Powering the Future Through LNG

CHART®

Innovation. Experience. Performance.®

LIQUEFIED NATURAL GAS (LNG)

LNG is natural gas that has been refrigerated to -260°F (-162°C). It is a clear, colorless, non-toxic liquid reduced to 1/600th of its original volume making it easy to transport and store.

Is it Economical?

- High energy density comparable to diesel and petrol
- 2.5x more fuel stored in the same space versus CNG

Is it Safe?

- Not explosive in an uncontained environment
- Rapidly evaporates when exposed to atmosphere and leaves no residue on soil or water
- Non-toxic
- Non-pressurized
- No major accidents, safety or security issues in over 50 years of commercial use

Is it Green?

- Compared to traditional heavy fuel oils, LNG provides a 25% reduction in CO_2, 90% reduction in NO_2 and 100% reduction in SO_2 and particulates
- Compared to coal LNG provides a 81% reduction in CO_2, 8% reduction in NO_2 and 100% reduction in SO_2 and particulates

Download Chart's free LNG Conversion Calculator app

Visit the app stores or scan the code with your device

Download on the App Store

GET IT ON Google Play

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CHART®

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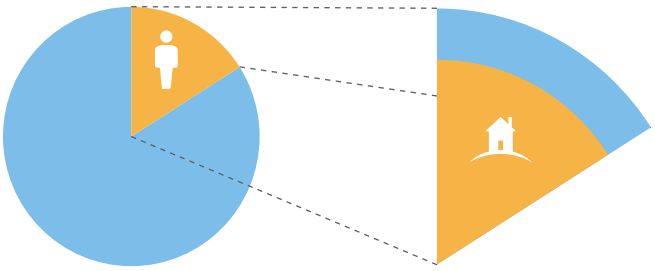
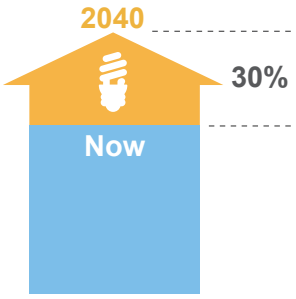
POWERING THE FUTURE THROUGH LNG

Access to reliable energy means empowerment and increased living standards. With an estimated 16% of the world's population, that's 1.2 billion people, still having little or no access to electricity and with around 80% of these living in rural areas, the IEA predicts that global energy demand is expected to increase by around 30% between today and 2040. At the same time society is committed to transitioning to a low carbon energy future and, without re-thinking our energy balance, the two are simply not compatible. The challenge therefore is to produce a lot more energy without worsening air quality conditions. While focusing solely on renewables will deliver the second part of the equation, the associated technologies are not developed sufficiently to deliver all the energy required and, as the cleanest burning fossil fuel, natural gas is fundamental to this transition.



16% of world population without access to reliable power

80% live in rural areas



IEA predicts energy demands to increase by 30% between today and the year 2040

LNG

LNG plays an important role in meeting future energy demands

When used to produce electricity in lieu of coal, natural gas produces significantly reduced greenhouse gas emissions and less than one-tenth of the air pollutants.

Liquefied Natural Gas (LNG) is natural gas that has been refrigerated to its liquid form so that it can be economically stored and transported. Not so long ago, LNG was only produced in huge base-load liquefaction facilities and distributed in large ships across oceans to distant markets, primarily for power generation, and re-gasified and delivered via pipelines to consumers for domestic use.

Today, although that trade continues to flourish, Chart has been a key player in the development of small-scale models and the associated infrastructure across the value chain; liquefaction, distribution and storage, that are revolutionizing the LNG landscape and delivering economic solutions bringing power to off-grid locations, displacing distillates for a range of high horsepower applications in industry and as an alternative transport fuel to heavy polluting diesel and heavy fuel oils for trucks, ships and railway locomotives.

It's an exciting and transient landscape where decisions in different parts of the value chain are highly interdependent. Therefore, it's important to select a partner that understands this. By choosing Chart you gain a reliable and trustworthy ally, with a proven, solution driven track record, who will accompany you through the entire project lifecycle.

WE ARE CHART

You may never use the products we make, but everyone uses the products we make possible.

Chart (Nasdaq: GTLS) is a recognized global brand for the design and manufacture of highly engineered equipment used from the beginning to end in the liquid gas supply chain. Our products and know-how are critical components in the separation, delivery and end-use of liquid gases across a multitude of applications in industry and for energy. You probably don't know, but Chart technologies are integral to many of the processes and items we take for granted every day; all the way from carbonated beverages through to life-saving medical equipment and the space satellite program.

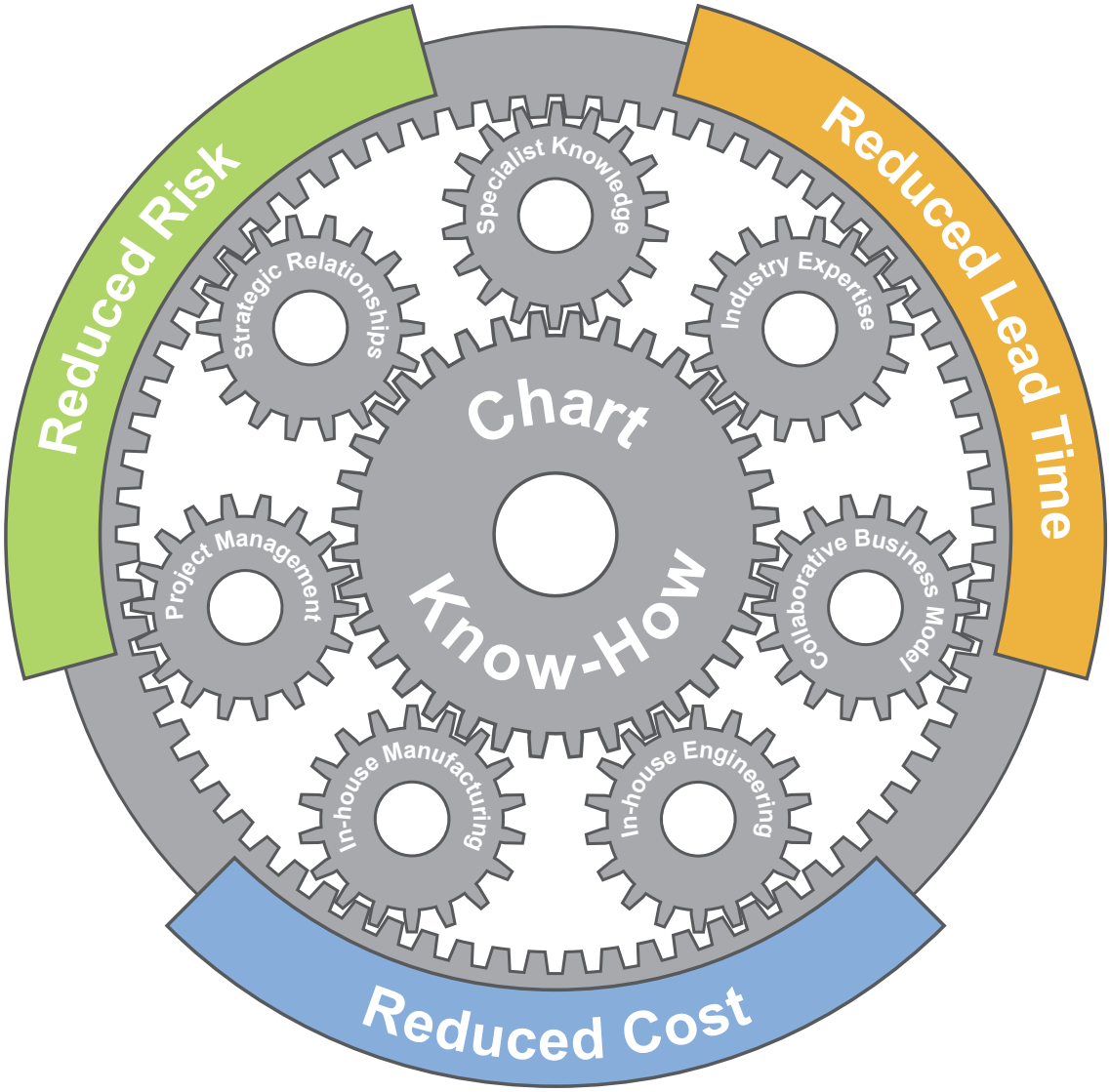
1. LNG liquefaction
2. LNG receiving terminals
3. Satellite LNG Stations
4. Air Cooled Heat Exchangers
5. Vaporizers
6. Cryogenic storage tanks
7. Mobile cryogenic vessels
8. LNG vehicle fuel tanks
9. LNG fueling systems
10. Chart MVE cryo-preservation solutions
11. AirSep oxygen and nitrogen generators
12. MicroBulk delivery system for packaged gases
13. CO_2 beverage systems
14. LNG/CNG fueling stations
15. LNG fueling dispensers
16. CAIRE oxygen concentrators
17. CAIRE portable oxygen concentrators
18. Brazed aluminum heat exchangers
19. Cold Boxes
20. Chart Lifecycle
21. Packaged gas systems
22. Liquid nitrogen dosing systems
23. Cryogenic ISO containers
24. Chartparts
25. CAIRE stationary oxygen concentrators
26. Vacuum Insulated Pipe (VIP)

Scan the code and take a digital tour of Chart City.

Scan the code to learn how customers rely on Chart solutions for increased efficiency and revenue and reduced costs.

CHART KNOW-HOW

Maximizing return on investment for LNG projects means choosing a partner that understands their complexity and is able to demonstrate engineering and manufacturing expertise and a proven track record of delivering complete solutions.



No-one has delivered more LNG solutions than Chart. Our Know-How is the combination of a number of capabilities that make us unique in the industry and is your guarantee of a successful project outcome through reduced risk, schedule and cost.

CHART PEOPLE

Our most important assets are our people, because they're your guarantee of a job well done.

Our staff is comprised of highly skilled, knowledgeable and experienced engineers, project managers, estimators, field and service technicians, HSE professionals and office support staff. We want you to access their expertise from the earliest project concept stage. Nobody knows LNG like Chart and our holistic approach will help you define the optimum solution, develop a business case for stakeholders, deliver a successful project and fulfill your after-sales requirements. We will support you with engineering options, cost estimates, permitting and technical advice. Our expertise is never further than a phone call or e-mail away.

Our People	
Engineering & Project Management	550
Safety	84
Quality	244
Manufacturing Supervision	248
Customer Service	136
Supply Chain	148
Information Technology	76
Our Manufacturing Facilities	
USA	13
China	3
Europe	4
Waterside	2

Quality Accreditations

ISO 9001, ISO 14001, BSOHSAS 18001, ASME, DOT, GB-120, AS1210, TUV, Chinese Manufacturing License, GOST 'R', GTTN, DNV, Korean Manufacturing Registration

References for other recognized, applicable design codes are available on request. Chart holds approved vendor status with a significant number of organizations. If you require additional information to complete Chart's registration in your vendor qualification program, please contact us at LNG@ChartIndustries.com

Innovation. Experience. Performance.®

We are passionate about what we do and dedicated to developing innovative solutions.

Customers rely on our knowledge because we are experts in our fields.

We guide you through the unfamiliar and are there when challenges surface.

We fulfill expectations.

We are trustworthy, honest, fair and responsible.

VERTICAL INTEGRATION

Chart provides certainty of outcome through robust, reliable, fit for purpose LNG solutions that are designed to integrate seamlessly with existing infrastructure.

Early engagement and continual dialogue between our respective process teams is the key to project optimization.

Working with Chart as a partner throughout the traditional project chain enables our clients to optimize designs for CAPEX and OPEX savings.

Principal equipment is designed and built in-house for guaranteed quality and lowest total cost of ownership.

From the earliest study phase, through to commissioning and after-sales service packages, we're with you throughout the entire project lifecycle.

VERTICAL INTEGRATION

Chart integrates what it engineers and builds, making us unique in the industry.

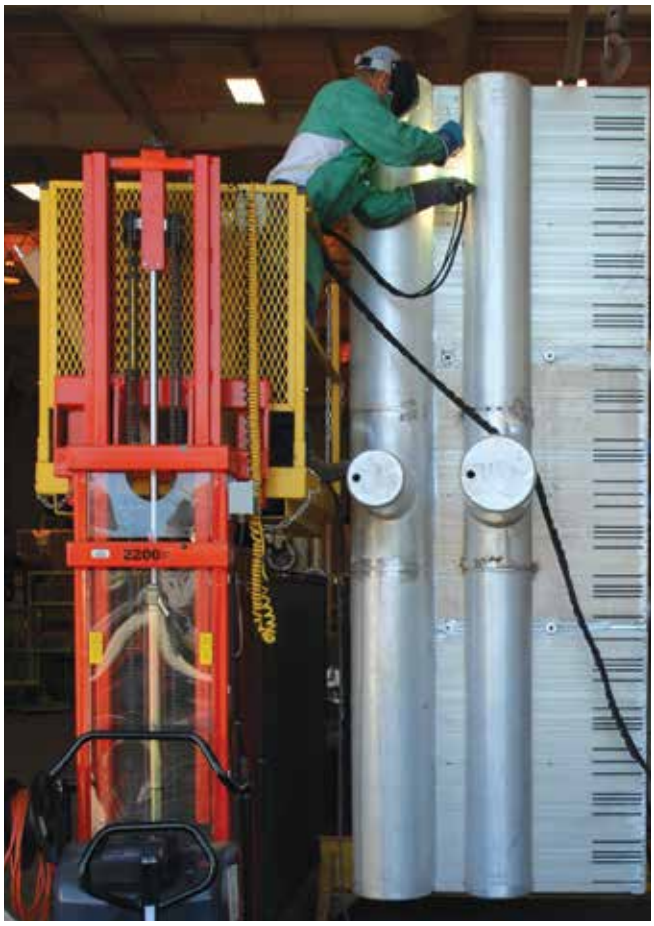
Major engineering and manufacturing locations include La Crosse, New Prague, Houston, Tulsa and Canton in the US, Changzhou, China, the Czech Republic and Germany.

Chart facilities hold the following international HSE and quality accreditations:

- Quality Management System in accordance with ISO 9001:2008
- Environmental Management System in accordance with ISO 14001:2004
- Occupational Health & Safety Management System in accordance with OHSAS 18001:2007

Chart's engineering and manufacturing Centers of Excellence are strategically located geographically and combine global quality standards with local knowledge. We have a total commitment to quality and safety and take an active role in industry organizations and societies responsible for developing and implementing standards and regulations.

Established relationships with key sourcing partners supplement our in-house engineering and manufacturing for balance of plant requirements, enabling Chart to provide complete Concept to Reality solutions and total project lifecycle support.



COMPLETE SERVICE SCOPE

Chart offers a complete service scope focused on optimizing the performance and longevity of your equipment.

Study | Design | Build | Install | Service

Concept to Reality - we offer the complete engineered and manufactured solution, from the front end engineering, through design and manufacturing and in to installation and on-site maintenance and service packages

Cost Optimization - focused on repeatable designs and modularized solutions to reduce overall lead times and cost

Vertical Integration - principal equipment is designed and built in house for guaranteed quality and lowest total overall cost of ownership

Strategic Partners - established network of specialist partner organizations to deliver balance of plant requirements as required

Proven Track Record - since pioneering the industry over 20 years ago, no-one has delivered more LNG solutions than Chart

Installation & Commissioning - everything from permitting assistance, to general contracting, final inspection/safety review, startup

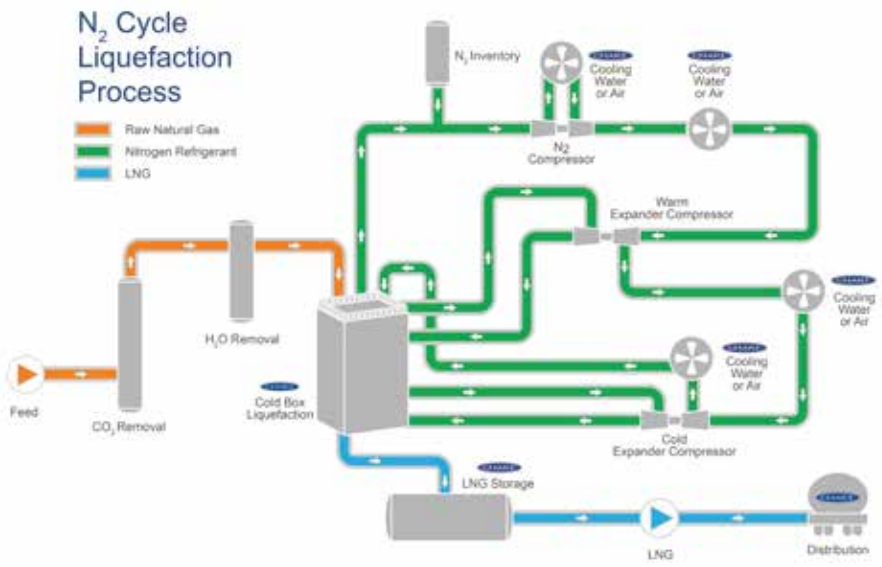
Training - hands-on cryogenics and operator training in the classroom and the field

Onsite Maintenance & Service Packages - from first fill to fine tuning the system as well as extended warranty offerings for fixed project costs

CORE TECHNOLOGY – LIQUEFACTION

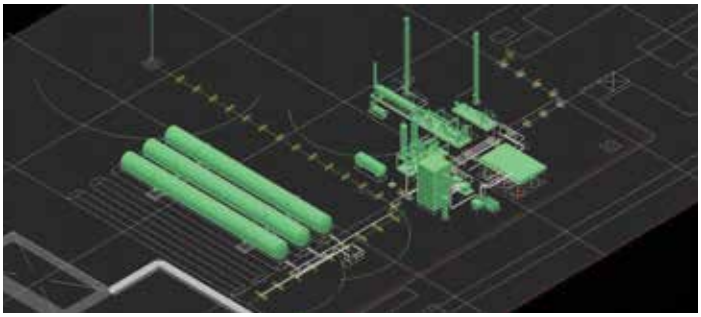
Chart process technology and liquefaction plant solutions are challenging the paradigm that a large base-load facility provides the best economy of scale.

Not so long ago, LNG was chiefly produced in huge base-load liquefaction facilities and transported in large ships across oceans to distant markets. Today, Chart's small-scale models are revolutionizing LNG production and distribution, enabling it to play a much greater role in natural gas supply and the overall energy mix.



Chart's nitrogen cycle process technology is simple to operate, eliminates the need for use and storage of hydrocarbon refrigerants and is ideally suited to standard plants and remote locations.

Typically, for plants of this size bringing LNG to market quickly and simple operation are the key drivers for project success. Consequently, Chart's standard plant solutions, which maximize fixed equipment designs for a portfolio of capacities are the optimum solution.



· Key equipment standardization, major component modularization and simple plant operation are the keys for small-scale LNG CapEx

· 'Off the shelf' designs incorporate pre-packaged, proven gas compression equipment and front end gas processing units

· Maximized shop fabrication for minimal field construction

CORE TECHNOLOGY – LIQUEFACTION

Chart's modularized plant solutions enable clients to stage growth and investment.

Chart's proprietary IPSMR® process is comparable to dual mixture processes, but less complicated. It delivers process optimization by varying the mixture of refrigerant components and operating pressures so the heating curve of the refrigerant mirrors the natural gas cooling curve of natural gas in a tight temperature approach. Chart brazed aluminum exchangers accommodate the surface area requirements and their multi-stream capability allows refrigeration to be added or removed along the process thermal gradient, as required, to optimize process efficiency. IPSMR® is also designed specifically to minimize operating differential temperature in the heat exchangers, which significantly reduces the possibility of over-stress from plant upset conditions and delivers additional process efficiencies.

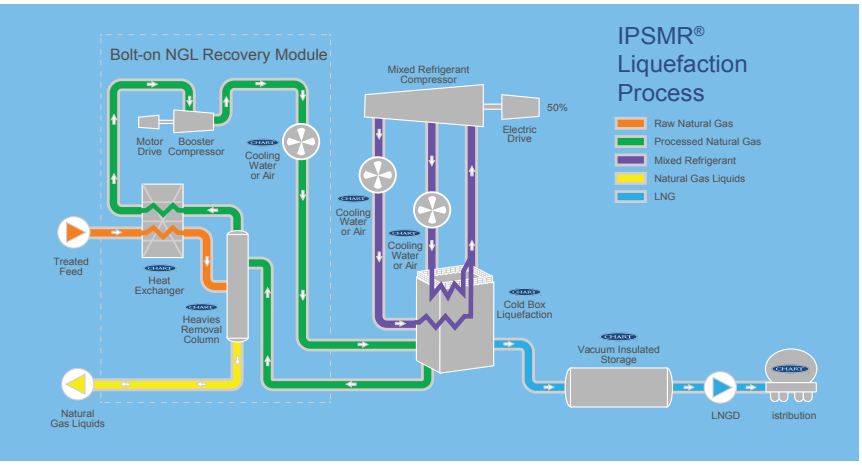
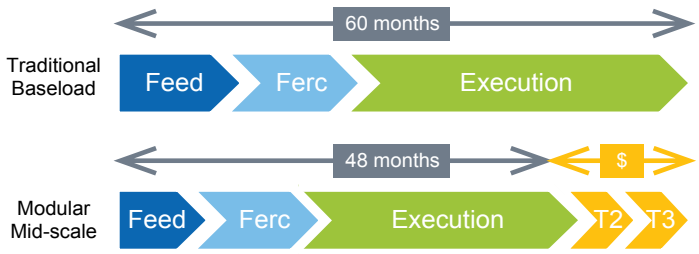


Chart has been at the forefront of developing the mid-scale market whereby plant capacities are achieved through multiple, identical, liquefaction modules instead of a single large train. Each modular train is typically engineered to provide between 900,000 gal/day (0.5MMTPA) and 2,700,000 gal/day (1.5 MMTPA) and can be matched to the gas turbine power available.



Modularization facilitates faster, cost effective construction. Trains can be brought on-line independently for earlier revenue.

- IPSMR process is 10% more efficient than other SMR processes and, together with Chart proprietary products, reduces liquefaction equipment costs by > 20%
- Modular solution offers lower risk profiles and CAPEX exposures than traditional base-load projects
- Modules are optimized for transportation, civil engineering and site services reducing on-site labor and camp costs by 20% to 30% versus stick built facility

CORE TECHNOLOGY – BRAZED ALUMINUM HEAT EXCHANGERS (BAHX)

BAHX are highly efficient, custom designed compact heat exchange devices that offer distinct advantages over alternative heat exchange methods.

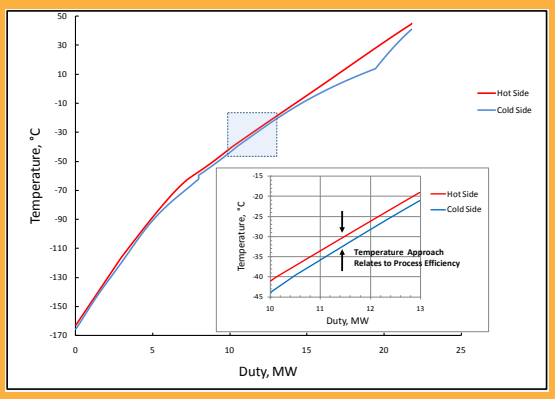
Chart BAHX are at the heart of processes used for the liquefaction of natural gas with >500 deployed across the world on plants of all sizes; from world-scale base-load facilities down to those that produce much smaller quantities of LNG for local use. Chart BAHX were first used to liquefy natural gas in the 1970's and it was a Chart unit that first produced LNG offshore, on board the Exmar Caribbean FLNG vessel.

A Chart BAHX provides a heat transfer area density of approximately 1000 to 1500 m2/m3, which is six to ten times greater than a coil wound heat exchanger and at least twenty times greater than conventional shell-and-tube technology. This characteristic advantage, coupled with the enhanced heat transfer performance of aluminum plate-fin construction and optimized heat transfer fin designs, results in significantly lower cost (25-50% less) and substantially lower weight.

BAHX means reduced capital and operating expenditure, plus lower transportation, installation and maintenance costs.

In October 2016 Chart BAHX earned the distinction of being the first to produce LNG on-board a floating facility.

BAHX technology enables application of pinch technology along with all the energy minimizing benefits. This feature significantly reduces installation and operation costs, engineering, insulation, support systems, testing, documentation, transportation and site arrangements.



Approach = Process Efficiency : 2°F (1°C)

CORE TECHNOLOGY – CRYOGENIC STORAGE VESSELS

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.

- Maximized internal liquid capacity allows for more storage
- Easily integrates with existing systems, offering flexibility in vessel orientation
- Chart Vacuum Technology® provides the highest thermal efficiency for maximum hold times and significantly reduced product loss

Chart provides a complete range of cryogenic storage tanks from the smallest standard units through to the world's largest shop built units.

Scan the code to see two of Chart's giant tanks en route from the Decin facility in the Czech Republic to the USA Eagle LNG terminal in Jacksonville, Florida.

These two Chart cryogenic storage tanks will provide sufficient natural gas to meet the average family's energy demand for 1000 years.

CORE TECHNOLOGY – CRYOGENIC STORAGE VESSELS

Chart's mobile units are rugged, efficient vessels for transporting cryogenic liquids anywhere in the world by any means – road, rail or sea.

It's now more than 25 years since Chart pioneered the concept of cryogenic ISO shipping containers and delivered our first units. As well as ensuring safe, economical and convenient transport of LNG by road, rail and water, the standard 20' and 40' containers are also integral to our skid mounted NGV fueling stations, on-board ship fueling systems, satellite stations and even feature as tender cars for natural gas powered locomotives.

Chart's mobile Orca technology has been safely and reliably delivering liquid gases for more than 20 years. For optimum safety and also because of methane's potency as a greenhouse gas, multiple features are incorporated for zero filling losses.

CORE TECHNOLOGY – FUELING STATIONS

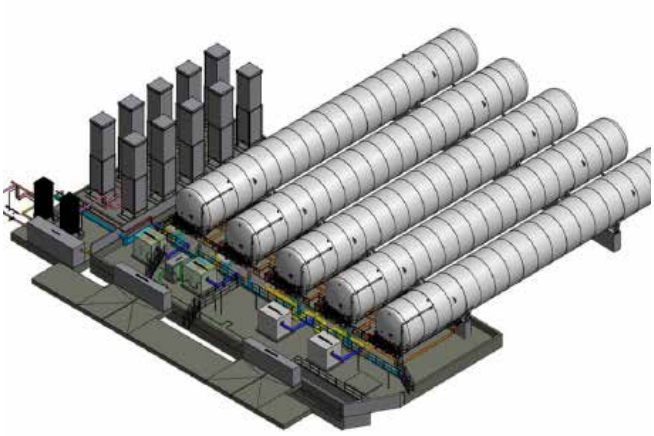
Chart designs and builds a complete portfolio of natural gas fueling stations from small, privately owned platforms through to public terminals.

- Permanent and temporary/relocatable solutions available
- Pre-bid assistance through station sizing, design and site selection
- Assistance with permitting and regulatory approvals
- Complete installation, commissioning and start-up support
- Remote performance monitoring
- Strategically located service personnel
- Chart fueling stations incorporate superior in-house technology and components, such as the Dynaflow 3000 dispenser

CONCEPT TO REALITY SOLUTIONS

Through the vertical integration of our proprietary core technologies we offer robust, reliable and cost efficient 'Concept to Reality' solutions facilitating the adoption of liquefied natural gas (LNG) as a safe, economical, clean-burning fuel alternative to diesel and other fuels for energy, transportation and in industry.

Concept



To Reality

Chart designed, built, installed and commissioned the complete cryogenic section for the small-scale import terminal to establish the Lithuanian port of Klaipeda as an LNG distribution hub for the Baltic region. The Chart solution enables LNG offloaded at the terminal to be used for marine bunkering, loaded into road tankers for small-scale distribution and re-gasified for pipeline transmission.

Modular construction facilitated reduced complexity, faster installation and minimized civil engineering. The overall plant design incorporates future expansion capable of doubling the storage capacity.

CONCEPT TO REALITY SOLUTIONS

Power Generation

Where no pipeline or electrical grid exists, Chart offers complete equipment solutions enabling clients to access natural gas, through LNG, and replace propane, LPG, diesel and oils for on-site power.

Chart **storage and regasification stations** are complete systems that incorporate LNG storage, vaporization, pressure regulation and controls to deliver natural gas at the point of use. We utilize our experience and expertise to engineer a total solution, according to individual client requirements, facilitating a seamless transition to natural gas power.

Regasification stations are configured according to any storage and demand requirements and can feature single or multiple storage tanks, which can be vertically or horizontally oriented. All Chart stations are modularized around factory built and tested equipment for reduced cost and schedule and to facilitate easier installation through reduced civil and site work. Modularization also allows for capacity expansion as required. Where possible, equipment packages are delivered skid mounted for easy transport and lift.

Regardless of station capacity, the model is essentially the same and mimics the familiar supply solution of diesel, propane and other LPGs. Liquid fuel is delivered, typically by road, to the site where it is off-loaded, stored and vaporized back to natural gas for use. The **LNG virtual pipeline** is the term used to describe the transport of LNG from its source, which can be an import terminal, distribution hub or liquefaction plant. Chart also manufactures cryogenic equipment for road, water and rail distribution for a completely integrated, intermodal solution.

Where there is insufficient or unreliable pipeline capacity, Chart regasification stations are an excellent solution for peak-shaving to meet additional capacity for load and seasonal variations, as well as providing emergency back-up during outages. This solution is far more efficient than diesel or LPG back-up as the enterprise is simply using stored natural gas to augment pipeline natural gas by utilizing the same delivery system.

CONCEPT TO REALITY SOLUTIONS

Chart equipment and solutions are facilitating the use of clean burning natural gas for transportation, energy and in industry.

Chart's satellite stations are enabling businesses to convert from distillates to natural gas despite not being connected to a gas pipeline system. Stations essentially comprise storage and vaporization and Chart engineers will work with you to tailor a solution according to your requirements. At the smaller end of the market our compact units are skid mounted for ease of installation with minimal civil work required.

Scan the code to see how a Chart compact satellite station enabled a small industrial enterprise in Europe to convert to natural gas for its fuel.

Drilling sites are fast-paced and unpredictable and demands can change in minutes, which is why, when asked to help a client convert fueling of their drill rigs to natural gas, Chart's solution was designed to enable them to handle flow and pressure variations quickly and efficiently. The system provides a continuous supply of natural gas to power generator sets used on oil and gas drill rigs and the all-in-one package significantly reduces footprint. The system is designed to operate uninterrupted in all weathers and climates and even during refilling. It accepts deliveries of full tanker loads, which saves on transportation and fuel supply costs.

CONCEPT TO REALITY SOLUTIONS

Chart delivered an LNG regasification plant to a US university campus to enable them to convert from diesel and provide an uninterrupted supply of natural gas during peak times.

As a result the facility will potentially save millions of dollars as well as improving their environmental footprint.

Chart provided a complete turnkey solution to provide LNG as the source for combined heat and power (CHP) at a remote diamond mine located in Quebec Canada and completely off both the electric and natural gas grids.

To combat the extreme climatic conditions, Chart used our cryogenic know-how to develop a novel cooldown process utilizing liquid nitrogen that dramatically reduced the cost and time of on-site work.

Chart's Virtual Pipeline Solutions are a substitute to a physical pipeline that distribute liquefied gas via land and/or sea to remote areas and/or regions not connected to the grid. Most recently they have been utilized to deliver natural gas, in the form of LNG, to island power stations enabling them to transition from using diesel to clean-burning and cheaper natural gas.

Scan the code to see how the virtual pipeline enables Madeira Island's thermo electric power plant to be fueled by natural gas.

CONCEPT TO REALITY SOLUTIONS

Marine

Aggressive environmental legislation, through the introduction of Emission Control Areas, has seen LNG emerge as key to the marine industry's ability to meet its objectives.

Chart's cryogenic experience and know-how is providing the on-board storage and fueling systems for the increasing number of LNG fuelled vessels of all sizes and we are also developing the bunkering and fueling infrastructure, which is vital to support continued wider adoption of LNG throughout the industry.

We supplied our first bunkering station in 2003 and most recently designed and built the cryogenic section for the small-scale terminal at Klaipeda that will establish the port as an LNG bunkering and distribution hub for the Baltic region. We have also developed port power solutions that enable ships to use natural gas power during port layovers, which is more economical for the operators and has huge environmental benefits for the local community.

A Chart LNG system fuels the Francisco, the world's fastest and cleanest high speed ferry.

Chart's LNG fueling system for LNG power barge 'Hummel' provides green energy to cruise ships during layovers in Hamburg, Germany.

Chart supplied the storage tanks for the Harvey Energy, Power, and Freedom, the first dual fuelled LNG vessels under US flag.

CONCEPT TO REALITY SOLUTIONS

Vehicle Fueling

LNG is gaining increased recognition as a viable alternative to diesel for a variety of heavy haul vehicles.

Not only does LNG provide significant direct environmental benefits through reductions in greenhouse gases and elimination of harmful Sox and particulates, but modern spark ignited LNG engines are quieter than their diesel counterparts, meaning trucks can operate longer in areas where noise restrictions apply.

Chart has helped prove the LNG model in a variety of closed environments where vehicles are fueled from a base, for example municipal buses and mine haul trucks, but we're also developing the infrastructure with a range of fueling stations, from small privately owned platforms for small vehicle fleets, through to public stations incorporating multiple dispensers, that will fuel the latest generation of LNG powered heavy vehicles. Our stations are also offered with CNG modules and have the capability to fuel all natural gas vehicles.

At the front end, Chart is also working with the OEM's and developing the fuel tanks and it this total approach that ensures compatibility between all the different elements in the fueling process for optimum performance, convenience, reliability and safety.

Chart teamed up with Ground Force Worldwide to develop the first diesel/LNG dual-fueling vehicle.

Chart on-board vehicle tanks are developed in close collaboration with leading truck and bus companies to support modern spark-ignite and dual-fuel compression engines.

India's first LNG bus features Chart on-board fuel tank and fueling technology.

CONCEPT TO REALITY SOLUTIONS

Rail

Through Chart LNG technology, natural gas as a fuel for locomotives and its distribution by rail are now realities.

The technology to power locomotives using LNG was proven by Chart more than 20 years ago on switching engines in North American rail yards. Today, with increased environmental concerns and escalating costs of diesel, there is huge renewed interest in LNG from the rail operators, particularly in areas, like North America, where the costs and logistics of establishing an electrification infrastructure would be prohibitive. In 2017 Florida East Coast Railway announced it was the first North American railroad to adopt natural gas for its entire line-haul locomotive fleet and the key to the fueling is a Chart designed and built LNG tender, which feeds twin locomotives for up to 900 miles of heavy haulage service. As the first of its kind, design safety is absolutely paramount and the cryogenic tender car was extensively modeled to withstand worst-case side impact and derailment scenarios.

Chart tender cars are fueling FECR locomotives and reducing emissions of CO2, particulates and SOx on the Jacksonville to Miami rail route.

Image supplied courtesy of William C. Vantuono / Railway Age

Chart has developed a series of tank car solutions for safely and efficiently transporting LNG by rail. Our proven designs are backed by decades of successful, incident free operating experience conveying cryogenic liquids across the North American and European rail networks.

Powering the Future through LNG

Chart holds the following international HSE and quality accreditations:

- Quality Management System in accordance with ISO 9001:2008
- Environmental Management System in accordance with ISO 14001:2004
- Occupational Health & Safety Management System in accordance with BSOHSAS 18001:2007

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