

# Nikkiso Clean Energy and Industrial Gases Group

Hydrogen Fill Station Edition



**NIKKISO**

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# Nikkiso Clean Energy & Industrial Gases Group

Nikkiso CE&IG's vision statement "Leading the Change to a Healthier World" represents what we want to accomplish as a company. We are dedicated to reducing carbon emissions and leading this valiant effort. Our commitment to Clean Energy and our heritage to Industrial Gases is in synergy with our mission statement. "We provide innovative equipment, technologies, and services through our global group of companies to help our customers make a difference". Our goal is to attain net-zero carbon and contribute to every part of the hydrogen value supply chain, to help create the demand and quickly build infrastructure.

Our role in this growing hydrogen economy is to integrate equipment systems and services, enabling clean energy generation, storage, distribution and consumption to be efficient and reliable. We strive to achieve this through innovation by focusing on new product development, design-build-delivery solutions for our customers and partnering with other OEMs, industry associations and regulatory policymakers. We are only successful if our customers are successful. Our customers have a vision of what they aspire to accomplish. If our total solutions help them make a difference in this world, we become the leaders of that change.

Peter Wagner  
CEO

## Vision

Leading the change to a healthier world

## Mission

We provide innovative equipment, technologies and services through our global group of companies to help our customers to make a difference.

## About Us

Nikkiso's Clean Energy & Industrial Gases Group (CE&IG) is part of the Nikkiso Co., Ltd group of companies. Nikkiso Co. is a \$1.4B public company. CE&IG comprises five distinct functional units: Cryogenic Pumps (ACD, Nikkiso Cryo), Process Systems (Cosmodyne), Heat Exchanger Systems (Cryoquip), Cryogenic Services (through 18 global facilities) and Integrated Cryogenic Solutions (providing centralized management of products and project development). In 2020, CE&IG expanded our capabilities further with the acquisition of what was GP-Strategies' Alternative Fuels Division. This addition provides yet another major manufacturing facility in Southern California. Acknowledged as a market leader in the design, engineering, manufacturing, construction and maintenance of Cryogenic infrastructure, this facility offers full in-house capabilities from engineering & permitting through manufacturing, construction and maintenance.

For over 50 years, we have been a leader in the Clean Energy industry and are leading the change to a healthier world. With our hydrogen filling technology, Nikkiso has become a leader in the evolving hydrogen revolution, including a project on the world's first LH<sub>2</sub> bunkering facility. For more information visit [www.NikkisoCEIG.com](http://www.NikkisoCEIG.com).

# We Know Hydrogen



For over 30 years, we have been a leader in the Hydrogen revolution. We will actively pursue the goals of reaching 200 light-duty H<sub>2</sub> stations by 2025 and a minimum of 200 heavy duty stations by 2035.

- Built over 400 pumps for liquid hydrogen service
- Built over 100 vaporizers & heat exchangers for hydrogen service
- Built 10 hydrogen fill stations in US
- Over 50 years of cryogenic experience

We design, build, deliver Next Generation Hydrogen Fill Stations.

Our operating range is what sets us apart. With the capability to deliver hydrogen at 1,000 kg/hr and 1,000 bar, we allow economical scalability for future stations.

We're able to do this because Nikkiso ACD has traditionally built very high-pressure high-flow equipment that our competitors have not. And, we've adapted that architecture to Hydrogen, which allows us to bring those high flows and pressures to the market very quickly.

We continually focus on research and development, increasing the efficiency and operating hours of our pumps. With our new sealing technology that's been in development, we can drive the efficiency of our pumps to the maximum theoretically possible limits.

## Hydrogen Filling Options

- H<sub>2</sub> is stored in vehicles in gaseous state.
- cH<sub>2</sub> to cH<sub>2</sub> – Uses compressors to pressurize low pressure H<sub>2</sub> gas into high pressure H<sub>2</sub> gas.
- LH<sub>2</sub> to cH<sub>2</sub> – Uses pumps to pressurize low pressure LH<sub>2</sub> liquid up to high pressure and send it through a vaporizer where it is heated and vaporized into a high-pressure H<sub>2</sub> gas. H<sub>2</sub> is stored in vehicles in gaseous state.
- sLH<sub>2</sub> to sLH<sub>2</sub> – Uses pumps to take low pressure LH<sub>2</sub> and through a moderate pressure increase subcool it. H<sub>2</sub> is stored in vehicles in subcooled liquid state.

LH<sub>2</sub> = Liquid Hydrogen

cGH<sub>2</sub> = Compressed Gas Hydrogen

sLH<sub>2</sub> = subcooled liquid hydrogen



# Capabilities

Our Integrated Cryogenic Solutions Unit was created to provide a central point of contact for multi-product and multi-tiered projects. Under the umbrella of our ICS division, the Escondido facility allows us to offer the following:

- Complete System and Site Design with In-house Registered Professional Engineers
  - Specialty System Fabrication (incl. vacuum jacket piping)
  - UL-508 Control Panel Design, Fabrication and Programming
  - Turnkey Construction in North America
  - System Installation and Maintenance
  - Permitting in North America
  - 24hr Maintenance Services
  - ASME Pressure Vessel Repair and Alternations
  - In-house HAZOP
  - Cryogenic System Design, Integration, Fabrication and Installation
  
- Completed Over 150 Projects in North America, including more than a dozen LNG stations built and supported for UPS



### Ambassador member of the CaFCP



Nikkiso Clean Energy & Industrial Gases Group is proud to be an Ambassador member of the CaFCP. California is on the forefront of the hydrogen movement deploying fuel cell electric vehicles and hydrogen Fill stations. The association is driving to establish 200 hydrogen fill stations by 2025 for a sustainable future for zero emission cars, trucks and buses. Joining the CaFCP is part of the Group's commitment to leading the change to a healthier world.

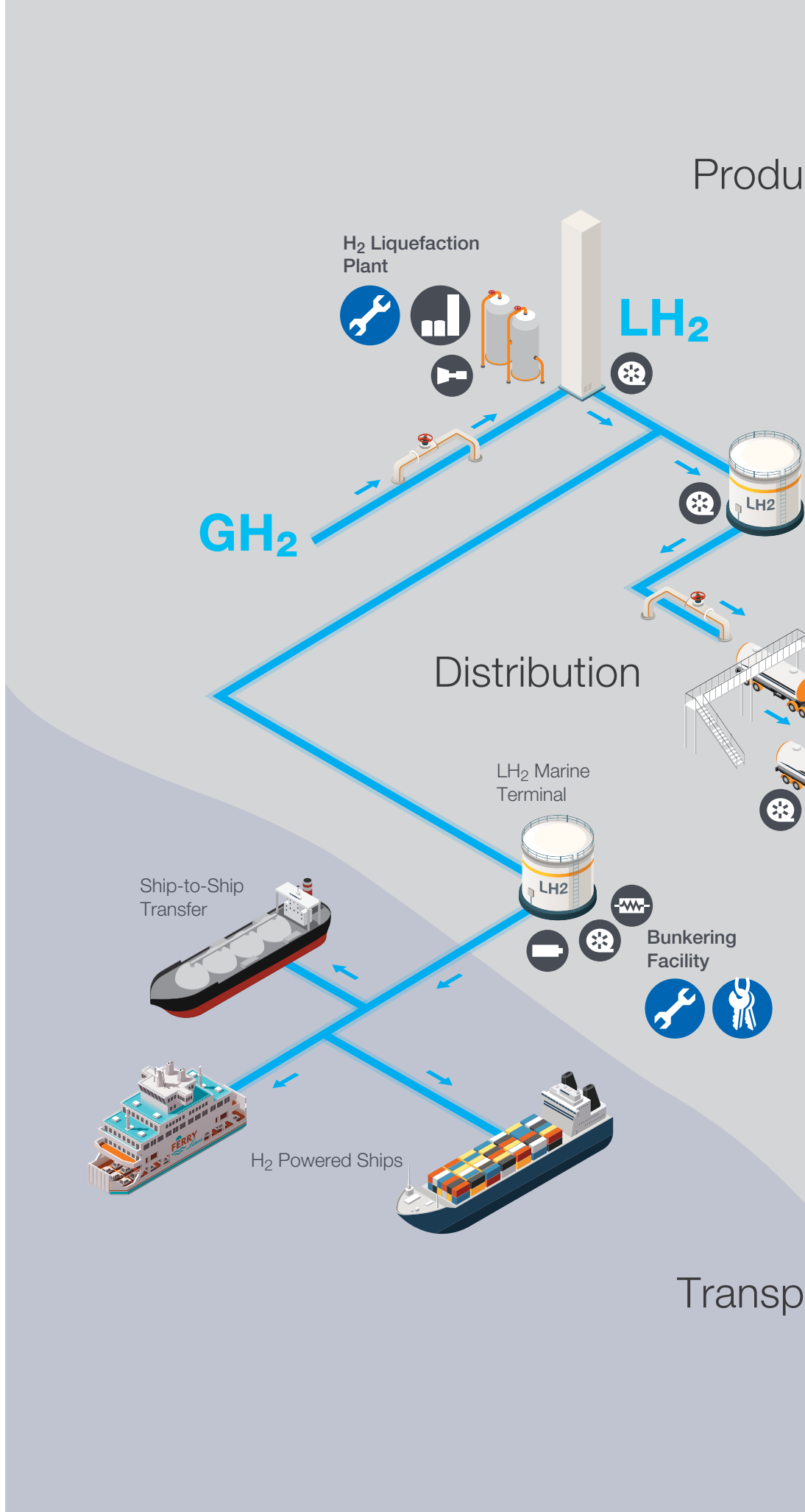


# Nikkiso Hydrogen Value Chain

From turn-key solutions to integration, components and service... Nikkiso has you covered every step of the way.

### MAP KEY:

-  Turn-Key Solutions
-  Service (All Products)
-  Liquefier
-  Centrifugal Pump
-  Receiprocating Pump
-  Vaporizer
-  Turbo Expander



Produ

LH<sub>2</sub>

GH<sub>2</sub>

Distribution

LH<sub>2</sub> Marine Terminal

Ship-to-Ship Transfer

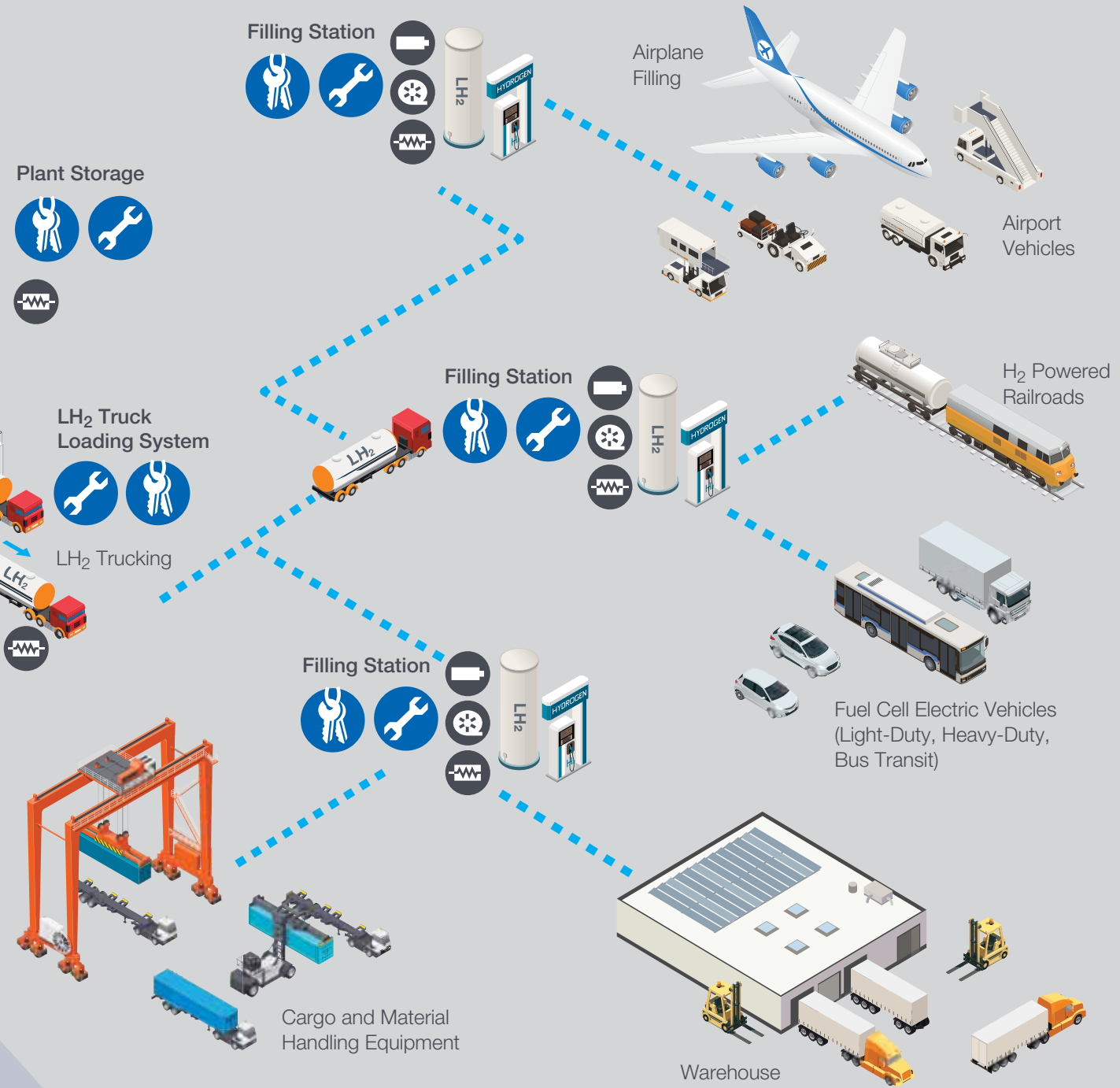
Bunkering Facility

H<sub>2</sub> Powered Ships

Transp

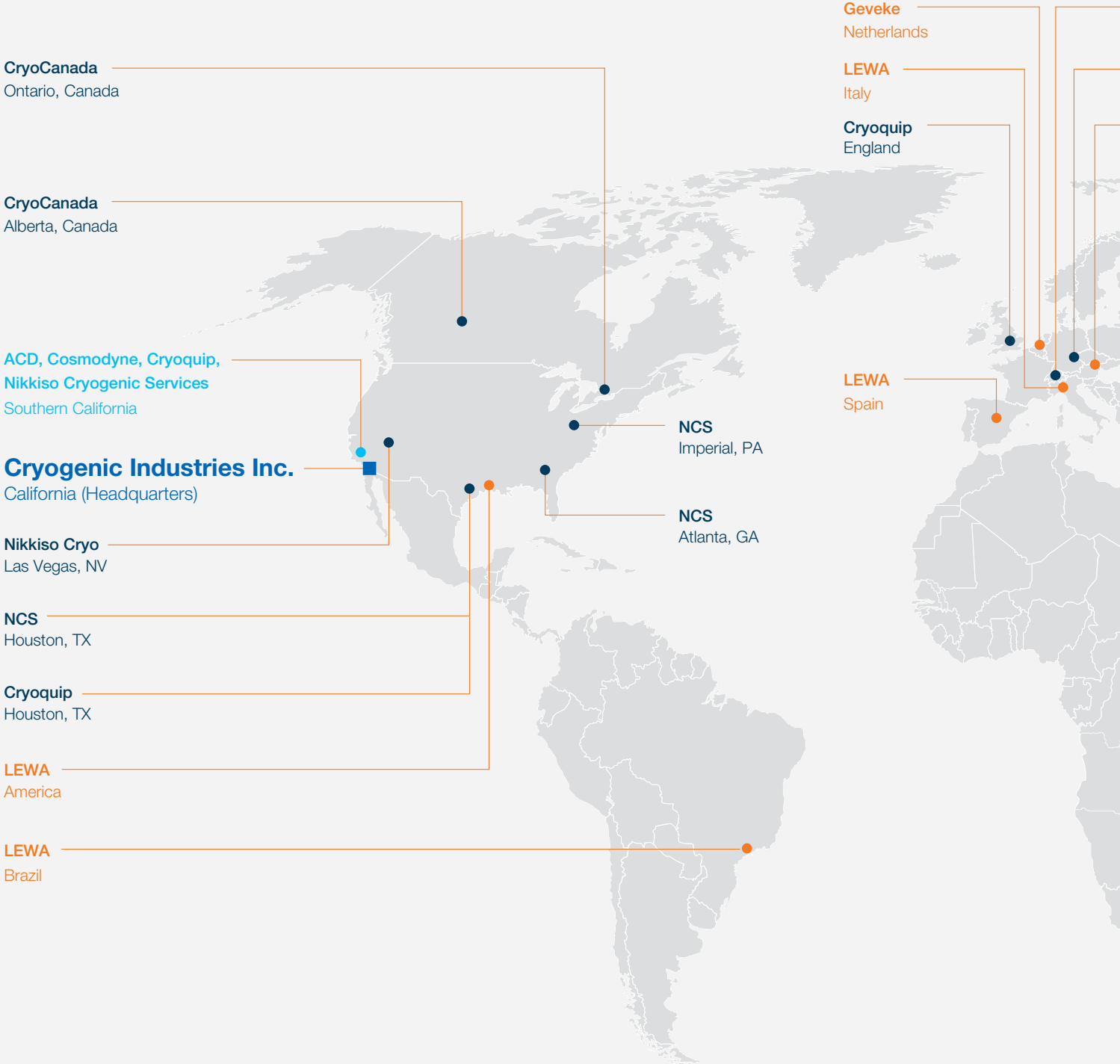
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# Consumption



ortation

# Nikkiso Clean Energy & Industrial Gases Worldwide Locations





# ations



# Products

## Pumps – Nikkiso ACD

### Model TC-34.2

State-of-the-Art Submerged Motor Pumps



Suction Pot Mounted  
Installation



In-tank and Removable  
Installations

#### Specifications

Flow Range	gpm	1 – 1,600
	lpm	4 – 6,056
	LH <sub>2</sub> kg/hr	15 – 25,000
NPSHR	feet	0.5 – 5
	meter	0.15 – 1.5
Differential Head	feet	50 – 4,000
	meter	15 – 1,220
Pump Design Rating	hp	3.35 – 335
	kw	2.5 – 250
Speed Range	rpm	2,000 – 10,000

Consult ACD engineering for actual performance ratings.

#### Features & Benefits

- Active thrust balancing system for extended bearing life
- High-efficiency hydraulics with extremely low NPSHR inducer
- Light weight and compact
- Available in sump and in-tank designs
- Special design VFD drive provides operation point control over the entire pump operating range
- Features a quick electrical disconnect for ease of maintenance
- Permanent magnet motor
- All parts from wrought aluminum are precision machined
- Vacuum jacketed sump
- Heavy-duty ceramic bearings

#### Applications

- Fuel supply systems for rail locomotives
- Low-pressure marine fuel systems
- HP Booster pump
- Liquid storage transfer
- Bunkering operations
- Peak-shaving
- Trailer loading and off-loading
- High-pressure pipeline injection
- Power generation

#### Complete Pumping System

- High-efficiency submerged pump
- Vacuum jacketed sump
- Custom made VFD drive – factory string tested
- Dual electrical feed thru hermetically sealed up to 500A

#### Liquids Pumped

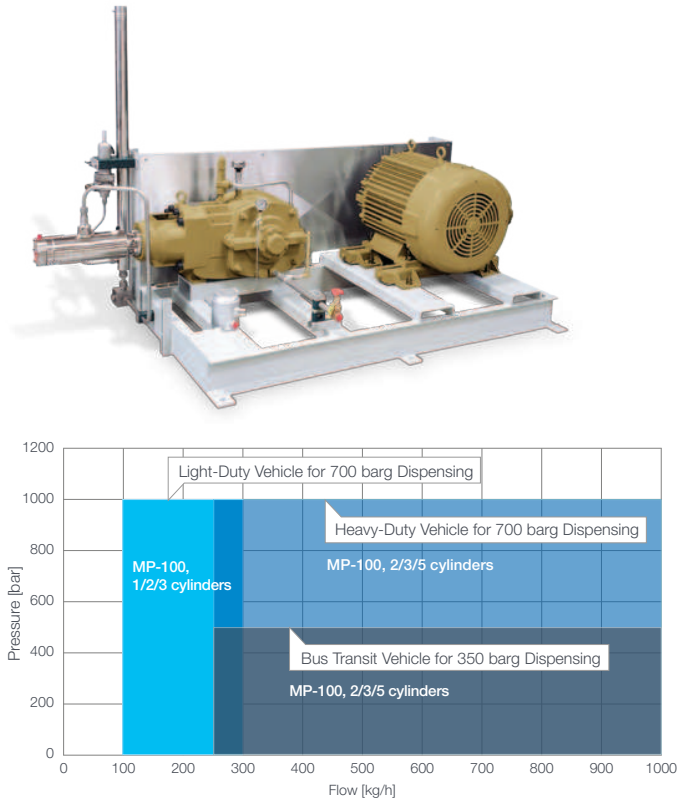
- Nitrogen
- Argon
- Ethylene
- Ethane
- Methane (LNG)
- Propane
- Hydrogen

#### Optional Accessories

- Differential pressure gauge
- Loss of prime detector (cavitation protection)
- Safety relief valve
- Dual conduit box per NFPA standards for LNG services
- Complete removal systems
- Long term storage container

## Model MP-100

Fill Station/Storage Filling/Special Application Pump



### Specifications

Bore x Stroke (single cylinder)	in	1.625 x 2.25	1.97 x 2.25
	mm	41 x 57	50 x 57
Flow Rate	gpm	2.6 – 51.5	3.8 – 75.7
	lpm	9.7 – 195.2	14.3 – 286.9
	LH <sub>2</sub> kg/hr	30 – 600	40 – 1,000
Pump Design Rating	hp	15 – 500	15 – 450
	kw	11 – 373	11 – 336
Maximum Discharge Pressure	psi	13,000	8,000
	bar	900	550
NPSPR	psi	5 – 15	5 – 10
	bar	0.35 – 1.0	0.35 – 0.70
Speed Range	rpm	150 – 600	150 – 600

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

900 bar applications require a booster pump (TC-34.2 or recip booster).  
500 barg applications do not require a booster. sizes and ratings.

### Features & Benefits

- Modular, compact displacement pumps available in 1, 2, 3 or 5 cylinder configurations provide a wide range of flows
- Vacuum jacketed cold end for minimal cool-down losses and economical operation, ideal for liquid hydrogen
- Pressurized oil lubricated drive with integral oil pump and reservoir, allows higher bearing loads/prevent oil leakage
- Compatible with external oil cooler or lube system for continuous duty applications
- State-of-the-art internal sealing design for high efficiency and minimized losses

### Applications

- Storage filling
- Special medium to heavy-duty applications
- Continuous duty applications
- LH<sub>2</sub> fueling station applications

### Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Methane
- Hydrogen

### Typical Scope of Supply

- Vacuum jacketed cold end with pressure oil lubricated drive end
- Standard suction adapter with Monel strainer
- Distance piece with purge ports
- Hot dipped galvanized steel skid
- TEFC motor
- High-pressure relief valve with discharge line and surge chamber
- Drip pan kit for LH<sub>2</sub> applications
- Suction/vapor return manifold for multiple cylinder configurations

# Products

## Pumps – Nikkiso ACD

### TC 34.2 Sump – Complete Liquid Hydrogen Bunkering Installation



Crowds gather to learn about this revolutionary future fuels technology.



Nikkiso sump

Nikkiso CE&IG is proud to be working to develop solutions for the future, particularly regarding LH<sub>2</sub>.

Continuing our commitment to lead the change to a healthier world, we partnered with clean energy solutions company Unitrove to lay the groundwork for zero-emissions marine fueling infrastructure at ports throughout the world. The first ever Liquid Hydrogen (LH<sub>2</sub>) Bunkering Solution was showcased at the COP26 Climate Change Conference in Glasgow (November 2021). This project is just one example of our drive toward more energy-efficient solutions for the Marine market.

We provided custom equipment from two of our Functional Units: a sump from our Heat Exchangers unit (Cryoquip) and Cryogenic Pumps unit (ACD).

### Nikkiso ACD's first Hydrogen Mobile Refueler Pump

**Dream it. Believe it. Build it.**

Nikkiso ACD is proud to present the first Hydrogen mobile refueler pump skid design by Mark Geipel and his team of engineers.

The synergy of exceptional sales and leadership, brilliant engineers, along with expert shop technicians sets us up for success not only today, but for the exciting technological/clean energy initiatives of the future.



Mark Geipel, Ricardo Garcia Manzo AL and Jose Cervantes.



## Variable Phase Turbine & Liquid Expander Turbine

Our latest Variable Phase Turbine (VPT) features a patented design that efficiently handles liquid, vapor or any combination during operation. No other product currently available on the market is capable of withstanding two phase fluids without breaking or damage.

The VPT's flashing liquid expander technology offers significant improvements in liquid production while reducing the impact of vapor in the system. This is applicable to the two most popular liquefaction processes—APCI and ConocoPhillips liquefaction processes on the LNG mainstream or the MR refrigeration stream. In addition, it can replace the JT valve in any application, including H<sub>2</sub> liquefaction.

This product enhances targeted reduction in carbon emissions, an increase in liquid production, and reduction in vapor generation. It also provides further reduction in the downstream pressure down tank pressure in APCI process.

This turbine represents a significant step toward the reduction of emissions while at the same time offering cost savings to our customers. Proven tests have shown that return on customer's investment can be achieved within 6-12 months, a significant value long term for customers.





# Products

## Hydrogen Heat Exchangers – Vaporizers



Ambient Air ((Permanent or Mobile)



LH<sub>2</sub> Loading Skid for Liquefaction Plant to Tanker Transfer



Electric



Fan Assisted Ambient Air

### Features & Benefits

- Ambient vaporizers represent the most cost-effective equipment to vaporize or re-gasify liquid cryogenes
- Electric cryogen vaporizers utilize high quality electric heating elements and stainless-steel heat exchanger tubes
- Water bath vaporizers for high volume vaporization and regasification of industrial gases and LH<sub>2</sub>
- Shell-and-tube direct contact vaporizers for high pressure vaporization and regasification of LH<sub>2</sub>.

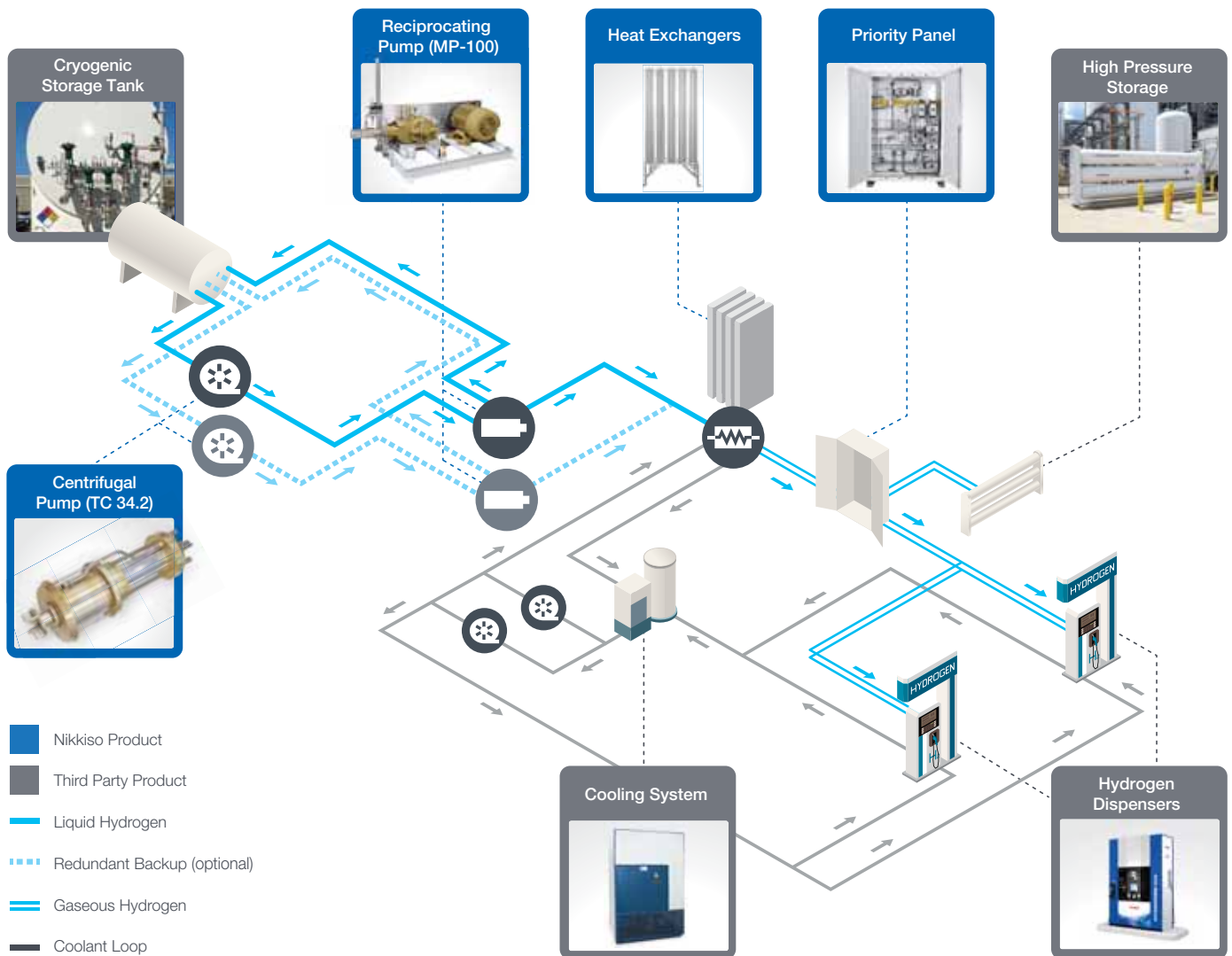
# Product Solutions

## Hydrogen Fill Station

Nikkiso provides total integrated solutions for Hydrogen Fill Stations. Utilizing our Group's global resources and products, we are able to provide solutions to our customers with the lowest total cost of ownership. We are unique in that many of the critical and proprietary cryogenic products are designed and manufactured within the Nikkiso Cryogenic Industries facilities. Additionally, we utilize our established relationships with key partners, to complement the in-house engineering

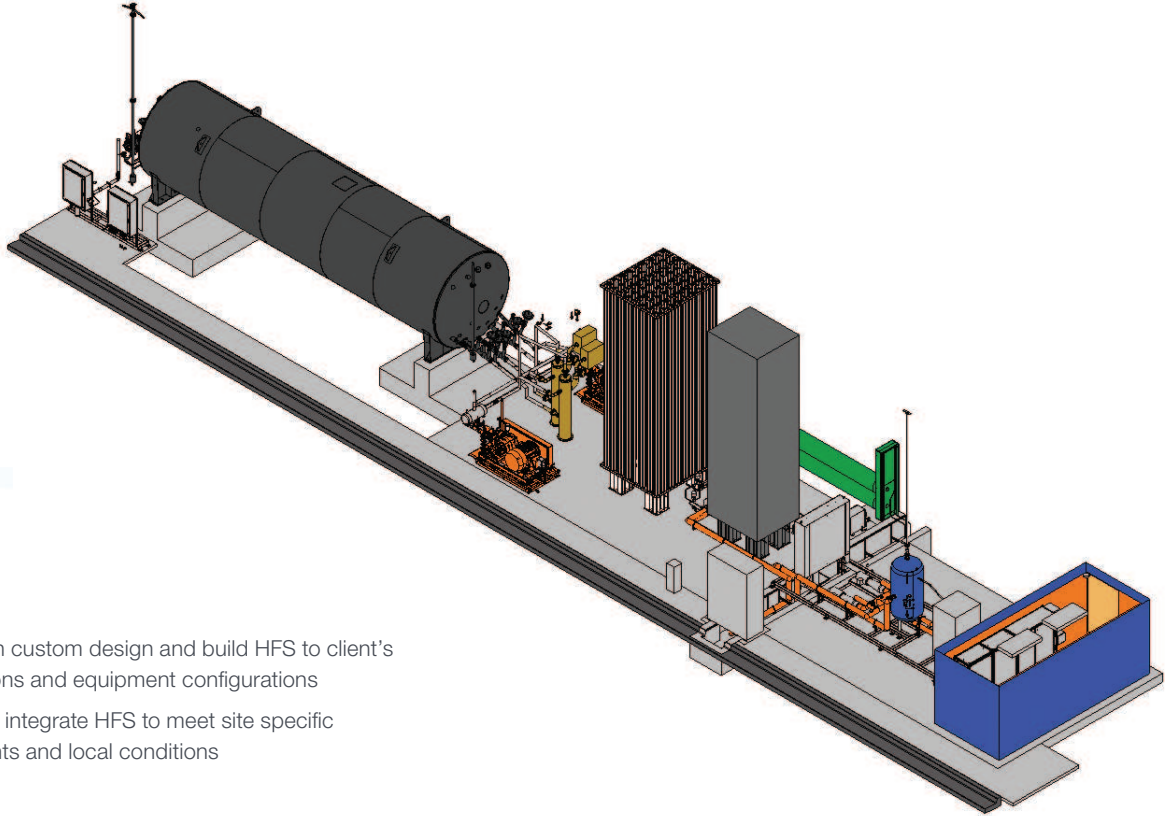
and manufacturing capabilities. The result is the total engineering, procurement and fabrication of your project. This ensures the highest quality equipment and guarantees a timely and successful project outcome. With over 50 years' experience in the cryogenic equipment business, we bring together the people, products and experience needed for system integration and single source responsibility.

### Typical Hydrogen Fill Station



# Product Solutions

## Hydrogen Fill Station



- Nikkiso can custom design and build HFS to client's specifications and equipment configurations
- Nikkiso will integrate HFS to meet site specific requirements and local conditions

### Hydrogen Fill Stations Configuration Examples

Fuel Cell Vehicles	Type of Filling (Source – Dispense)	Standards Compliance	Pressure (barg)	Temperature (°C)	Max Pump Flow (kg/hr)	FCEV Capacity (kg)
Light-Duty Passenger Vehicles	LH <sub>2</sub> – cGH <sub>2</sub>	SAE J2601-1 Categories A, B, C & D SAE J2799 SAE J2719	700	minus 40	120	5
					240	45
Heavy-Duty Class 8 Trucks	LH <sub>2</sub> – cGH <sub>2</sub>	SAE J2601-2 J2719	350	minus 40	280	65
			700	minus 40	500	100
	sLH <sub>2</sub> – sLH <sub>2</sub>	CEP Subcooled LH <sub>2</sub> Fueling Process v1.8 CEP Subcooled LH <sub>2</sub> Fueling Interface v1.10 J2719	20 – 25	minus 247	500	60
				500	80	
Transit Buses	LH <sub>2</sub> – cGH <sub>2</sub>	SAE J2601-2 Categories A & B SAE J2799 SAE J2719	350	minus 20	280	37.5
Drayage Truck	LH <sub>2</sub> – cGH <sub>2</sub>	SAE J2601-2 J2719	700	minus 20	480	60
Yard Truck					20	
Top Handler					40	
RTG					60	
Custom	LH <sub>2</sub> , cGH <sub>2</sub> , sLH <sub>2</sub>	Per Customer Request	350 or 700	minus 20 or minus 40	up to 1,000	Per Customer Request

\* Include 255 sec wait time in between fills

\*\* Based on target flow achievable by new generation dispenser.



# Tatsuno Hydrogen Dispensers

Nikkiso is an Authorized North America Aftermarket Partner for Tatsuno's Hydrogen Dispensers

## Dispenser – H35/H70

### Nikkiso's Service Offer:

- New Installation
- Commissioning
- Integration with Fuel and/or Fleet Management Systems
- Spare parts
- Maintenance service
- Repair services
- Local Support in CA

### Features & Benefits

- ETL Intertek Certification
- SAE 2601, SAE 2799 compliant
- Dual Sided Design for simultaneous fueling
  - A dual-sided hydrogen dispenser equipped with two nozzles for simultaneous fueling
  - No problem even during the peak of the rush hours

- Fast and smooth operation
  - Equipped with touch panels and payment terminals on both sides
  - Easy and stress-free operation from the arrival to the station to the end of the fueling
- Fueling Performance test
  - The dispenser passed a fueling performance test on a HySTEP device in California



Station Size (kg/day)	# of FCEV Per Day*	Profile	Centrifugal Booster Pump	Reciprocating Pump	Dispenser	Filling Positions	Average. Vehicle Flow (kg/min)	Package
808	580	Chevron Friday	Yes	Simplex	1	2	1.0	Containerized
1615	684		Yes	Simplex (2x) or Duplex	2	4	1.0	Containerized
3,671	82		–	Duplex	2	2	2.3	Skidded
3,887	60	Flat 16 hrs	–	Duplex	2	2	2.3	Skidded
5,908	59		Yes	Quintuplex	1	1	8.3**	Skidded
4,347	72	Flat 16 hrs	–	Quintuplex	1	1	6.7**	Skidded
4,726	59		–	Quintuplex	1	1	6.7**	Skidded
935	25	Flat 8 Hrs	–	Duplex	1	1	2.5	Skidded
1,684	28		–	Duplex	2	2	5**	Skidded
1,870	62		Yes	Duplex (2X)	2	4	2	Skidded
1,684	84	Flat 5 Hrs			2	4	2	
2,244	56		–	Duplex (2X)	2	4	2.3	Skidded
2,403	40				2	4	2.3	
24,000			Contact Nikkiso for optimized solution				1 to 10**	Skidded

# Summary of Scopes



## Design, Build and Project Delivery

### Project Management

- Scope, Cost & Schedule Management
- Risk Management
- Stakeholder Coordination & Communication
- HFS System Integration (inc. Balance of Plant)
- Regulatory Compliance (NFPA 2, NFPA 55 etc.)
- Permitting (Grading & Building)

### Engineering

- Design Package:
  - Process Design, Control & Instrumentation
  - Mechanical & Electrical Package
  - Civil & Structural
- HAZOP / Fire Safety

### Procurement

- Intercompany Transactions (ACD, CQP, ICS)
- 3rd Parties (Compressor, Tank, HP Vessels, Dispensers)
- Logistics (inc. Expediting)
- Spares

### Fabrication

- Equipment Skids
- Electrical & Control Enclosure
- Priority Panels
- Interconnecting Piping (inc. VJ) & Wiring
- Quality Control (inc. Factory Acceptance Tests)

### Construction

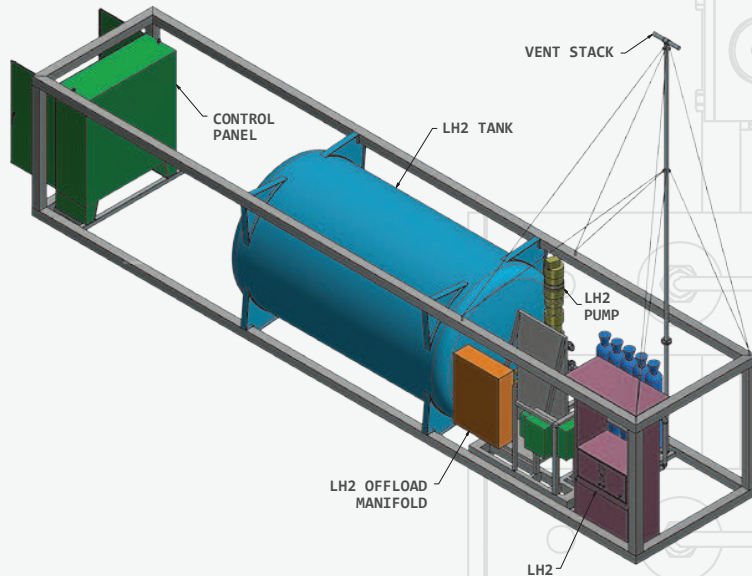
- Contractor & Site Management
- Site Preparation and Foundation
- Mechanical & Electrical Installation
- Facility Integration (inc. Utilities, Safety System)
- Pre-start Safety Review

### Commissioning

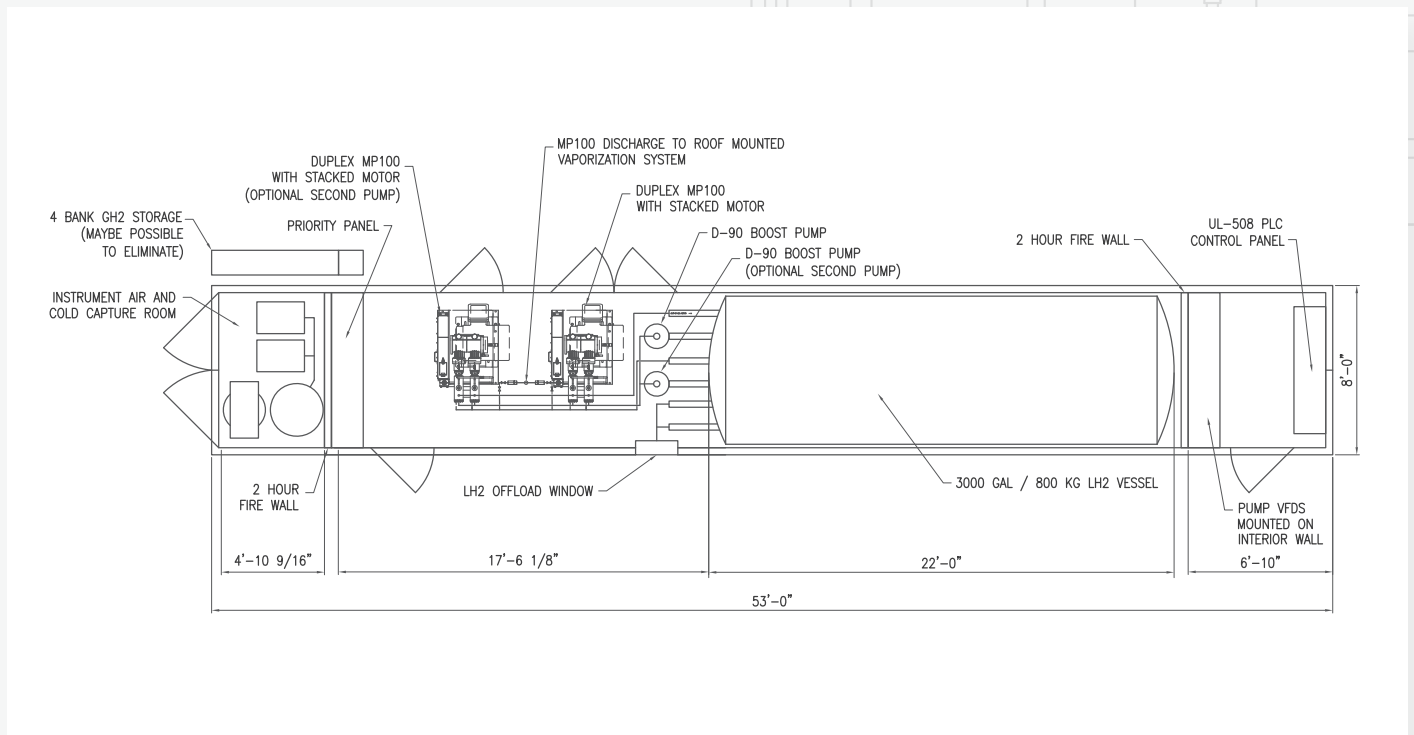
- Documentation
- Equipment/System Start-up
- Quality Assurance (inc. Site Acceptance Tests)
- Training

# New Hydrogen Products & Upcoming Development

## Skidded sLH<sub>2</sub> Station



## Containerized LH<sub>2</sub> Station





Nikkiso Clean Energy & Industrial Gases –  
Ambassador to CaFCP



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