

°LAUDA



CONSTANT TEMPERATURE SOLUTIONS FOR THE HYDROGEN INDUSTRY

°FAHRENHEIT. °CELSIUS. °LAUDA.

HYDROGEN

Overview

Hydrogen – A promising energy source for the future

Hydrogen plays a decisive role in overcoming the challenges of energy transition. Whether used to store energy or for future mobility, hydrogen is an environmentally friendly solution with enormous potential. However, it is important that green hydrogen is produced efficiently using climate-neutral methods. The benefits of hydrogen as an energy source of the future are significant: It has a high energy content of 33 kWh/kg, in contrast to diesel fuel, which has only 10 kWh/kg.

Compared to combustion engines, a 5 kg tank of hydrogen can reach ranges of around 650 km in conjunction with an efficient system of fuel cells and an electric drive. Hydrogen electrolysis is also an excellent way to store surplus electricity from renewable energies. LAUDA offers innovative constant temperature solutions to meet the challenges of handling hydrogen encountered when refueling hydrogen vehicles, for example.

Cooling solutions for electrolyzers and compressors

LAUDA offers innovative cooling solutions that are used worldwide in electrolyzers and hydrogen purification for hydrogen production. LAUDA Ultracool process coolers play a decisive role in cooling electrolyzers and compressors to make hydrogen production more efficient. Connectivity makes it possible to seamlessly connect, monitor and maintain these devices, making LAUDA cooling solutions the key to reliable hydrogen production.



Cooling systems for hydrogen filling stations

LAUDA offers state-of-the-art cooling solutions for hydrogen filling stations that facilitate the smooth operation of the refueling infrastructure. Since 2015, LAUDA has been developing and optimizing modular cooling systems that can be adapted to different pressure and temperature requirements and are used at filling stations for both passenger vehicles and heavy-duty transport vehicles as well as in tube trailers and trains. One outstanding feature of these solutions is the efficient cooling of the compressors for pressure generation by proven LAUDA Ultracool process circulation coolers, which enable a holistic solution from a single source.

Testing of fuel cell and hydrogen components

LAUDA has been known in the field of automotive testing for many years and can now transfer this experience into the hydrogen sector. LAUDA constant temperature equipment is primarily used for climate and environmental tests, component and material tests, and fuel cell performance tests.



EFFICIENT COOLING DURING PRODUCTION AND COMPRESSION

Drying and storage of hydrogen

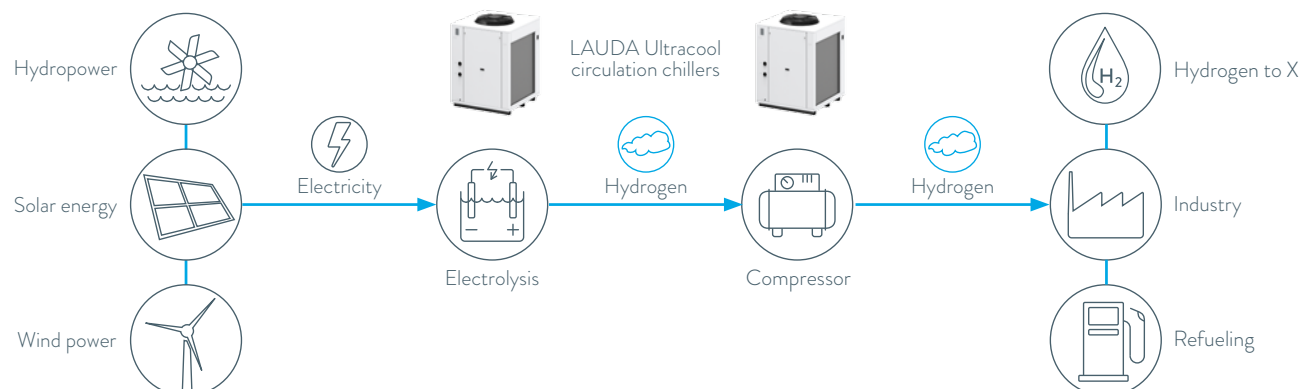


Cooling solutions for electrolyzers and compressors

Cooling systems from LAUDA are already making a significant contribution to increasing the efficiency of hydrogen production and have enjoyed widespread use around the world for many years. They play a decisive role in cooling electrolyzers and are also used to dry and purify the hydrogen produced. Our customers rely on the new generation of LAUDA Ultracool devices.

After being produced, hydrogen must be compressed to a higher pressure level. The compressors are also cooled by LAUDA Ultracool devices. The connectivity of these devices not only allows the seamless interconnection of the devices, but also monitoring, maintenance and data analysis. LAUDA cooling solutions are the key to reliable and efficient hydrogen production.

Cooling solutions along the entire value chain





LAUDA ULTRACOOOL

Energy-efficient process circulation chillers from -10 to 35°C

Energy-efficient

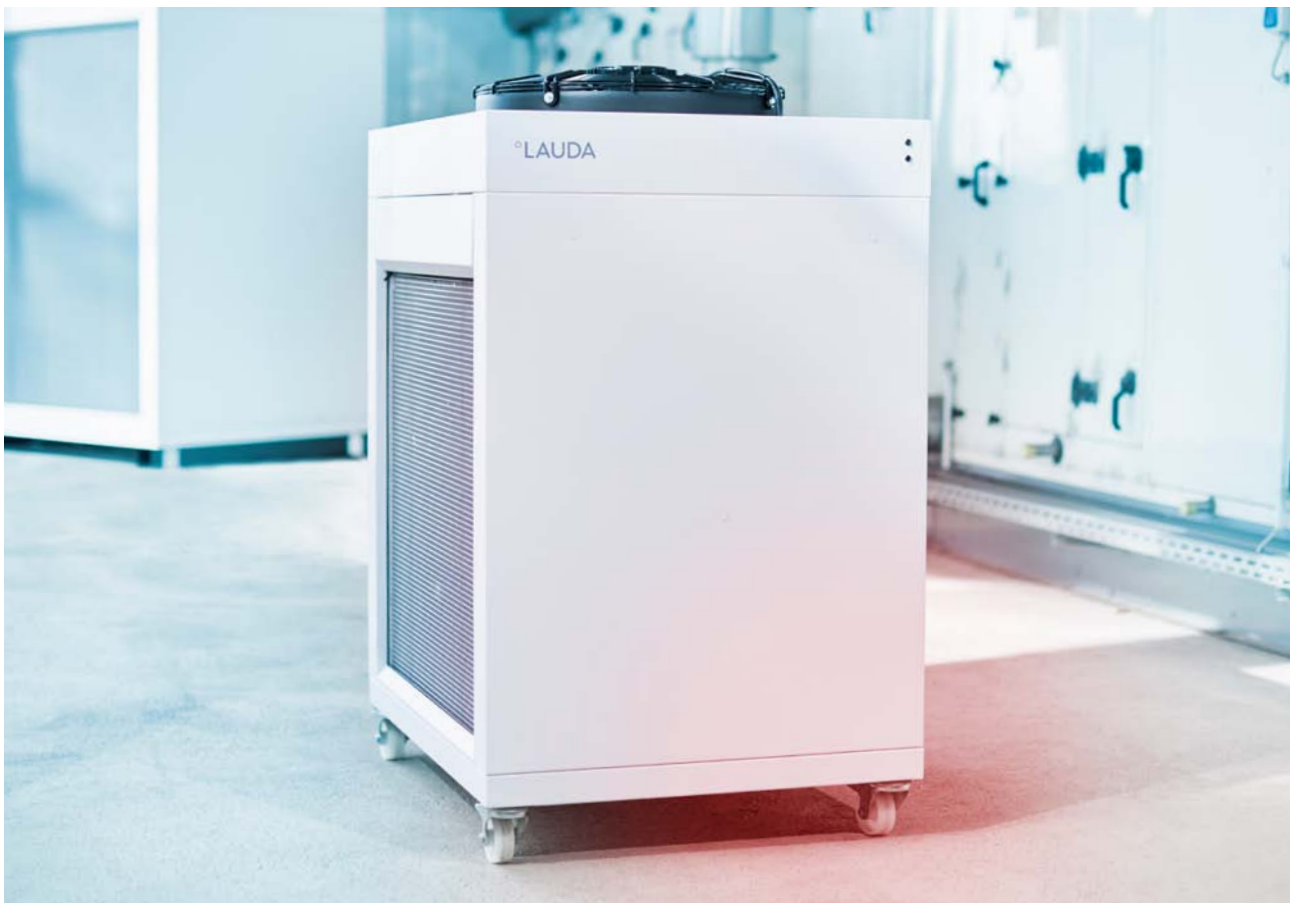
Developed with a focus on energy efficiency, the LAUDA Ultracool circulation chillers make a pivotal contribution to reducing your operating costs. Compared to classic circulation chillers, the devices can reduce energy costs by up to 50 percent, depending on the operating conditions. This plays a very important role in increasing overall efficiency, especially in hydrogen production.

Optimized for Industry 4.0

Thanks to the innovative operating concept, the LAUDA Ultracool circulation chillers can be conveniently monitored and controlled from a distance – via a connected control panel or the integrated web server on a PC or laptop. A connection to LAUDA.LIVE allows device data to be saved, analyzed and used for remote maintenance.

Advanced technology for a broad range of applications

Extensive technical innovation and a significantly expanded range of functions characterize the various LAUDA Ultracool devices and additional equipment options. Custom options and a wide cooling output range make LAUDA Ultracool circulation chillers the ideal solution for a broad range of hydrogen-based applications.

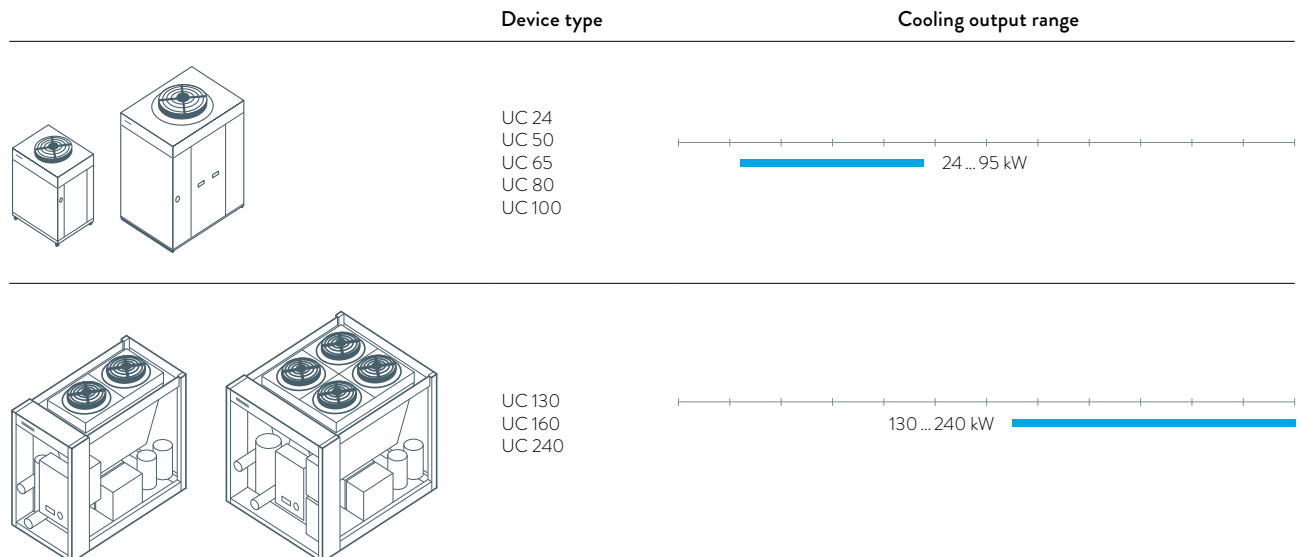


Technical data

| Device type | Working temperature range °C | Temperature stability ±K | Ambient temperature in °C | Cooling output at 20 °C Water outlet temperature ¹ kW | Cooling output at 10 °C Water outlet temperature ¹ kW | Nominal pump pressure in bar | Nominal flow rate in L /min | Pump connection thread | Water tank volume in L | Weight in kg | Protection level | SEPR* | Part Number |
|--------------------------------------------------|------------------------------|--------------------------|---------------------------|---------------------------------------------------------------------|---------------------------------------------------------------------|------------------------------|-----------------------------|------------------------|------------------------|--------------|------------------|-------|-------------|
| LAUDA Ultracool – specifications at 50 Hz | | | | | | | | | | | | | |
| UC 24 | -10...35 | 0.5 | -15...50 | 30.9 | 24.3 | 2.7 | 84.1 | Rp 1 | 35 | 180 | IP 54 | 5.63 | L002855 |
| UC 50 | -10...35 | 0.5 | -15...50 | 65.5 | 51.2 | 3.3 | 150.0 | Rp 1 ½ | 210 | 410 | IP 54 | 5.37 | L002856 |
| UC 65 | -10...35 | 0.5 | -15...50 | 85.2 | 66.9 | 3.3 | 196.0 | Rp 1 ½ | 210 | 440 | IP 54 | 5.16 | L002857 |
| UC 80 | -10...35 | 0.5 | -15...50 | 101.4 | 79.0 | 3.0 | 230.0 | Rp 2 ½ | 125 | 700 | IP 54 | 6.87 | L003684 |
| UC 100 | -10...35 | 0.5 | -15...50 | 121.4 | 95.3 | 3.0 | 287.0 | Rp 2 ½ | 125 | 700 | IP 54 | 6.2 | L003685 |
| UC 130 | -10...35 | 1 | -15...50 | | 130.0 | 3.0 | 373.0 | Rp 2 ½ | | | IP 54 | 6.1 | |
| UC 160 | -10...35 | 1 | -15...50 | | 160.0 | 3.0 | 459.0 | Rp 2 ½ | | | IP 54 | 5.9 | |
| UC 240 | -10...35 | 1 | -15...50 | | 240.0 | 3.0 | 689.0 | DIN-2566 DN 80 | | | IP 54 | 5.9 | |

¹at 25°C ambient temperature

*SEPR = Seasonal Energy Performance Ratio



FUEL CELLS AND COMPONENT TESTING

Temperature control on test benches and systems



Decades of experience

For many years, LAUDA has been a leading provider of innovative constant temperature technology in test bench construction for the automotive, electrical and aviation industries, and can now apply this extensive experience to the development of components and systems for the hydrogen industry. The area of testing not only extends to hydrogen vehicles, but also to electrolyzers, filling stations, tanks and compressors.

Development of hydrogen technology

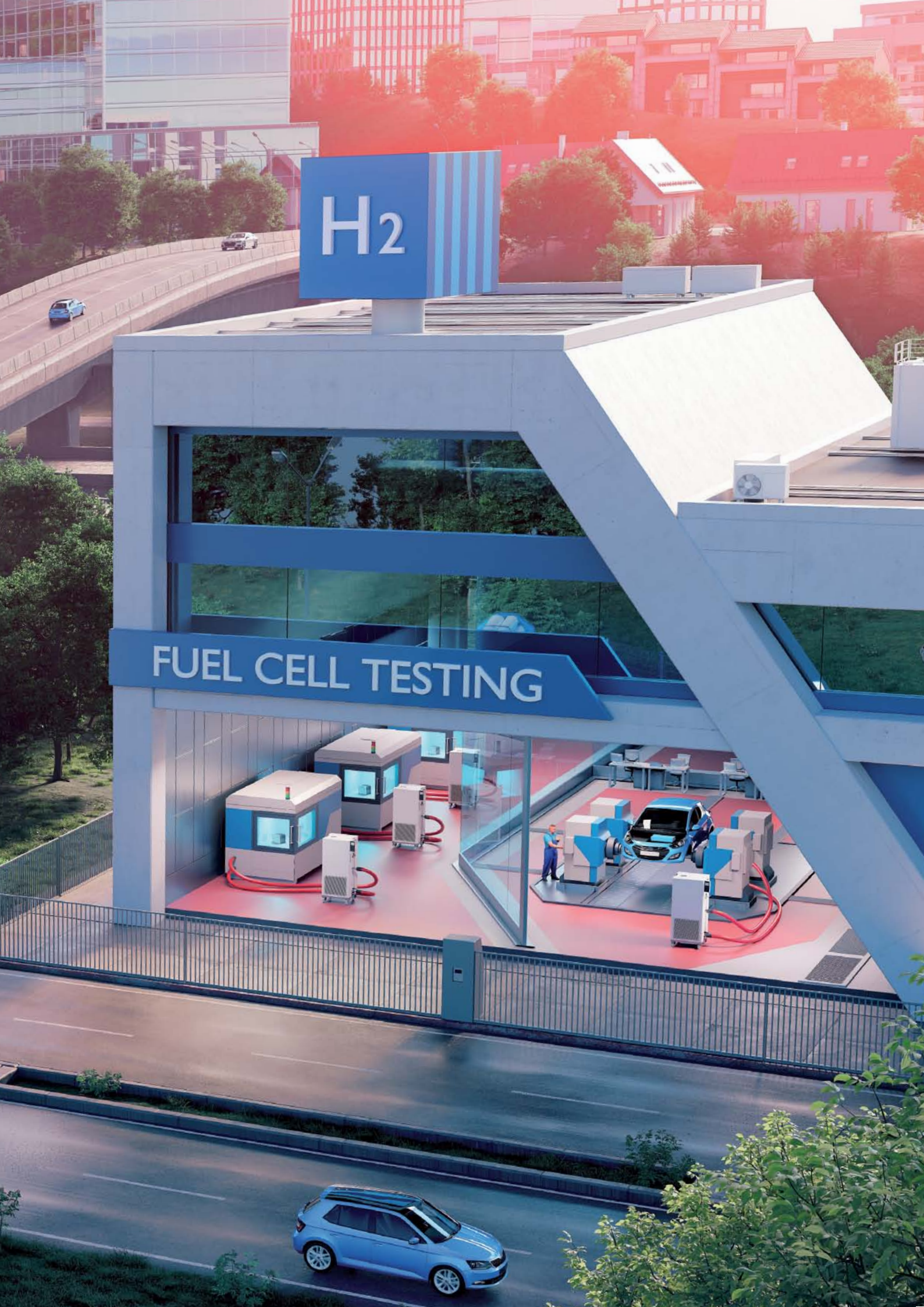
Components developed to come into contact with hydrogen are subjected to intensive test processes in special test environments to ensure that they function correctly and reliably during subsequent operation. One vital part of material testing is simulating extreme environmental conditions across different temperature ranges to increase the quality and safety of hydrogen technologies.

Testing in the development of hydrogen components

- Test benches for fuel cells and hydrogen combustion engines
- Accelerated service life testing for fuel cells
- End-of-line testing of components
- Load and performance tests of fuel cells
- Stability testing of materials
- Temperature stability and alternating tests

H₂

FUEL CELL TESTING



LAUDA Integral

Powerful constant temperature systems for test bench construction

Renowned quality

The Integral product line has proven itself in a wide variety of industries and applications for more than 20 years. Several thousand installations ensure the extensive testing and development of innovative components and systems on test benches in the automotive, electronics and aviation industries.

Testing hydrogen components

LAUDA Integral process thermostats are used in the automotive industry and by a large number of testing service providers to test fuel cells, components and hydrogen combustion engines, often in combination with LAUDA through-flow control units or LAUDA filling and emptying systems.

Powerful and dynamic

With a maximum cooling output of 28 kW, a maximum heating output of 24 kW, and a working temperature range of -90 to 320 °C, our integral process thermostats perform outstandingly well in every application.

Maximum connectivity

Fit for the future and ready for LAUDA.LIVE: Integral constant temperature systems can be flexibly integrated in various communication scenarios thanks to an integrated web server, monitoring and control via PC or mobile devices, and the modular interface concept.

User-friendly operation

Softkey control directly on the device, remote control via touch display or mobile devices mean that it has never been easier to control your constant temperature applications according to your requirements. The new Integral devices determine the optimum control parameters for the application at the touch of a button, and the temperature control media can be selected to ensure safe and optimum use of the liquid. The high-precision through-flow control unit extends your options and ensures you have control over your test and production processes.



LAUDA INTEGRAL XT



LAUDA Integral XT process thermostats with a cold oil blanket operate according to the flow principle and enable the utilization of temperature control media over a significantly larger temperature range – ideal for dynamic temperature control tasks.

The electronically controlled, magnetically coupled pump can set the flow rate optimally both for the requirements of pressure-sensitive consumers and for applications with high hydraulic resistance.

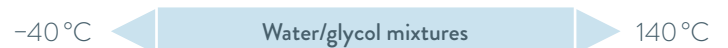


LAUDA INTEGRAL P



The new **LAUDA Integral P** process thermostats function with a pressure blanket of up to 4 bar according to the through-flow principle. This allows non-flammable water/glycol mixtures to be used in a temperature range of -40 to 140 °C.

Thanks to the electronically controlled, magnetically coupled pump, optimized flow rates can be set for different applications.

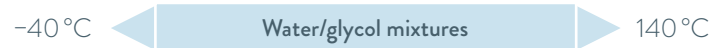


LAUDA MID 80 THROUGH-FLOW CONTROLLER



Compatible with Integral IN XT, IN P. through-flow control system with magnetic inductive measuring method. Control range 0.2 to 70 L/min, max. measuring range of 99 L/min. Flow control accuracy (20 °C; 20 L/min; 1 bar): ± 0.2 L/min

Process sequences and their changes can be simulated or heat quantities can be calculated during heating or cooling by controlling the volume flow. A high degree of measurement accuracy is essential for the consistent reproduction of test procedures.

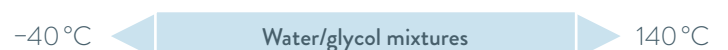


LAUDA FILLING AND EMPTYING UNIT FD 50



Active filling and emptying system for thermostatic circuits with changing test specimens. A buffer volume of 50 L and manual or digital control of the filling and emptying stages displayed by pilot lamps guarantee maximum safety. Can be combined with MID 80 for reduced space requirements.

When the test specimen is changed during standardized test procedures, it is extremely advantageous if the constant temperature medium is first blown out with compressed air in a controlled manner and a leak test is performed using compressed air before the next test specimen is filled. In this way, the automation of tests can be expanded.

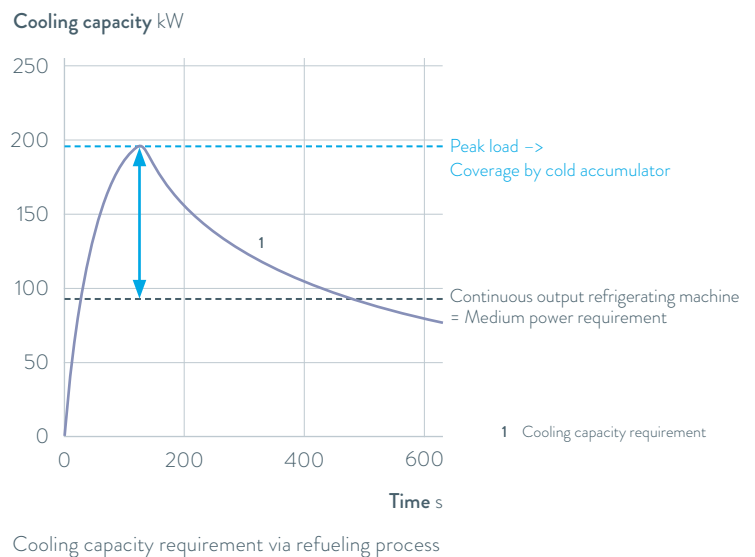


COOLING SOLUTIONS FOR HYDROGEN FILLING STATIONS

Indirect cooling concept

The future of hydrogen mobility

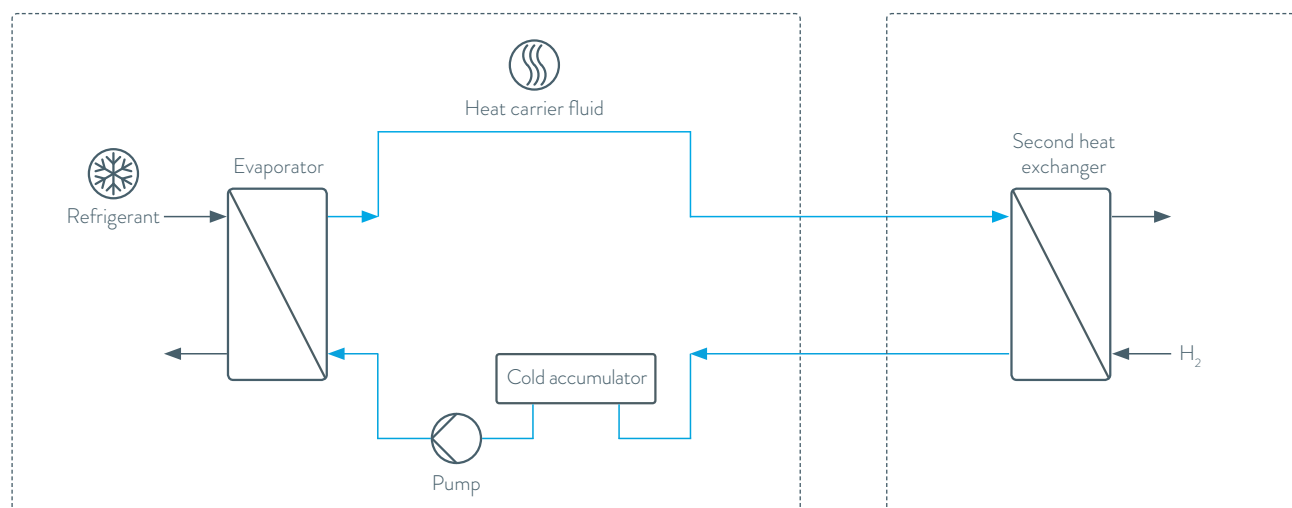
Our state-of-the-art cooling solutions for hydrogen filling stations make sure that the hydrogen infrastructure operates smoothly and efficiently. Since 2015, we have been developing and continuously optimizing our cooling systems through pioneering work. The modular systems are extremely flexible and can be adapted or extended to suit different pressure and temperature requirements. Our cooling solutions are not only used in classic filling stations for both passenger vehicles and heavy-duty transport vehicles, but are also used in tube trailers and for refueling trains. One key feature of our solutions is the efficient cooling of the compressors required to generate pressure by our LAUDA Ultracool process circulation coolers. We are therefore able to offer a holistic solution from a single source.



Benefits of indirect cooling

- Possible to design the system for average performance instead of peak performance using cold accumulators
- The system can be located away from the dispenser (e.g. outside the hazardous area)
- Modular concept for adapting or extending the system to suit different use cases
- Compact design

LAUDA cooling system



Indirect cooling system:
Evaporator cools using refrigerant. Heat carrier circuit cools hydrogen H₂.



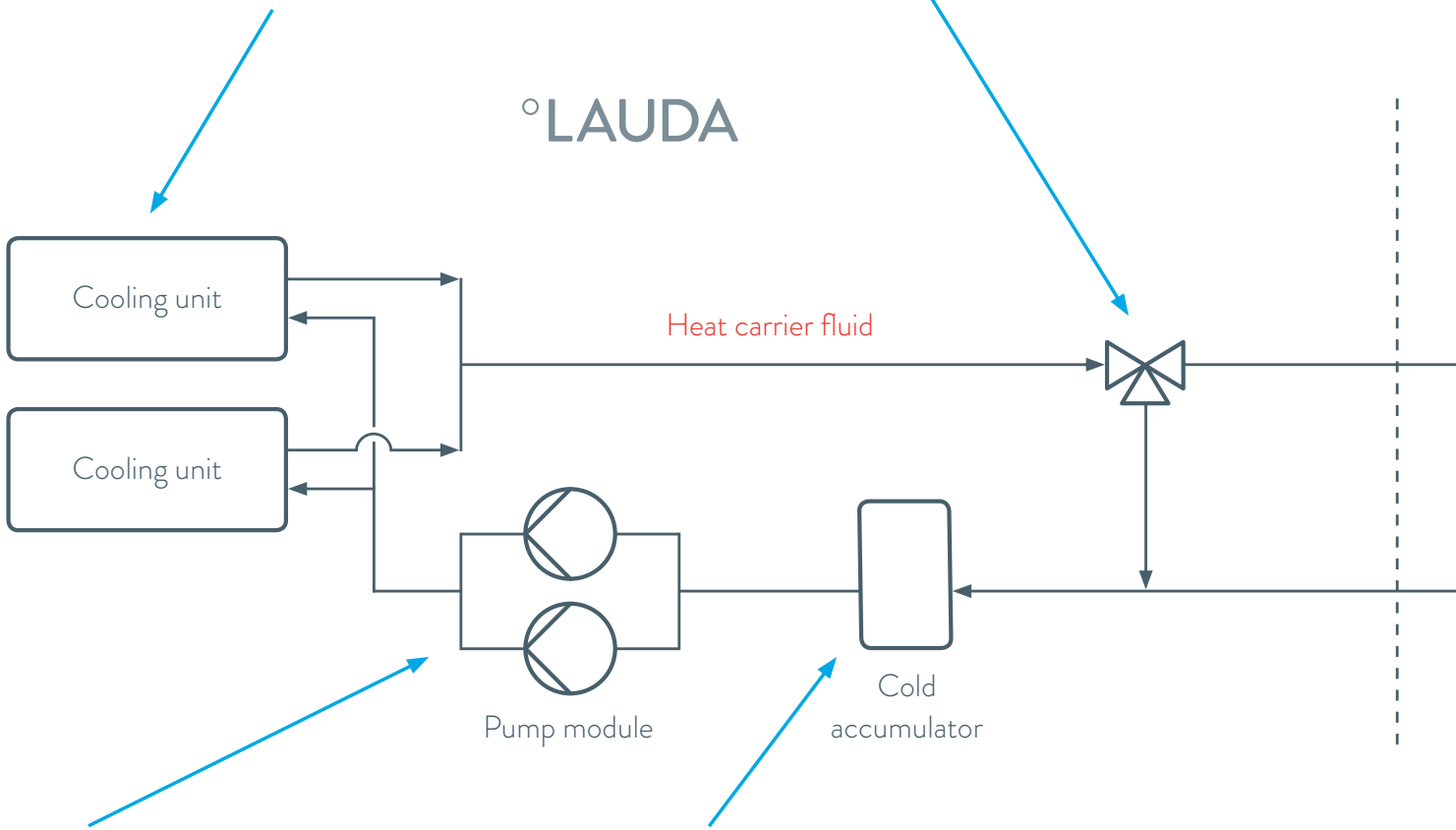
LAUDA PROCESS COOLING UNITS

Modular systems for different applications and future expansion stages



Cooling unit is a direct evaporator that can have a redundant design to ensure maximum reliability and enable continued operation of the tank system, even during service campaigns. It also offers better partial load efficiency, which makes sense from an energy perspective, especially when demand is low. It is therefore possible to install just one cooling unit in a refilling station and add another module to the system as demand increases. The cooling unit has two refrigerant circuits in a cascade connection, which are operated with natural refrigerants.

Three-way valve, designed primarily to pre-cool the cold accumulator in standby mode. Even if there is a decrease in load at the fuel pump, the excess cooling capacity can be used to regenerate the cold accumulator during the refueling process in order to start subsequent refueling directly without a break.



Pump module, can be fitted with a powerful pump or with an additional redundant pump to increase reliability. The pump capacity is designed specifically for the application.

The volume of the **cold accumulator** containing heat carrier fluid can be adjusted according to the tank cycles and the accumulator can also be refilled via the three-way valve during the ongoing refueling process to achieve efficient back-to-back refueling.



LAUDA Process cooling unit SUK 350 L

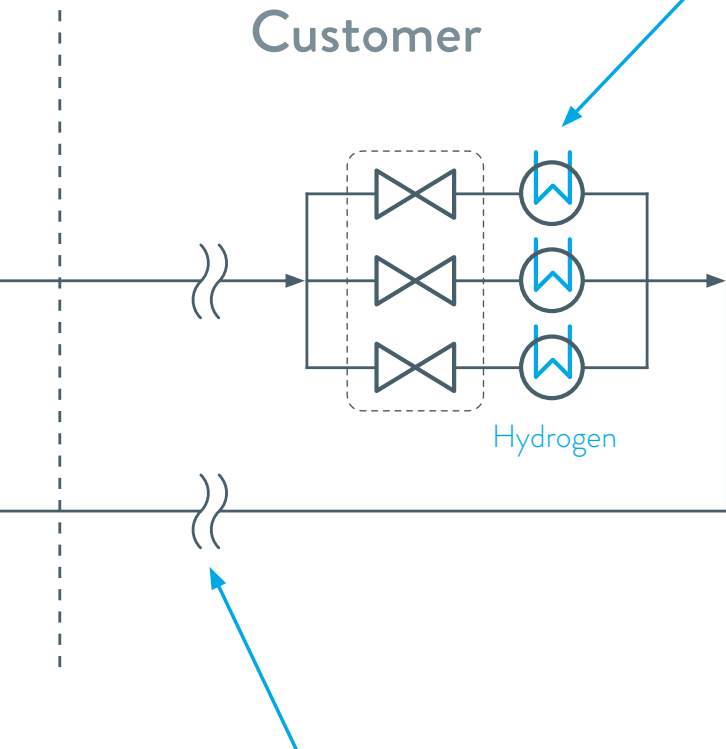
Modular system – application spectrum*

- Refueling protocols according to SAE J2601
- Fuel delivery temperature category: T10 (-10 °C), T30 (-30 °C), T40 (-40 °C)
- Pressure classes: H35 (350 bar) – H70 (700 bar)
- Natural refrigerant
- Refrigerant circuit (chiller) in air/water-cooled design possible
- Pressure class up to 1000 bar
- Applications: Lightweight/heavy-duty vehicles, forklifts, trains, tube trailers, etc.
- Ambient temperature: -40 ... 50 °C
- Mean mass flow H₂: 150 g/s
- Peak mass flow H₂: 300 g/s
- Short refueling times/back-to-back refueling
- Distance to dispenser: usually up to 50 m
- ATEX possible
- Remote maintenance module

*based on current hydrogen projects, for illustrative purposes only.

A wide variety of protocols can be installed at the **fuel pumps**, for example, 1x350 bar and 2x700 bar for LDV and HDV. One possible solution, e.g. at high flow speeds and large volumes, can be implemented via the upstream valves so that power is channeled to the fuel pump where it is needed.

Customer



Cooling units can be located away from the fuel pumps. In terms of energy efficiency, distances of usually 50 m are possible. Explosion or noise protection can often be avoided as a result.

Customized solutions are developed individually by LAUDA System engineering. Due to the modular system, customized cooling systems can be developed for the respective application within a very short time frame, whether passenger vehicles, trucks, buses, etc. In order to develop a solution, the following information should be specified prior to concept creation:

- Fuel delivery temperature (e.g. T10, T20 or customer-specific)
- Pressure class (e.g. H35, H70 or customer-specific)
- Mean and peak cooling capacity [kW] (unless otherwise specified at 15 °C ambient temperature)
- Mean and peak mass flow H₂ at MPa/min (APRR)
- Ambient temperature
- Refrigerant (e.g.: F-Gas according to European F-Gas Regulation, natural refrigerants GWP <15)
- Pipe length between system and fuel pump [m]
- Explosion/noise protection required?
- Max. overall dimensions
- Interfaces

We would be glad to help you with your design and answer any questions you may have.

EU PROJECT

RHeaDHy: Research project on the hydrogen refueling of heavy-duty trucks

Pioneering hydrogen refueling for the future of mobility

High-performance hydrogen filling stations are key players in efforts to reduce carbon emissions in the European transport sector. The ›RHeaDHy‹ project, funded by the European Union, is playing a leading role in revolutionizing hydrogen refueling for heavy-duty trucks.



We are primarily focusing on developing a high-performance cooling system that forms the basis for high-performance fueling protocols. Intensive simulations are conducted in advance to verify the refueling process that has been developed. The next step will be to install two high-performance refueling systems in France and Germany to test these innovative protocols in practice.

The RHeaDHy project therefore represents a decisive step in the development of hydrogen refueling systems and paves the way for a promising future in the industry. We are proud to be part of this important process and look forward to shaping the mobility of tomorrow.



Funded by
the European Union

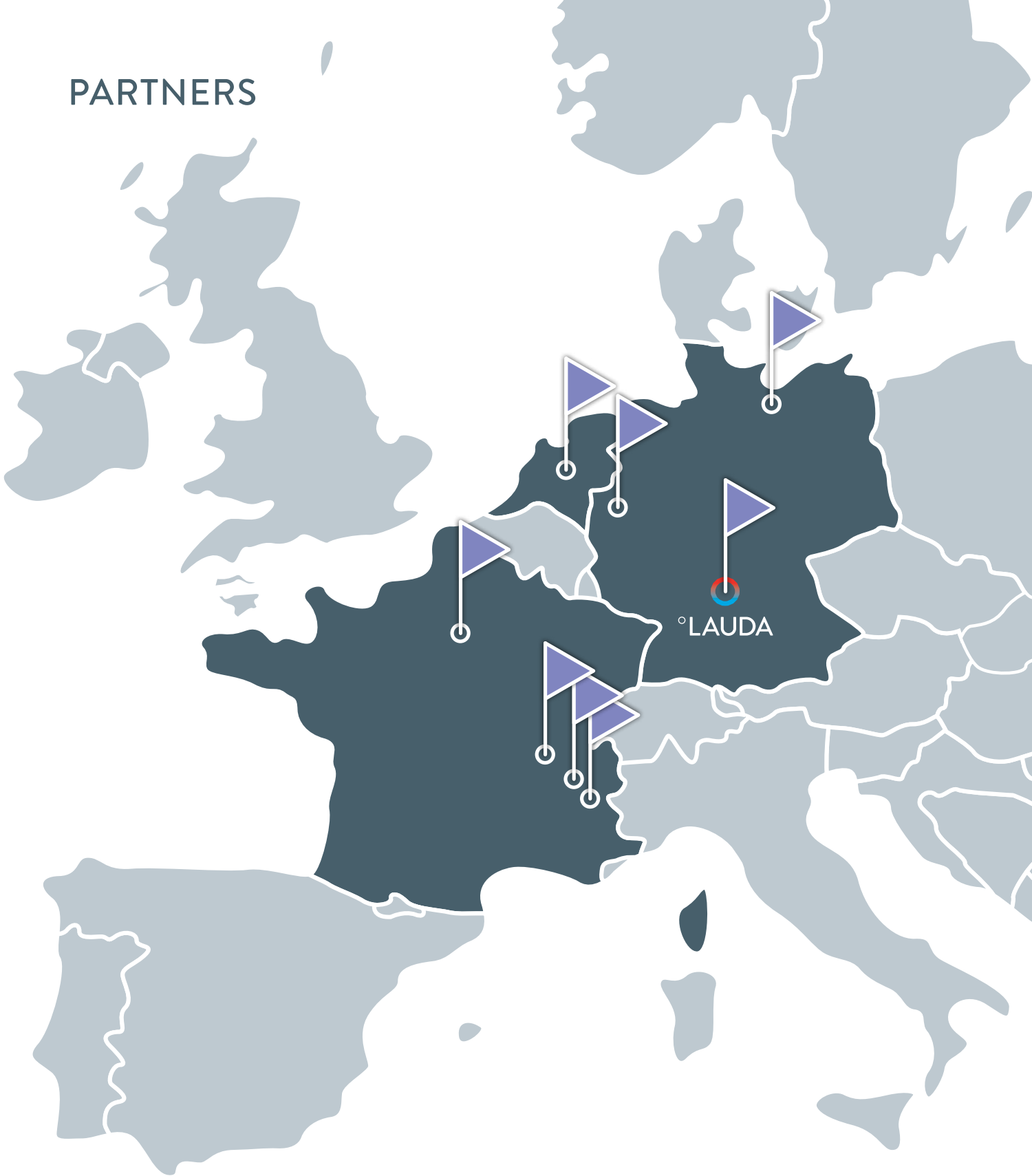


Clean Hydrogen
Partnership

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PARTNERS



Facts and objectives

- Refueling of long-distance trucks
- H₂ quantity: 100 kg
- Refueling time: 10 min
- Pressure class: 700 bar (H70)
- Flow rates: 170 g/s (300 g/s peak)
- Timeline: February 2023 – January 2027
- Based on PRHYDE

<https://rheadhy.eu/>

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