



# LNG SOLUTIONS



[www.ChartLNG.com](http://www.ChartLNG.com)





Chart is a leading independent global manufacturer of standard and custom engineered products and systems for a wide variety of cryogenic and gas processing applications. Chart develops solutions to meet the needs of the liquid natural gas infrastructure, providing innovation and proven quality throughout the value chain. In every market we serve, Chart strives to engineer products that deliver value and make the most of your investment in LNG.



# END-USE APPLICATIONS



**PHOTO COURTESY UPS**  
UPS truck equipped with Chart LNG vehicle fueling system



## VEHICLE FUELING

Natural gas is a lower-cost alternative fuel being utilized in a variety of vehicles. For larger truck applications, LNG is effectively displacing diesel without compromising on vehicle weight, fuel tank location or filling speed. As a naturally cleaner burning fuel, LNG has demonstrated success for more than two decades, and now with a compelling cost advantage, growing networks of fueling stations across America, China and Europe are leading the way to energy independence for heavy-duty trucking.



## SHIP FUELING

Aggressive environmental regulations and economic drivers are pushing the marine-fuels market to cleaner and greener fuel alternatives. LNG is emerging as the future of marine fueling and already has a stronghold in the European market. As the LNG movement spreads across seas, Chart will continue to supply ship fueling solutions that meet this market's unique needs. With industry-leading cryogenic experience, Chart can supply on-board LNG fuel tanks, fuel systems and bunkering solutions for vessels of all sizes.



**PHOTO COURTESY INCAT**  
Incat-built LNG ferry powered by Chart fuel system





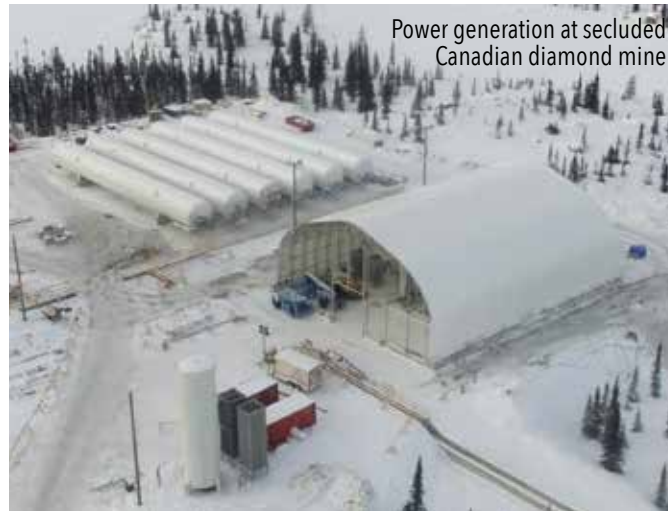
# END-USE APPLICATIONS

CN - Canadian National Railway locomotives with tender car



## RAIL FUELING

Natural gas as a fuel for locomotives has been gaining steam in the U.S. and Canada due to cost saving benefits. The potential is simply too big to ignore – in 2012 alone, the cost of diesel fuel to Class 1 railroads was more than \$11 billion. Even a small reduction in fuel costs would create massive savings for the industry, and mark a new chapter of rail powered by a clean, abundant and low-cost North American energy resource. LNG fuel tenders are an emerging technology and Chart is actively engaged with the governing bodies and major railroads to define standards that will lead this revolutionary change.



Power generation at secluded Canadian diamond mine



## POWER GENERATION

Where no pipeline or electrical grid exists, LNG provides clean, low-cost fuel for use in all continuous power generation requirements. Chart has the experience and knowledge to help match generators with the right systems to supply a steady flow of natural gas – from small, continuous-use generators used on oil fields to large multi-megawatt systems for temporary utility applications. As regulations push for alternatives to diesel fuel, LNG's popularity as a power source increases.



## INDUSTRIAL

Across the board, industrial applications are anticipated to become a dominant player in LNG usage. Liquefied natural gas' low carbon footprint and negligible emissions (when compared to other fossil fuels) make it a preferred fuel for industrial applications in many parts of the world. The birth of the natural gas virtual-pipeline has paved the way for off-grid industrial consumers to take advantage of this natural gas energy source.



Chart's mobile regasification trailer at drill rig site



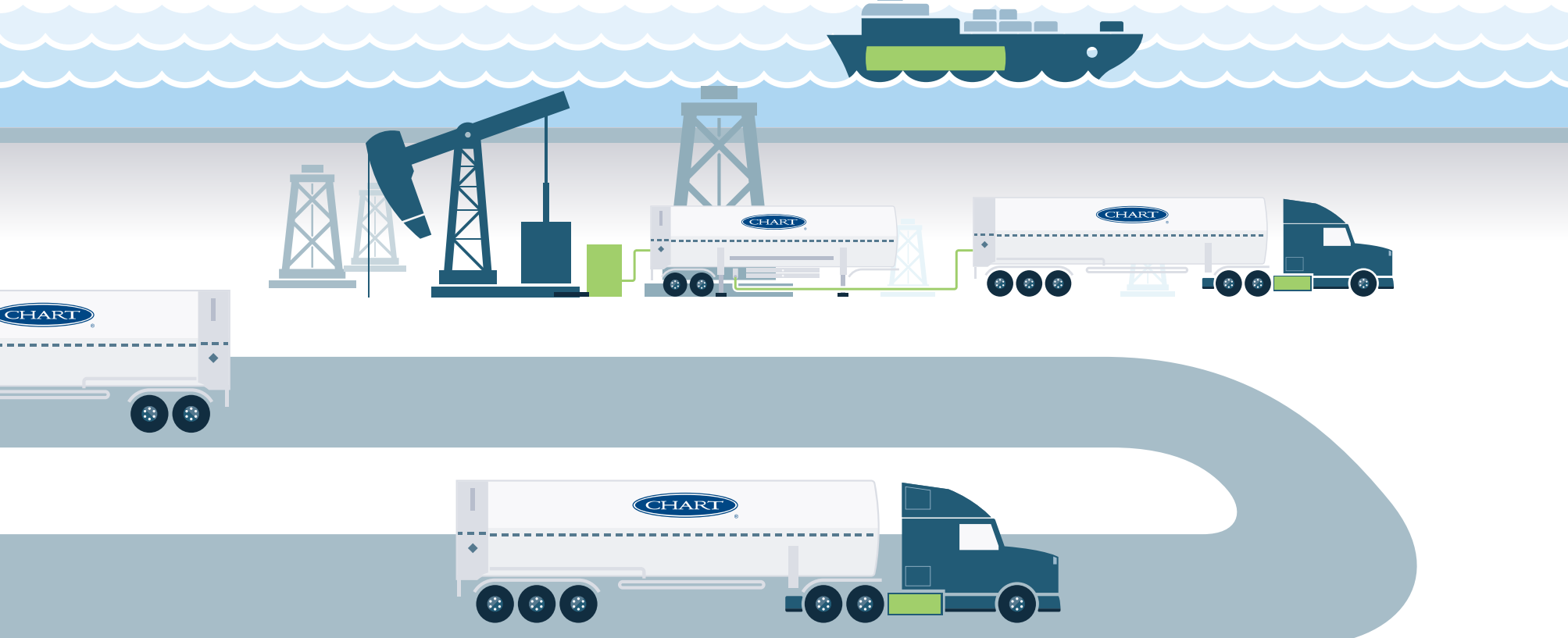
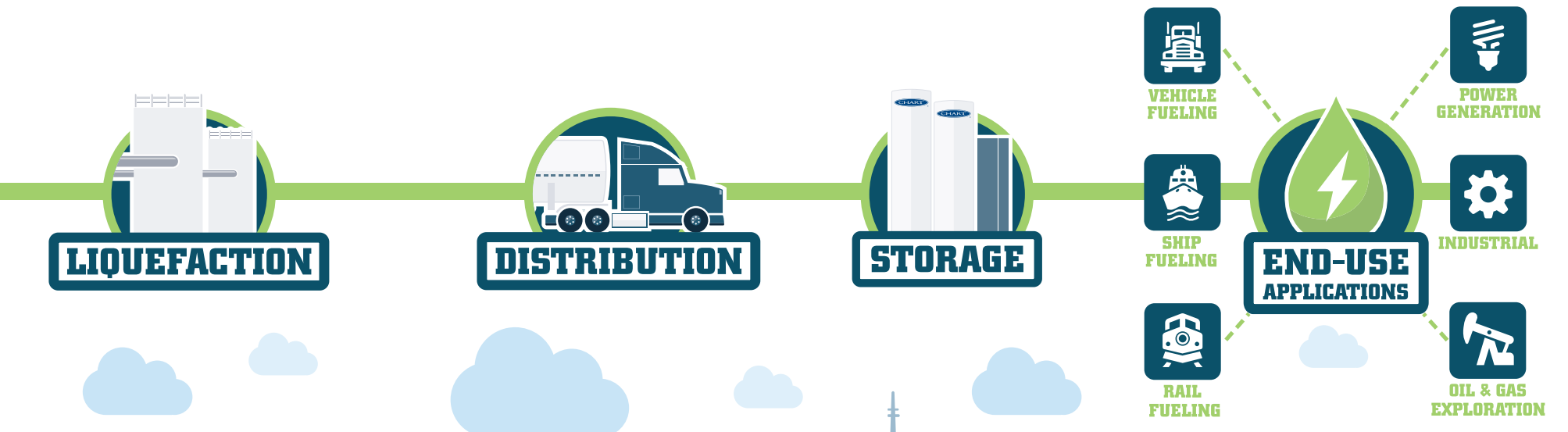
## OIL & GAS EXPLORATION

With a typical drilling site consuming 700 to 2500 gallons of diesel per day, a highly-efficient fuel like LNG could be a smart option. Oil and gas rigs are often located in remote, extreme environments - where no pipeline or electrical grid exists. Chart has been a pioneer in the field for consistency, developing solutions that offer durability, mobility and a continuous supply of natural gas - meaning less downtime and greater cost savings.

# LNG VALUE CHAIN

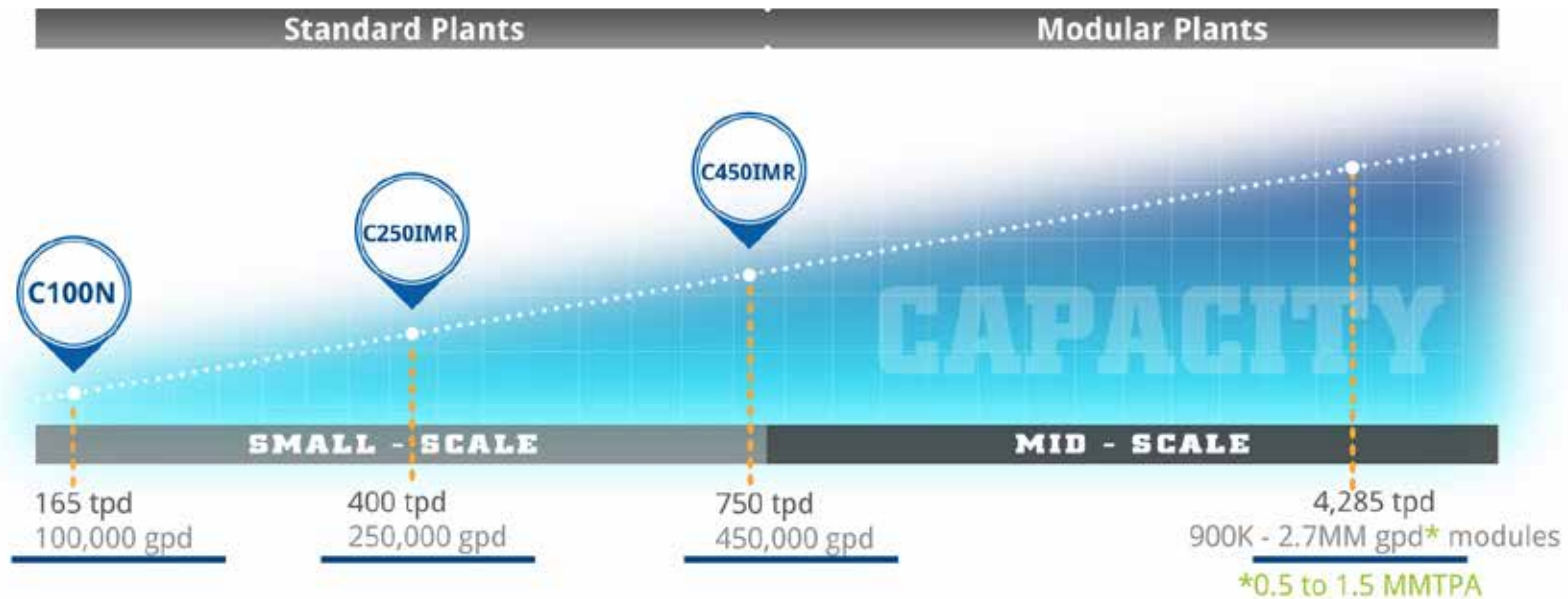
Chart offers supply chain support from the LNG plant through on-site storage and regasification. The natural gas is cryogenically cooled and loaded as a liquid to a ruggedized Chart vacuum-insulated transport trailer. Once on site, the liquid is stored and dispensed as gas for use in numerous market applications, where it efficiently replaces traditional fossil fuels.







# LIQUEFACTION Plant Definitions & Features



## SMALL SCALE Liquefaction Plant Features

- Standard Plant Solutions - repeated designs, 3 standard sizes.
- Proven, low risk, standardized technology platform.
- Maximum standardization.
- Brazed Aluminum Heat Exchanger for optimum operating efficiency.

## MID SCALE Liquefaction Plant Features

- Modular plant solutions - replicable designs & multiple modules.
- Proven, low risk, standardized technology platform.
- Modular construction.
- Brazed Aluminum Heat Exchanger for optimum operating efficiency.



Chart designed and built standard and modular plant solutions are overcoming the economies of scale traditionally associated with world scale facilities in the areas generically referred to as small- and mid-scale LNG.

Chart's standard plants for small-scale LNG are the ideal solution for addressing the transportation demands of trucking, marine and rail together with displacing diesel for high horsepower applications in power generation, drilling, mining and other industrial and agricultural projects.

For each of the specified nominal capacities; 100,000; 250,000 and 450,000 gallons per day, the associated plant consists of a fixed design for a portfolio of capacities across the range with standard equipment packages for pre-treatment, liquefaction, refrigeration, storage, truck-loading and balance of plant utilities.

Chart's mid-scale modular model challenges the traditional paradigm that a large baseload facility provides the best economy of scale for an export project.





# MODULAR LNG PLANT SOLUTIONS



The modular solution uses multiple, smaller, standard, modular LNG trains to achieve total plant capacity, as opposed to a custom engineered stick-built facility, and allows clients to scale their project and costs.

- Serve immediate off-takers and expand plant capacity as demand grows
- Much reduced planning, permitting and construction schedule
- Reduced operational risk

Modular LNG plant solutions are quicker to market and generate revenue faster for stakeholders.



## PROJECT SCHEDULE COMPARISON

### Traditional Custom Plant



### Chart Modular Solution



# LIQUEFACTION

## BRAZED ALUMINUM HEAT EXCHANGERS (BAHX)

Chart brazed aluminum heat exchangers (BAHX) are the key to liquefaction – a BAHX is a highly efficient custom designed compact heat exchange device offering a number of advantages versus other heat exchanger types for LNG service. Minimising power consumption is a key design criterion for all liquefaction processes and a BAHX provides optimum process efficiency by minimizing temperature approaches between the hot and cold streams.

The BAHX design permits multiple heat exchange services (10 or more streams in a single block is common) to be combined into a single compact application and provides a heat transfer area density 6 to 10 times greater than a coil wound heat exchanger and at least 20 times greater than conventional shell and tube technology.

As well as the plant performance benefits the compact BAHX solution also significantly reduces installation and operating costs, engineering, insulation, support systems, testing, documentation, transportation and site arrangements.

### BAHX



BAHX footprint comparison vs. shell and tube technology

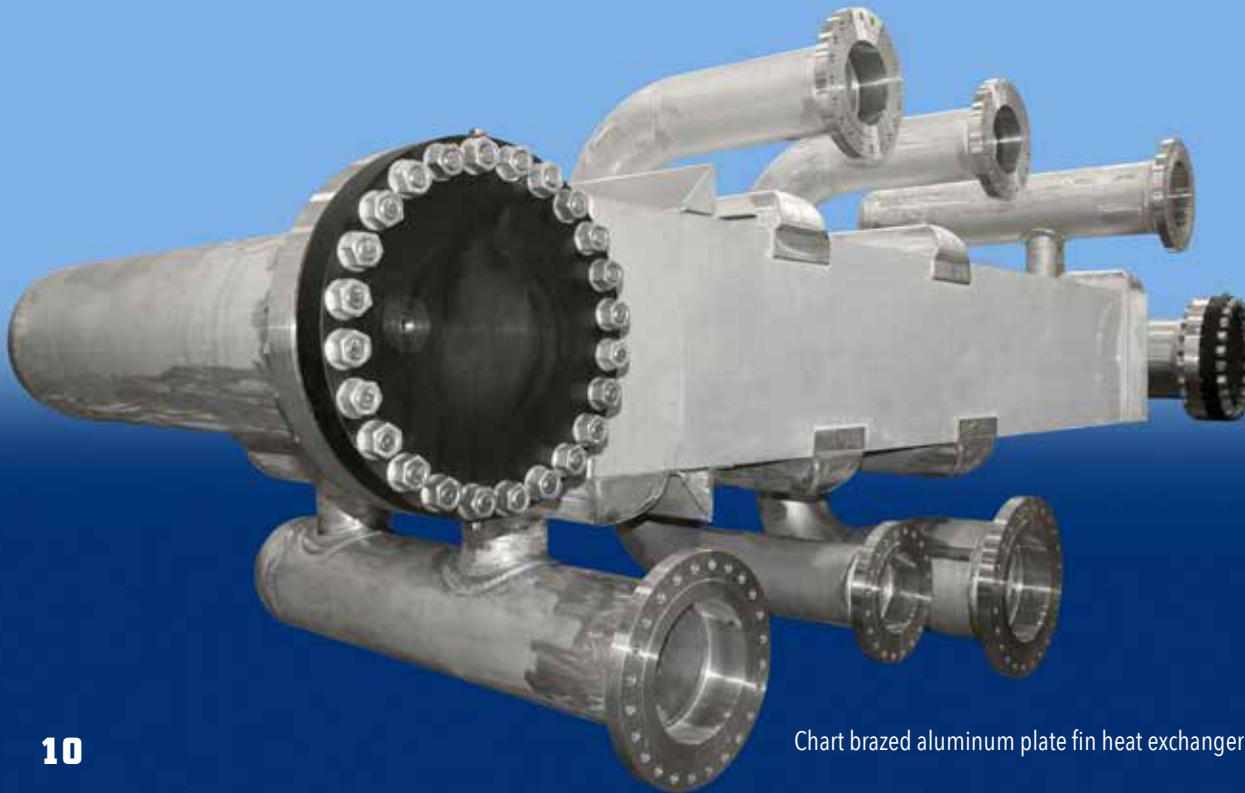
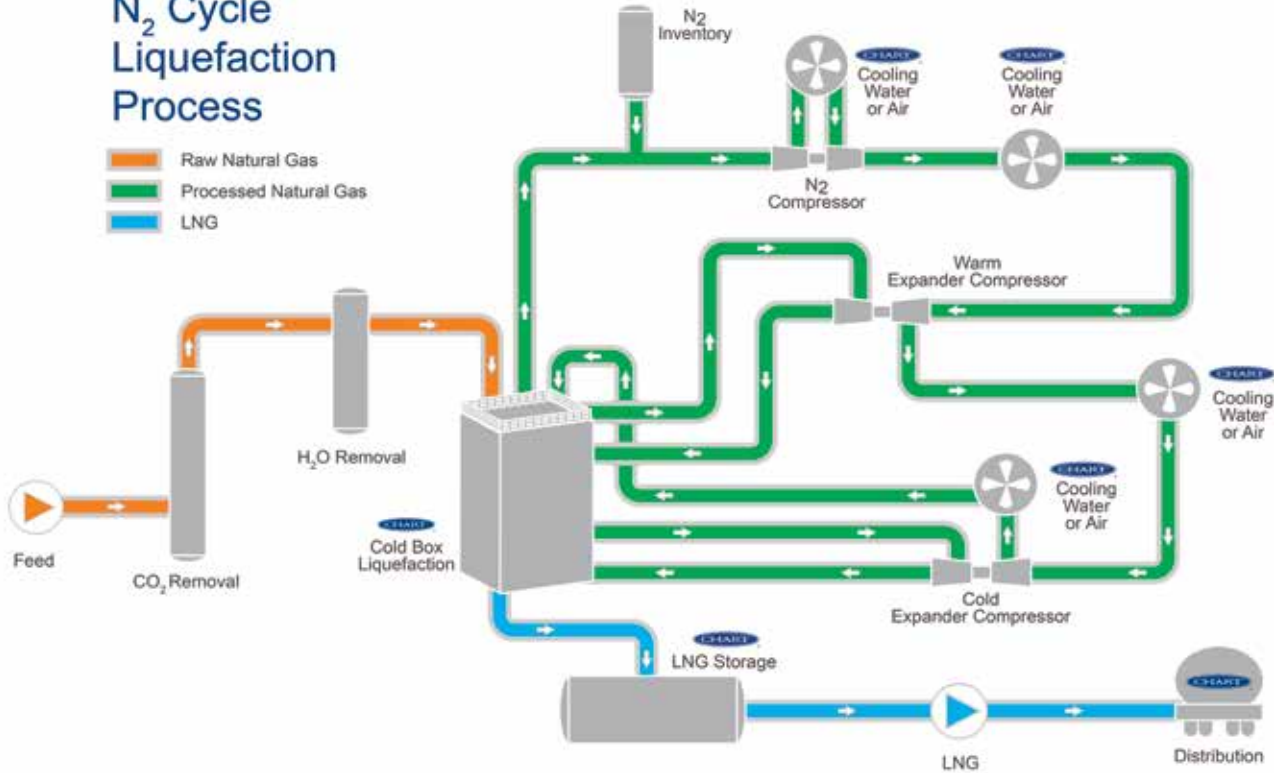


Chart brazed aluminum plate fin heat exchanger



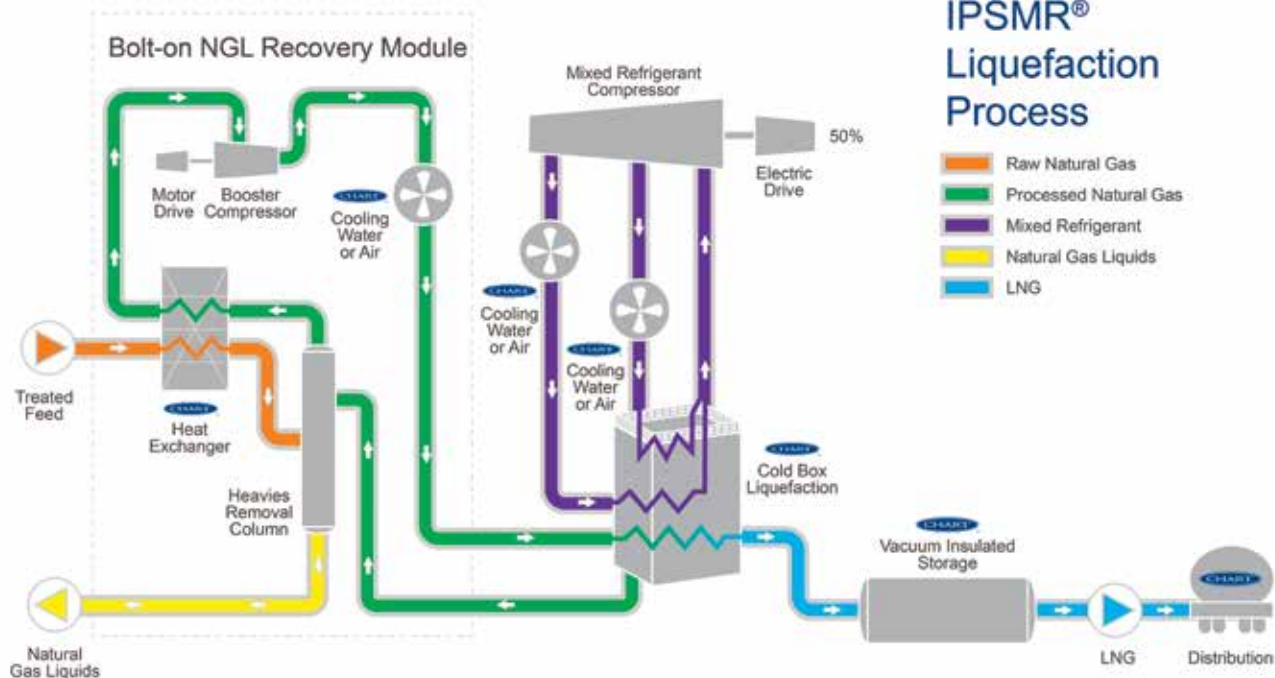
## N<sub>2</sub> Cycle Liquefaction Process



# PROCESS TECHNOLOGY

Chart's proprietary LNG process technology supports the small- and mid-scale LNG plant solutions.

Our nitrogen cycle process is simple to operate and ideally suited to our smaller standard plants and for remote areas without easy access to hydrocarbon refrigerants.



Integrated Pre-cooled Single Mixed Refrigerant (IPSMR<sup>®</sup>) was designed specifically to minimize operating differential temperature in the BAHX, which significantly improves process efficiency.

Chart's liquefaction solutions can be deployed both on- and offshore.

Chart performs feasibility, Front End Engineering and Design (FEED) and other studies to help clients understand their project economics while making decisions around LNG.





# DISTRIBUTION



**ST-16300 TRANSPORT TRAILER**



# TRANSPORT TRAILERS

The no-nonsense LNG Transport Trailer has one simple job that it does very well: transporting liquid over the road. These cryogenic semi-trailers feature:

- Horizontal vacuum-insulated tank composed of an inner pressure vessel and a structural frame outer jacket
- Very large capacity pressure-building coils and coil piping that allow off-loading by pressure transfer at rates up to 300 GPM
- Construction using durable, lightweight, thin-gauge carbon and stainless steel

These trailers are designed to effortlessly transport LNG by road providing liquid to fueling stations, large tanks, stationary equipment and more, in order to smoothly operate without interruption.



**ST-12700 TRANSPORT TRAILER**





# DISTRIBUTION



## ORCA™ DELIVERY SYSTEM

Having access to a permanent fueling station is not always an option, but that doesn't stop the need for filling vehicle tanks to power your operations in remote locations. The LNG Orca™ Delivery System is a completely self-contained mobile fueling station specifically designed to provide safe LNG fueling capabilities, with the flexibility to move where there is demand.

The system includes a patented liquid-submerged pump that greatly reduces refueling time. The Orca unit also features an integrated meter system that allows operators faster start-ups and single-hose, zero-loss filling with auto-shutoff when paired with our vehicle tanks. The system also features an integrated saturation coil that allows pump filling for spark-ignited natural gas or high-pressure, direct-injection engine

platforms – so you only need one solution to fuel multiple engine technologies. The Orca system complies with the most stringent weights and measure requirements and highest safety and quality standards in the industry.





# RAIL

LNG tank cars offer the ability to cost-effectively transport more than 30,000 gallons per tank car by rail. Model SR-603 tank car complies with the Association of American Railroads (AAR) and the US Department of Transportation (DOT) regulations. For optimum tank car integrity, safety and reliability, the SR-603 is completely manufactured from the wheels up – including the outer jacket.

The control piping and instruments are located in spacious cabinets on each side of the car at the center. The functional piping is duplicated on each side, with the rupture discs on one side and the relief valves on the other. Cabinets, piping, components and instruments are virtually all stainless steel for added durability and long-life reliability. Valves have fire-resistant packing, and the pressure building coil is built with stainless

steel piping and aluminum fins for optimum durability and performance.

Chart's experience in designing and manufacturing tank cars for cryogenic liquids ensures a reliable tank car to move LNG safely across North America and in Europe.

# DISTRIBUTION

## MOBILE REGASIFICATION SYSTEM

Drilling sites are fast-paced and unpredictable. The flexibility of the all-weather, all-climate LNG Mobile Regasification System allows you to operate uninterrupted, even when refilling, so you don't have to waste time or worry about a drop in pressure.

This system is designed to provide a continuous supply of natural gas to power generator sets used on oil and gas drill rigs. It is comprised of a 15,000 gallon LNG storage tanker trailer with integrated vaporization, system controls and an offloading pump – an all-in-one package solution that significantly reduces the footprint of the drill rig.

We understand the demand of a drill rig can change in a matter of minutes, which is why this system is designed

to accommodate flows ranging up to 50,000 SCFH with pressures up to 100 PSIG, giving you the ability to handle variation quickly and efficiently. In addition, the system accepts deliveries of full tanker loads, helping save on transportation and fuel supply costs.

### PRODUCT FEATURES:

- High-capacity offload pump is strategically located to allow flexibility of offloading on either side of the system
- Completely automated for delivery of gas – no need to turn valves, etc. – which means reduced man hours and opportunity for error



## MOBILE HIGH-FLOW VAPORIZATION SYSTEM

The Mobile High-Flow LNG Vaporization System is designed to meet the high-volume fuel requirements of the increasing number of pressure pumps, blenders and other field equipment used in the oil and gas industry today.

The system consists of a trailer-mounted water bath vaporizer, on-board generator and the associated controls, valves and piping. System operation is mostly

automated and controlled by an on-board PLC and touch-screen operator interface.

Robust design and construction makes the vaporization system ideal for the harsh operating environments often encountered at pressure pumping and drilling sites. The natural gas-fired water bath vaporizer delivers up to 150,000 SCFH with outlet pressures ranging from 40 to 100 PSIG.







# DISTRIBUTION

## ISO INTERMODAL CONTAINERS

Our ISO Intermodal Containers provide an easy method to transport LNG worldwide by ship, rail or road. They are designed with highly-engineered thermal insulation and a rugged, durable construction that ensures your low-pressure, low-temperature liquid has a safe journey when traveling long distances for extended periods of time.

These reliable, low-maintenance containers come in a variety of working pressures, have a maximum gross weight of 34 tons and are currently offered in either 20 or 40-foot lengths.

The versatility of their design maximizes payload while providing a lower tare weight. Not only are the ISO Intermodal Containers considered one of the best values available on the market for LNG transport, but they also comply with important codes and standards including UN T75, ASME/DOT, EN, RID, IMDG, ADR, IMO and TPED.



# STORAGE



## BULK STORAGE VESSELS

You need smart, low maintenance storage solutions that last. Chart offers just that: highly-engineered custom storage options to suit your specific needs. Our LNG bulk storage vessels are used to store large quantities of extremely cold liquefied natural gas to a temperature of  $-260^{\circ}\text{F}$ . To maintain this low temperature, Chart's vessels utilize a lightweight stainless steel inner vessel with a durable outer jacket and highly-efficient vacuum insulation technology. The design allows for greater thermal performance and extended LNG hold times that result in minimal loss of stored product.

These shop-fabricated cryogenic vessels can be manufactured in a variety of sizes and in either horizontal or vertical orientation, depending on the specific needs of the customer. For those with space restrictions, the vertical vessels are a great option while vessels that will be in an area with high wind, seismic activity or even regulations with nearby tall buildings or monuments, are best served by a horizontal arrangement.

By manufacturing the vessels in a controlled environment versus site-erected vessels, Chart is able to offer quicker turnaround time for production and deliveries to the job site, as well as more accurate and comprehensive testing abilities. Shop-fabricated storage vessels allow for minimized on-site field welding, standardized piping configurations and reduced installation time.

- Maximum Allowable Working Pressures (MAWP) of 50 PSIG (3.45 barg) or greater
- The 90,000 gal horizontal vessel is our most popular storage solution and weighs 168,300 lbs empty
- Low life-cycle costs and lightweight construction reduce operational and installation costs







Clean Energy LNG vehicle fueling station

# STORAGE

## VEHICLE FUELING STATIONS

Chart offers a wide variety of vehicle fueling stations, from small, self-contained stations to large, custom stations that provide both LNG and LCNG dispensing for any size vehicle fleet. Heavy-duty trucks, buses, refuse vehicles and frequently operated fleet vehicles, such as taxis, all have great potential for LNG fueling. Compared to more traditional CNG systems,

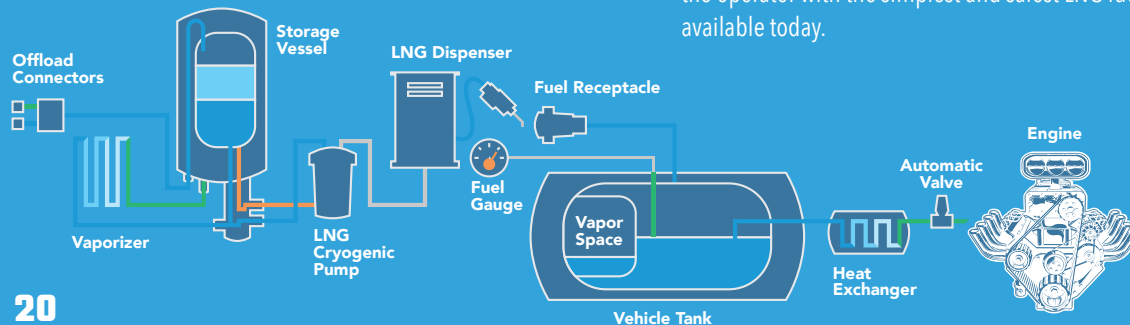
LNG enables lower vehicle dead weight and longer range because of its high density and low pressure.

Our fueling stations are engineered for single-hose, no-loss filling and auto shut-off for all LNG vehicle tanks. The patented submerged pump, controls and vehicle tank system provides the operator with the simplest and safest LNG fueling process available today.

### ONE-STOP COMPLETE SERVICE

Chart has an engineering and sales staff experienced in all aspects of LNG/LCNG station design, operation and maintenance. We will help you set up the design and functional specifications for the station, as well as provide commissioning and training.

- Pre-bid assistance in sizing station, design and site selection
- Remote monitoring of station's performance and status
- Assist in obtaining permitting and regulatory approvals
- Supervise and install, test and debug, and assist in a station's early operations
- Service personnel stationed in key markets





# FUEL SYSTEM

The industry leader in vehicle fueling systems for more than 20 years, Chart offers LNG on-board vehicle fuel systems to support modern spark-ignite or dual-fuel compression-ignition engines. Best-in-class performance and durability are standard.

## SCOPE OF SUPPLY:

- Storage tanks
- Receptacle connections
- Auto-refrigeration
- Cryogenic tanks
- Gauging and electronics
- Heat exchangers
- Valves and regulators

Chart's on-board LNG fuel systems are optimal for heavy-duty vehicles requiring significant fuel capacity. LNG is vaporized during engine operation, in a vaporizer heated by the engine's cooling system, while a pressure regulator controls the delivery of gas to the vehicle's engine and maintains a constant pressure. The systems consist of one or more super-insulated fuel tanks, ensuring long-time, on-board storage and loss-free operation. Chart systems operate in the U.S. and Europe.



# MICROFUELER

The Microfueler is a cylinder with a full-protection palletized frame designed specifically for the temporary storage and/or transportation of LNG. Its rugged design and construction allows for mobility even when full. The super-insulated permanent vacuum system has a 119 gallon capacity and provides days of holding time without product loss. It comes equipped with connectors, controls and a pressure-builder for convenient dispensing.



# THERMAX VAPORIZERS

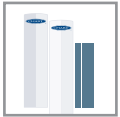


## Fuel Fired Vaporizers

For large or remote systems where fossil fuels may be the only heat source, heat from combustion can be used indirectly in either a fuel fired water bath or in a fuel fired circulating water system.

## Ambient Air Vaporizers

Natural draft vaporizers benefit from zero maintenance and zero impact on the environment. To improve the vaporizer performance, air can be forced by fans to increase heat transfer rates while minimizing the required plot area. Ambient air vaporizers are commonly used to vaporize LNG and all other cryogenics and liquefied gases.



Fuel fired vaporizer for a natural gas peak shaving station

Ambient air vaporizer



# VACUUM INSULATED PIPE (VIP)

Vacuum insulated pipe (VIP) offers a long list of proven LNG distribution advantages over the commonly used mechanically insulated pipe (MIP). Although MIP has a lower purchase price, the savings end there. With its double-wall design, VIP heat leakage is 90% less than MIP. VIP is also easy to install, maintain and expand upon, while lasting for decades instead of only a few years. All of this results in a significantly lower total cost of ownership.

As a leading global manufacturer of products, systems and services for cryogenic and gas processing applications, Chart provides flexible, integrated VIP solutions for

almost any LNG bulk transport configuration imaginable — whether over water, overhead, underground, at grade or in any combination. We offer the broadest portfolio of standard and custom-engineered products. Our VIP Design Services team also applies 50 years of experience toward ensuring the safest, most reliable and most cost-efficient installations for every customer, over the long term.



PHOTO COURTESY DARWIN LNG  
21,000 feet of VIP distributing LNG







Two 265,000 gallon LNG tanks shipping to the Caribbean for power generation





[www.ChartLNG.com](http://www.ChartLNG.com)

Let's get to work. Call us at 1-800-838-0856.

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