03.2020

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Energy islands: Exploring the North Sea's potential

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Power to gas: How wind energy is transformed into green methane

we can

HYDRO-NEXT-GEN

How industry can benefit from tomorrow's technology

BILFINGER

Hydrogen has the potential to make an entirely carbon-neutral power supply a reality.

ENERGY TRANSITION

HYDROGEN TECHNOLOGY FOR THE FUTURE

Hydrogen technology is playing a key role in the energy transition. With its integrated solutions, Bilfinger is driving this evolution and helping industrial companies to retrofit their plants and processes for tomorrow's energy supply.

In his novel *The Mysterious Island*, published in 1870, Jules Verne wrote that "water will one day be employed as fuel." He further predicted that by using electricity to split it into hydrogen and oxygen, these two elements would provide power on the planet indefinitely.

A hundred and fifty years later, his vision looks set to become reality. Because hydrogen could play a leading role in making a success of the energy transition. Hydrogen makes it possible to store and transport energy so that it can be used anywhere. If produced with renewable energy, the resulting "green hydrogen" could act as fully carbon-neutral fuel source.

This is why a number of initiatives promoting hydrogen technology have been launched in recent years. Within the framework of the European Green Deal, the European Commission has also defined a hydrogen strategy, after individual member states had already prepared national action plans and batteries of measures. This is currently an incredibly dynamic market.

A key application area for hydrogen technology is industry. For several decades now, it has been harnessed – albeit as gray hydrogen – in reforming crude oil as well as producing ammonia and methanol, among other things. If gray hydrogen can be successfully replaced by green hydrogen in the future, this would help to drastically reduce the current process-related CO_2 emissions. What's more, green hydrogen could also be employed in carbon-neutral steel production. Exploiting hydrogen technology would also help other industries, including chemicals and concrete, with decarbonization by reducing their process-related emissions.

In order to make the most of all of hydrogen technology's benefits, existing infrastructure will, however, need to be adapted on both the supplier and consumer sides. On this front, Bilfinger offers its customers a broad spectrum of solutions ranging from assisting with hydrogen production, through storage and distribution, to its use. Products and services specifically created for this purpose facilitate industrial-scale hydrogen production, storage, transport and on-site supply.

"As Europe's biggest industrial services provider, we are able to provide services at every link in the hydrogen value chain," says Tom Blades, Chairman of the Executive Board of Bilfinger SE. "We are already actively involved in numerous hydrogen projects and processes, providing customers with consulting and engineering, plant construction as well as inspection and maintenance services. Hydrogen is the energy source of the future. That's why we will continue to significantly expand our range of solutions in this field going forward."

There is a lot of overlap between hydrogen technology and fields such as renewable energy, power to gas, carbon capture and storage as well as many more. "As far as possible, we aim to serve as a single source for all of our clients' needs," says Blades. "This is why we have incorporated our hydrogen-related activities into our energy transition services. That way, we can be sure to always provide integrated, forward-looking customer solutions."

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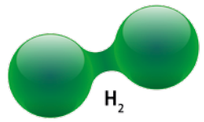
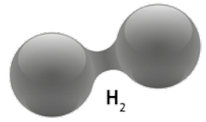
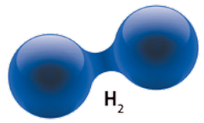
HYDROGEN COLORS



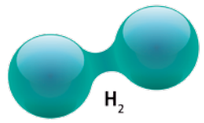
Green hydrogen:
Produced using renewable power to electrolyze water. It currently accounts for around 4 percent of global hydrogen production.



Gray hydrogen:
Derived from steam-methane reforming, partial oxidation or fossil fuel gasification. It currently accounts for around 95 percent of global hydrogen production.



Blue hydrogen:
Gray hydrogen where the carbon emissions have been captured and stored.



Turquoise hydrogen:
Produced through methane pyrolysis.

3 questions for … Ulrich Trebbe

Ulrich Trebbe is head of H2 sales at Bilfinger EMS

Mr. Trebbe, how important do you believe hydrogen technology is for the future?
Green hydrogen is poised to become increasingly important in the coming years. It will be a mainstay for reducing our carbon footprint – both in industrial applications and in daily life. At the moment, it's still early days for this development. But there are already industrial-scale projects that will go a long way to cutting carbon emissions released during the burning of fossil fuels. In the foreseeable future, hydrogen produced from non-fossil sources will be as common a fuel as natural gas is today.

How can Bilfinger support its customers in transitioning to hydrogen technology?
Today, Bilfinger is already advising its customers on investing in green hydrogen. From the early engineering stages, we can walk customers through selecting the right technology and integrating it into their systems. Once the investment decision has been made, we guide them through implementation or take full responsibility for delivering a turnkey project. After commissioning, we continue to assist customers by providing maintenance services or, if necessary, operating the facility.

What is Bilfinger's special area of expertise in this field?
Bilfinger has a presence in many countries around the world, so we are always close to customers. This is especially important when operating a plant over many years. Thanks to our extensive experience in maintenance, these insights are incorporated into plant design from the engineering stage. That means we are able to keep operating costs to a minimum. What's more, we see ourselves as systems integrators, who dovetail hydrogen production with existing customer plants.

Cover: Shutterstock; Photos: iStockphoto, Shutterstock, Bilfinger

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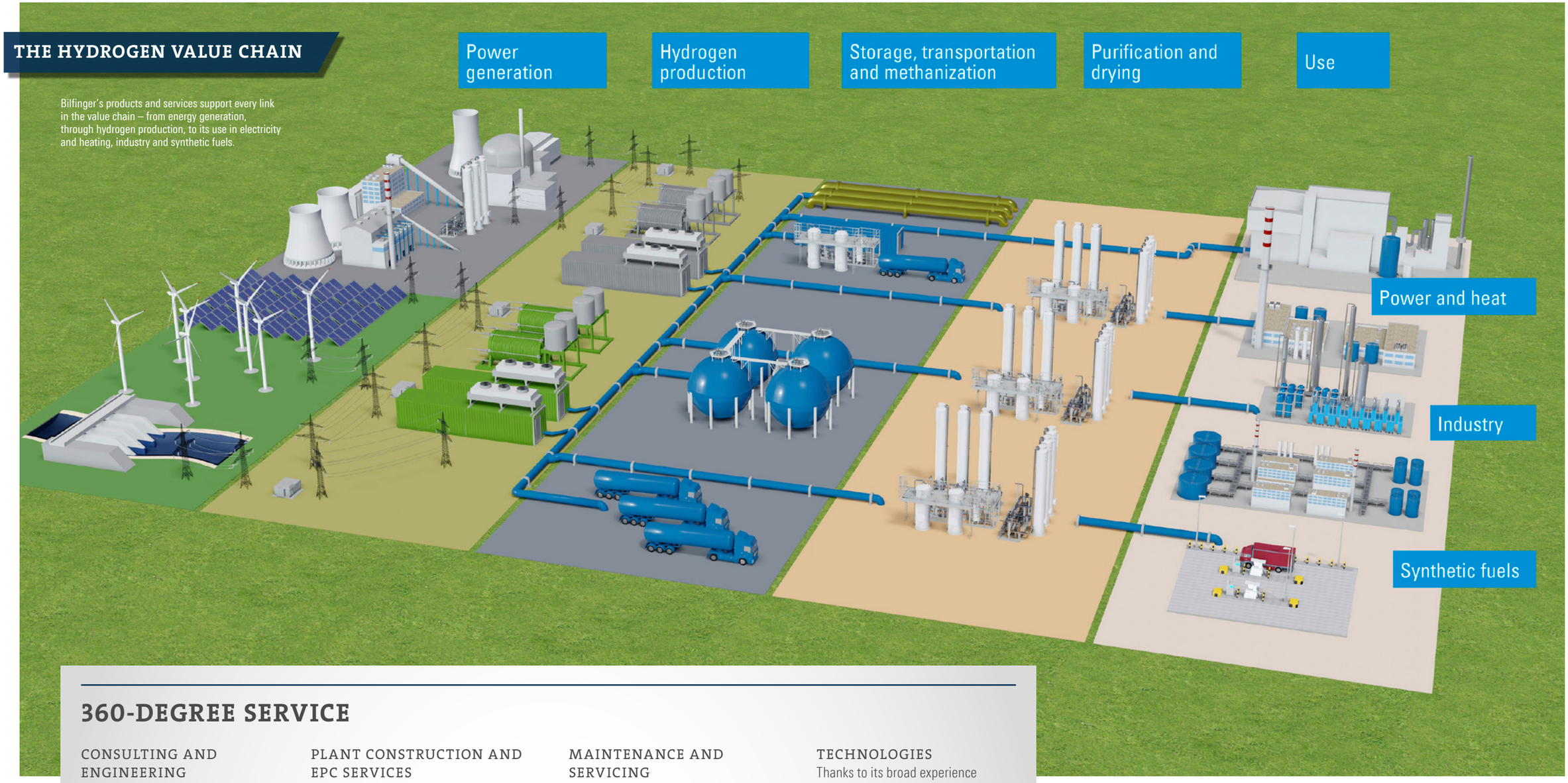
THE HYDROGEN VALUE CHAIN

Bilfinger's products and services support every link in the value chain – from energy generation, through hydrogen production, to its use in electricity and heating, industry and synthetic fuels.



360-DEGREE SERVICE

CONSULTING AND ENGINEERING

From concept to basic engineering: Bilfinger supports production facility owners, gas distribution and storage operators as well as hydrogen users in planning, developing and calculating ROI on their facilities. The service range spans feasibility studies to conceptual and basic engineering. Our goal is to guide prospective customers by providing the best possible advice and highlighting alternatives throughout the plant planning phase.

PLANT CONSTRUCTION AND EPC SERVICES

Once the decision to invest in a plant or facility has been made, Bilfinger offers end-to-end EPC (engineering, procurement and construction) services for all aspects of the construction process. These include project management, detail planning, procurement and manufacturing as well as carrying out construction and installation work. On top of that, Bilfinger also takes on the task of integrating systems. Customers can therefore turn to Bilfinger as their single source for everything that goes into a turnkey project.

MAINTENANCE AND SERVICING

Once a plant has been built, it must be operated, maintained and its efficiency optimized. Bilfinger performs all maintenance and servicing – from plant operation, through on-call service, routine maintenance, turnarounds and calibration, to plant optimization. The company's leading position in this market translates into cutting-edge methods and insights.

TECHNOLOGIES

Thanks to its broad experience acquired over many years, Bilfinger boasts strong process expertise. From gas compression and plant optimization, through gas scrubbing, to plant management, the company's employees are skilled in the most varied processes and can evaluate process and component effectiveness and efficiency. This expertise is brought to bear across the spectrum of hydrogen production, transport and storage as well as industrial use.

Illustration: Bilfinger

"Our wide-ranging experience with hydrogen technology makes us an ideal partner to our customers."

TOM BLADES, CEO BILFINGER

RENEWABLE ENERGY

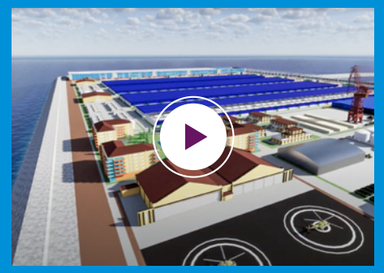
GREEN HYDROGEN FROM THE NORTH SEA

With the European Green Deal, the continent aims to be carbon neutral by 2050. The North Sea Energy program explores how much energy islands in the North Sea can contribute to this goal.

CONCEPT ANIMATION

ENERGY ISLANDS

How they work, in a nutshell



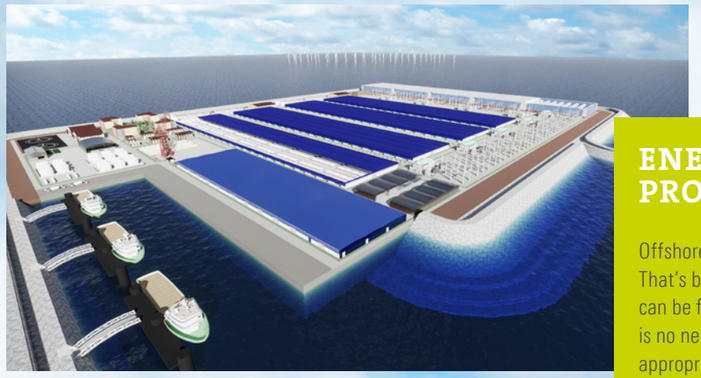
Looking ahead, will our power be generated on energy islands? What would they look like? And what potential does the North Sea hold in this regard? The third phase of the North Sea Energy program, which brings together over 30 organizations, companies and research institutes from countries bordering the North Sea, aims to answer those questions.

"Energy islands offer fascinating possibilities," says René de Schutter from Bilfinger Tebodin. "They provide a way to combine multiple energy production and storage technologies without the need for long transport routes and the losses they entail." Power generated on neighboring off-shore wind farms, for instance, can be immediately converted into hydrogen or used to produce methanol and ammonia. What's more, energy islands could facilitate CO_2 capture and storage in the North Sea.

HIGH WINDS GUARANTEED

"The North Sea is perfect for this," says de Schutter. "It's not particularly deep in many areas and strong winds are practically guaranteed." As part of a study conducted together with other companies and research institutions, René de Schutter and his team at Bilfinger Tebodin are exploring the North Sea's potential for integrated energy production and supply.

Within the scope of this study, Bilfinger Tebodin also designed a 2-gigawatt, 5-gigawatt and 20-gigawatt plant for large-scale production of green hydrogen on three islands respectively. In total, the team developed six different-sized hydrogen production facilities. "Units on this scale would bring us very close to reaching the EU's goal of carbon neutrality by 2050," says de Schutter. "So far, the findings gathered as part of the North Sea Energy program are very encouraging. Energy islands could well contribute significantly to the power supply of the future."



Short transport routes are a major advantage of energy islands. And the North Sea is an ideal location in this respect.

Illustrationen: North Sea Energy; Photo: Shutterstock

ENERGY ISLANDS FOR PRODUCING HYDROGEN

Offshore energy islands are currently a hot topic. That's because power generated at nearby wind farms can be fed directly into hydrogen production so there is no need to invest in expensive undersea cables with appropriate transmission capacities. Instead, the existing North Sea natural gas pipelines could be used to transport the hydrogen.

THE NORTH SEA ENERGY PROGRAM

The North Sea plays a key role in generating energy from renewable resources. It is not only a possible location for offshore wind farms and underground carbon storage but might also prove very important for hydrogen production.

In 2017, the North Sea Energy program was set up to explore the North Sea's potential as an integrated energy system. The program brings together more than 30 organizations, companies and research institutions. A number of projects and studies aim to research the advantages of combining wind energy, hydrogen and CO_2 storage in the North Sea. Furthermore, the public-private research program is testing innovative concepts in practice.

RESULTS AND STUDIES

Further information on the North Sea Energy program is available on the initiative's website. There, you can also read about the results of the study, which Bilfinger played a major part in conducting.

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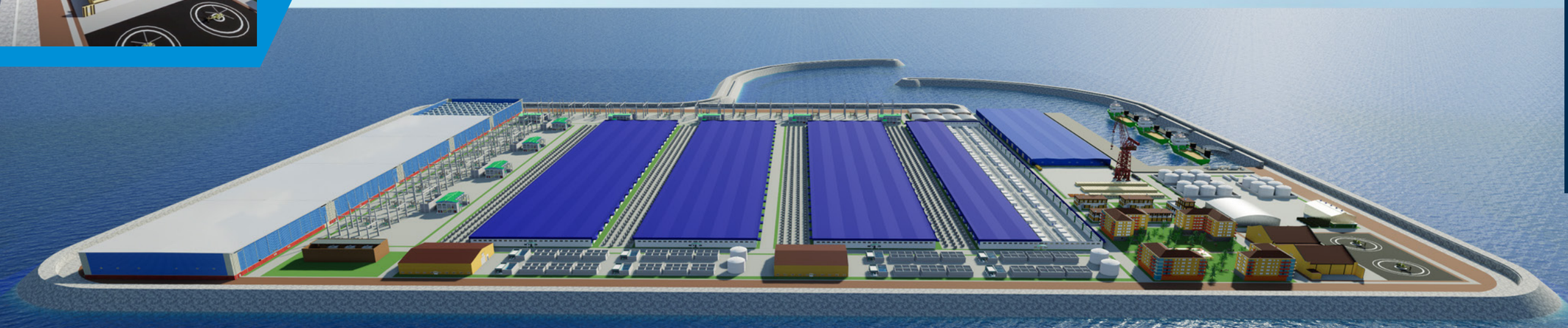

This is what the energy islands in the North Sea might look like. By harnessing various technologies for generating and storing power, they could play an important part in the energy transition.

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POWER TO GAS

HOW GREEN METHANE CONTRIBUTES TO THE ENERGY TRANSITION

Power from the sun and wind is abundant and carbon neutral. But what is produced often exceeds local demand. A pilot plant at Falkenhagen in the German state of Brandenburg aims to make storing the green energy possible. The operator is relying on Bilfinger's technical expertise to monitor and control the facility.

Tomorrow's energy storage system: In Falkenhagen, wind power is already being converted into green hydrogen today.

Germany's north-eastern Prignitz region features a wealth of wind and solar farms that produce large quantities of green power. There are, however, few industrial consumers in the area and the power often cannot be fed into the grid because of the risk of overloading it. That is why energy company Uniper chose this location for its pilot plant to trial storing and transmitting wind power. Bilfinger assisted with the construction of the power-to-gas facility by providing the control system and data storage devices. The company's responsibilities also included a leakage monitoring system for the hydrogen feed-in as well as remote access to dispatching.

As early as its first year of operation, the pilot plant used wind power to produce more than two million kilowatt-hours of green hydrogen via electrolysis. Thanks to a 1.6-kilometer-long pipeline, the hydrogen is fed directly into the gas grid.

The highly promising experience gained with the pilot plant ultimately resulted in a follow-up project. Now, the hydrogen is added to carbon dioxide from a bioethanol plant to create methane – a synthetic natural gas. As a result, the plant is capable of producing up to 1,400 cubic meters of synthetic methane per day. That's equivalent to 14,500 kilowatt-hours of power – enough for 200 natural gas-powered vehicles to travel about 150 kilometers each day.

Green methane's major advantage is that – compared to pure hydrogen – making it available to the electricity and heating market, to industry and also as a vehicle fuel is relatively straightforward. That's because it's easier to safely transport and store it using existing infrastructure.

With these kinds of facilities, Bilfinger's aim to serve as a one-stop shop really pays dividends, especially as many hydrogen production plants are initially designed and built as compact units that are then successively expanded following successful commissioning. Within a few years, a bigger gas treatment plant, more extensive piping, upgraded controls and system integration are needed. Bilfinger bundles all of these services into one performance package.

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GERMAN AEROSPACE CENTER

HIGH-PRESSURE HYDROGEN STORAGE FOR RESEARCH PURPOSES

The Cologne-based German Aerospace Center (DLR) is researching gases, including hydrogen, for energy technology. Internal and external aviation and energy technology partners can conduct tests under realistic conditions by mixing various gases under high pressure. Bilfinger joined forces with the German Aerospace Center to develop a 300-bar, high-pressure hydrogen storage solution. As part of the project, Bilfinger conducted feasibility studies, basic engineering and permitting as well as procuring materials and constructing the storage units.

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Photo: Uniper; Icons: nounproject

REFERENCES

GASUNIE

HYSTOCK PILOT PLANT

The 1-megawatt HyStock pilot plant converts green energy into hydrogen. Energy network operator Gasunie's first power-to-gas plant in the Netherlands is driving the onward development of the hydrogen market as well as research into new technologies. On the construction project, Bilfinger provided system integration services and the high-voltage power supply to the proton exchange unit. The company was also responsible for planning and laying piping systems as well as the hydrogen pipelines and tube trailers.

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AIR LIQUIDE

HYDROGEN MOBILITY

Near Rotterdam in the Netherlands, Air Liquide has built one of the first hydrogen filling stations open to the public. The station is connected to Air Liquide's European hydrogen pipeline network. Bilfinger was tasked with the engineering, coordinating approval of the filling station with the Dutch Ministry for Infrastructure and Water Management as well as construction.

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SIEMENS

GAS TURBINE TEST CENTER

Just outside German capital Berlin, Siemens runs a burner test center for gas turbines. It is dedicated to researching combustion processes under realistic conditions. One of the things Siemens needed to do this was a cryogenic hydrogen storage unit. Bilfinger was responsible for investment calculation, pre-basic engineering and permitting.

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