

SINCE

2008

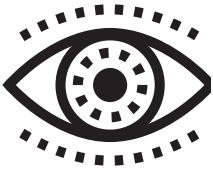
EXPERIENCE IN
HYDROGEN
COOLING



HYDROGEN - COOLING - POWER



Think KUSTEC



Our Vision

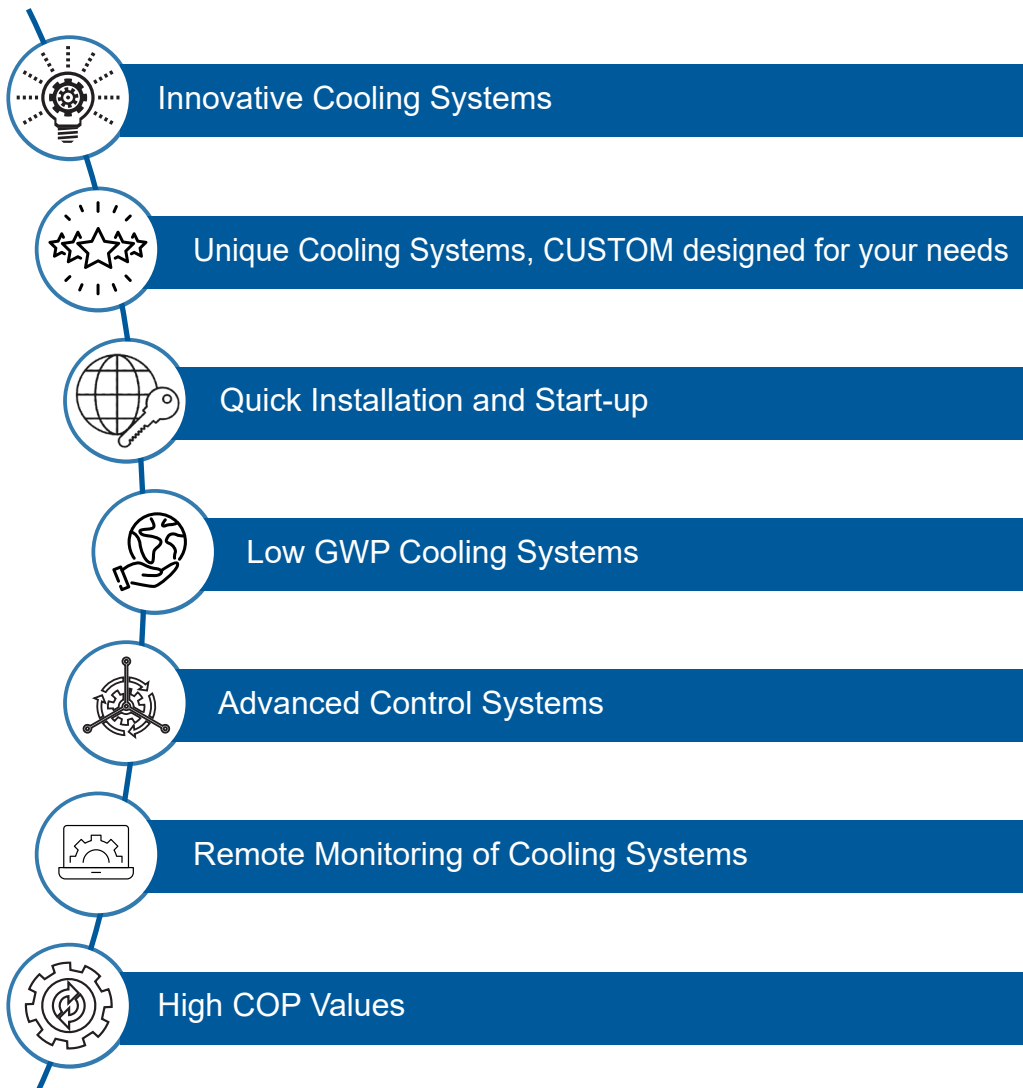
We believe our first responsibility is the innovation of cooling systems. Our priorities are to provide our customers with optimized cooling systems, to follow the UN's environmental SDG's and to foster the worldwide development of hydrogen vehicle industry.



Our Mission

We develop innovative cooling systems for our customers and standardize the worldwide hydrogen vehicle industry using low GWP refrigerants.

Efficient and Reliable Cooling Systems are an important part of Manufacturing Technologies, thus we provide:

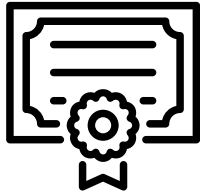


We deliver cooling concepts for Hydrogen Refuelling Stations for the futuristic sustainable mobility!



-  Since 2006 Cooling Systems Experience
-  Professional Technicians
-  International Engineers
-  Worldwide Partners

KUSTEC Quality Certificates



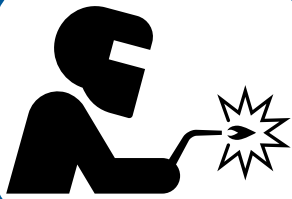
Management System Certificate

- EN ISO 9001:2015
- SCC 2011
- BMLFU-KK-Nr. 45



Fluorinated Greenhouse Gases Regulations 2009

- Section 4, Paragraph 1, Ordinance BGBl. II No. 2/2011
- Federal Ministry for Agriculture and Forestry, the Environment and Water Management



Brazing Process Testing

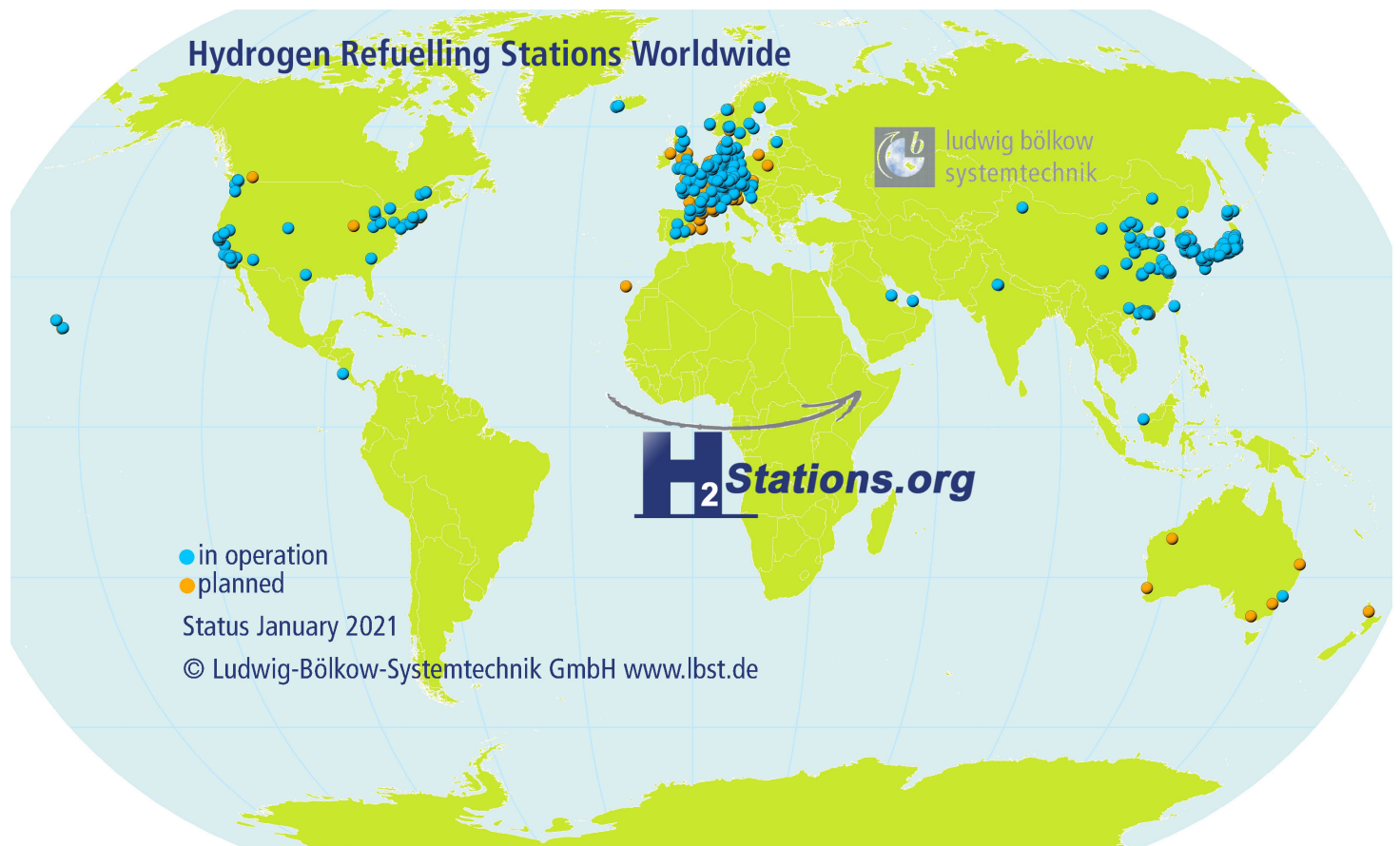
- EN 14276-1:2020
- EN 13585



- Expert in Handling Natural Refrigerants
- SAE J2601 Hydrogen Filling Protocol



KUSTEC built cooling systems for more than 250 out of the 553 existing Hydrogen Refuelling Stations worldwide, according to 2020 statistics.



In 2020, 107 Hydrogen Refuelling Stations went into operation worldwide, which is the highest annual growth rate observed. In Europe, 29 new stations were commissioned, 72 in Asia and 6 in North America. Among these, four countries had a particular growth rate: Germany with 14 new stations, China with 18, South Korea with 26 stations and Japan had 28 new stations.

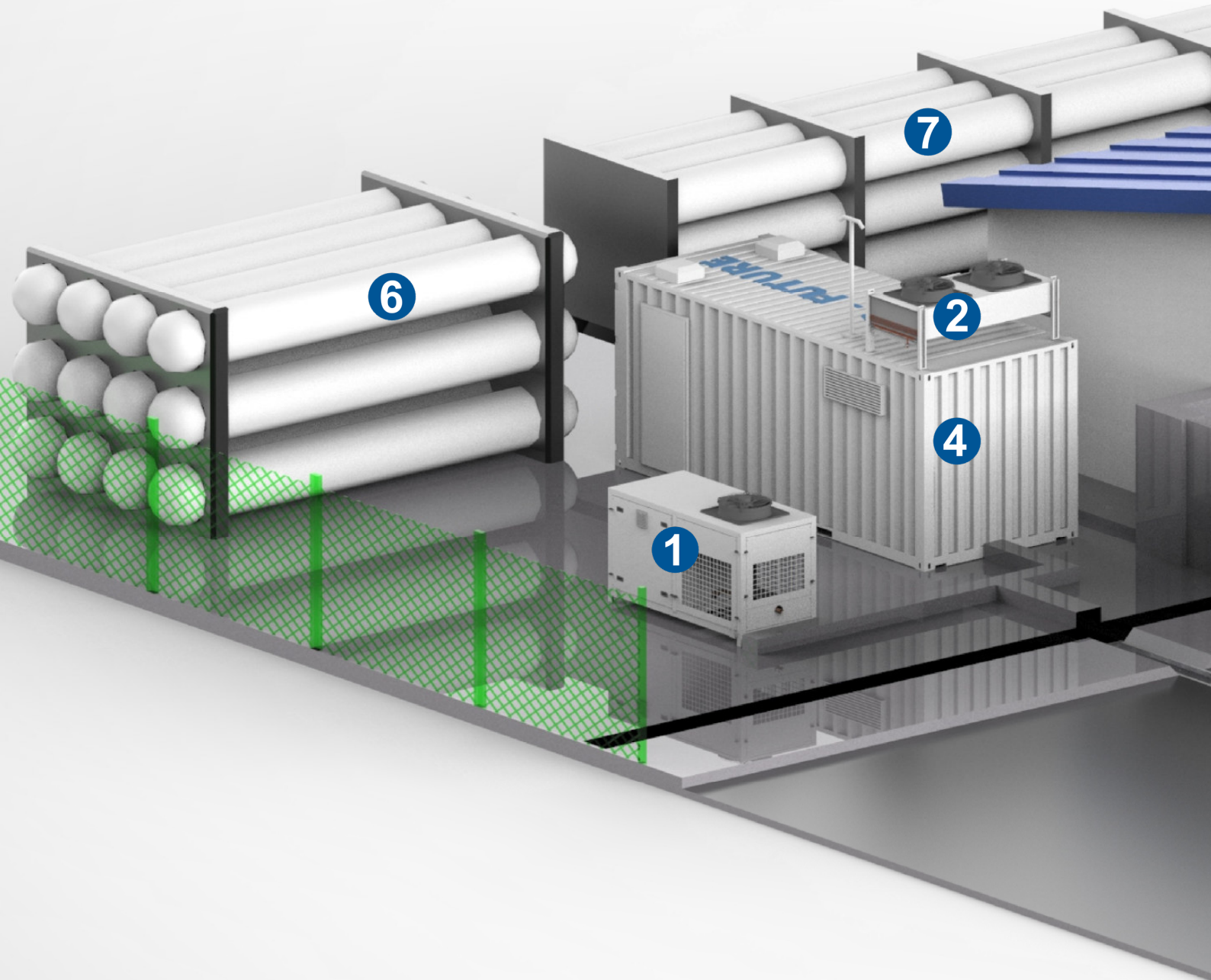
The 553 global stations, according to 2020 statistics, include 200 stations in Europe, mainly focused with 100 in Germany, 34 operational in France and 38 planned stations. Thus, France holds the strongest growth rate in Europe.

However, while European countries focus on publicly accessible passenger car refuelling stations, most of the French stations aim at the refuelling of buses and delivery vehicle fleets.

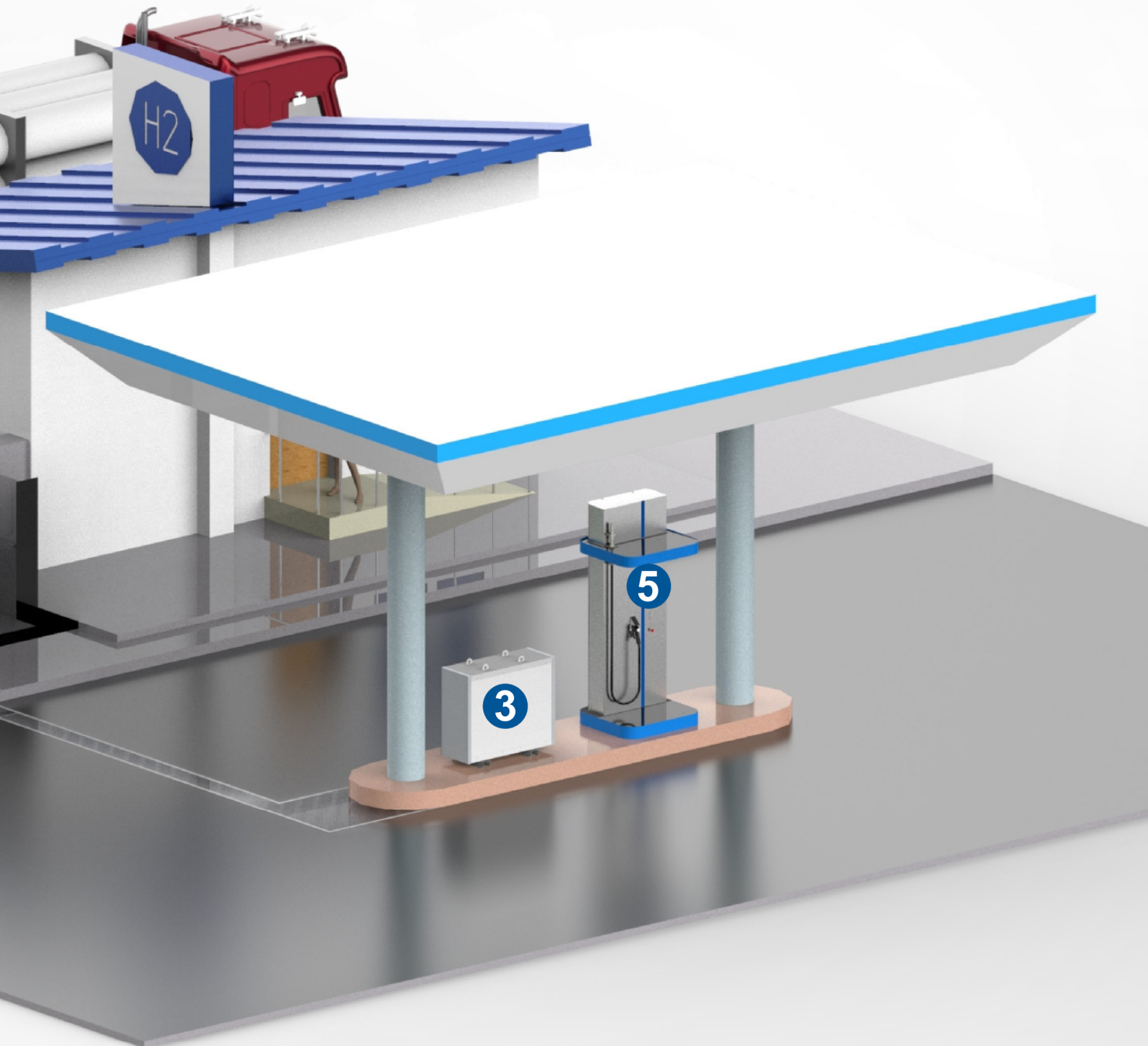
A significantly increasing number is also projected in the Netherlands, where the number of planned stations has increased to 23. In line with plans, the 9th refuelling station was recently opened in Switzerland.

Planning

KUSTEC designs your cooling system taking care of the detail, thinking of the whole.



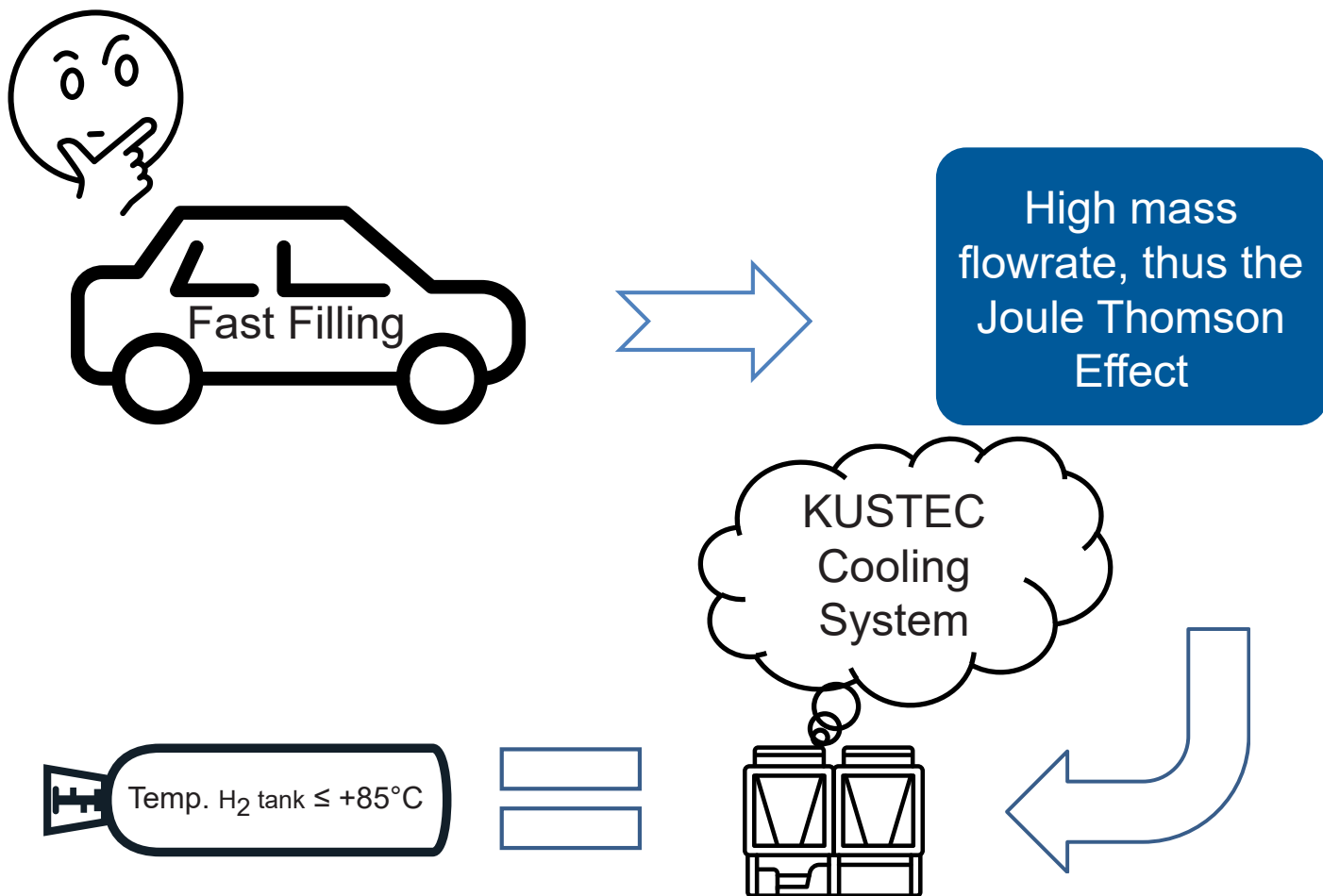
- 1 KUSTEC Cooling System
- 2 KUSTEC Air heater
- 3 KUSTEC Aluminium Block, the H₂ heat exchanger!



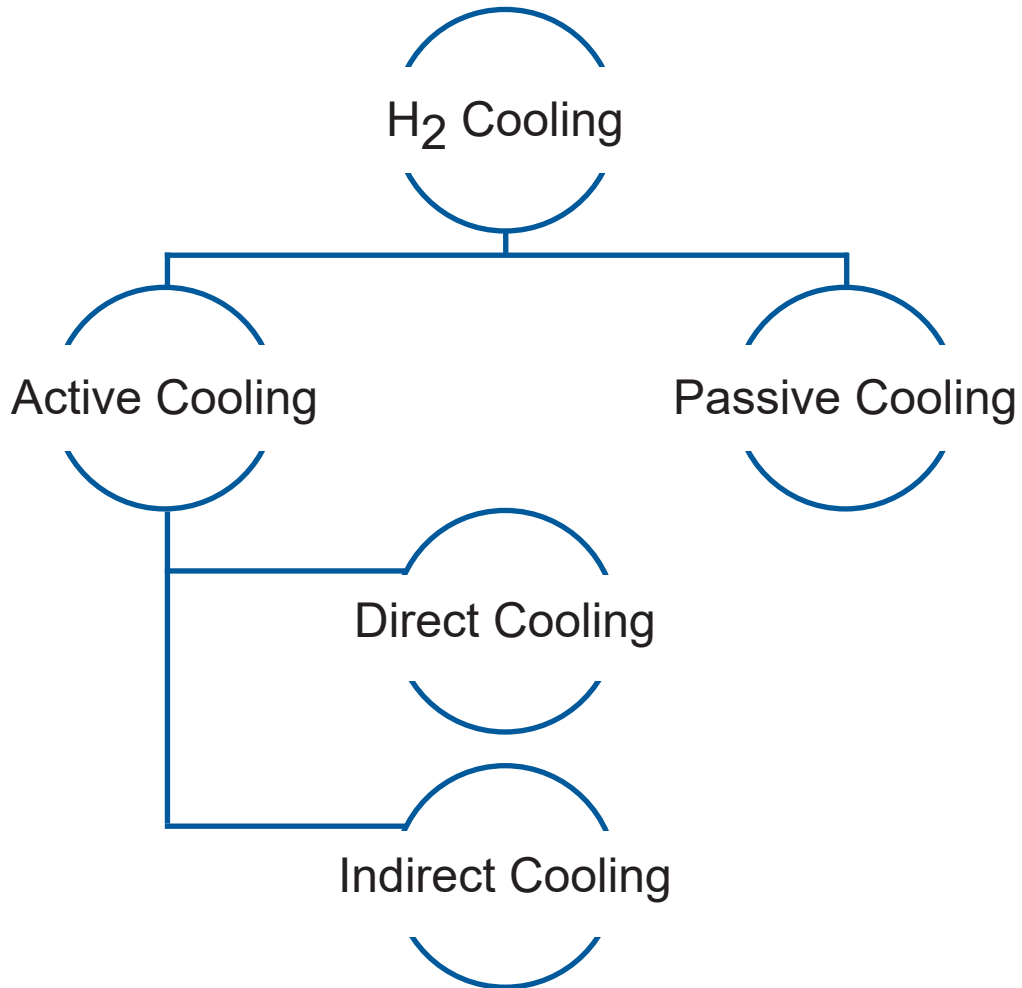
- 4** Container H₂ Compressor
- 5** Dispenser
- 6** Middle and High pressure H₂ - Tanks
- 7** Hydrogen supply

Cooling Systems Summary

Why H₂ Cooling?!

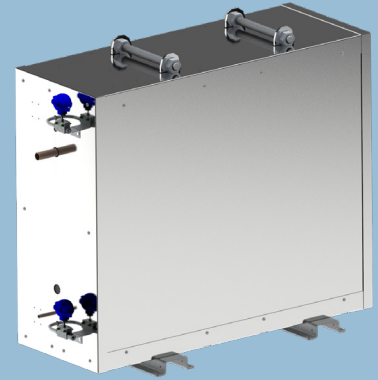
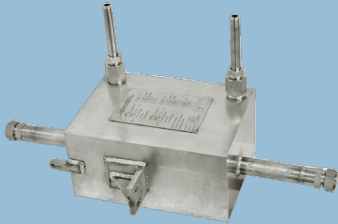


Types of Cooling Systems



Cooling Systems Summary

Types of Cooling Systems



Direct Cooling

- DHE*
- Full cooling capacity
- Direct expansion

Indirect Cooling

- DHE*
- Full cooling capacity
- Additional Glycol cycle
















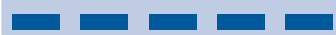
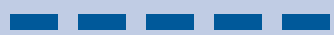
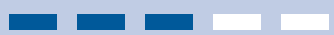
Passive Cooling

- Alu Block HE**
- Reduced cooling capacity
- Direct expansion

* DHE - Diffusion Bonded Heat Exchanger

** Alu Block HE - Aluminium Block Heat Exchanger

Types of Cooling Systems

	Direct Cooling	Indirect Cooling	Passive Cooling
Size of Heat Exchanger			
Size of the Chiller System			
Energy Consumption			
Connection Load			
CAPEX			
B2B Fillings Rate			
Product Name	Racoon Eagle	Chiller	H ₂ ercules H2PCU

Annex:

Biggest / Highest

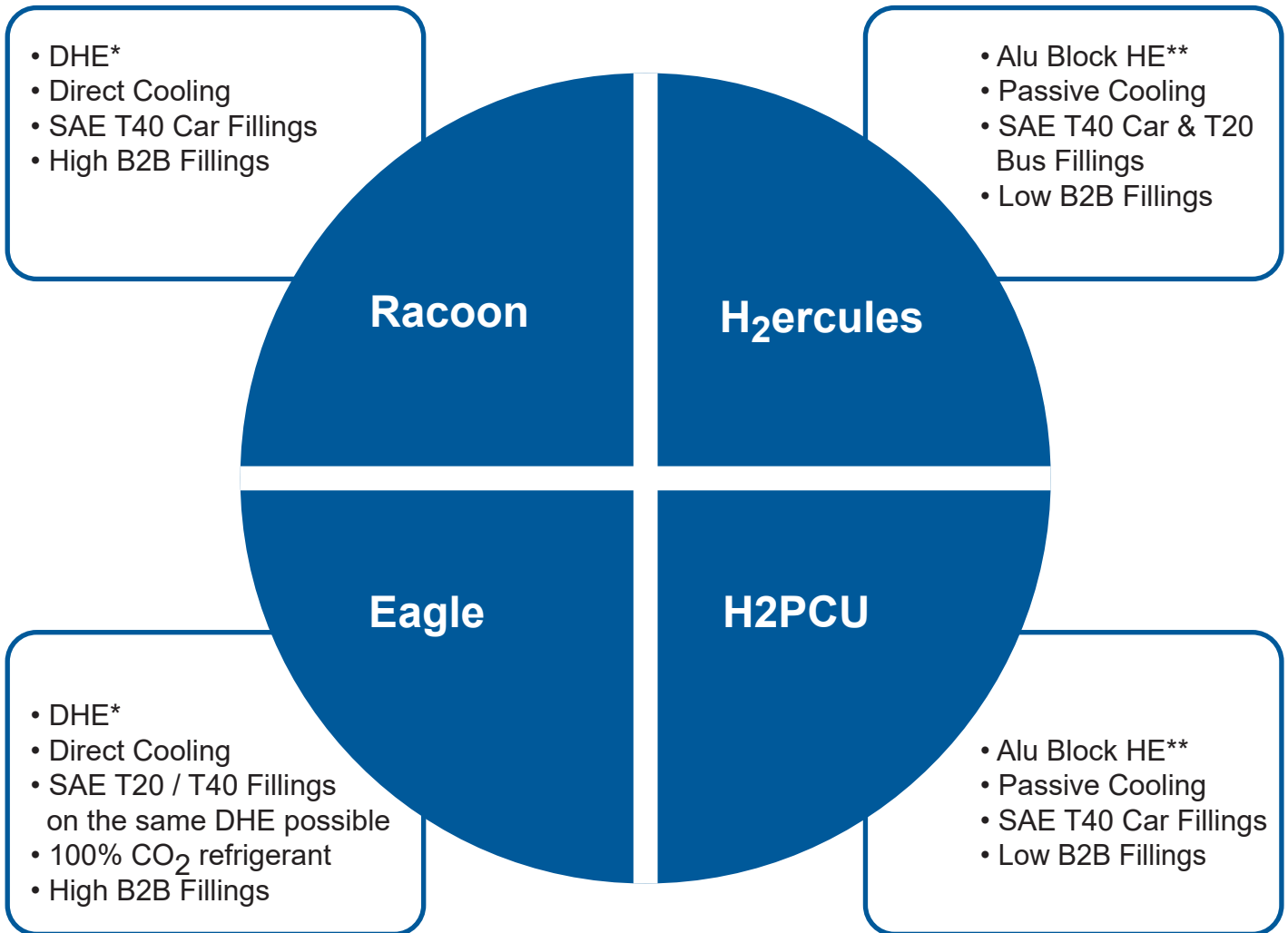


Lowest / Smallest



Cooling Systems Summary

KUSTEC Standard Cooling Systems

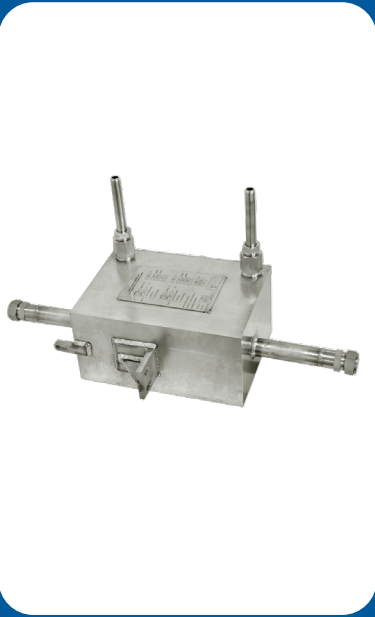


* DHE - Diffusion Bonded Heat Exchanger

** Alu Block HE - Aluminium Block Heat Exchanger

KUSTEC Cooling Systems

DHE vs. Alu Block HE

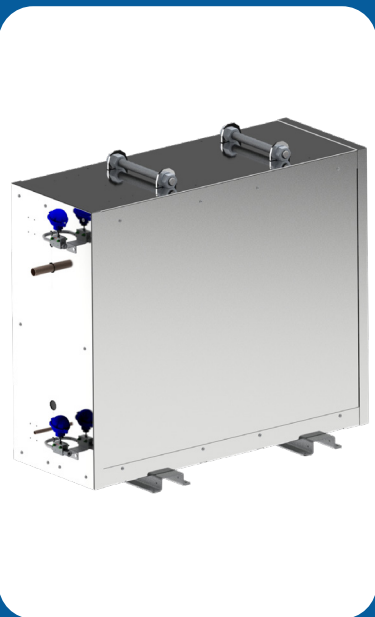


DHE

Diffusion Bonded Heat Exchanger

H₂ is cooled directly through a DHE.

- Anytime availability of required Cooling Capacity
- Unlimited B2B Fillings
- Compact Heat Exchanger
- Higher electrical Connection Load



Alu Block HE

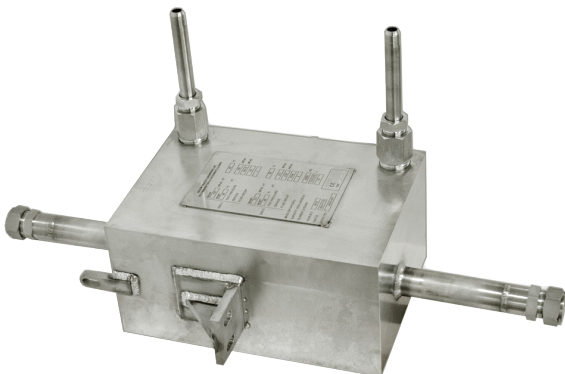
Aluminium Block Heat Exchanger

H₂ is cooled indirectly through an Alu Block HE, which is cooled via a Refrigerant Cycle.

- High Heat Capacity
- Smaller Cooling System
- Limited B2B Fillings

Hydrogen Cooling System: „Racoon 45“

Racoon 45 is used where high performance is required, delivering over 45 kW cooling capacity.



Hydrogen Pre-Cooling Heat Exchangers realize many advantages for hydrogen fuelling, including virtually infinite B2B filling capability and significant savings due to low weight and fluid inventory. As a result, they fit within a small footprint such as dispenser cabinets.

The cascade system is capable of delivering the required cooling capacity at anytime. This ensures:

- High B2B fillings, without recovery time
- A very compact Hydrogen cooling system, since a “diffusion bonded heat exchanger” is used

The Racoon is a cascade refrigeration system, using the refrigerants R449A and R744 (CO₂).

Design conditions: 45kW cooling power at -39°C evaporation temperature and a condensation temperature of 47°C.

KUSTEC’s control system, specially customized for Hydrogen cooling, guarantees high efficiency and reliability.

Electronically controlled valves and transmitters, in addition to the frequency inverters allow full control over the system.

Separate versions are available for the European and American markets accordingly.

Technical data



Cooling Capacity: 45 kW



Connection Load: ~ 50 kW



Temperature Protocol: T40 / MC Protocol



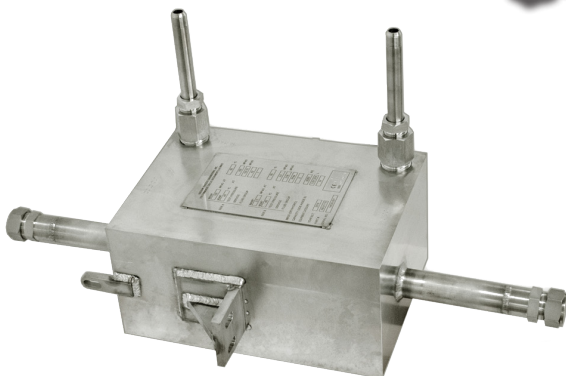
Refrigerant: R449A + R744



Application: Cars

Hydrogen Cooling System: „Eagle 45 EU OD“

Eagle 45 is a low GWP booster cooling system operating with a R744 refrigerant.



Hydrogen Pre-Cooling Heat Exchangers realize many advantages for hydrogen fuelling, including virtually infinite B2B filling capability and significant savings due to low weight and fluid inventory. As a result, they fit within a small footprint such as dispenser cabinets.

Eagle 45 is a special hydrogen cooling system with a low GWP.

Like the Racoon, the Eagle is designed to work with a diffusion bonded heat exchanger, and provide the required cooling capacity for high B2B fillings following the SAE J2601 hydrogen refuelling standards.

Eagle 45 is designed to work at high ambient temperatures, till 45°C, thus the condenser works as a gas cooler at high temperatures.

It delivers 43kW cooling power at -40°C evaporation temperature and 40°C ambient temperature.

KUSTEC's control system, specially customized for Hydrogen cooling, guarantees high efficiency and reliability. The valves are electronically controlled while the compressors are coupled to inverters to ensure full system control.

Technical data



Cooling Capacity: 45 kW



Connection Load: ~ 75 kW



Temperature Protocol: T40 / MC Protocol



Refrigerant: R744



Application: Cars

Hydrogen Cooling System: „HRS 350“

Refrigeration system for outdoor installation. The plant components are housed in a soundproof machine housing.



Another example of our customized systems based on the customer requirements.

The 20-foot container uses two parallel cooling cycles to deliver 150 kW via an indirect cooling system based on two parallel R449A refrigeration cycles and combined with a water-glycol cycle.

The unit is capable of cooling 120 g/s of hydrogen from +60°C to -20°C, under extreme ambient conditions ranging from +40°C to -20°C.

The machine delivers the cooling capacity while maintaining a 100m distance between the hydrogen dispensers and the chiller.

Technical data



Cooling Capacity: 145 kW



Connection Load: ~ 280 kW



Temperature Protocol: T20



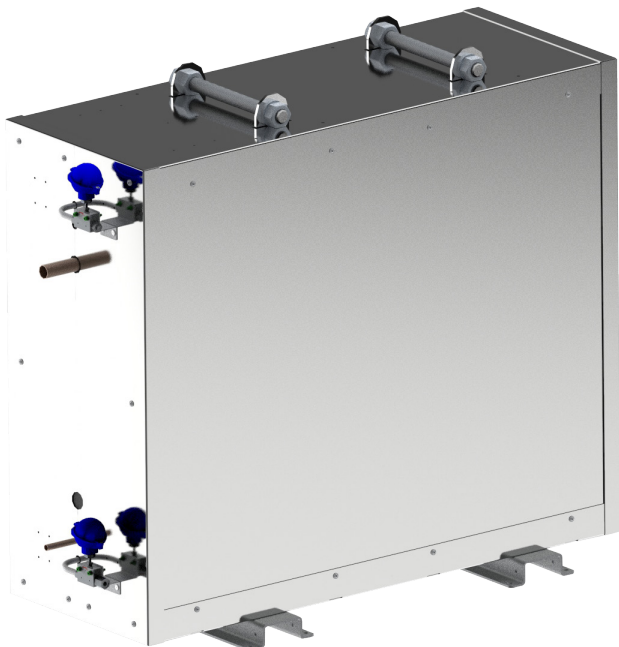
Refrigerant: R449A



Application: Ultra Heavy Duty Trucks

Hydrogen Cooling System: „H2PCU Compact“

The **H2PCU** offers a high cooling capacity with low power usage due to the Aluminium Block HE, thus reduced investment costs.



The Aluminium Block has a high thermal mass, which is an advantage at stations where highly intermittent refuelling is planned.

In the **H2PCU** cooling system, hydrogen flows through an Aluminium Block HE, which is pre-cooled via the cooling system refrigerant. Thus, the Aluminium Block provides the advantage of simultaneous Active and Passive cooling!

The system proves most worthy for one dispenser hydrogen stations.

The high mass and heat capacity of the Aluminium Block Heat Exchanger allows to have a cooling unit with low connection load values!

The nominal operating points of the system are: $t_c=45^{\circ}\text{C}$; $t_o= -40^{\circ}\text{C}$, delivering the cooling capacity as per the SAE J2601 hydrogen refuelling standard.

As a KUSTEC cooling system, the advanced control system ensures optimizing operational points to maximize COP, thus efficiency.

Technical data



Cooling Capacity: 15-24 kW



Connection Load: 24-36 kW



Temperature Protocol: T40



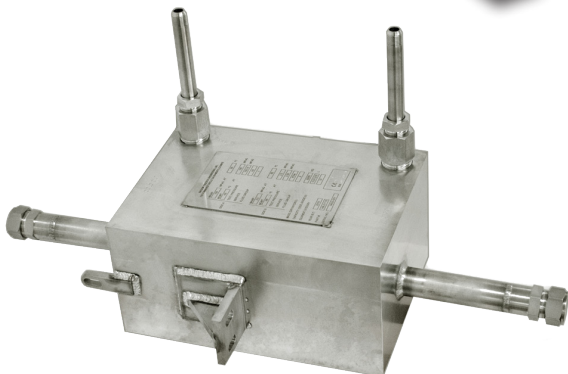
Refrigerant: R452A



Application: Cars / Forklift

Hydrogen Cooling System: „Mobile Cooling“

Considering a mobile Hydrogen Refuelling Station?



Hydrogen Pre-Cooling Heat Exchangers realize many advantages for hydrogen fuelling, including virtually infinite B2B filling capability and significant savings due to low weight and fluid inventory.

As a result, they fit within a small footprint such as dispenser cabinets.

On our mission to support the global Hydrogen Refuelling Stations development, we designed a mobile Hydrogen Cooling System. It entails a compact cooling system delivering the required cooling capacity at a 30°C ambient temperature with a 2.4m x 1.5m footprint.

KUSTEC customized the system to deliver the customers' requirements at a minimal cost. Thanks to our team of specialized engineers and technicians, we supplied two versions of the system.

Technical data



Cooling Capacity: 59 kW



Connection Load: ~ 35 kW



Hydrogen flowrate: 100g/s @ 0°C



Refrigerant: R449a



Application: Railway

You need Cooling



has the Solution



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