ENERGIE PARK MAINZ

A spirit of innovation is in the air!

Storing renewable energy
using hydrogen

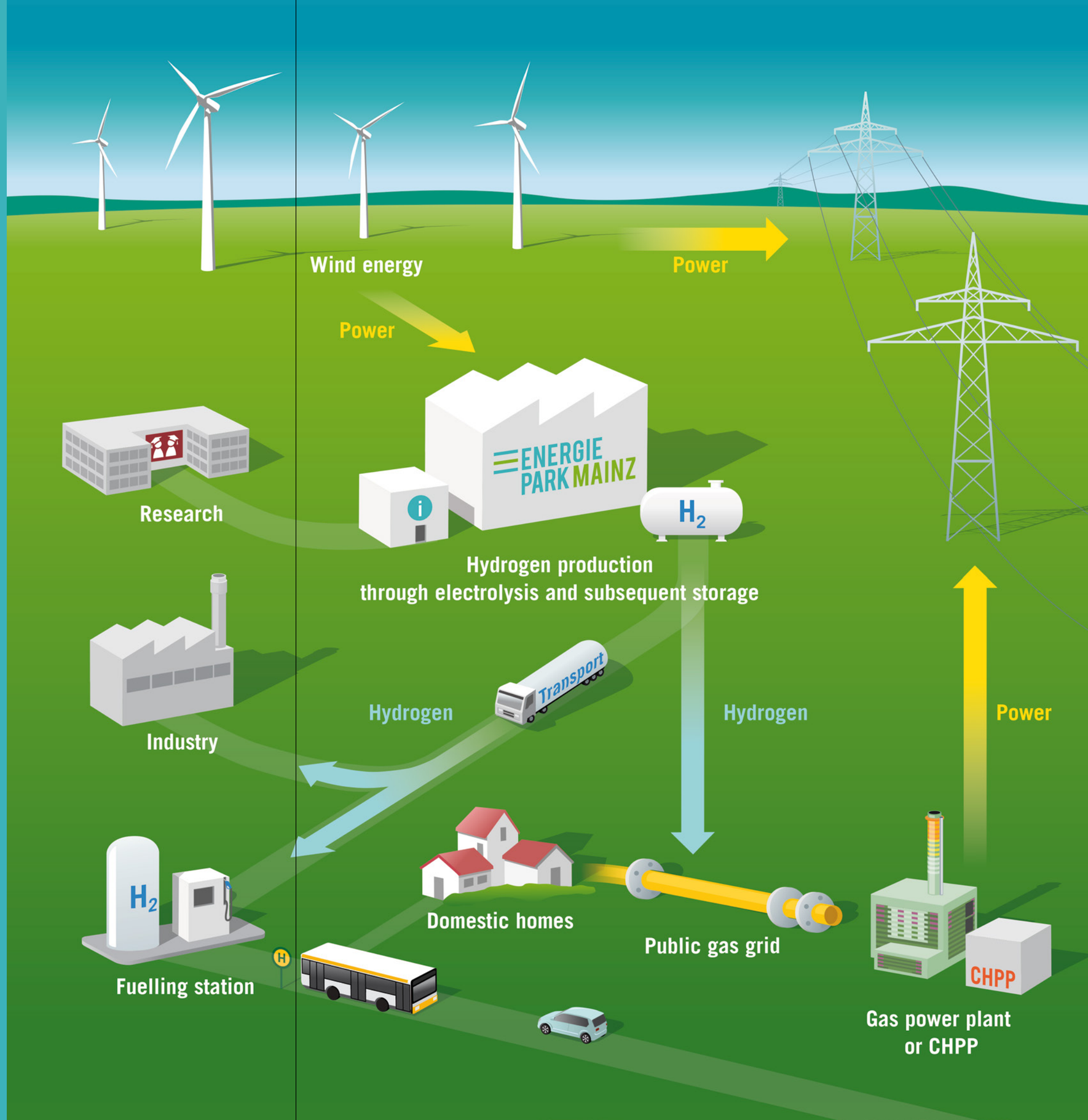
Unique research plant

Can a car be refueled with wind energy? Can renewable energies make us more independent from natural gas imports? Even when the wind is not blowing and the sun is not shining? Yes. We are convinced that all of this is possible already today. Therefore Mainzer Stadtwerke and The Linde Group together with Siemens and the RheinMain University of Applied Sciences developed the “Energiepark Mainz”. In this project, environmentally friendly electricity from renewable energies helps to produce green hydrogen since 2015. Hydrogen is a versatile source of energy that can be used in mobility, industry and energy applications.

Leading-edge technology

The energy transition requires a prompt advancement of environmentally friendly technologies and processes to convert and store energy. In this context the “Power-to-Gas”-process will play a significant role. The process aims at storing wind and solar energy by converting it to hydrogen or methane.

The erection and operation of a power-to-gas plant in an energy park specifically designed for the purpose places considerable requirements on the location infrastructure – including the interfaces between the energy park and wind turbine systems and the power and gas grids.



A hydrogen electrolysis system produces hydrogen from excess power

Setting new standards in hydrogen production via electrolysis

At “Energiepark Mainz” hydrogen is being produced by electrolysis. The energy necessary for this will partially be supplied by excess power of adjacent wind energy plants.

The plant works with up to 6 megawatt electric power. This is enough to compensate capacity shortages in the distribution grid. In the future similar plants could work in various locations to stabilize the grid.

The central link between green power from wind energy and hydrogen are innovative hydrogen electrolyzers from Siemens. Since being successfully commissioned in the “Energiepark Mainz”, these have been offered as standard systems for large electrolysis plants.

The process that is used involves acid electrolysis with solid polymer electrolytes. During electrolysis process, water is broken down into its constituent components at the anode of the electrolysis cell: Each water molecule is split down into half an oxygen molecule and two protons. The oxygen molecule is removed at the anode, while the protons are transported to the cathode using a conductive membrane – where two electrons are combined with the protons to create a hydrogen molecule.

This so-called PEM electrolysis technology (Proton Exchange Membrane) facilitates operation with a highly dynamic performance, as is required for power generated using renewable energies. Three of these PEM electrolysis systems, with peak powers of up to two Megawatt each, are operated at “Energiepark Mainz”. PEM Electrolysis systems in this power class were absolutely unique worldwide when commissioned in 2015 as previous PEM-based systems were mainly used to produce small amounts of hydrogen.

Further main system components comprise a two-stage ionic compressor, a natural gas grid injection unit, a trailer filling station and an electric switchgear. The “ionic compressor” developed by Linde compresses the hydrogen to feed into the storage tank, the natural gas grid and the tanker trailer. Up to now, this compression technique was especially used for hydrogen fueling stations. It also offers some significant advantages in the “Energiepark Mainz”, especially due to its high operational flexibility, which is an excellent fit when it comes to electrolysis systems and the utilization of power from renewable energy sources.

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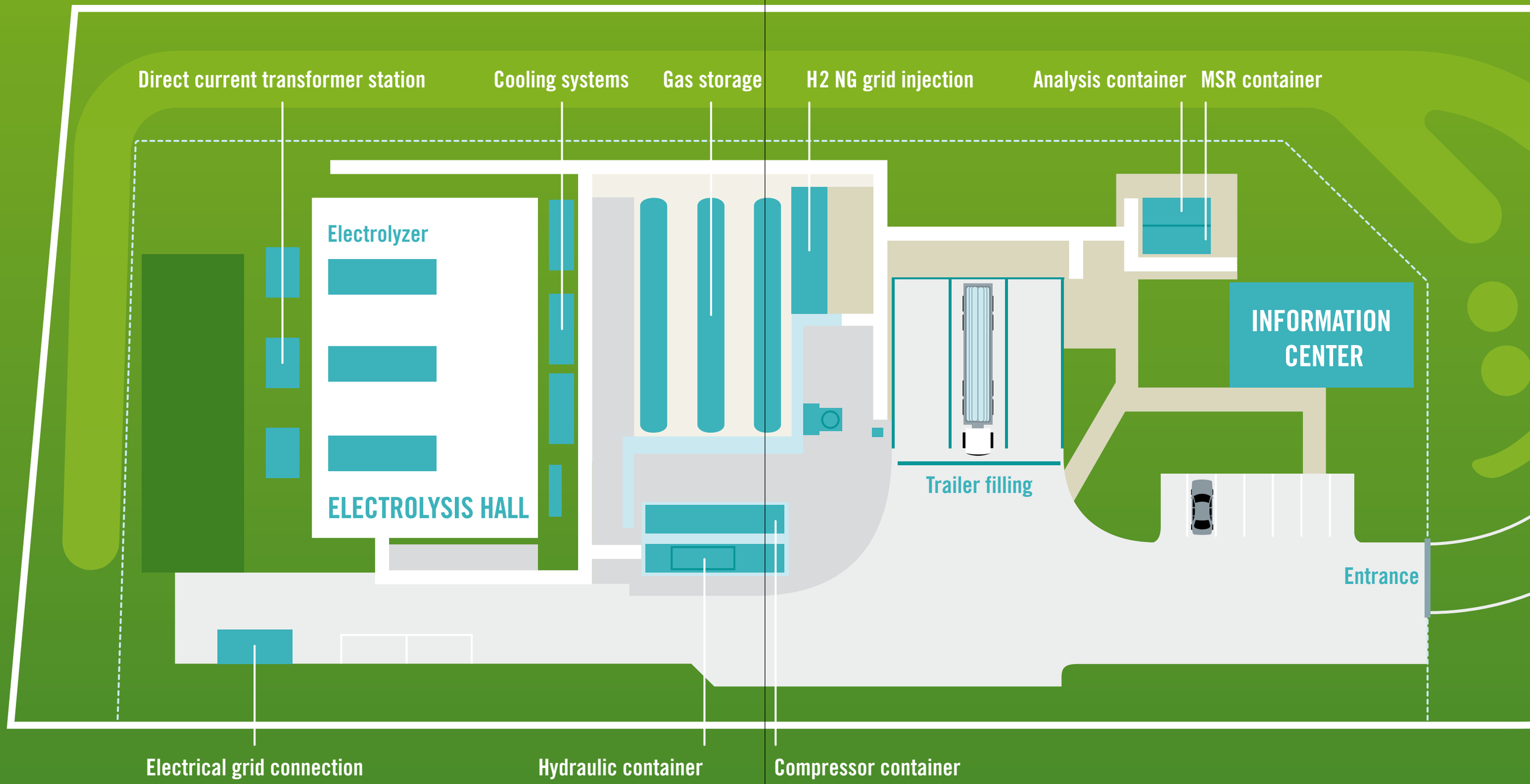

EXHIBITION PARKING

Technical data

Electrical grid connection

The Power-to-Gas system is directly connected to both the medium-voltage grid of Mainzer Stadtwerke and an adjacent wind farm. The decentralized storage of electrical energy in times of high wind feed-in is used for the network integration of renewable energy and guarantees grid stability.
The objectives include optimization of local load management with the help of controlledwind power feed-in as well as offering anciallary grid services such as control reserve for voltage and frequency regulation.

Direct current transformer stations

Three direct current stations generate the high direct current required for the electrolysis process. The electrical power required for this by each station are drawn directly from the medium voltage grid using GEAFOL cast-resin transformers. The current is inverted by industry-proven SINAMICS inverter cabinets. Unwanted high grid interference is prevented by an integrated multiple-stage filter circuit system.

Water treatment plant

The electrolysis process requires demineralized water. To produce water with this level of very high purity, the water treatment plant draws out all the dissolved minerals contained in normal tap water over a number of stages. A buffer tank ensures a constant supply of water to the electrolysis process even during periods of downtime, for instance during maintenance work on the water treatment plant.

Electrolysis system

Three SILYZER 200 electrolyzers equipped with innovative proton exchange membrane (PEM) technology split water into hydrogen and oxygen using electrical direct current. The proton conducting membranes used in the electrolyzer cells keep the gases apart reliably and offer a high safety level, also thanks to the innovative cell design.

Gas conditioning and storage

Raw hydrogen from the electrolyzers is first passed through a catalyst to convert residual oxygen to water vapor. The major part of the moisture fraction is condensed before and after the compression and recycled back to the electrolyzer.

The hydrogen is stored in the pressure vessels. From there, or directly from the first compressor stage, the gas can be delivered to the NG grid injection. Also, after running through the second compressor stage and the final drying based on temperature swing adsorption, it can be delivered to the trailer filling station.

Hydrogen natural gas grid injection

The hydrogen produced in the energy park can be injected into into the high-pressure natural gas grid of Mainzer Stadtwerke. The admixing occurs in a stub line, which supplies the Mainz-Ebersheim district. This process replaces fossil natural gas. All applications connected to the natural gas network, such as heating systems, gas burners, thermal power stations and gas power plants can be partly supplied with the hydrogen generated. In addition, the enormous storage capacity of the natural gas grid can therefore be utilized for the energy from the power system.

Ionic compressor

The ionic compressor, an in house development by Linde, is the core component of hydrogen conditioning. An “ionic liquid” (a liquid salt) lubricates, cools and seals the hydraulically driven piston compressor, without adding any impurities to the hydrogen. The unit has been designed for multi-variable operation, including fast load changes and high efficiency at part load. With its two stages it can be used to feed both the storage vessels and the trailers. A further novel feature is the integrated drying of the hydrogen.

Trailer filling

Here, the hydrogen is filled into trailers using a fully automated process. After the filling hose is connected to the trailer, its remaining contents are analyzed. Then, the trailer is filled with hydrogen from the compressor. Purity, temperature and pressure are monitored continuously.
After finishing the filling process, the filling hose is disconnected and transfer documents are printed. The trailer is ready for pickup and delivery of the hydrogen to refueling stations or industrial consumers.

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