. The TipCheck method also provides a calculation of amortization so that the savings to be achieved can be predicted in a well-founded manner.

> "Our experience shows that with the right measure, significant amounts of energy can be saved in almost any industrial plant."
>
> MARK COURAGE, DIRECTOR OF ENGINEERING AT BILFINGER TEBODIN IN THE NETHERLANDS

Powerful analysis methods

There is also a considerable amount of energy-saving potential in optimizing the refrigeration and heat coupling in a plant. "The so-called pinch analysis has been shown to be effective here – our quick-scan pinch approach in particular", explains Courage. "This approach not only evaluates the cooling and heating flows of a process, but also determines the theoretical ideal state of the plant. Based on the results obtained, even more powerful concepts for optimizing refrigeration and heat coupling can be developed."

The global goal of dramatically reducing CO_2 emissions has led to a significant number of innovations and processes now being developed every year to increase energy efficiency. "Operators of industrial plants can quickly lose track of suitable and forward-looking solutions," says Courage. "This makes it all the more important to work with partners who systematically analyze the market, embrace a comprehensive approach and also have a detailed understanding of the processes in industrial plants."

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RENEWABLE ENERGY

REACHING A NEW ERA

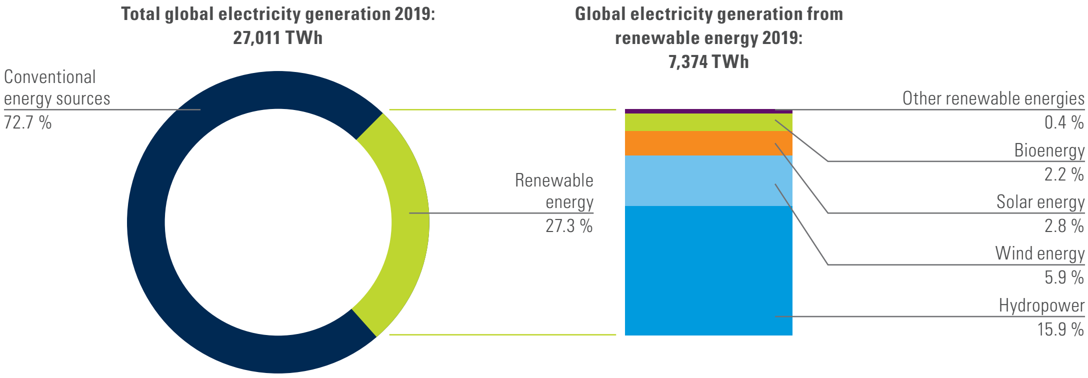
Climate goals will not be reached without electricity from renewable sources. But the shift to zero-emission electricity presents some formidable challenges.

The latest figures are encouraging and frustrating at the same time: according to the Renewable Energy Policy Network, renewables now account for 27.3 percent of total electricity generation worldwide. This is another encouraging gain – but the road to a completely emission-free energy supply remains long.

According to IRENA, the International Renewable Energy Agency, more than 85 percent of global electricity generation must come from renewable sources if climate targets established by the United Nations are to be met. This is feasible, according to IRENA, but only if the use of renewable energy increases at least sixfold compared to current government plans.

Such an increase would depend on further accelerating the already impressive progress made and significantly stepping up decarbonization efforts. The share of electricity in total energy consumption would have to rise from 20 percent today to almost 50 percent by 2050. This can only succeed if existing infrastructure is completely rebuilt and innovative technologies are used to take full advantage of the potential offered by renewable energies. IRENA lays out how this can be achieved in its “Roadmap to 2050”.

The status quo



Source: REN21: Renewables 2020 Global Status Report; REN21 Secretariat, Paris, 2020 [58]

THE IRENA ROADMAP

The International Renewable Energy Agency (IRENA) is an intergovernmental organization that helps countries transition to a sustainable energy future and serves as a central platform for international cooperation and as a center of excellence. Its objective is to promote all forms of renewable energy including bioenergy, geothermal, hydropower, marine, solar and wind as well as to ensure energy access, energy security and low-carbon economic growth.

IRENA roadmap

WITH THE POWER OF WATER

Hydropower is by far the largest source of renewable energy in the world. Stephan Ebner, Head of the Hydropower Business Unit at Bilfinger Industrial Services Austria, explains what potential hydropower still has for the future – and what challenges exist in the construction and modernization of hydropower plants.

Mr. Ebner, we have been using hydropower to generate energy for centuries. Does hydropower still offer potential for the future?

Absolutely! The power of water is already being used in many ways, but there is still a significant amount potential. Simply modernizing and expanding existing hydropower plants can considerably increase the amount of electricity generated with hydropower today. And because hydropower – unlike photovoltaic or wind power – has been around for such a long time, the technology is profitable for utilities even without subsidies. I would therefore expect hydropower to continue to play a very important role in the global energy mix in the future.

What are the challenges being faced in the expansion of hydropower as a renewable energy source?

The greatest potential for using hydropower lies in mountainous regions. There, however, construction or modernization of hydropower plants brings with it a wide range of challenges: work often takes place at high altitude or in rough terrain – sometimes it can only be carried out by cable ropeway, inclined elevator or using helicopters. Meter-thick pressure piping that weighs several tons has to be laid, which requires the use of heavy equipment. For this reason, construction and inspection projects in the hydropower sector are usually very time-consuming. Even a modernization can often take several years.

In what regions is investment in hydropower currently highest?

In Europe, most activities are currently taking place in the DACH region – primarily in Austria and Switzerland – as well as in France and Spain. We are also involved in the construction of various new power plants in South America. There are many interesting hydropower projects that are scheduled to get underway in the years ahead, particularly in Chile, Peru and Venezuela.

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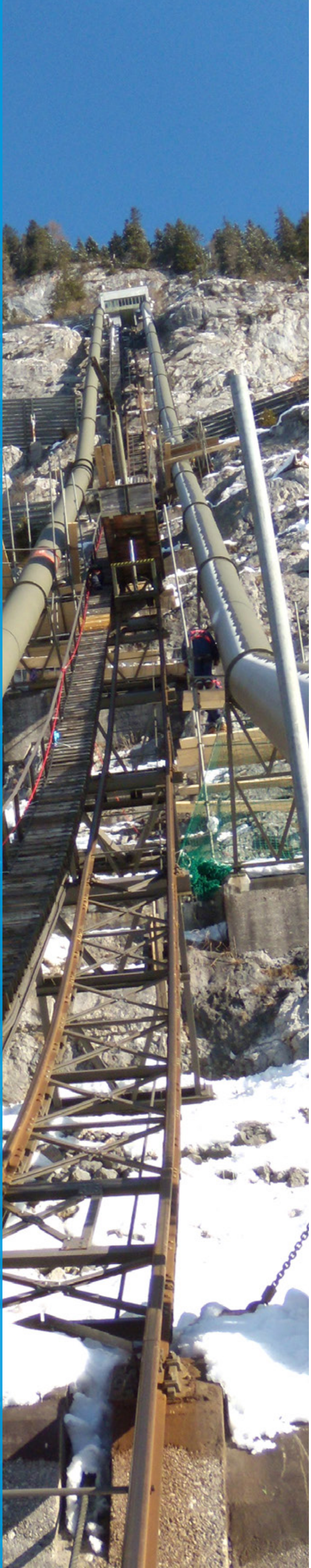

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POWER-TO-X

THE MISSING LINK

A climate-neutral supply of energy can only be achieved when it is possible to store and transport electricity from renewable sources. Power-to-X processes – and hydrogen technology in particular – could prove to be the missing link.

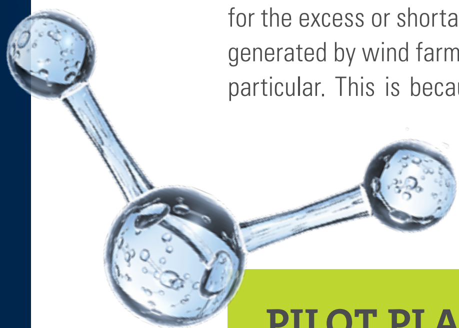
Power-to-X is generally understood to mean various technologies for storing renewable energies. These technologies include power-to-gas and power-to-liquid processes in particular. The processes use renewable electricity to produce climate-neutral hydrogen by means of electrolysis. In further process steps, this hydrogen is also processed into fuels that can be used as energy sources for various purposes.

These processes make it possible to store and transport electricity from renewable sources – without generating harmful emissions. They compensate for the excess or shortage of energy that is inevitably generated by wind farms and photovoltaic systems in particular. This is because wind energy can only be generated when it is windy and solar energy can only be generated when the sun is shining – and not necessarily when energy is needed.

The flexibility of hydrogen

Hydrogen, which is produced within the framework of a power-to-gas process, is regarded as having the greatest potential here. “Hydrogen technology is by no means new,” says Ulrich Trebbe, Head of Sales at the Engineering and Plant Construction unit at Bilfinger in Germany. “For decades, people have been using hydrogen in the refining of crude oil, for example, or for the production of ammonia or methanol. So far, however, it is mainly gray hydrogen that has been used, the production of which generates CO_2 emissions.”

For this reason, green hydrogen production needs to be expanded. Green hydrogen is produced with zero emissions using renewable energies, thus enabling



PILOT PLANT FOR THE STORAGE OF GREEN ELECTRICITY

Uniper operates a pilot plant for the storage and transmission of wind energy in the German municipality of Falkenhagen. The process uses electrolysis to produce green hydrogen that was fed directly into the gas grid in the first years of the pilot plant. Today, hydrogen is mixed with carbon dioxide from a bio-ethanol plant to convert it into methane, or synthetic natural gas. Bilfinger supported construction of the power-to-gas plant and supplied both the control system and data storage. Bilfinger was also responsible for the pipeline leakage monitoring system and the remote control of dispatching.

a completely CO_2-free supply of hydrogen. Industry is considered one of the most important areas of application for green hydrogen: with its help, it would be possible to drastically reduce current CO_2 emissions in the process industry, especially in the metal, chemical and cement industries.

Unanswered questions

Production of green hydrogen still poses many challenges, however. “Hydrogen does not occur in nature in a pure form and must therefore be produced using significant amounts of energy,” Trebbe says. “Therefore, to be able to produce enough green hydrogen, large amounts of renewable energy must be available.”

Transporting and storing hydrogen is also not problem-free by any means. “Hydrogen molecules are particularly small and light. As a result, they diffuse through most materials,” Trebbe explains. “This poses a unique set of challenges for pipeline systems and process plants in which hydrogen is to be transported and treated.”

Huge benefits for the future

Hydrogen technology is therefore far from mature at this point. A number of research projects have been initiated around the world to take advantage of the enormous potential of green hydrogen and to be able to produce it on an industrial scale. But there is a lot of confidence among the experts. “I am absolutely convinced that green hydrogen will grow to become a key component of efforts to reduce our carbon footprint – both in industry and in everyday life”, Trebbe says. “We are only at the beginning of this development. Green hydrogen will become an everyday fuel in the foreseeable future, just like natural gas is today.”

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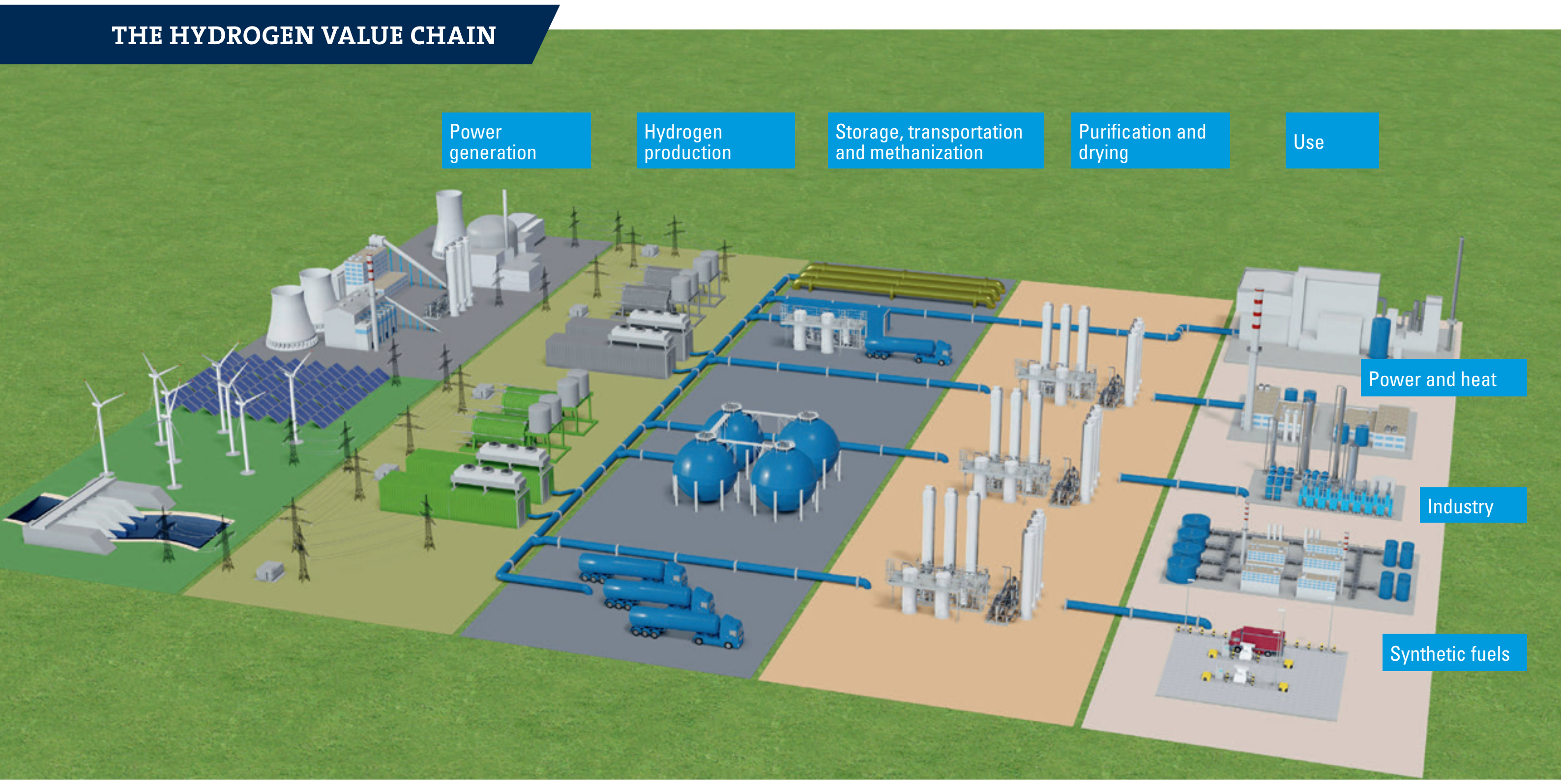
THE HYDROGEN VALUE CHAIN



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CCU/CCS

A KEY COMPONENT FOR THE ENERGY TRANSITION?

To achieve the goal of climate-neutral industry, there are many who are pinning their hopes on carbon capture, utilization and storage. Using this approach, heavy industry in particular can significantly reduce its relatively high emissions.

In addition to utilities and the transport sector, industry in particular produces considerable amounts of CO_2. Roughly a quarter of CO_2 emissions produced by industry can be traced back to production processes such as those in iron and steel production, lime and cement production or in basic chemicals. According to experts, these so-called process emissions, which are difficult to avoid, are among the greatest impediments to climate-neutral industry.

CCU and CCS technologies can make a significant contribution to overcoming this challenge: carbon capture and utilization (CCU) and carbon capture and storage (CCS) which focuses on the safe and permanent storage of CO_2 in deep geological rock formations. Both technologies have in common the initial capture of emissions, their purification and preparation for transport. "Carbon capture is particularly suitable for large industrial plants, because here it is difficult to fully replace fossil fuels in the foreseeable future," says Massimo Pardocchi, Global Development Director Projects at Bilfinger. For the subsequent transport – preferably through a pipeline for safety and economic reasons – capture itself is not the only important factor: "For the gas mix to start the journey to its destination, it must also be strongly compressed using liquefaction and/or cooling," says Pardocchi.

Wide range of possible uses

If the CO_2 is to be utilized further (CCU), very different recipients come into consideration. While in Germany, for example, it is mainly the chemical industry that depends on a supply of carbon, in the Netherlands significant quantities of CO_2 are also delivered to greenhouses. Carbon can also be captured in waste-to-energy plants and utilized for the production of sodium bicarbonate, which is required in the flue gas cleaning process: "This can both save valuable raw materials

STORAGE OF CO_2 UNDER THE NORTH SEA

Several countries bordering the North Sea, including Norway, the Netherlands, Belgium and the UK, have launched pilot projects to store CO_2 under the North Sea floor. One of the world's largest and most advanced projects of this kind is the Porthos project: a facility is currently being built in the port of Rotterdam to combine carbon emissions captured by industry, compress, transport and store them in gas fields under the North Sea that are no longer in use. Bilfinger is providing various services for the Porthos project, including development of a simulation model for the complete system and also supporting the engineering for parts of the project.

> CCU technologies can save valuable raw materials and reduce carbon emissions."
>
> MASSIMO PARDOCCHI, GLOBAL DEVELOPMENT DIRECTOR PROJECTS & KEY ACCOUNT MANAGEMENT, BILFINGER

and reduce carbon emissions," says Pardocchi. There is also promising experience with the reuse of CO_2 in the production of alternative fuels, plastics and chemicals: "All these alternatives are contributing to the ultimate goal of a future circular economy where CO_2 is produced, captured and recycled back to the market."

Suitable sites for permanent carbon storage (CCS) include depleted oil and gas fields that would otherwise be shut down by the operating companies as well as rock layers containing salt water – so-called saline aquifers. They are located in the geological subsurface at a depth of about 1,000 to 4,000 meters. In Europe, the largest storage capacities are located beneath the North Sea and the Norwegian Sea: they have natural geological structures and combined offer enough space for the storage of more than 200 billion tonnes of CO_2.

Increasing requirements for carbon-neutral production

Whether and to what extent this potential will be used in the future is currently still the subject of pilot and research projects as well as climate policy discussions in many European countries. "The fact is that requirements for carbon-neutral production are increasing and society must face up to this problem," says Pardocchi. "And because we are already obligated to achieve a significant CO_2 reduction in 2030, immediate action is needed. CCS is most certainly one solution that can be implemented directly, and such an implementation is important, as is the avoidance of emissions and the use of carbon-free fuels such as hydrogen," the Bilfinger manager is convinced. "For this reason, it is recommended that operators of larger industrial plants in particular take a close look at this technology, evaluate its potential and derive roadmaps for its possible use."

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