Cryogenic Systems



Liquid gas solutions for the Nexus of Clean[™]





About Chart

"Chart's vision is to be the global leader in the design, engineering and manufacturing of cryogenic process technologies and equipment for the Nexus of Clean[™] – clean power, clean water, clean food and clean industrials, regardless of molecule." Our focus is cryogenics. Chart is a recognized global brand for the design and manufacture of highly engineered cryogenic equipment used from the beginning to the end in the liquid gas supply chain.

Jill Evanko, CEO of Chart Industries



Chart Vacuum Technology®

Providing the best insulation system to protect your valuable gases from harsh ambient conditions results in lower pressure rise and lower losses, yielding better gas utilization. Chart Vacuum Technology[®] is at the core of why Chart is recognized around the world as the premier supplier of cryogenic equipment.

Chart's production plants are fully audited and compliant with Quality System ISO 9001:2015 and Environmental System ISO 14001:2015













Complete Service Scope

Chart storage and regasification systems are a significantly more efficient, reliable, cost effective, scalable and safe alternative to high pressure gas storage. They can be configured for any demand requirement and a multitude of liquid gases including nitrogen, oxygen, argon, helium, hydrogen, LNG, carbon dioxide, nitrous oxide and ethylene. They are employed in a huge variety of applications where gas is required at the point of use across industry, science, leisure, medical, food and beverage, water treatment, aerospace; are fundamental to the energy transition bringing clean burning natural gas and hydrogen to areas not connected to a pipeline grid.

Chart designs and builds the total equipment scope for full turn key solutions and accompanies you through the complete project lifecycle, from feasibility study to on-site commissioning. Our extensive after-sales network ensures that your equipment continues to perform safely, reliably and at optimal performance in the field.

Equipment scope includes:

- Cryogenic storage tanks
- Vaporizers
- Vacuum jacketed pipework
- Control system
- · Valves, heaters and other ancillaries as required

Storage and regasification systems are typically skid mounted and/or modular to facilitate simplified transportation and installation with minimized civil engineering requirements.





1. Storage Vessels

Vertical or horizontal vacuum (typically perlite) insulated cryogenic storage tanks with volume up to 1.225 m³ each.

2. Vaporizers

Thermax aluminum star-fin type ambient vaporizers generate their own heat and require no external energy source. Electric and water bath options are also available.

3. Piping & Components

Chart proprietary vacuum insulated pipe consists of double walled stainless steel piping where the combination of super insulation and a high level of vacuum ensures maximum heat insulation.

4. Skids

Skid mounted temperature control and pressure regulation.

5. Remote Fill Modules

Including the ability to fill multiple bulk tanks in a given system, if required.

6. Buffer Tanks

Provide contingency storage and additional supply for peak loading.

7. Programmable Logic Controller (PLC)

Fully integrated safety and control system.

8. Supervision, Start-up, Commissioning and Training

Optional packages for a complete turnkey solution and total lifecycle support. All work is carried out by Chart engineers or approved contractors.



Distribution

GOFA – Trailers

An internationally established specialist for the design and manufacture of mobile units for the distribution distribution of liquid gases including air gases, carbon dioxide, LNG, hydrogen and more. Configurations include trailers, semitrailers, truck mounts, swap-bodies and tube trailers.

Based in Germany, GOFA operates from a 100.000 m^2 site of which a quarter is covered work and office space.





ISO Containers

Chart also provides ISO containers for liquid gases, including air gases and carbon dioxide, and recently launched the first ISO tank for hydrogen.

MicroBulk

Chart MicroBulk is recognized as the industry benchmark for the safe, reliable and cost effective delivery of liquid gases including oxygen, nitrogen, carbon dioxide and LNG. It is the preferred solution across many sectors including medical institutions (critical oxygen), the food industry (nitrogen for preservation) and the world's leading restaurant chains (CO_2 beverage carbonation).

MicroBulk incorporates Orca, a fast filling ADR and EN 13 530 compliant cryogenic tanker, and Perma-Cyl superior liquid cylinders.

Orca's submerged pump eliminates cool down losses and reduces delivery time. Perma-Cyl has a shut-off device that protects against cylinder overfilling.



Liquefaction

Small-Scale LNG

Chart defined small-scale LNG through a range of standard plants with capacities ranging from 3.000 gallons per day (10 tons per day) to 450.000 gallons per day (725 tons per day). Each plant is a complete packaged solution required to liquefy natural gas.

Chart's mid-scale solutions use multiple, smaller modular LNG trains that allow clients to scale projects according to market conditions and expand capacity as demand grows.





Biogas Liquefaction

Commercially viable solution for the liquefaction of smaller gas volumes typically associated with biogas. Bio-LNG can be used as a source for power generation, fueling natural gas vehicles and bunkering, loaded into cryogenic containers and transported for regional use or vaporized and injected into the pipeline.

Hydrogen Liquefaction

Complete in-house engineered and built hydrogen liquefaction plants with current capacities ranging from 5 to >30 metric tons per day. Complete solution including compressors, oil removal systems, vacuum coldbox with integral turboexpanders, heat exchangers, storage tanks, cryogenic distribution and trailer loading systems.





Nexus of Clean[™] – Industrials



Innovative Solutions for Industrial Gases

Chart thermosyphon storage tanks provide fast filling of liquid cylinders and high pressure bottles for industrial and medical applications in South Africa.



Stacked Storage

A 4-pack stack of 300 m³ horizontal tanks minimizes footprint for the storage of nitrogen and oxygen.



Mega – Storage

Four million litres of liquid nitrogen and oxygen storage being installed at an industrial gas facility in Finland.



Cryotherapy

Whole-body cryotherapy is increasingly used in sports medicine, elite athlete training programs and beauty procedures as well as in clinical settings to treat conditions such as multiple sclerosis and rheumatoid arthritis. Chart's Euro-Cyl stationary liquid cylinders offer storage capacities from 230 to 3.000 litres of liquid nitrogen and are an integral part of the cryosaunas that produce the very low temperatures required.



Nexus of Clean[™] – Energy



Gas to Power

Chart provided a dedicated LNG import terminal to provide Gibraltar with a secure energy source for its 80 MW gas fired power plant. The terminal is built on reclaimed land and complies with the island's zero emission policy.



LNG/LBG Vehicle Fueling Stations

Chart vehicle fueling stations are dedicated to safely and reliably delivering fuel for Natural Gas Vehicles (NGVs). LNG is typically used for heavy duty vehicles, including buses and trucks, and an LCNG module can be incorporated for fueling passenger cars and vans. All stations are fully compatible with Liquid Bio-Gas (LBG) and bio-gas.

We provide a complete range, from private and relocatable stations through to ones with multiple dispensers open to the public and fleet operators.



Small-Scale Import Terminals

Multi-functional terminals are proving the technical and commercial viability of small-scale LNG. Modular construction facilitates reduced project cost and complexity with minimized civil engineering and faster installation.



Nitrogen Storage and Vaporization Systems in LNG Terminals

Complete nitrogen solutions for LNG terminals incorporating storage, vaporization and control. Chart reference points include the major import terminals at Zeebrugge and Dunkerque. Package comprises bulk tanks, ambient and/or electrical pressure building, product vaporizers, vaporizer skids, pressure control units and buffer tank for gaseous nitrogen.



Carbon Capture and Utilization

Cryogenic Carbon Capture TM (CCC) is a patented post-combustion capture technology that removes up to 95–99 percent of CO₂ emissions along with other harmful pollutants such as nitrogen oxides (NOx), sulfur oxides (SOx), particulates and mercury at half the cost and energy of alternative carbon capture technologies. Furthermore, the captured liquefied carbon dioxide is available as a usable or saleable commodity.





Hydrogen Storage

Liquid hydrogen storage eliminates high pressure cylinders and tanks and is a more compact and energy dense solution than gaseous storage. Chart is the undisputed leader in cryogenic liquid hydrogen storage with > 800 tanks in hydrogen service around the world for aerospace, FCEV fuel stations, FC forklift fueling, liquefaction and many industrial applications.

Helium Storage for ITER Project

Chart supplied two 400 m³ capacity Quench Tanks for gaseous helium as part of the prestigious international ITER project.

This project aims to build a fusion device to demonstrate the scientific and technical feasibility of fusion power. In order to function properly, the Tokamak (toroidal magnetic confinement chamber), requires huge refrigeration power for its magnets, where the fusion takes place, which is provided by the "Cryoplant". Chart's "LN2 Plant and Auxiliary Systems" is a tailored solution that forms part of the large cryoplant system with 3 cooling loops at 4 K, 50 K and 80 K.





Nexus of Clean[™] – Food and Beverage

Reducing Waste

Nitrogen and carbon dioxide are used as auxiliary media in the vaporization process and as inert gas for protecting sensitive liquids and the carbonation of soft drinks. A precise amount of gas delivered by a Chart dosing system reduces the thickness of plastic bottles and provides significant cost and waste savings.

Beverage Carbonation

The world's leading soft drink companies choose Chart systems for lowest total cost of ownership.



Integrated Processes for the Brewing Industry

Carbon dioxide is fundamental to beer quality, consistency and the customer's acceptance of the product. Treatment, control, dosing and recovery are vital aspects of the brewing process and why major brewers trust Chart's integrated solutions.

Carbon Capture and Utilization

Through subsidiary company Earthly Labs, Chart provides a full solution for the capture and reutilization of CO_2 from smaller sources such as craft breweries and growing houses. As well as capturing carbon dioxide from the manufacturing processes, the Earthly Labs technology purifies and recycles it for use as a valuable commodity, either during manufacturing or as a salable asset in the circular CO_2 economy.















Nexus of Clean[™] – Water

Incorporating water treatment specialists AdEdge Water Technologies[™] and BlueInGreen[®], **ChartWater[™]** offers the most efficient, cost-effective solutions for contaminant removal, including PFAS and arsenic, aerobic biological processes, pH adjustment, ozonation, desalination and odor control.for all water types, including drinking water, wastewater, industrial water and water reuse applications.



PFAS Removal

PFAS are a family of man-made chemicals known to cause health issues.

- Choice of validated treatment solutions for optimized life cycle costs
- Any size system
- Turnkey media replacement and disposal services
- Can be combined with our matrix of treatment technologies to provide a complete system.





pH Adjustment

The combination of Chart equipment and BIG technology delivers a completely integrated solution that consumes up to 40 % less gas than other alternatives for the same level of treatment while featuring the smallest energy, carbon and physical footprint available.

Manganese Removal

Manganese is common in groundwater and typically seen as a nuisance contaminant causing discoloration and taste issues. However, recent studies have shown manganese toxicity targeting the central nervous system resulting in lowered IQ, poor motor functions, decreased attention span and hyperactivity, especially in children.







Providing Clean Water and Green Hydrogen

Chart's combined cryogenic and water treatment technologies and products create a complete value chain delivering clean water and green hydrogen.



Sustainable Beverage/Brewery Operation

ChartWater systems optimize water use, wastewater treatment, water recycle and re-use, eliminate waste and improve efficiencies at food and beverage plants.



- 1. Water source
- 2. Utility water
- 3. Granular activated carbon
- 4. High recovery reverse osmosis
- 5. High quality process water
- 6. Utility water
- 7. Carbon capture
- 8. Recycled CO,
- 9. Precision nitrogen dosing
- **10. Wastewater treatment**
- 11. High recovery water re-use
- 12. On-site use of recycled water
- 13. Recycling of backwash water



Nexus of Clean[™] – Carbon Capture

Chart's carbon capture processes integrate seamlessly with our traditional liquid carbon dioxide storage and distribution products to provide a complete circular CO₂ economy.

Sequestration and Beyond

As well as removing carbon dioxide from a variety of sources, both Cryogenic Carbon Capture [™] and Earthly Labs' carbon capture processes can go beyond permanent below ground geologic storage by providing recycled liquid carbon dioxide as a usable or saleable commodity, which can be distributed and stored for use in Chart built tanks, ISO containers and road and rail tankers.

Select the carbon capture process that best reflects your requirements from the matrix below and turn the page for more details.





Nexus of Clean[™] – Carbon Capture

Cryogenic Carbon Capture™

Cryogenic Carbon Capture[™] (CCC) is a post-combustion technology that reduces carbon emissions by 95 to 99 % from fossil energy power stations, cement, pulp and

paper, iron and steel facilities as well as certain chemical production plants, with half the cost and energy of competing processes. Furthermore, CCC also eliminates harmful Sox, NOx and mercury pollutants from flue gases.

Conceptually Simple Process

- Integrates seamlessly with Chart's cryogenic liquefaction, distribution and storage technology and products
- · Lowest cost and easiest retrofit carbon capture technology
- Integrated grid scale energy storage
- Produces high purity CO₂

"Of all these [carbon capture] processes, I regard the CCC process to have the greatest potential." Howard Herzog, MIT Energy Initiative





Small-Scale Carbon Capture

Earthly Labs technology is uniquely designed to capture carbon dioxide waste from smaller sources that make up more than half of all carbon dioxide emissions. We provide the complete solution; engineering hardware, software, installation, and real time remote maintenance services.

Meet CiCi®

Cici's patented purification technology transforms a mixed gas waste stream into valuable beverage grade CO_2 while reducing greenhouse gas emissions. With 3 models available according to specifications, Oak, Elm and Teak, each CiCi unit follows our three step process:

- Drying the gas to remove moisture
- Scrubbing the gas to remove volatile organic compounds (VOCs) and other impurities
- Refrigerating the gas to a liquid

CiCi[®] emissions monitoring and reporting software controls gas processing, while providing real-time alerts, permitting

24/7 unstaffed operation. The remote dashboard also facilitates tracking by desktop or mobile devices and is ready to provide traceability and transparency for carbon credits.







Leveraging the skills and experience of the Chart family to provide a comprehensive aftermarket program with single source accountability.

Repairs & Refurbishment

Serving the complete range of cryogenic tanks including bulk tanks and liquid cylinders (MicroBulk), ISO containers, tank trailers and other mobile units, piping systems and valves.

- All repairs and refurbishments carried out in accordance with recognized international accreditations and fully warranted
- 'As new' condition includes full vacuum leak check with mass-spectrometer, pressure test, renewal of piping systems and valves and painting





Field Service

Your field service partner across Europe. Full range of services including calibrations, routine maintenance, shutdowns and turn-arounds, performance optimization, repairs and emergency response.

- Multiple service locations
- Core cryogenic expertise
- Supplemental specialist knowledge of subsidiary companies
- · Single source contact and accountability
- Unrivalled experience
- Largest installed equipment database

Chart Parts EU

Spare and replacement parts inventory specifically for Chart equipment manufactured in Europe.

- Automated stock replenishment
- Consumption based invoicing
- Inventory requests can be modified at any time
- Most despatches made within 24 hours

www.eu.chartparts.com

Please contact us

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