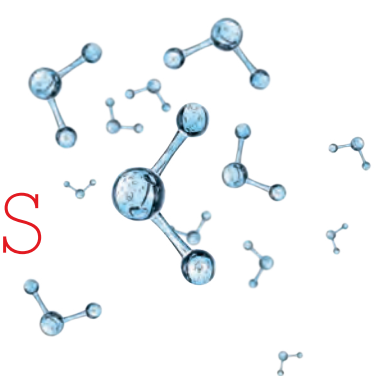




Hydrogen refueling stations

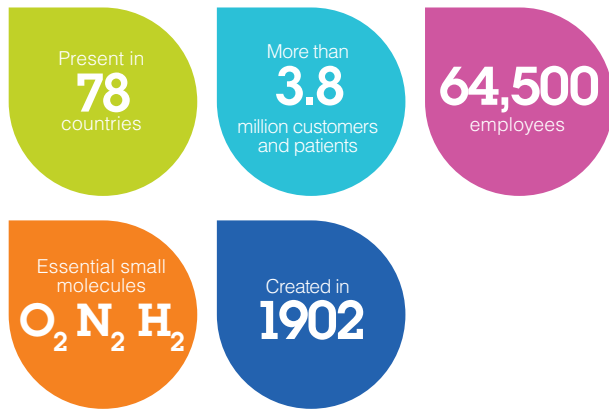
Power your mobility
with clean energy



 **Air Liquide**

Air Liquide Group

A world leader in gases, technologies and services for industry and healthcare



Air Liquid has ambitions to contribute to sustainability, through the commitment and inventiveness of its stakeholders, and has been working for a long time to combine growth and reducing its environmental footprint.

Safety is an essential part of Air Liquide's operational excellence and culture. The Group is committed to effectively reducing the exposure of customers to professional and industrial risks under all circumstances.

Air Liquide and hydrogen energy

Committed to the energy transition

With over 50 years of development, Air Liquide covers the whole hydrogen energy value chain, including hydrogen production, supply chain, storage, and distribution to the end users.



200
H₂ plants



1,850 km
of H₂ piping lines



More than **120**
H₂ refueling stations
50
stations operated
by Air Liquide

With nearly **20 years** of development on hydrogen stations, Air Liquide is able to supply both standardized and tailor-made **design, integration, manufacturing, installation, commissioning, and maintenance solutions** that meet the customer's needs.



Our product portfolio

We offer the most extensive portfolio of hydrogen refueling stations and related services for all your clean mobility hydrogen energy needs.

Our team will support you at every stage of your hydrogen energy project, from the choice of hydrogen source, design (appropriate refueling times, footprint), installation, start-up, operation, and maintenance.

Our offers

A large portfolio of hydrogen refueling stations

- A wide range of protocols
- Compatible with all types of vehicles

Engineering and installation services

- Process
- Design
- Commissioning

Maintenance and operational support

- Preventive and predictive maintenance
- Technical assistance
- Spare parts
- Training

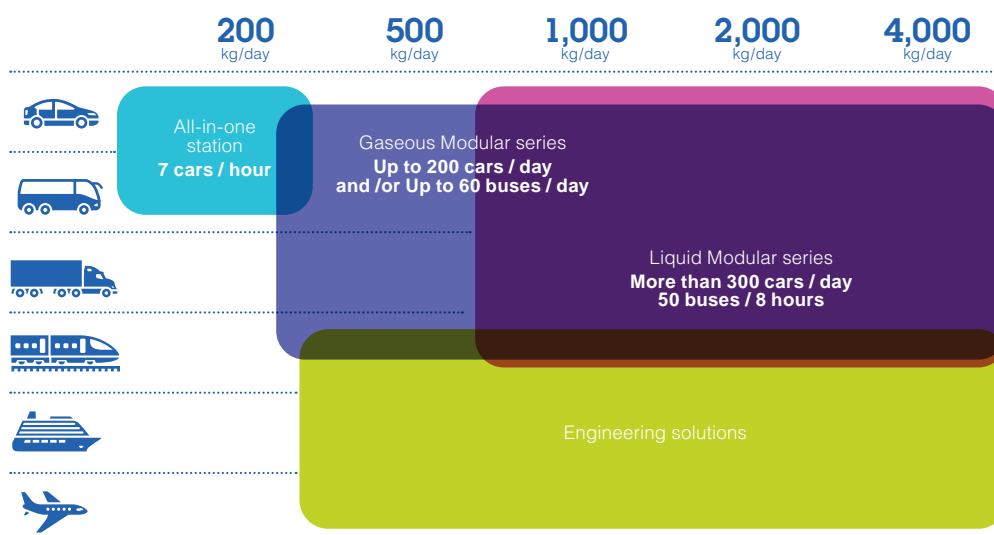
Key benefits

- Get access to our worldwide expertise
- Standard and customized solutions
- Simplest design to ensure safety and reliability
- Optimized total cost of ownership
- Design for easiest maintenance
- Patented applications

Our mission towards customers

Our expertise, your needs

We strive to enhance customer-oriented hydrogen energy applications and continue to exceed customer expectations through our reliable solutions and hydrogen energy distribution services for clean mobility worldwide.



All-in-one hydrogen refueling station

The all-in-one hydrogen refueling station is designed for gaseous hydrogen refueling for hydrogen-powered vehicles at 35MPa and 70MPa, especially for the small captive fleets and public use. It has a capacity of up to 95 cars per day, with a high level of reliability. This series also offers a mobile solution with portable hydrogen refueling stations.



Advantages

- Easy to install and disassemble
- Easy to ramp up
- Containerized product
- Mobile solution
- Reliability proven with endurance tests on the Air Liquide test pad



Gaseous fueling series for cars and buses

Types of vehicle

- 35MPa cars
- 70MPa cars
- Buses 35MPa for demonstration

Options

- 35MPa vehicle refueling line (possible to refuel buses)
- T20 and T40 chiller and/or smaller compressor for optimization of CAPEX
- Third-party payment system
- Compatible with hydrogen sources:
 - 20MPa trailers
 - Stationary storage (20MPa or 30MPa)
 - Electrolyzers

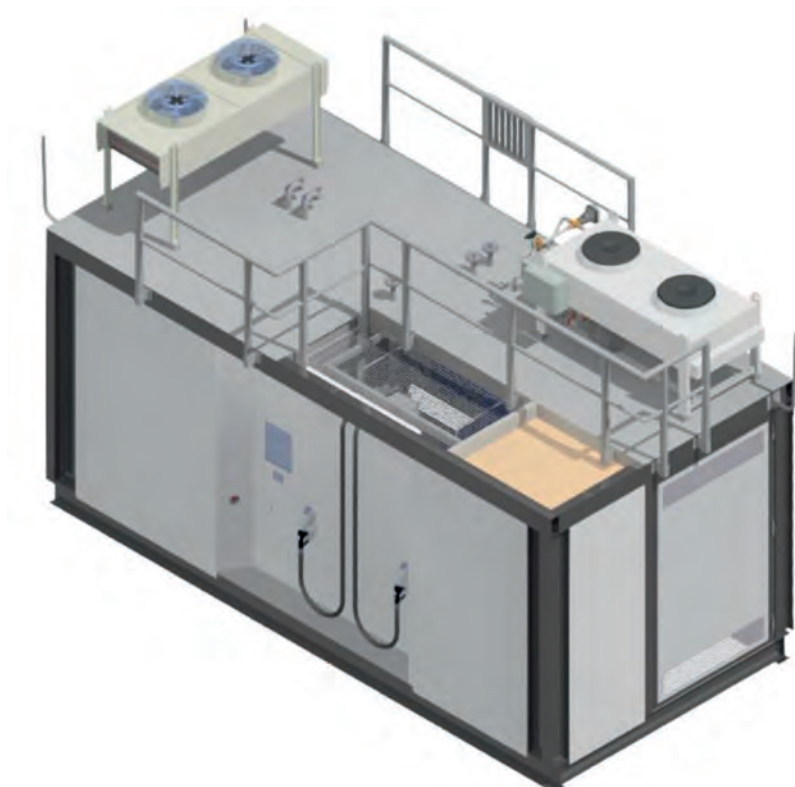
Specifications

Footprint for the whole station:

- 6m x 3m x 4m (EU)
- 25'-4" x 8'-4" x 11'-7" (US)

Power supply:

- 480V, 3 phases, 100kW (EU & US).



Key figures



H70 Cars refueling
(approx. 2.5kg per fill)

H35 Cars refueling
(approx. 0.8kg per fill)



Peak time performance
(at 20MPa inlet pressure)

Waiting time between 2 vehicles

8 minutes

2 minutes

Max. vehicles in one hour

7

21



Daily performance
(for 21m³ H₂ source @ 20MPa)

Linear refueling profile

Up to 95 cars
(235kg)

Up to 295 cars
(235kg)

Modular hydrogen refueling station

The modular hydrogen refueling station range is designed for refueling hydrogen-powered vehicles at 35MPa and 70MPa. The products are modularized and easy to install and ramp up according to the customer's needs. This range offers gas series and liquid series hydrogen refueling stations with a high level of reliability, and it is capable of refueling up to 200 cars per day.

Types of vehicles

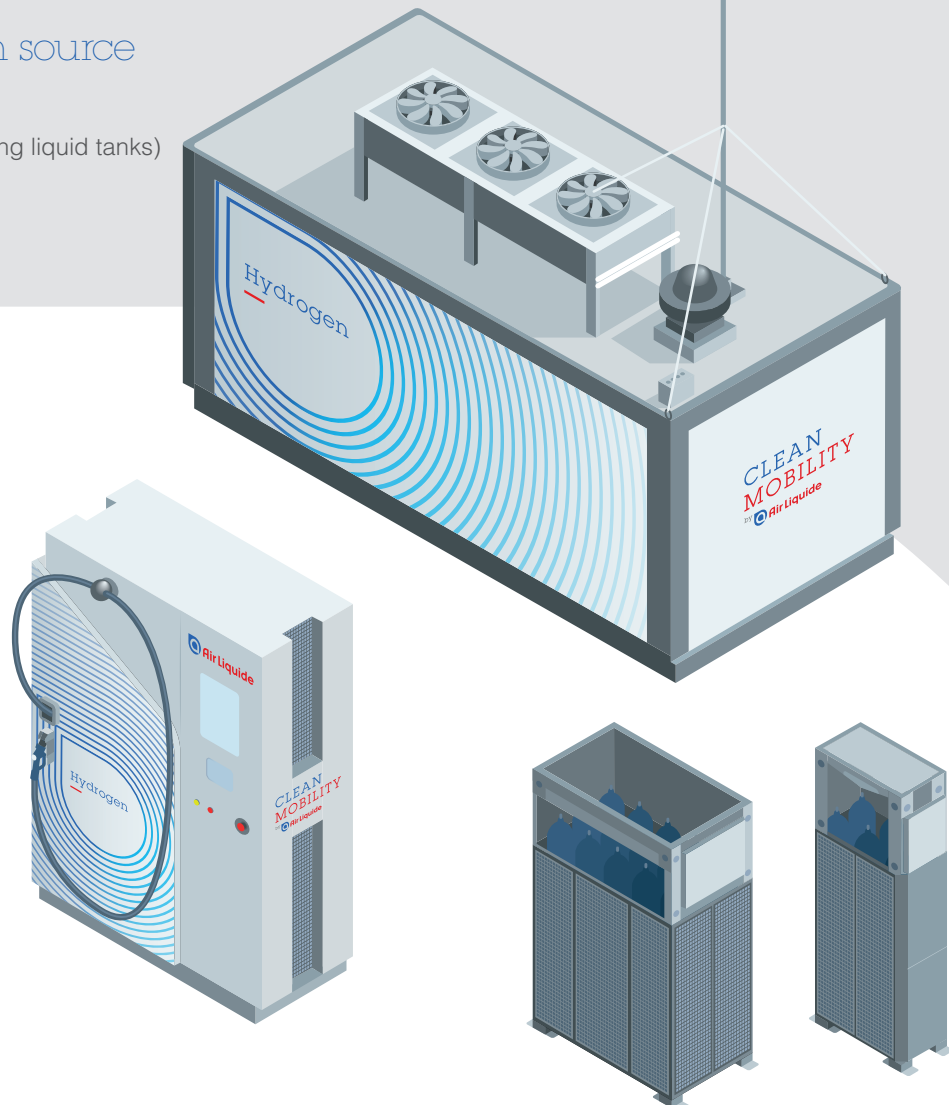
- 70MPa cars, buses and trucks
- 35MPa cars
- 35MPa buses (for operation)
- Light-duty trucks

Hydrogen source

- Bundles
- Trailers
- Tanks (including liquid tanks)
- Electrolyzer

Advantages

- Modularity and scalability
- Optimised total cost of ownership (TCO)
- Reliability proven with endurance tests on the Air Liquide's test pad



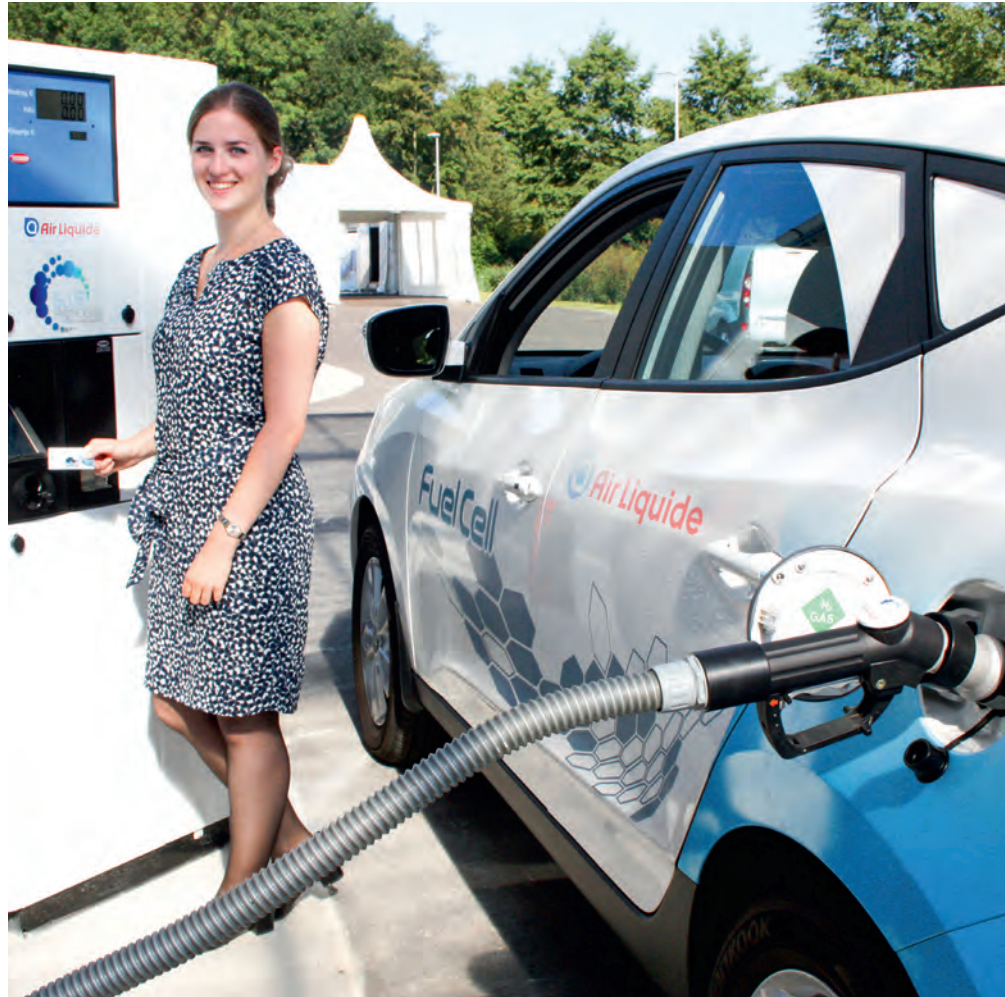
Gaseous fueling series for cars

Modularity and scalability





The hydrogen refueling station can be modulated based on the customer's needs. It is able to upgrade its refueling capacity up to 200 cars* per day. Furthermore, it is also possible to upgrade an existing modular gas car refueling station to a bus refueling station. Easy to upgrade after years of operation.

Options

- 70MPa double dispenser
- Heavy-duty dispenser
- Operation and maintenance services



Key figures

		Barebones configuration GM-S-70	GM-M-70	Enhanced configuration GM-L-70
 Peak time performance	Back to back performance**	127	151	177
	Max. cars in one hour	Up to 18 cars in 1 hour with double dispenser		
Modularity	 	GM 70-35	Expandability up to 17 buses and 80 cars	

* Source of 45.15m³ 30MPa. ** One car every 3 minutes. 0 minute waiting at peak time.

Gaseous fueling series for bus

Types of vehicle

- 35MPa and 70MPa buses

Modularity and scalability

The hydrogen refueling station can be modulated based on the customer's needs. It is possible to upgrade its refueling capacity from 18 to 60 buses at 35MPa and 70MPa.





Options

- Cooling system
- MP* buffers extension
- Redundant compressor
- Redundant dispenser
- Wide range of H₂ sources
- Operation and maintenance services

Key figures



		Barebone configuration GM-M-35	GM-L-35	Enhanced configuration GM-XL-35
 Peak time performance	Refueling time for one bus Filling of 30kg	10	10	10
	Back-to-back performance	14	17	24
 Daily performance	Linear refueling profile	17	52	61

* MP: Medium Pressure

Note: source 30MPa, 45.15m³. Source is changed when pressure reaches 5MPa.

Liquid to gas fueling series for cars

Types of vehicles

The liquid-series modular hydrogen refueling station is designed for light-duty fuel cell vehicles.

Key benefit




- Optimization of capex (over 1,000kg/day)
- Energy-saving
- 70MPa
- Highly efficient liquid hydrogen pump
- No-fog vaporizer technology

Options

- Dual dispenser
- Reinforced structure for vehicle impact enhancement



Key figures

		LM-L-70	LM-XL-70
 Peaking time performance	Waiting time between 2 cars	4 minutes	4 minutes
	Max. cars refueling/hour (5kg fuelling/car)	12	18
 Daily performance	Linear refueling profile	More than 300 cars (1,600kg)	

Liquid to gas fueling series for buses

Types of vehicle

- 35MPa buses
- Fleet size: 10 - 50 buses

Key benefit

- Optimization of capex (over 4,000kg per day)
- Energy-saving
- Small footprint
- Highly efficient liquid hydrogen pump
- No-fog vaporizer technology

Options

- Redundant dispenser
- Additional buffer
- Redundant pumping system
- Additional vaporization system
- Horizontal tank position



Key figures 35kg refill



Minimal configuration LL-S-35

>

Enhanced configuration LL-XL-35

	Minimal configuration LL-S-35	>	Enhanced configuration LL-XL-35
# of fueling positions	Single	Single	Dual
Fueling capacity per 8 hours	Up to 15 buses / 525kg	Up to 25 buses / 875kg	Up to 50 buses / 1,750kg
Fueling duration / Time between fills	~15 minutes / 10 minutes	~10 minutes / 3 minutes	~10 minutes / 9 minutes

Customized engineering solutions

Our engineering solutions focus on the customer's unique needs and we are able to provide customized solutions for hydrogen-powered heavy-duty trucks, trains, ships or aircraft.

Beyond the standard solution, with Air Liquide's know-how, we are also capable of offering tailor-made solutions through optimized hydrogen sources (including SMR* and electrolysis), distribution by piping or hydrogen supply trailer, or on-site hydrogen production.

SMR*: steam methane reforming



Range of dispensers

Our dispensers

Air Liquide offers a wide range of dispensers, including single dispensers, double dispensers, and dual dispensers, complying with SAE J2601 2020 (including MC Method) fueling protocol and ISO standard 19880-1 to meet our customers' diverse needs.

Our innovative products are designed for:

- Reducing refueling waiting time
- Increasing H₂ filling capacity
- Adapting to the client's station layout with:
 - Flexible configuration
 - Small footprint in customer fuelling area
- Easy integration with any types of station
- Enhancing customer experience through:
 - Screen communication interface
 - Long tube for filling both sides of vehicles



Types of dispenser:

- Single dispenser
 - 1 filling point
- Dual dispenser
 - 2 filling points at the same location
 - Consecutive fillings
- Double dispenser
 - 2 filling points at the same location
 - Simultaneous fillings



Possible options for each filling point:

- H35* for cars
- H35 for buses and trucks (high flow)
- H70* for cars
- H70 for buses, trucks (high flow)



Mobile dispenser

Air Liquide's mobile dispenser is capable of remote operation without power connections.

Fuel type:

Ambient temperature fills of H70 vehicles

Hydrogen source:

Gaseous hydrogen up to 45MPa (tube trailer or hydrogen cylinders)

Fuel time:

45-60 minutes for 2-4kg fills

Nozzle type:

H70



* H35: dispensing pressure of 35MPa; H70: dispensing pressure of 70MPa.

Our unique and additional competencies

Metering

Flow Meters

Patented Air Liquide solution for accurate H₂ measurement, with software built into the flow meter. Benefit demonstrated on existing working hydrogen refueling stations.

Verification means of H₂ dispensers

- Mobile reference test bench certified by official body (PTB / LNE / NMI Certin) to determine the accuracy of hydrogen dispenser
- Initial & Periodic Verifications
- Well performed in several test campaigns in Europe

Certification

- **First** dispenser certified in Germany according to OIML R139
- For an Accuracy Class 2 (Type Examination Certificate)

Metering certified by LNE, PTB, according to OIML R139.
PTB (Physikalisch-Technische Bundesanstalt) in Germany
LNE (Laboratoire national de métrologie et d'essais) in France
NMI Certin in the Netherlands

Air Liquide's engineering tools

Air Liquide has developed several simulation and modeling tools to design safe and reliable products, with guaranteed performances.

Software to simulate the FILING (SOFIL)

- To design innovating filling protocols ensuring tank safety
- To study special behavior (no pre-cooling, pressure regulation broken, very high flow, etc.)
- Respecting temperature

ALDEA tools

- Release and dispersion of H₂
- Physical burst
- Deflagration and flame

Hydrogen refueling stations performance modeling

- Based on feedback from 10 years of operation
- Guaranteed on performances

Operability

- FMECA methodologies
- H₂ leaks tracking
- Maintenance plan and scheduling
- Life cycle management to support our clients
- Safety capitalization and improvement

Air Liquide's dedicated test pad Product tested with more than 2000 real fillings on FCEV receptacles.



Services and maintenance activities

Maintenance and operational support

- Several levels of maintenance services from preventive to corrective maintenance
- Upgrade and ramp-up
- Spare parts management
- Troubleshooting and revamping
- Teams in the different geographies to be close to customers

Start-up team

- Procedure and experiences
- Training
- Worldwide

Key references and initiatives

Les Loges - Paris / **France**

- GM-S-70-35 v2
- **First buses hydrogen refueling station in Paris area**
- 3 fueling positions (35MPa & 70MPa)
- 15-minute refueling time for 35MPa buses
- In operation since 2017



Düsseldorf-South / **Germany**

- GM-S-70-35 v2
- G2 station with connection to pipeline, hydrogen purification units, pre-compression unit
- **First hydrogen refueling station with pipeline connection in Germany**
- 1 dual dispenser 35MPa & 70MPa
- Refueling of both passenger cars and buses
- Bus refueling: on average 20kg/fill, in less than 15 minutes
- In operation since 2019





Tokorozawa Matsugo / Japan

- GM-S-70v3
- Hydrogen refueling station with on-site H₂ supply (SMR)
- **Designed for both passenger cars and buses**
- Refueling capacity: 3 buses/hour
- 2 single 70MPa dispensers
- In operation since 2019



West Shanghai / China

- GM-L/XL-35-CH
- 1,000kg/12h
- 2 compressors
- 2 dual 35MPa dispensers
- In operation since 2020

Anaheim (CA) / USA

- GM-S-70v1
- 70 fills per day
- Lifetime fill: more than 57,000
- Lifetime capacity: more than 162,000kg
- In operation since 2016



Busan / Korea

- GM-S-70v1
- **First 70MPa hydrogen refueling station dedicated to 25kg buses**
- 12,000kg/month (the highest record for mass dispensed)
- 30 buses per day
- In operation since 2019



Our international partnerships



Our teams are there for you

France
Grenoble

China
Chengdu

United States of America
Houston

Germany
Dusseldorf

Korea
Seoul

Japan
Tokyo



Contact us

2, rue de Clémencière
BP 15 - 38360 Sassenage, France
Phone: +33 (0)4 76 43 68 21
E-mail: ww-h2refuelingstations@airliquide.com

www.energies.airliquide.com



A world leader in gases, technologies and services for Industry and Healthcare, Air Liquide is present in 78 countries with approximately 64,500 employees and serves more than 3.8 million customers and patients.