energy innovation austria

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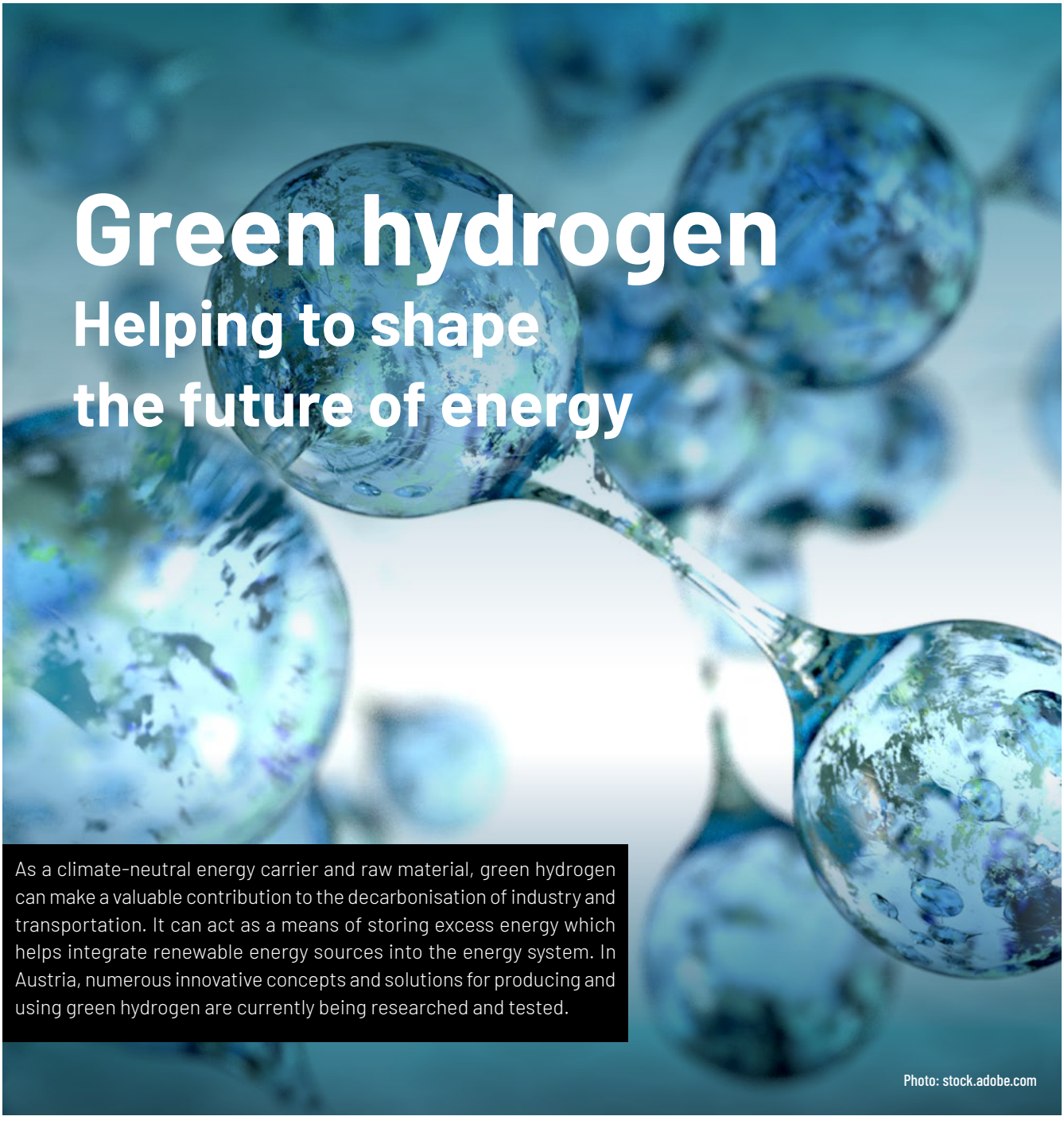
Current developments
and examples
of sustainable energy
technologies

klima+ energie fonds

Federal Ministry
Republic of Austria
Climate Action, Environment,
Energy, Mobility,
Innovation and Technology



Green hydrogen

Helping to shape the future of energy

As a climate-neutral energy carrier and raw material, green hydrogen can make a valuable contribution to the decarbonisation of industry and transportation. It can act as a means of storing excess energy which helps integrate renewable energy sources into the energy system. In Austria, numerous innovative concepts and solutions for producing and using green hydrogen are currently being researched and tested.

Photo: stock.adobe.com

Green hydrogen and fuel cells

Key technologies on the path to climate neutrality

Photo: stock.adobe.com

To date, hydrogen has primarily been produced from fossil raw materials (natural gas and coal). The production of this "grey hydrogen" releases 230 to 318 g of CO_2 emissions per kWh of hydrogen generated. If the CO_2 is largely separated by the application of energy, it is called "blue hydrogen", and the emissions typically range from 23 to 150 g of CO_2 per kWh. Then the separated CO_2 can be used either as a raw material or stored in geological formations. "Green hydrogen" is produced when renewable energy sources are used, such as electrolysis (splitting water into hydrogen and oxygen using renewable electricity), photolysis (direct splitting of the water using solar energy) or the gasification of biomass. In 2018, the global demand for hydrogen was roughly 115 million tonnes. Of this, 40% was obtained as a by-product of industrial processes, while 60% was intentionally produced. At the moment, only 2% originates from the electrolysis of water, and 0.7% is produced based on renewable energy sources or fossil energy with CO_2 separation.[1]

The production of green hydrogen gives rise to new opportunities to increase the security of our energy supply and reduce our dependence on fossil imports. Renewable hydrogen, both as an energy carrier and as a raw material, also plays an important role in the decarbonisation of diverse consumption sectors, especially energy-intensive industries and transportation.

STORING RENEWABLE ENERGY

The conversion of energy with the help of power-to-gas technologies opens up many options for future integrated energy systems and enables a coupling of the electricity, heat and mobility sectors. Surplus wind and solar power is converted by electrolysers into hydrogen, which can be transported and stored in the existing natural gas infrastructure. Alongside the long-term storage of renewable electricity in the natural gas grid, H_2 has many other uses, such as supplying energy for the production of electricity and heat (by reconversion in stationary fuel cell systems or in gas engines) or as a fuel to be used in transportation.

With fuel cell technologies, the energy stored in hydrogen can be made useful again. In an electrochemical process, the chemical energy is converted directly into electrical energy or heat. The avoidance of any intermediate steps (such as steam generation, turbine, generator) makes fuel cells very efficient.

RESEARCH AND DEVELOPMENT

Technologies for hydrogen production and use have made great strides in recent years. Intensive research in this area is under way in Austria, and pioneering concepts and solutions are being developed and implemented.

Hydrogen technologies are viewed as an important part of achieving Austria's goal of "climate neutrality by 2040". The Austrian federal government has outlined a national hydrogen strategy as part of its policy programme. Hydrogen research and technology development should be promoted in particular for the industry and transportation in order to make Austria an innovation leader and the number one nation in hydrogen. In the mobility sector the Austrian Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) sees the main area of application for H_2 and fuel cells in heavy vehicles and special purpose vehicles. ●

[1] Source: VCÖ fact sheet, transportation news 2020-02

”Sector coupling is not just a catchword; its implementation will be essential for the successful reduction of greenhouse gas emissions around the world. Solutions that integrate the areas of energy, mobility and industry will be in high demand. Hydrogen and climate-neutral gases will play a key role here. As a European energy hub and a nation with a strong industrial sector, Austria can play a leading role in many areas. The projects in the Hydrogen Initiative Energy Model Region Austria Power & Gas (WIVA P&G) are tasked with developing the necessary technologies and implementing them in demonstration projects.“

PROF. HORST STEINMÜLLER
ENERGY INSTITUTE JKU LINZ / GENERAL MANAGER WIVA P&G

Photo: Energy Institute JKU Linz

IEA HYDROGEN TECHNOLOGY PROGRAMME

Austria has been participating since 2018 in the International Energy Agency (IEA) programme TCP (Technology Collaboration Programme) Hydrogen. This technology programme is intended to accelerate the use of hydrogen technologies by coordinating activities at the international level in the area of analysis, applied research and communication. The research topics include the production and storage of hydrogen, safety, power-to-x technologies (gas, heat, liquid) and possible hydrogen applications in the areas of energy and mobility.

https://nachhaltigwirtschaften.at/en/iea/

MISSION INNOVATION CHALLENGE 8

Austria is a member of the global research alliance Mission Innovation (MI), which was founded by leading countries in the field of energy technology to fight climate change and advance the development of clean energy technologies. The Mission Innovation Challenges promote global research efforts to create a sustainable energy future. Challenge 8 “Renewable and clean hydrogen” is dedicated to the research, development and demonstration of green hydrogen technologies. The goal is to overcome technological hurdles to the production, distribution, storage and use of H_2 at the gigawatt scale and to create a cost-effective hydrogen value chain. This should accelerate the establishment of a global hydrogen market.

www.mission-innovation.net

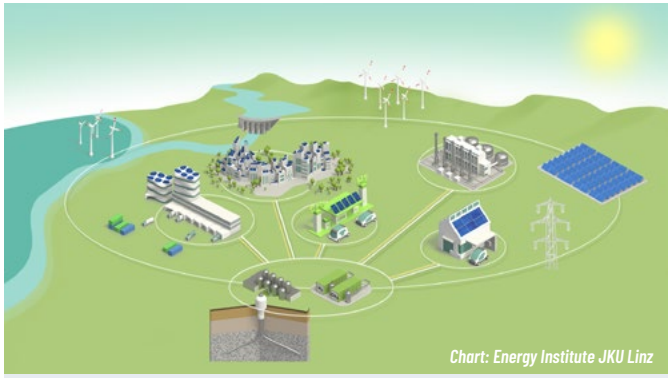


Chart: Energy Institute JKU Linz

THE WIVA P&G ENERGY MODEL REGION

The “Hydrogen Initiative Energy Model Region Austria Power & Gas” (WIVA P&G) is pursuing the goal of demonstrating the transition of the Austrian economy to a largely CO_2-neutral structure, with the production and use of renewable hydrogen as a key component of this plan in the sectors of energy, industry and mobility. The research association WIVA P&G engages and coordinates work to realise the model region, which spans Austria and enjoys international visibility.

WIVA P&G compiles and networks the experience gained from more than 30 completed and ongoing projects, and is planning the implementation of at least 25 future subprojects as well as the integration of additional projects. Within this framework, the entire value chain – from the production and storage of green hydrogen to its chemical conversion to methane or other hydrocarbons, as well as burning and reconversion – is being analysed, developed and demonstrated in various applications and processes.

www.wiva.at

KEYTECH4EV

Electric mobility with a fuel cell-battery hybrid

100 kW
electric motor

0.8 kg/100 km
hydrogen consumption

~4 kg hydrogen
for 500 km range

~3-minute
hydrogen fuelling time

The goal of the Keytech4EV project was to develop a highly efficient, cost-optimised and CO_2-free propulsion (drive) design for electric vehicles based on hydrogen fuel cells and battery technology. A demonstration vehicle with a hybrid fuel cell-battery drive developed by the Keytech4EV consortium[1] under the direction of AVL was presented at the start of 2020. The technology is of particular interest for heavy vehicles such as trucks and buses as well as for special purpose vehicles. This is also where the BMK has placed its strategic focus.

INNOVATIVE COMBINATION OF TWO TECHNOLOGIES

The best technology available at present consists of vehicles with large fuel cell systems and very small buffer batteries, or vehicles with purely battery-driven electrical systems. The innovative approach of Keytech4EV lies in combining these two technologies into a complete system that takes advantage of many synergies. Preliminary studies showed that a fuel cell-battery hybrid could reduce drive system costs significantly compared with pure fuel cell systems or pure battery solutions, while also better satisfying all efficiency and driving performance requirements. In addition, the fuel cell-battery hybrid offers the advantage of a large range and short fuelling times. The disadvantages of purely battery-powered electric vehicles, such as limited range and long battery charging times, are thus avoided.

CROSS-SECTOR EXCHANGE OF EXPERTISE

In a project consortium the industrial powertrain developer AVL List GmbH worked together with three component and subsystem manufacturers as well as several research institutions.[1]

Hoerbiger developed the hydrogen injection valve and collaborated with HyCentA to design the passive hydrogen recirculation. Magna contributed the hydrogen tank for the centre tunnel and the hydrogen tank system. HyCentA handled the calculation and simulation of fuelling procedures. ElringKlinger further developed a fuel cell platform to achieve 70 kW of fuel cell output. The Graz University of Technology assisted with investigating the service life of the vehicle systems.

Demonstration vehicle,
Photo: Climate and Energy Fund/APA-Fotoservice/Ferlin-Fiedler

Left: Hydrogen tank, Photo: AVL List GmbH

Right: Demonstration vehicle, Photo: Climate and Energy Fund/ APA-Fotoservice/Ferlin-Fiedler

AVL developed the entire fuel cell system, including its regulation and, in cooperation with IESTA, the fuel cell cooling system. The Vienna University of Technology developed a model for monitoring the condition of the fuel cells during operation.

HYBRID DEMONSTRATION VEHICLE

All core technologies at the system and vehicle level were integrated into the vehicle by AVL and validated. The heart of the Keytech4EV drive is a 70 kW fuel cell, which allows the vehicle to reach its maximum speed and climbing ability. This is combined with a battery with about 10 kWh capacity for maximum efficiency, excellent acceleration and good driving performance.

KeyTech4EV is making an important contribution to the development of a national and European value chain for fuel cell technology. The participation of five major global vehicle manufacturers as associated partners highlights the innovation and market orientation of this project. ●

www.iesta.at/keytech4ev/

A standard mid-sized vehicle as an example should demonstrate the following:

- Energy efficiency corresponding to the fuel consumption of 2.5 L/100 km gasoline of a C/D mid-sized vehicle
- Reduction in power-train costs
- No CO_2 emissions during operation
- Range > 500 km
- Driving performance similar to comparable series production vehicles

Photo: Climate and Energy Fund/ APA-Fotoservice/Ferlin-Fiedler

”Thanks to the unique combination of a fuel cell with a deliberately larger battery, this project represents an important step towards high efficiency, attractive driving performance and a good cost balance with this first Austrian fuel cell vehicle in the form of a fuel cell-battery hybrid.“

PROF. HELMUT LIST,
CEO AVL LIST GMBH

Photo: AVL List GmbH

[1] **PROJECT PARTNERS**: AVL List GmbH (Project leader), MAGNA STEYR Engineering AG & Co KG, ElringKlinger AG, HOERBIGER Vienna GmbH, HyCentA Research GmbH, IESTA – Institute for Advanced Energy Systems & Transport Applications, Graz University of Technology – Institute of Chemical Engineering and Environmental Technology, TU Wien – Institute of Mechanics and Mechatronics

Photo: voestalpine

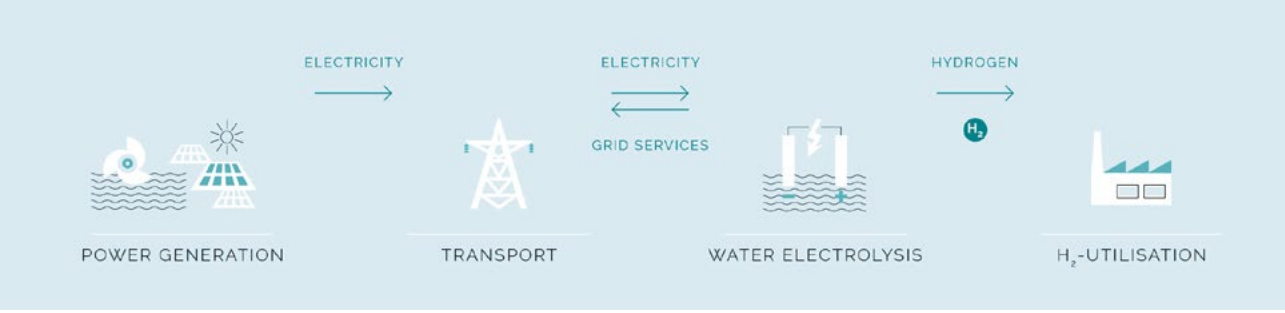
H2FUTURE

Green hydrogen pilot plant at industrial scale

H2FUTURE is a European flagship project concerned with the production of green hydrogen from renewable electricity for use in the steel industry. Coordinated by VERBUND and in cooperation with project partners voestalpine, Siemens and Austrian Power Grid, as well as research partners K1 MET and TNO, a proton exchange membrane (PEM) electrolyser was implemented at the voestalpine production site in Linz. The PEM electrolyser has a connected load of 6 MW and a production capacity of 1,200 cubic metres of green hydrogen per hour. The green hydrogen pilot plant has been in operation since November 2019.

RENEWABLE ENERGY IN INDUSTRY

The reduction of ore into raw iron takes place today largely in blast furnaces that use coke as a reducing agent. Although it is highly efficient, this method is associated with emissions of over one ton of CO_2 per ton of steel. The iron and steel industry is responsible for 30% of industrial CO_2 emissions worldwide. Intensive research is therefore being conducted into so-called breakthrough technologies in order to advance the integration of renewable energy in industrial processes. Green hydrogen has the potential to become an energy carrier of the future, contributing to industrial decarbonisation.



Production of green hydrogen – process graphic: VERBUND H2FUTURE project

Green hydrogen pilot plant, Photo: voestalpine

The H2Future project is exploring possibilities for replacing coke and coal with green hydrogen as the reducing gas. This could significantly lower CO_2 emissions in the steel industry. Electrolysis technology makes it possible to produce green hydrogen with electricity from renewable sources, which is then available as an environmentally friendly energy carrier for various applications in industry and the mobility sector, as well as an energy storage medium.

PROJECT GOALS

The goal of the project H2FUTURE is to test various "use cases" with the PEM electrolyser. In addition, the system's potential for providing grid services is being researched. Using demand-side management, the PEM electrolyser acts as a dynamic load-balancing component to help compensate fluctuations in the increasingly stressed power grid.

The insights from the project are of great significance not only for the steel industry. The research partners are also investigating the transferability of the findings to other industry sectors where hydrogen is used (such as the chemicals or fertilizer industries). Another aspect of the project is an analysis of the regulatory framework. For this purpose, the H2FUTURE consortium is in regular contact with the stakeholders and other hydrogen innovation projects. ●

Photo: voestalpine

EU FLAGSHIP PROJECT

H2FUTURE is a research project subsidised by the European Commission as part of the Fuel Cell and Hydrogen Joint Undertaking (FCH JU), start 1/2017, duration 4.5 years. This project was recognised in 2018 with the "FCH JU success story award".

More information:
www.h2future-project.eu

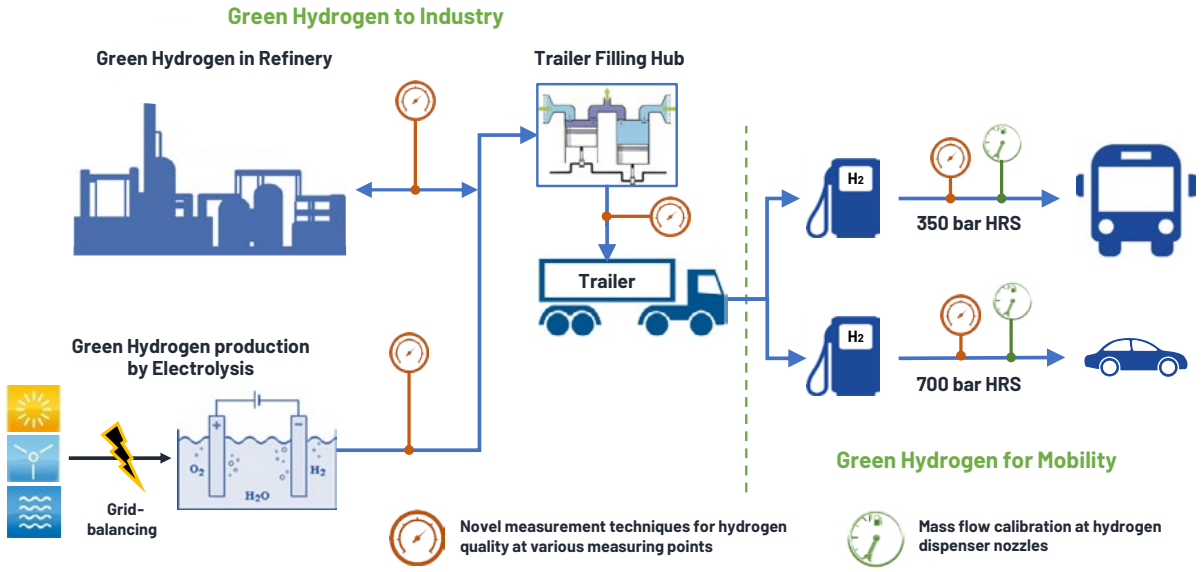


Chart: OMV

UpHy I&II

Upscaling of green hydrogen for industry and mobility

The goal of the project is to produce green hydrogen (H_2) through electrolysis at industrial scale for use in industry and mobility. It is intended to be used as fuel for public buses in the Vienna region, as well as for industrial use in the H_2 hub of the refinery, for uses such as the hydrogenation of CO_2 from waste gas flows to produce sustainable fuels.

Supplying the industrial and mobility markets with green H_2 is expected to achieve considerable synergies in the efficient utilisation of the necessary investments. Furthermore, the flexibility of the system, which consists of multiple H_2 consumers plus a highly responsive H_2 production system, should be leveraged to support a cost-optimised electricity (participation in balancing power markets). The construction of a large electrolysis plant of up to 10 MW is planned for this purpose. This is a unique size for Austria that is intended to demonstrate not only lower production costs but also the lowest downtimes and highest plant availability for commercial use in industry and mobility. In addition to the electrolysis system itself, the entire value chain is to be built, including H_2 purification, H_2 trailer loading, trailer logistics (using 300 bar trailers in Austria for the first time) and a high-availability, energy-optimised bus fuelling station.

The measuring technology developed in the preceding project UpHy I will be tested and optimised under real-world conditions to verify the level of H_2 quality required for H_2 mobility (as per ISO 14687-2) and calibrated metering at the fuelling station. The insights from the industrial operation and optimisation of the green H_2 value chain, in combination with the newly developed measuring technology, are the basis for a successful rollout of the efficient use of green H_2 in industry and mobility in the future.

In close cooperation between Austria's leading energy companies, OMV and VERBUND, the planning for implementation of the investments was completed in the project UpHy I. The innovative concepts for the H_2 logistics were coordinated with qualified partners. HyCentA Research GmbH and VF-Service GmbH developed new high-quality and calibratable metering technology. The Energy Institute at the Johannes Kepler University Linz is analysing how future H_2 mobility developments in Austria will effect the economy, society and the environment.

Declarations of intent were signed for the sale of the H_2 in the mobility market, although the binding purchase amounts are contingent on receiving the promised subsidies for the bus fleets. Partnering with WIVA P&G has ensured the integration of the project into the Hydrogen Initiative Energy Model Region Austria Power & Gas. ●

Photo: VERBUND

MICHAEL STRUGL

Vice Chairman of the Board of VERBUND

VERBUND is actively engaged in pioneering technologies to create an environmentally friendly energy system. What are the central challenges for ensuring a sustainable, competitive and affordable energy supply over the long term?

The climate crisis is one of the most central challenges of our time. We must respond and become climate-neutral as quickly as possible. The European Green Deal and the Austrian government policy programme define clear goals for doing this. Against this backdrop, the European energy system is experiencing a radical upheaval. Green electricity is the driving force of the energy future. Now we also need the appropriate infrastructure, clean technologies and usable products and services. To live up to these demands, everyone involved must rise to the challenge: this means policymakers as well as the energy industry and the various industrial sectors. We must blaze new trails and develop solutions that are fit for the future.

What role do research, development and innovation play in this regard?

Without innovation, a clean energy future will not be possible. VERBUND is setting standards in the energy economy and implementing flagship projects. We are going in new directions, taking advantage of market opportunities and developing innovative business models and services for and with our customers. In this way, we are developing forward-looking lines of business and strengthening our existing business. At VERBUND, we are working on innovative projects along the entire value chain: from generation and storage to the transmission, trading and sale of energy as well as services. However, the VERBUND innovation system depends on networking and the exchange of ideas. Together with research partners, innovative companies and start-ups, we are creating solutions that add value. Agility and flexibility are key factors here.

The production, storage and use of green hydrogen is an important research topic around the world. Does this energy carrier have the potential to become a key component of the energy system of the future?

Hydrogen produced using renewable energy sources offers tremendous potential as a replacement for hydrogen from natural gas, for reducing CO_2 emissions in industry and mobility and as a storage medium for wind and solar power. We are working with partner companies from industry as well as research institutes on a variety of production and utilisation methods. We believe that green hydrogen can make a decisive contribution to decarbonisation via sector coupling and integration.

What conditions are necessary to promote the use of green hydrogen?

To optimally realise the potential of green hydrogen, the regulatory framework must be adapted today. For Austria, a hydrogen strategy is under development. We expect this strategy to yield a clear commitment at the national level for the support of R&D and innovation projects in order to be able to implement large-scale demonstration projects in Austria.

HydroMetha

Coupling of high-temperature co-electrolysis and methanation

Conventional power-to-gas systems use electrolysis to convert water into hydrogen with the option of subsequent methanation. The lead project HydroMetha is focused on the optimisation and coupling of these two processes, with the goal of increasing the overall efficiency to >90%$_{el}$. Under the direction of AVL List GmbH,[1] a cutting-edge, fully integrated system for CO_2 + H_2O high-temperature co-electrolysis with solid oxide fuel cells (Co-SOEC) and catalytic methanation is under development. These two key technologies are being integrated at laboratory scale in a complete 10 kW$_{el}$ system for study and testing in sustained operation.

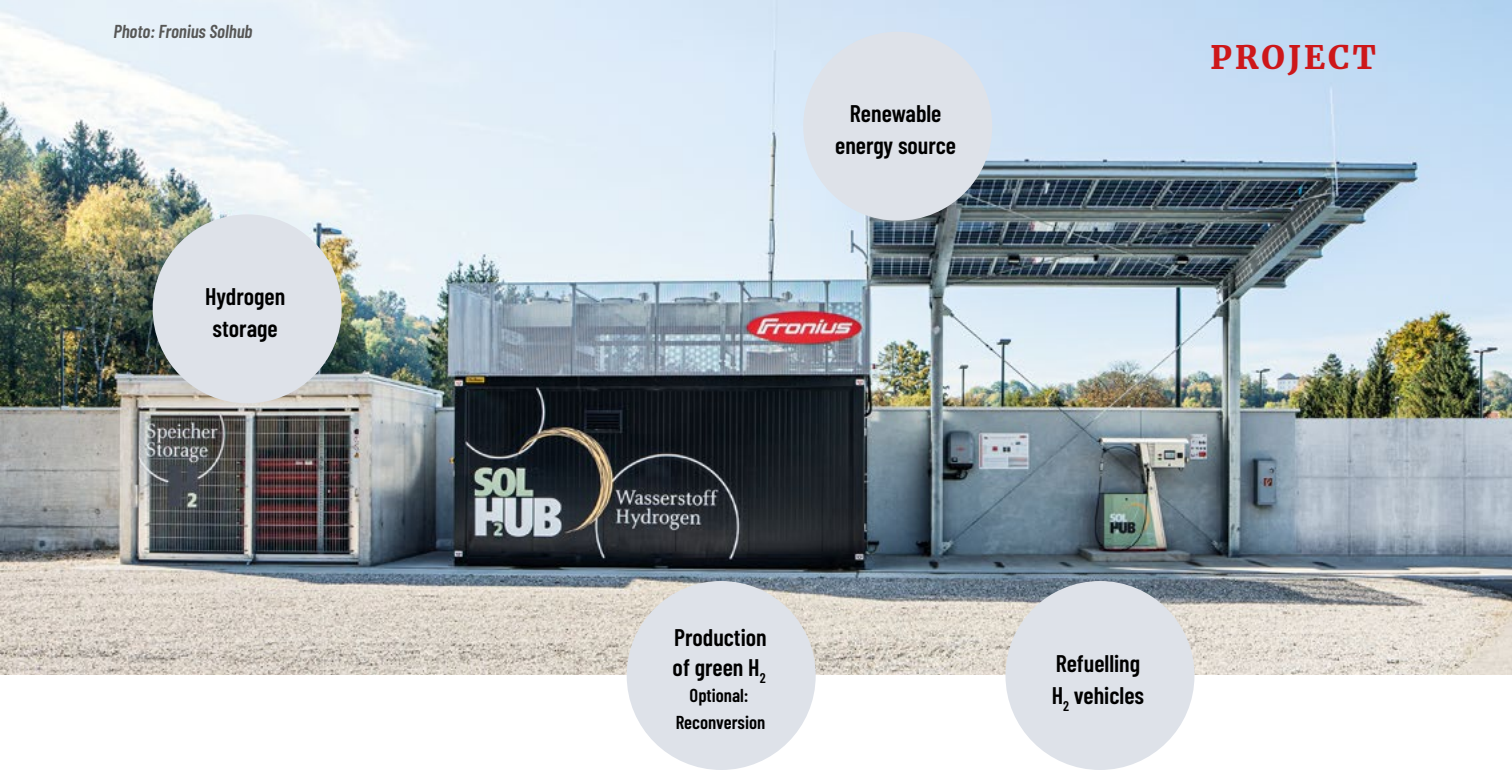
The key targets of this carrier are as follows:

- Highly efficient CO_2 sink via the conversion of CO_2 + H_2O into H_2 and CO in the developed Co-SOEC fuel cell with an efficiency of >90%
- Increasing the overall electrical Co-SOEC plus methanation efficiency compared to systems using low-temperature PEM electrolysis >30%
- Increasing the power density of the Co-SOEC cell by >100%
- Dynamic operation of the methanation in a load range between 20 and 120%
- Significantly improving heat management compared to systems without Co-SOEC, leading to a reduction of heat energy losses >50%

The aim is to establish a national and European value chain for Co-SOEC technologies. By simplifying the system, increasing its useable life and durability as well as optimising the entire process chain, researchers anticipate that costs will fall, resulting in great market potential for an integrated electricity storage system. ●

[1]**PROJECT PARTNERS:**
Fraunhofer - Institute for Ceramic Technologies and Systems, Energy Institute at Johannes Kepler University Linz, University of Leoben/Faculty of Physical Chemistry and Faculty of Process Engineering in Industrial Environmental Protection, Prozess Optimal CAP GmbH

Fig.: stock.adobe.com



FRONIUS SOLHUB

Local production, storage and use of solar hydrogen

For many years, the Austrian company Fronius International GmbH has researched and developed forward-looking solutions for the energy transition. In addition to having many years of experience as an internationally leading manufacturer of inverters for photovoltaic systems, the company is currently focusing intensively on seasonal energy storage systems and sector coupling. Fronius has been involved in hydrogen technologies for roughly two decades and has become an innovation leader in the handling of solar hydrogen. Green hydrogen enables the long-term storage of renewable energy while also representing a sustainable alternative to fossil fuels in the mobility sector.

The Fronius Solhub is an innovative system solution for local production, use and storage of green hydrogen. Using solar energy from a photovoltaic power plant, local green hydrogen is produced for refuelling vehicles and is stored on site. With the help of the PEM fuel cell, the hydrogen can be reconverted into electricity, if needed. This allows for seasonal storage of excess PV electricity produced in the summer for use in winter or to supply additional energy on days with low insolation levels. The waste heat generated in the electrolysis and fuel cell process can be captured with heat exchangers and used effectively (for heating process water or low-temperature heating). This increases the overall efficiency of the system.

The components for converting excess solar electricity into hydrogen via electrolysis as well as the stationary fuel cells (offered in a variety of output ranges) are developed in-house by the high-tech Austrian company Fronius. The system represents a sustainable energy and mobility solution for small-scale manufacturing and municipalities. The Fronius Solhub can be customised to specific applications and is both scalable and modularly expandable. ●

www.fronius.com

HYTECHBASIS 4 WIVA

Within the framework of the WIVA P&G – Hydrogen Initiative Energy Model Region Austria Power & Gas, Fronius International GmbH is working with Miba Sinter Holding GmbH & Co KG, HyCentA Research GmbH, Heraeus GmbH and the Energy Institute at the JKU Linz on the further development and optimisation of PEM electrolysis and fuel cell technology. The results will be integrated into the Fronius Solhub for practical application.

You can also visit us at:

www.energy-innovation-austria.at

INFORMATION

Keytech4EV
Electric mobility with a fuel cell-battery hybrid
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H2FUTURE
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UpHy I&II
Upscaling of green hydrogen for industry and mobility
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HydroMetha
Coupling of high-temperature co-electrolysis and methanation
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IEA TCP Hydrogen
nachhaltigwirtschaften.at/en/iea/
ieahydrogen.org

WIVA P&G – Hydrogen Initiative Energy Model Region Austria Power & Gas
www.wiva.at

Climate friendly production, FSC certified,
Green Seal and Austrian Eco Label

energy innovation austria presents current Austrian developments and results from research work in the field of forward-looking energy technologies. The content is based on research projects funded by the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology and the Climate and Energy Fund.

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