

# LNG

## A glossary of terms



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# A GLOSSARY OF TERMS

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# Introduction

**With liquefied natural gas (LNG)** playing an increasingly important part in the world's energy mix, familiarity with LNG terminology is needed by a growing number of professionals. The growing and changing nature of LNG means that its language brings together terms from the worlds of finance, utilities, trading and many other sectors, as well as from gas and shipping.

Our LNG Glossary provides a comprehensive guide to these terms. Like any guide to language it is, at times, intriguing and fascinating. For example, someone from outside the LNG industry might be forgiven for thinking that admeasurement would help tell them if their latest television commercial is performing well. In fact, it refers to the confirmed or official dimensions of an LNG ship.

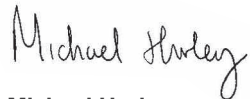
It will be of use to a broad audience – chief executive officers, accountants, traders, regulators, tax consultants and many more – bringing together technological, engineering, commercial, accounting and other terms from both inside and outside the sector. We publish it in conjunction with The Petroleum Economist Ltd as a practical contribution to promoting transparency, understanding and knowledge in the global LNG industry.



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**Abandoned well:** a well (oil, natural gas, or water injection) not in use because it was a dry hole originally, or because it has ceased to produce economical quantities of oil and/or natural gas, or has become unusable. Regulations require the plugging of abandoned wells to prevent the seepage of oil, gas, or water from one stratum of underlying rock to another.

**Able-bodied seaman (AB):** a member of an LNG crew, with three years of sea service, certified by examination to perform all the duties of an experienced seaman. A typical LNG ship carries five ABs in her crew complement. See *Crew*

**Acid gas:** a gas that contains compounds, such as CO<sub>2</sub>, H<sub>2</sub>S, or mercaptans, that can form an acid in solution with water.

**Acquiring shipper:** in the context of capacity release, a shipper who acquires firm capacity rights from a releasing shipper. Also known as replacement shipper. See *Capacity (gas)*

**Adiabatic:** a term describing a thermodynamic process in which no heat is added to or removed from the system.

**Admeasurement:** the confirmed or official dimensions of an LNG ship.

**Advanced turbine systems (ATS):** industrial gas turbines, approximately 5 and 15 megawatts (MW) in capacity, for distributed generation, industrial and cogeneration markets; and gas turbines, combined-cycle systems, 400 MW, for large, baseload, central-station power-generation markets. ATS expectations are to meet or exceed 60% system efficiencies in the utility market, and to increase efficiencies of industrial turbines by 15%. The new turbines emit far less nitrogen oxides, carbon dioxide, and unburned hydrocarbons than current gas turbine systems. See *Combined-cycle gas turbine (CCGT)*

## Agency service

**Agency service:** an arrangement that allows a gas buyer to give an agent authority to act on the buyer's behalf to arrange or administer pipeline transportation and/or sales services.

**Aggregate receipt points:** 1) a hub where different supply sources intersect on a gas pipeline; 2) multiple producer meters entering a pipeline. See *Hub or Market centre*

**Aggregator:** 1) acts on behalf of groups of producers to collect producer supplies and sell the gas in commingled blocks to end-users. Prior to deregulation, a limited number of aggregators operated. Aggregators do not take title to the gas but simply find markets and negotiate prices for pools of producers. Also called core transport agent; 2) also a firm that bargains on behalf of a large group of consumers to achieve the lowest possible price for utilities such as electricity and gas. The firm "aggregates" or combines many smaller customers into one large customer for purposes of negotiation and then purchases the utility commodity on behalf of the group.

**Alternative fuel capability:** the on-site availability of a power plant to burn more than one fuel.

**Ambient temperature:** environmental temperature unaffected by other heat sources, such as radiation from artificial objects.

**American National Standards Institute (ANSI):** the coordinating organization for US federated national standards system.

**Annual contract quantity:** the annual delivery quantity contracted for during each contract year as specified in a gas sales or LNG contract.

**Annual delivery programme (ADP):** a key document for both the buyer and seller in determining how they will work together



over the life of an LNG project to achieve the efficient delivery and receipt of LNG cargoes; normally agreed between the parties before the beginning of each contract year. For an ex-ship sale, the ADP deals with the dates on which the sellers' LNG ships will deliver LNG to the buyers' terminals. For a Free on board (FOB) sale, the ADP covers the dates of arrival of the buyers' ships at the LNG plant. Whether the sale is ex-ship or FOB, the ADP provides a basis for decisions on how buyers and sellers will operate their facilities during the contract year covered. Usually, the procedures to be adopted to develop the ADP are agreed upon in the Sales and Purchase Agreement (SPA), CIF contract, Ex-ship contract, and FOB contract

**Arbitrage:** the simultaneous purchase and sale of an asset in order to profit from a difference in the price, usually on different exchanges or marketplaces. Where appropriate infrastructure exists, LNG offers the opportunity for price arbitrage between different gas markets.

**Articles of agreement:** the document containing all particulars relating to the terms of agreement between the Master of the LNG vessel and the crew. Sometimes called ship's articles or shipping articles.

**Asian Development Bank (ADB):** a major multilateral financing institution engaged in LNG project finance. See *Export-credit agencies (ECAs)* and *Multilateral institutions*

**Ask:** the average price asked by those persons recently willing to sell a commodity at a point in time. The asking price is considered by commodity purchasers in a market-making or price-discovery context.

**Associated gas:** natural gas found mixed with oil in underground reservoirs, that comes out of solution as a by-product of oil

## Associated-free natural gas

production. In these fields, natural gas production fluctuates with oil production. See *Non-associated gas*

**Associated-free natural gas:** in immediate contact, but not in solution, with oil in the reservoir. One usually distinguishes between associated (free) gas, dissolved gas and non-associated gas.

**Astern:** a backward direction in the line of a vessel's fore and aft line. If a vessel moves backwards it is said to move astern, opposite to ahead.

**Atlantic basin market:** See *LNG markets*

**At-risk condition:** a certificate condition that places the responsibility for under-recovery of costs regarding pipeline expansion or new construction on the pipeline sponsor, rather than on the pipeline's other customers.

**Average daily quantity (ADQ):** the monthly contracted quantity of gas divided by the number of customers' operating days in that month.

**Average day:** the temperature condition corresponding to a typical day in an average temperature year. The gas sales or requirements for an average day are annual totals divided by 365 days.

**Average demand:** measure of the total of energy loads placed by customers on a system divided by the time period over which the demands are incurred.

**Average temperature year:** long-term average recorded temperature.

**Backhaul:** a natural gas transportation service that requires movement of gas from a point of receipt to a point of delivery such that the contractual direction of movement on the pipeline is in a direction opposite to the flow of the gas.

**Back-stopping:** arranging for alternate supplies of gas in the event the primary source fails to be delivered.

**Backwardation:** a market where the price for nearby delivery is higher than for further forward months. The opposite of backwardation is contango – a market situation where prices are higher for forward delivery dates than for nearer delivery dates.

**Balance:** the amount of natural gas put into the pipeline and the amount of gas taken out of the pipeline are equal on a fixed-time basis.

**Balancing service:** gas-balancing service accommodates imbalances between actual customer usage and gas delivered for that customer's use.

**Balancing:** 1) the requirement imposed by both electricity grids and natural gas pipelines that supply and demand be equal over a certain time period; 2) the practice by shippers of offsetting (balancing) their gas deliveries from the pipeline with injections of gas supplies into the pipeline on a regular basis.

**Ballast:** heavy substances loaded by a vessel to improve stability, trimming, sea-keeping and to increase the immersion at the propeller. Seawater ballast is commonly loaded in most vessels in ballast tanks, positioned in compartments right at the bottom and in some cases on the sides, called wing tanks. On a tanker, ballast is seawater that is taken into the cargo tanks to submerge the vessel to a proper trim.

## Ballast tank

**Ballast tank:** compartments at the bottom of a ship or on the sides that are filled with liquids for stability and to make the ship seaworthy. Any shipboard tank or compartment on a tanker normally used for carrying salt water ballast. When these compartments or tanks are not connected with the cargo system, they are called segregated ballast tanks or systems.

**Bare-boat charter:** a charter in which the bare ship is chartered without crew; the charterer, for a stipulated sum takes over the vessel for a stated period of time with a minimum of restrictions; the charterer appoints the master and the crew and pays all running expenses.

**Barrel (b/bl/bbl):** a volumetric unit of measure for crude oil and petroleum products equivalent to 42 US gallons or 158.978 litres. See *Barrel of oil equivalent (boe)*

**Barrel of oil equivalent (boe):** the oil equivalence of natural gas is normally based on the amount of heat released when the gas is burned as compared with burning a barrel of oil. For a typical natural gas, burning 6,000 standard cubic feet liberates about the same amount of heat as burning one barrel of an average crude.

**Barrels per calendar day (b/cd):** total throughput divided by number of calendar days. The total divided by actual number of days in operation (i.e., stream days) gives the stream-day-rate, which equals or exceeds the calendar-day-rate. Calendar day is a term describing the throughput of a facility that occurs on a daily basis averaged over a long period of time. A calendar day rate times 365 gives the average annual rate.

**Barrels a day (b/d, bpd, or bbl/d):** a unit of measurement used in the industry for the production rates of oilfields, pipelines and transportation.

**Base gas:** gas required in a storage pool to maintain sufficient pressure to keep the working gas recoverable.

**Baseload capacity:** the generating equipment normally operated to serve loads on an around-the-clock basis.

**Base period:** in the US under FERC regulations, a recent 12-month period that serves as the “sample” period for demonstrating pipeline operational costs on which the pipeline’s future rates will be based.

**Base pressure:** standard unit of pressure used in determining gas volume. Volumes are measured at operating pressures and then corrected to base-pressure volume. Base pressure is normally defined in any gas measurement contract. The standard value for natural gas in the US is 14.73 psia, established in 1969 by the American National Standards Institute as standard Z-132.1. Also called base conditions. The standard pressure specified in US state regulations on base pressure varies slightly from state to state.

**Base temperature:** an arbitrary temperature to which measurements of a volume of gas are referred. The standard value in the US is 60°F (520°R) for natural gas as established by the American National Standards Institute as standard Z-132.1.

**bcf:** acronym for billion cubic feet. Used to measure the volume of large quantities of natural gas.

**Beach gas:** natural gas transported through offshore pipelines to a number of gas gathering and processing terminals at or near a coastal region.

**Beach price:** price applying to natural gas at landfall.

**Beam:** the width of a ship; also called breadth.

## Best bid

**Best bid:** in the context of bids for firm transportation capacity to be released, the highest bid that qualifies under the specified criteria.

**Bid:** the purchase price suggested by those in a market to purchase a commodity from suppliers.

**Bid-Ask Spread:** The market-making differential between buyers and sellers of a commodity. Narrow spreads are a sign of market liquidity.

**Bill of lading (B/L):** a document by which the Master of a ship acknowledges having received in good order and condition (or the reverse) certain specified goods consigned to him by some particular shipper, and binds himself to deliver them in similar condition, unless the perils of the sea, fire or enemies prevent him, to the consignees of the shippers at the point of destination on their paying him the stipulated freight. A bill of lading specifies the name of the master, the port and destination of the ship, the goods, the consignee, and the rate of freight; documentation legally demonstrating a cargo has been loaded. The bill of lading is signed by the Master of the ship and the contract supplier.

**Black start:** the initial operation of a facility that begins with no utilities in service.

**Block:** the subdivision of a nation's exploration and production acreage. Blocks are generally defined in terms of latitude and longitude, at one-degree intervals.

**Blowdown:** the depressuring of a reservoir through production of gas. This can occur with either gas or oil reservoirs at any stage in their lifecycle.

**Blowout:** an uncontrolled flow of natural gas, oil, or water from a well caused by the release of pressure from a reservoir; may

be the result of the failure of the containment system.

**Boatswain (Bosun):** on an LNG vessel, tantamount to a foreman; directly supervises maintenance operations. See *Crew*

**Boiler:** a closed vessel in which a liquid is heated, or heated and evaporated. Boilers are often classified as steam or hot water, low pressure or high pressure, capable of burning one fuel or a number of fuels.

**Boil-off vapour:** usually refers to the gases generated during the storage of volatile liquefied gases, such as LNG. LNG boils at slightly above  $-163^{\circ}\text{C}$  at atmospheric pressure and is loaded, transported and discharged at this temperature, which requires special materials, insulation and handling equipment to deal with the low-temperature and the boil-off vapour (heat leakage keeps the cargo surface constantly boiling).

**Booster station:** an installation built in an onshore or offshore pipeline to increase the pressure of the fluid in the pipeline. Also applies to oil and NGL pipelines. See *Compressor station*

**Bottled gas:** liquefied petroleum gas (LPG) stored in a liquid state in steel containers at moderate pressure and ambient temperatures.

**Bow thrusters:** propeller at the lower sea-covered part of the bow of the ship that turns at right angles to the fore-and-aft line and provides transverse thrust as a manoeuvring aid.

**Break bulk:** to commence discharge of cargo.

**Bridge:** loosely used to refer to the navigating section of the vessel where the wheelhouse and chart room are located; erected either amidship, aft or very rarely fore over the main deck of a ship.

## British thermal unit (Btu)

**British thermal unit (Btu):** an energy unit; the quantity of heat necessary to raise the temperature of one pound-mass of water one degree Fahrenheit from 58.5°F to 59.5°F under a standard pressure of 30 inches of mercury at 32°F. The following conversions would apply to gas that contains exactly 1,000 Btu/cf – approximately true for most gas delivered in the US:

1 cubic foot (cf) = 1,000 Btu

1 therm = 100 cf = 100,000 Btu

mcf = 1 mmBtu

1 bcf = 1 trillion Btu

1 tcf = 1 quad = 1 quadrillion Btu

**Broker:** gas merchant who charges a fee for matching sellers to buyers and who may help arrange gas transportation, but does not take title to the gas.

**Bubble point:** the temperature and pressure at which a liquid first begins to vapourise to gas.

**Bulk cargo:** any liquid or solid cargo loaded on to a vessel without packaging (for example, oil or LNG).

**Bulkhead:** name given to any vertical partition that separates different compartments or spaces from one another on a ship.

**Buoy:** a floating object employed as an aid to mariners to mark the navigable limits of channels, their fairways, sunken dangers, isolated rocks, telegraph cables, and so forth; reference points for navigation.

**Burner tip:** the point at which natural gas is used as a fuel.

**Buy/Sell arrangement:** whereby a party sells gas at the wellhead to a party with priority space in the pipeline queue and then repurchases the gas downstream, paying transmission costs and any prearranged differentials.



**Calendar month:** the period beginning on the first gas day of the calendar month and ending on the first gas day of the next calendar month.

**Calorific value:** the quantity of heat produced by the complete combustion of a fuel. This can be measured dry or saturated with water vapour, net or gross. The general convention is dry and gross. See Heating value

**Capacity:** unit of volume of infrastructure and shipping, usually quoted in billions of cubic metres (cm) or millions of tonnes (t).

**Capacity allocations:** allotment of space in a pipeline or regasification infrastructure.

**Capacity assignment:** the process by which an entity that holds the rights and obligations to pipeline capacity transfers those rights and obligations to another entity.

**Capacity brokering:** the assignment of rights to receive firm gas transportation service.

**Capacity constraint:** a restriction or limitation at any point along a pipeline system that affects acceptance, movement or subsequent redelivery of natural gas. A pipeline company determines the sufficiency of its capacity to deliver gas to customers.

**Capacity emergency:** a condition that exists when a system's or pool's load exceeds its operating capacity and cycling reserve margin, plus firm purchases from other systems and available imports from adjacent systems.

**Capacity release:** enables a shipper (releasing shipper) who has reserved firm transportation capacity to release – sell – excess capacity to a replacement shipper. The revenue received from the replacement shipper can be

## Capital lease (finance lease)

used to offset some of the costs associated with reserving firm transportation. Although capacity-release deals can be negotiated between shippers, the preferred method of releasing capacity is with the use of a pipeline's electronic bulletin board through a closed bidding process. Capacity release has created a secondary market and has increased efficiency in the gas transportation market. Capacity release can also occur in regasification terminals.

**Capital lease (finance lease):** a lease that transfers substantially all the risks and rewards incidental to ownership of an asset. Legal title of the asset may or may not eventually be transferred.

**Capital investment:** money spent for an asset expected to produce income over its useful life.

**Captive customer:** buyer that can receive natural gas from only one service provider, with no access to alternate fuel sources; usually describing a residential or small commercial user, but may apply to a large industrial and electricity utility user that is attached to a single pipeline.

**Carbon:** the base of all hydrocarbons; capable of combining with hydrogen in almost numberless hydrocarbon compounds. The carbon content of a hydrocarbon determines, to a degree, the hydrocarbon's burning characteristics and qualities.

**Cargo handling:** the act of loading and discharging a cargo ship.

**Cargo plan:** a plan giving the quantities and description of the various grades carried in the ship's cargo tanks, after the loading is completed.

**Cash-out:** a procedure in which shippers are allowed to resolve imbalances by cash payments, in contrast to making up imbalances with gas volumes in-kind. See *Imbalance trading*

**Casinghead gas:** unprocessed natural gas produced from a reservoir containing oil.

**Catalyst:** a substance whose presence changes the rate of chemical reaction without itself undergoing permanent change in its composition. Catalysts may be accelerators or retarders.

**Cathodic protection:** a method employed to minimize the rate of electrochemical corrosion of pipelines or structures.

**Celsius (C):** temperature scale based on the freezing (0°) and boiling (100°) points of water at atmospheric pressure; formerly known as Centigrade. To convert Celsius to Fahrenheit, multiply the number by 1.8 and add 32.

**Certificate of discharge:** an essential document for officers and seamen; official certification confirming completion of the employment for which engaged.

**Certificate of registry:** a document specifying the nation registry of the vessel.

**Charter party:** contractual agreement between a shipowner and a cargo owner, usually arranged by a broker, whereby a ship is chartered (hired) either for one voyage or a period of time.

**Charter rates:** tariff applied for chartering tonnage in a particular trade.

**Charterer:** the entity to whom is given the use of the whole of the carrying capacity of a ship for the transportation of cargo to a stated port for a specified time. See *Time charter party*

**Cherry-picking:** pursuing desirable customers and ignoring less desirable customers. The term is commonly used to describe a company's tactic of trying to secure the business of the largest energy or service users.

**Chief engineer:** the senior engineer officer who generally oversees functioning of all mechanical equipment on ship; calculates fuel and water consumption and requirements, and co-ordinates operations with shoreside port engineer. See *Crew*

**Chief officer:** the officer next in rank to the Master. Also called First Mate, Chief mate. See *Crew*.

**Chlorofluorocarbons (CFCs):** family of manufactured chemicals; also called chlorinated fluorocarbons.

**City gas:** treated and conditioned gas for consumer use. Also known as Sales gas.

**City-gate rate:** the rate charged a distribution utility by its suppliers; refers to the cost of the natural gas at the point at which the distribution utility historically takes title to the natural gas. Also called gate rate.

**City-gate station (city gate):** the point or measuring station at which a gas-distribution utility physically receives gas from a pipeline or transmission company; the point at which the backbone transmission system connects to the distribution system. There is not necessarily a change of ownership at a city-gate station.

**Class of service:** a group of customers with similar characteristics (for example, residential, commercial, industrial) that are identified for the purpose of setting a rate for service.

**Classification society:** private organisations that arrange inspections and advise on the hull and machinery of a ship. Supervise vessels during their construction and afterwards, in respect to their seaworthiness, and places vessels in grades or classes according to the society's rules for each particular type. It is not compulsory by law that a shipowner have his vessel built according to the rules of any classification society.

In practice, the difficulty in securing satisfactory insurance rates for an unclassified vessel makes it a commercial obligation. The major classification societies – American Bureau of Shipping, Lloyds Register of Shipping, Det Norske Veritas, Bureau Veritas and Germanischer Lloyd – have included the International Maritime Organization (IMO) LNG Gas Codes in their rules. See *International Maritime Organization (IMO)*

**Co-firing:** the process of burning natural gas simultaneously with another fuel. Co-firing can reduce sulphur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) emissions.

**Cogeneration (Cogen):** the simultaneous production of electrical energy from the combustion of a single fuel source through two means: gas turbines and steam turbines. See *Combined-cycle gas turbine*

**Combined-cycle gas turbine (CCGT):** this is the combination of simple gas turbines with a heat-recovery steam generator (HRSG) and a steam turbine in a power generation plant. Gas is combined with air and burned, with the expanded gas turning the blades of the gas turbines to power an electricity generator (the Brayton thermodynamic cycle). The hot exhaust gases are passed to the HRSG, in which water is converted to steam that is used in a single steam turbine to power another generator (the Rankine thermodynamic cycle). Also called combined cycle generation.

**Combined heat and power (CHP):** the simultaneous generation of two forms of energy from a single fuel source. Electrical energy is produced through gas turbines and heat energy (steam) is produced through a heat-recovery steam generator. See *Combined-cycle gas turbine*

**Commercial field:** a hydrocarbons field that, under existing economic and operating conditions, is judged to be capable of generating

enough revenues to exceed the costs of development.

**Committed gas contract:** a source-specific natural gas sales contract that commits the seller to deliver natural gas, from specific described reserves or sources.

**Commodity charge:** throughput or usage charge, a fee paid to the pipeline operator, based on the number of decatherms moved by the pipeline for the shipper. At the local market it is referred to as the gas portion of the end-user's bill – charged at the burner tip; the component of rates charged to customers that reflects the volume of gas actually transported by a utility or the cost of gas actually purchased by the utility.

**Common carrier:** a facility obligated by law to provide service to all potential users without discrimination, with services to be prorated among users in the event capacity is not sufficient to meet all requests. In the US, interstate oil pipelines are common carriers, but interstate natural gas pipelines are not (they are open-access contract carriers).

**Company-used gas:** natural gas consumed by a gas-distribution or gas-transmission company, or the gas department of a combination utility, for example, fuel for compressor stations.

**Complement:** the number of officers and crew employed upon a vessel for its safe navigation and operation.

**Compressed natural gas (CNG):** natural gas that has been compressed under high pressures (typically between 3,000 and 3,600 psi) and held in a container; expands when released for use as a fuel.

**Compressibility factor:** the ratio of the actual volume of a gas divided by the volume that would be predicted by the ideal gas law, usually referred to as the Z factor.

**Compression ratio:** the relationship of absolute outlet pressure at a compressor to absolute inlet pressure.

**Compression:** the act or process of contracting a volume of gas into a smaller space.

**Compressor station:** a booster station associated with a natural gas pipeline that uses compressors to increase the gas pressure. When gas turbines are used to provide compressor power, stations can use some of the gas moving through the line as fuel.

**Compressors:** a mechanical device used to raise the pressure of a gas. Compressors can be of three types: axial, centrifugal, or reciprocating. The usual means of providing the required power are electrical motors, steam turbines, or gas turbines.

**Condensate:** a hydrocarbon liquid that forms by precipitation from a gas. When the liquid precipitates in the reservoir during pressure depletion, the liquid is referred to as retrograde condensate. Surface production of hydrocarbon liquids through primary separation facilities is referred to as condensate when it comes from a gas reservoir. Natural gas condensates consist primarily of pentanes (C<sub>5</sub>H<sub>12</sub>) and heavier components; there will be some propane and butane dissolved within the mixture.

**Confirmed nomination:** verification by a pipeline company that a change in a customer's level of transportation service will be matched by a change in supplier quantities.

**Consignee:** the entity to whom cargo is consigned as stated on the bills of lading.

**Consignor:** the entity named in the bill of lading as the one from whom the goods have been received for shipment.

**Consumer:** the ultimate end-user of natural gas at their burner tip as contrasted with a customer who may purchase natural gas for resale.

**Contingent asset/liability:** a possible asset/liability that arises from past events and whose existence will be confirmed only by the occurrence, or non-occurrence, of one or more uncertain future events not wholly within the control of the entity.

**Contract price (CP):** price agreed between sellers and buyers.

**Contract term:** the term of effectiveness of a contract.

**Contracted reserves:** natural gas reserves dedicated to fulfill gas contracts.

**Conventional gas:** 1) natural gas occurring in nature, as opposed to synthetic gas; 2) gas produced under present-day technology at a cost not greater than the current market value.

**Core customer:** buyer that can purchase natural gas from only one supplier, with no access to alternate fuel sources; usually describing a residential or small commercial user, but may apply to a large industrial and electric utility user as well. Usually pays a higher rate for assured service.

**Cost of capital:** the weighted average cost of financing investment projects, primarily through debt and/or equity financing.

**Cost of development/boe (COD):** the unit cost (\$/boe) required to develop a project. Calculated by taking the total unescalated net development investment including seismic, technical data, drilling and completion costs, and costs of incremental surface facilities divided by incremental net proved developed reserves.



**Cost, insurance and freight (CIF):** used in international trade statistics and sales contracts, transactions on CIF basis mean the purchase price includes all costs of moving the goods from the point of embarkation to their destination. With respect to LNG shipping, this means that the buyer purchases the gas at the point of vessel loading or during its transit to the receiving terminal, while the agreed price includes shipping charge and insurance for the load. See *ex-Ship contract and Free on Board contract*

**Crew:** the company of officers and personnel on board ship. Although operations are similar to other types of ships, there is more emphasis on crew training for steam turbine plant and LNG cargo handling operations, as well as planned maintenance procedures.

**Critical pressure:** 1) for a pure component, the pressure above which separate liquid and gas phases cannot exist; 2) the vapour pressure of a substance at its critical temperature; partial liquefaction can occur below the critical pressure even at the critical temperature.

**Critical temperature:** for a pure component, the temperature above which a liquid phase cannot exist.

**Cryogenics:** the production and application of low-temperature phenomena. The cryogenic temperature range is usually from  $-150^{\circ}\text{C}$  ( $-238^{\circ}\text{F}$ ) to absolute zero ( $-273^{\circ}\text{C}$ , or  $-460^{\circ}\text{F}$ ), the temperature at which molecular motion essentially ceases. A most important commercial application of cryogenic gas liquefaction techniques is the storage, transportation, and regasification of LNG.

**Cubic capacity:** the volumetric measurement of the ship's cargo compartments.

## Cubic feet a day (cf/d)

**Cubic feet a day (cf/d):** at standard conditions, the number of cubic feet of natural gas produced from a well over a 24-hour period, normally an average figure from a longer period of time. Generally expressed as mcf/d = thousand cubic feet a day; mmcf/d = million cubic feet a day; bcf/d = billion cubic feet a day; or tcf/d = trillion cubic feet a day.

**Cubic foot (cf):** The amount of gas required to fill a volume of 1 cubic foot under stated conditions of temperature, pressure and water vapour.

**Cubic metre (cm):** unit of measurement for gas volume. The amount of gas required to fill the volume of one cubic metre.

**Curtailement:** an action by which the customer receives less than the contract quantity of natural gas or services because of a system-wide shortage.

**Cushion gas:** the volume of gas that is required in an underground storage field to maintain minimum field pressure. This cushion gas (or base gas) is not available for withdrawal unless replaced with immiscible injectant to maintain field pressure.

**Custody transfer measuring system (CTMS):** LNG ships are fitted with high-accuracy liquid-level, temperature and vapour-pressure measuring equipment. The cargo tanks are calibrated by an independent measurer so that the volume of cargo can be determined accurately. The CTMS is accepted by the buyer and the seller of the cargo as the basis for the quantity purchased or sold. Samples of the LNG cargo are taken ashore and analysed to determine the cargo's chemical composition from which the heating value can be calculated. The heating value is then multiplied by the volume loaded or discharged from the ship to obtain the British thermal unit (Btu) content of the delivered cargo, which is used as the basis for cargo invoices, import duties and fiscal accounting.

**Customer demand charge:** the component of rates charged to customers that is expected to cover the fixed costs incurred by the pipeline. The other component of rates is the commodity charge. This charge is also referred to as a reservation charge.

**Cycle volume:** volume of natural gas that can be withdrawn from underground storage during the winter season and then be replaced during the summer season.

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## Daily average send-out

**Daily average send-out:** total volume of natural gas delivered during a proscribed period of time, divided by the total number of days in the period.

**Daily contracted quantity (DCQ):** the average daily quantity of natural gas that is contracted to be supplied and taken.

**Day-one-gains:** Under International Financial Reporting Standards, the best evidence of the fair value of a financial instrument at initial recognition is the transaction price, unless the fair value of that instrument is evidenced by comparison with other observable recent market transactions. The application of this standard may result in no gain or loss being recognised on the initial recognition of a financial asset or financial liability. The unobservable part of any fair value calculated at inception of a contract (also known as day-one-gains) should be deferred over the life of the contract.

**Deadfreight factor:** percentage of a ship's carrying capacity that is not utilised.

**Deadfreight:** space booked by shipper or charterer on a vessel, but not used.

**Deadweight tonnage (DWT):** a measure of ship carrying capacity: 1) the number of metric tonnes (2,204.6 pounds) of cargo, stores and bunkers that a vessel can transport; 2) the difference in weight between a vessel when it is fully loaded and when it is empty (in general transportation terms, the net) measured by the water it displaces when submerged to the deep-load line. A vessel's cargo is less than its DWT.

**Dedicated design-day capacity (DDDC):** the maximum volume of gas dedicated to a customer's use and based on the maximum number of therms recorded by meter on the most demanding day – typically the coldest day – of the year; expressed as a decimal number. Also known as premise demand factor.

## Deliverability (LNG ships)

**Degree days:** measured as the number of degrees above or below a standardised temperature on any given day.

**Dehydration:** the removal of water from a fluid.

**Dehydrator:** natural gas processing equipment that removes water vapour. Typically, glycol dehydration units are used to dry gas before it is sent to a gas transmission line. If the gas is to be sent to a cryogenic expander plant or LNG plant, then the gas is typically dehydrated using molecular sieves.

**Deliverability (LNG ships):** one major aspect of LNG project planning consists of estimating the transportation capacity required, taking into account the time necessary for each function in the chain of events within a typical round voyage of an LNG carrier. A typical delivery calculation for a 137,500-cm LNG carrier might be:

One-way distance (nautical miles)	6,000
Ship 'service' speed (knots)	19
Sea days (round trips)	26.31
Port days (round trips)	2
Total days in voyage	(28.31) 29
Operating days in year	350
Voyages per year	12.07
Ship capacity (net cm)	135,000
Less: heel (cm)	3,000
Discharge quantity (cm) =	132,000
Annual delivered quantity (cm) =	132,000 x 12.07
	= 1,539,103 cm

LNG specific gravity varies depending on gas composition, but is typically about 0.45, therefore, the annual deliverability of the vessel is  $0.45 \times 1,593,103 = 716,896$  tonnes. If the

maximum output of the liquefaction train is 3.3 million tonnes a year (mmt/y), this would equal a maximum daily production of 10,000 tonnes over the 330-day annual operating period. The deliverability of a 137,500 cm ship is 59,400 tonnes, which means it can cater for a daily production of 2,048 tonnes on this route, or five ships can carry 10,240 tonnes, slightly more than maximum production.

**Deliverability:** the volume of natural gas that a pipeline or distribution system can supply in a given period normally during a 24-hour period.

**Delivery point:** designates the point where natural gas is transferred from one party to another.

**Delivery-point operator:** the operator responsible for balancing loads and allocating natural gas quantities received at delivery points to parties who have contracted to receive deliveries at the point.

**Demand charge:** a fixed fee, generally paid monthly, to reserve capacity space in a pipeline, storage, or distribution facility.

**Demand forecast:** estimate of the level of energy or capacity that is likely to be needed at some time in the future.

**Demurrage:** a fee, per day or per hour, agreed to be paid by the charterer or receiver of the cargo, for the detention of a vessel, loading or unloading, beyond the laytime allowed in the charter party.

**Department of Energy (DOE):** the US federal department that manages programmes of research, development and commercialisation for various energy technologies, and associated environmental, regulatory and defence programmes. DOE announces energy policies and acts as a

principal advisor to the President on energy matters.

**Deregulated gas:** natural gas no longer subject to sales and/or price regulation.

**Deregulation:** the process of removing restrictive regulations on previously regulated power and utility companies.

**Desulphurisation:** processes by which sulphur and sulphur compounds are removed from gases or petroleum liquid mixtures.

**Development agreement (DA):** one of the range of agreements between governments and petroleum-resource developers is the DA or one of its variants – the Development and Fiscal Agreement (DFA) or the Development and Production Sharing Agreement (DPSA).

**Dewpoint:** the temperature, at a given pressure, at which a vapour will form a first drop of liquid on the subtraction of heat. Further cooling of liquid at its dew point results in condensation of part or all of the vapour as a liquid.

**Disabled ship:** a vessel impaired so as to be incapable of proceeding on her voyage.

**Discount:** an amount agreed between buyer and seller to be subtracted from an existing benchmark.

**Dispatch:** the monitoring and regulation of an electrical or natural gas system to provide co-ordinated operation; the sequence in which generating resources are called upon to generate power to serve fluctuating loads.

**Displacement gas:** 1) in pipeline transportation, the substitution of a source of natural gas at one point for another source of

## Dissolved gas

natural gas at another point. Through displacement, natural gas can be transported by backhaul or exchange; 2) in natural gas marketing, the substitution of natural gas from one supplier of a customer with natural gas from another competing supplier.

**Dissolved gas:** natural gas in solution in oil in the reservoir.

**Distribution company (gas):** a gas utility that obtains the major portion of its natural gas operating revenues from the operation of a retail gas-distribution system, a gas distributor.

**Distribution:** the delivery of a utility (natural gas, electricity, water) to a household or business.

**Diurnal storage:** daily storage; refers to short-term or peak storage in pipelines or natural gas holders, as opposed to seasonal storage.

**Diversion:** the flexible routing of LNG cargoes where gas suppliers will seek to move cargoes to markets. Diversion rights for sellers and buyers in LNG supply contracts create opportunities for physical arbitrage, depending on the correlation of such demand and price variations between regional markets.

**Downstream pipeline:** pipeline receiving gas from another pipeline at an interconnection point. See *Upstream pipeline*

**Downstream:** commercial gas operations that are closer to the end-user or burner tip, as opposed to upstream, which is closer to production.

**Draft:** the depth of a ship in the water; vertical distance between the waterline and the keel, expressed in feet in the US, elsewhere in metres; also Draught.

**Dry (or lean) gas:** 1) gas that has been treated to remove liquids



and inerts making it suitable for shipping in a pipeline; 2) natural gas from the well containing no water vapour that will liquefy at ambient temperature and pressure, i.e. the gas is water dry. Gas is usually priced on a dry basis. See *Pipeline quality gas*; 3) a gas whose water content has been reduced by dehydration or; 4) a gas containing little or no hydrocarbons that could be recovered as a liquid condensate.

**Dry dock:** an enclosed basin into which a ship is taken for underwater cleaning and repairing. It is fitted with water-tight entrance gates which, when closed, permit the dock to be pumped dry.

**Dry gasfield:** reservoir(s) consisting primarily of light hydrocarbons and negligible quantities of condensate.

**Dry-measurement basis:** method of measuring total heating value, whereby one cubic foot of gas is measured absent of water vapour under standard conditions of pressure and temperature.

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**EFET (European Federation of Energy Traders):** a group of more than 80 energy-trading companies from 18 European countries focused on improving the conditions of energy trading in Europe and the promotion of a sustainable and liquid European wholesale energy market.

**Embedded derivative:** a derivative instrument contained within another contract – the host contract. The embedded derivative may change in value in different ways or to different magnitudes than its host contract (as it may be linked to a different price, asset or index). IAS 39 requires all derivatives to be marked-to-market, placing explicit reporting requirements on embedded derivatives to achieve enhanced transparency in financial reporting.

**Emergency-shutdown systems (ESD):** a system, usually independent of the main control system, that is designed to safely shut down an operating system. For example, at ship-shore interface, LNG cargo transfer between ship and shore is accomplished by a series of shore-based articulated loading arms, usually three or four liquid arms and a single vapour arm. The configuration is similar at both the loading and discharge terminals. These arms have flexibility in three directions to allow for relative motion between ship and shore. If this allowable motion is exceeded, alarms sound on the ship and shore. Cargo transfer is automatically stopped, either by the shore pumps shutting down during loading, or the ship's pumps shutting down during unloading.

**Emissions trading:** Emissions trading is emerging as a key instrument in the drive to reduce greenhouse-gas (GHG) emissions. Emissions trading is particularly suited to the emissions of GHGs, which have the same effect wherever they are emitted. This allows central government to regulate the amount of emissions produced in aggregate by setting the overall cap for the scheme, but gives companies the flexibility

of determining how and where the emissions reductions will be achieved. By allowing participants the flexibility to trade allowances, the overall emissions reductions are achieved in the most cost-effective way possible. The EU Emissions Trading Scheme (EU ETS) is a mechanism being introduced across Europe to reduce emissions of carbon dioxide and combat the serious threat of climate change. Phase I of the scheme began on 1 January 2005 and will run until 31 December 2007. Phase II will run from 2008-2012, to coincide with the first Kyoto Protocol commitment period.

**Enabling agreement:** provides the general terms and conditions for the purchase, sale, or exchange of LNG, pipeline gas and electricity, but does not list specific contract details.

**End-users:** the ultimate consumers of natural gas, including residential, commercial, industrial, wholesale, cogeneration and utility electricity-generation customers.

**Engineering, procurement and construction (EPC) contract:** 1) a legal agreement setting out the terms for all activities required to build a facility to the point that it is ready to undergo preparations for operations as designed. 2) the final contracting phase in the development of the export portion of the LNG chain that defines the terms under which the detailed design, procurement, construction and commissioning of the facilities will be conducted. Greenfield LNG project development entails a wide variety of design, engineering, fabrication and construction work far beyond the capabilities of a single contractor. Therefore, an LNG project developer divides the work into a number of segments, each one being the subject of an EPC contract. For example, separate EPC contracts are executed for construction of onshore LNG plant and related infrastructure, for the offshore production facilities and for the pipeline from the offshore location to the plant site. See *Front-end engineering and design (FEED) contract*

**Enriching:** increasing the heat content of natural gas by mixing it with a gas of higher Btu content.

**Ensign:** flag carried by a ship to show her nationality.

**Environmental-impact assessment (EIA):** an assessment of the impact of an industrial installation or activity on the surrounding environment, conducted before work on that activity has commenced. The original baseline study, a key part of this process, describes the original conditions.

**Environmental Protection Agency (EPA):** the US federal agency that administers federal environmental policies, enforces environmental laws and regulations, performs research and provides information on environmental subjects. The agency also acts as chief advisor to the President on US environmental policy and issues.

**Equation of state:** a mathematical relationship between pressure, volume and the temperature of a fluid that permits the prediction of the real volumetric and thermodynamic behaviour.

**Equity gas:** the proportion of gas to which a producing company is entitled as a result of its financial contribution to the project.

**Escalator clause:** a clause in a gas purchase or sale contract that permits adjustment of the contract price under specified conditions.

**European Commission:** the executive body of the European Union. Its Directorate-General of Energy and Transport develops community transport and energy policies, including dealing with state aid, and is responsible for managing the financial support programmes for the trans-European networks, technological development and innovation.

**Evergreen clause:** a contract clause that extends the contract beyond the initial term, until one of the parties gives a required notice of termination.

**Excess capacity:** a pipeline that is operating at a point below capacity. If a pipeline has excess capacity, it can receive additional gas.

**Exergy analysis:** the evaluation of a thermodynamic process' irreversibility and inefficiency. Exergy analysis is a fundamental design mechanism to increase efficiency and reduce costs.

**Export-credit agencies (ECAs):** government agencies whose mission is to facilitate the export sale of goods and services by providing credits that are more attractive than those available commercially and by providing security for credit and political risk that may not be available at an economic cost from private-sector finance sources. ECAs of the US, Europe and Japan have been consistent financing sources for LNG projects; includes Export-Import Banks of the US (USEXIM) and Japan Bank for International Cooperation (JBIC), the UK's Export Credit Guarantee Department (ECGD), Germany's Hermes, France's Coface and Italy's Sace. See *Multilateral institutions*

**Ex-ship contract:** in an LNG ex-ship contract, ownership of the LNG transfers to the buyer as the LNG is unloaded at the receiving terminal, payment is due at that time. See *Cost, insurance and freight contract and Free on board contract*

**Extraction loss:** the reduction in volume of wet natural gas caused by the removal of natural gas liquids, hydrogen sulphide, carbon dioxide, water vapour and other impurities from the natural gas stream. Also called shrinkage.

**Federal Energy Regulatory Commission (FERC):** the chief energy regulatory body of the US government. Responsible for regulating LNG facilities in the US. FERC is considered an independent regulatory agency responsible primarily to Congress, but is housed in the US Department of Energy.

**Feedstock gas (feedgas):** dry gas used as raw material for LNG, petrochemicals and gas-to-liquids (GTL) plants.

**FERC blanket certificate:** authorisation from FERC to the interstate pipeline to offer a service to the public without individual certification or approval filings.

**FERC Order 497 – a 1988 FERC Order:** to do with the activities of marketing affiliates of interstate pipeline firms. Among other things, it establishes guidelines for sharing of certain insider information. It requires disclosure of certain information regarding shared personnel and affiliate transactions.

**FERC Order 636:** 1992 order that unbundled US pipeline services, requiring pipelines to cease their merchant function and instead become solely a transporter of gas.

**FERC Order 637 – 2000 FERC Order:** required changes in FERC regulation of interstate pipelines, changes designed to encourage greater comparability between primary pipeline capacity and the secondary capacity (capacity release) market.

**Field natural gas:** gas extracted from a production well prior to entering the first stage of processing, such as dehydration.

**Field:** an area consisting of a single or multiple reservoirs all grouped on or related to the same individual geological structural feature and/or stratigraphic condition. There may be two or more reservoirs in a field that are separated vertically by intervening impervious strata, or laterally by local geologic barriers, or by both.

**Financial-guarantee contract:** a contract that requires the issuer to make specified payments to reimburse the holder for a loss it incurs because a specified debtor fails to make payment when due in accordance with the original or modified terms of a debt instrument.

**FIP:** Free in pipe. LPG is sometimes sold on this basis.

**Firm energy (contract):** energy sales guaranteed to be delivered under terms defined by contract.

**Firm transportation:** a fixed obligation where the transporter is obligated to provide a specified capacity without interruption.

**First mate:** directly responsible for all deck operations – cargo handling and storage, deck maintenance and deck supplies; ship's medical officer. See *Crew*

**Fixed-price contract:** contract in which a specific price is agreed for commodities.

**Flare:** a flame used to burn off unwanted gas; a flare stack is the steel structure on a processing facility from which gas is flared.

**Flash point:** the temperature under very specific conditions at which a combustible liquid will give off sufficient vapour to form a flammable mixture with air in a standardised vessel. Related to the volatility of the liquid.

**Flash vapours:** gas vapours released from a stream of natural gas liquids as a result of an increase in temperature, or a decrease in pressure.

**Force Majeure:** a term commonly used in contracts to describe an event or effect that cannot be reasonably controlled. This term essentially frees one or both parties from liability of obligation

## Forward contract

when an extraordinary event or circumstance prevents one or both parties from fulfilling their contractual obligations.

**Forward contract:** a commitment to buy (long) or sell (short) an underlying asset at a specified date at a price (known as the exercise or forward price) specified at the origination of the contract.

**Forward haul:** a gas-transportation service that requires movement of gas from a point of receipt to a point of delivery such that the contractual direction of movement on the pipeline is in the same direction as the flow of the gas.

**Fossil fuel:** any naturally occurring organic fuel formed in the earth's crust, such as petroleum, coal, or natural gas.

**Fractionation:** the process of separating a fluid mixture into its primary constituents, for example, separating a gas condensate into ethane, propane, butanes and heavier components.

**Fracturing:** refers to a method used by producers to extract more gas from a well by opening up rock formations using hydraulic or explosive force. Advanced fracturing techniques are enhancing producers' ability to find and recover natural gas, as well as extending the longevity of older wells.

**Free-on-board (FOB) contract:** in an LNG FOB contract, the buyer lifts the LNG from the liquefaction plant and is responsible for transporting the LNG to the receiving terminal. The buyer is responsible for the shipping, either owning the LNG ships or chartering them from a shipowner. In a FOB contract, the seller requires assurance that the shipping protocols provide a safe and reliable off-take for the LNG to prevent disruption to the sales and purchase agreement (SPA). See *Cost, insurance and freight (CIF) contract*, *Ex-ship contract* and *Sale and purchase agreement (SPA)*



**Freight:** charge made for the transportation of a cargo.

**Front-end engineering and design (FEED) contract:** 1) a legal agreement setting out the terms for all activities required to define the design of a facility to a level of definition necessary for the starting point of an engineering, procurement, and construction (EPC) contract; 2) generally, the second contracting phase for the development of the export facilities in the LNG chain which provides greater definition than the prior Conceptual design phase. In an LNG project, the most important function of the FEED contract is to provide the maximum possible definition for the work to be performed by the EPC contractor. This enables potential EPC contractors to submit bids on a lump-sum basis, with the least possibility that the contract cost will change through undefined work or through claims for unanticipated changes in the work. Clear definition of contract costs is important not only for cost control purposes, but also for purposes of project financing – LNG project lenders will normally limit their lending commitment to a specific percentage of forecast project costs, and cost overruns will have to be covered by the borrower's equity investment. See *Engineering, procurement and construction (EPC) contract*

**Fuel gas:** a process stream internal to a facility that is used to provide energy for operating the facility.

**Fuel loss:** a proportion of natural gas received by a pipeline or local distribution company that is retained to compensate for lost and unaccounted for natural gas.

**Fuel-switching capability:** the ability of an end-user to readily change fuel.

**Full-cycle economics:** economic analysis that includes all costs of field development including seismic, lease cost and construction, drilling, completion, development and, where relevant, decommissioning and environmental restitution.

**Gas cap:** a free gas phase within a reservoir that overlies an oil zone.

**Gas condensate reservoir:** a reservoir initially containing natural gas that will precipitate hydrocarbon liquid (retrograde condensate) during pressure depletion. To increase the recovery of the condensate, gas may be re-cycled in early years and produced at a later date.

**Gas cycling:** process in which produced gas is re-injected into the reservoir after removal of condensate in order to maintain reservoir pressure and prevent condensate from condensing in the reservoir (retrograde condensation) and becoming difficult to recover.

**Gas day:** in the US, a period of 24 consecutive hours, beginning at 09:00 Central Time.

**Gas-distribution line:** a gas pipeline, normally operating at pressures of 60 pounds per square inch (psi) or less, which transports gas from high-pressure transmission lines to end-users.

**Gasfield:** a field or group of reservoirs of hydrocarbons containing natural gas, but insignificant quantities of oil.

**Gas-gathering system:** a system for collecting gas production from different sources for delivery by pipeline to a central point, such as a platform or processing facility. The gas sources could be individual wells, smaller gathering systems, field facilities and platforms.

**Gas grid:** 1) the system of pipelines from the wellhead to the city gate; 2) the network of gas transmission and distribution pipelines in a region or country, through which gas is transported to industrial, commercial and domestic users.

**Gas imbalance:** a discrepancy between a transporter's receipt and deliveries of natural gas for a shipper.

**Gas lift:** one of several methods of artificial lift. A mechanical process using the continuous or intermittent injection of a gas into the production conduit (tubing or casing) to aerate or displace the produced fluids. This creates a reduction of the bottom-hole pressure of the well, increasing or sustaining the flow rate of the well.

**Gas processing:** the separation of oil and gas, and the removal of impurities and NGLs from natural gas.

**Gas reserves:** those quantities of gas that are likely to be commercially recovered from known accumulations from a given date forward.

**Gas revenue:** the product of gas volume times gas price; gross cash flow from sales of gas.

**Gas send-out:** the total natural gas produced or purchased (including exchange-gas receipts), or the net natural gas withdrawn from underground storage within a specified time interval, measured at the point of production, purchase or withdrawal, adjusted for changes in local storage quantity.

**Gas treatment:** removal of impurities, such as sulphur compounds, carbon dioxide and water vapour from natural gas.

**Gas-turbine power plant:** a power plant in which the prime mover is a gas turbine. A gas turbine typically consists of an axial-flow compressor that feeds compressed air into one or more combustion chambers where liquid or gaseous fuel is burned. The resulting hot gases are expanded through the turbine, causing it to rotate. The rotating turbine shaft drives the compressors as well as the generator, producing electricity.

**Gas well:** a well drilled and completed that primarily produces natural gas.

**Gas/condensate ratio:** for a gas condensate reservoir, the ratio of gas to condensate is reported in cf per barrel. The inverse ratio (condensate-gas ratio, CGR) is also used, and is reported in barrels per mmcf.

**Gas to liquids (GTL):** a processing technology that converts natural gas into high-value commodity liquid fuels and blending agents, petrochemicals feedstocks and chemicals by changing its chemical structure. GTL produces products that can be easily traded as commodities on world markets.

**Gas-to-oil ratio (GOR):** the number of standard cubic feet of gas produced per barrel of crude oil or other hydrocarbon liquid. In some parts of the world, the units are cubic metres of gas per cubic metre of liquid produced.

**Gathering line:** network-like pipeline that transports natural gas from individual wellheads to a compressor station, treating or processing plant, or main trunk transmission line. Gathering lines are generally relatively short in length and smaller in diameter than the gas sales line.

**Gigajoule (GJ):** a joule is an international unit of energy defined as the energy produced from one watt flowing for one second. A very small unit of energy, there are 3.6m joules in a kilowatt-hour. For gas, one gigajoule = 960 cf under standard temperature and pressure conditions. Roughly, 1 gigajoule (Gj) = mcf; one terajoule (Tj) = 1 mmcf; one petajoule (Pj) = 1 bcf; one exajoule (Ej) = 1 tcf.

**Gigawatt (GW):** a unit of electric power equal to 1bn watts, 1m kilowatts or 1,000 megawatts – enough power to supply the needs of a medium-sized city.

**Gigawatt hour (GWh):** 1bn watt-hours.

**Grandfather clause:** a clause in a contract which maintains the prior rule or policy where a new rule or policy would otherwise be applicable.

**Greenfield LNG facility:** a new LNG facility constructed on a new site.

**Grid:** a network of pipelines through which gas is transported.

**Gross freight:** freight cost excluding the expenses relating to the running costs of the ship.

**Gross gas withdrawal:** the full volume of compounds extracted at the wellhead, including non-hydrocarbon gases and natural gas plant liquids.

**Gross tonnage:** common measurement of the internal volume of a ship determined in accordance with prescribed methods and formulas and expressed in units of 100 cf (= 2.83 cm)

**Grounding:** contact by a ship with the bottom while she is moored or anchored or under way.

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## Hague rules (1921)

**Hague rules (1921):** adopted by the International Law Association at the Hague Conference in 1921, international code for conditions for the carriage of cargo under a bill of lading.

**Harbour dues:** various local charges against all seagoing vessels entering a harbour, to cover maintenance of channel depths, buoys, lights; not all harbours assess this charge.

**Hard aground:** a vessel that has gone aground and is incapable of refloating under her own power. Also referred to as Hard and Fast.

**Heads of agreement (HOA):** a preliminary agreement covering the outline terms for the sale and purchase of LNG or natural gas. See *Sales and purchase agreement (SPA)*.

**Headstation:** mainline receipt point on a pipeline.

**Heat rate:** the measure of efficiency in converting input fuel to electricity. Heat rate is expressed as the number of Btu of fuel (for example, natural gas) per kilowatt hour (Btu/kWh). Heat rate for power plants depends on the individual plant design, its operating conditions and its level of electricity output. The lower the heat rate, the more efficient the plant.

**Heating value:** the amount of heat produced from the complete combustion of a unit quantity of fuel. There are two heating values: the gross (high) and the net (low) heating value. The gross value is that which is obtained when all of the products of combustion are cooled to standard conditions, and the latent heat of the water vapour formed is reclaimed. The net value is the gross value minus the latent heat of vapourisation of the water.

**Hedge for accounting purposes:** an accounting election, subject to certain criteria, allowing a breach of two fundamental

principles of generally accepted accounting principles; either allowing gains and losses on derivatives at fair value to be deferred in equity; or allowing the measurement for financial assets and liabilities to be recorded at fair value through income.

**Hedge for commercial purposes:** taking a financial position by use of a derivative or non-derivative financial asset or liability whose fair value or cash flows are expected to be effective in reducing or eliminating changes in the fair value or cash flows of a risk or a range of risks.

**Hub:** a contractual point where buyers and sellers execute transactions for gas. Hubs can be notional or physical, trans-regional (one or more transmission system operators (TSOs)) or within-country (one TSO). Hubs generally consist of a Hub Services Agreement (operator) and Standard Trading Contract (trader). Examples of notional hubs are the National Balancing Point (NBP) in the UK and the Title Transfer Facility (TTF) in the Netherlands. Physical hubs include the Henry Hub in the US and the Zeebrugge Terminal (ZBT) in Belgium. See *Market centre*.

**Henry Hub:** pipeline interchange near Erath, Louisiana, US, where a number of interstate and intrastate pipelines interconnect through a header system. It is the standard delivery point for the Nymex natural gas futures contract in the US, the benchmark gas price in the US Gulf.

**Hydrocarbon:** an organic chemical compound of hydrogen and carbon in gaseous, liquid, or solid phase.

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## ICE (Intercontinental Exchange)

**ICE (Intercontinental Exchange):** formerly the International Petroleum Exchange, an electronic marketplace for energy trading and price discovery. ICE provides market participants with direct access to energy futures and thousands of over-the-counter commodity products for oil and refined products, natural gas, power and emissions.

**Ideal specific gravity:** the ratio of the molecular weight of a gas to the molecular weight of air. Molecular weight of air = 28.9644.

**Imbalance penalties:** penalties implemented by a pipeline to provide an incentive for shippers to maintain actual receipts and deliveries at nominated and confirmed levels.

**Imbalance trading:** process by which shippers can acquire gas from, or sell to, other customers to minimise or avoid cash-out.

**Improved (enhanced) recovery:** the operation whereby natural gas is recovered using any method other than those that rely primarily on the use of natural reservoir pressure, gas lift, or a pump.

**Independent power producer (IPP):** an unregulated power generator that has no franchised retail service territories.

**Indexing:** tying the commodity price of natural gas in a contract to published prices of other commodities or price indices.

**Inert gas:** a chemically inert gas, resistant to chemical reaction with other substances.

**Injected gas:** natural gas placed in underground storage or returned to the producing reservoir to maintain pressure.

**Interconnector (the European):** a 238 km pipeline providing



a strategic link between the UK and continental Europe, connecting the two gas transmission systems at Bacton, in the UK, and Zeebrugge, in Belgium.

**International load line certificate:** a certificate that gives details of the minimum freeboard granted to a particular ship and the position of the appropriate load lines to be marked on her sides. This certificate is issued by a government or duly appointed person or organisation such as a classification society.

**Interruptible demand:** the amount of customer demand that, in accordance with contractual arrangements, can be interrupted by direct control of the system operator, remote tripping, or by action of the customer at the direct request of the system operator.

**Interruptible gas:** gas sold to customers with a provision that permits curtailment or cessation of service at the discretion of the supplier; the opposite is firm gas.

**Interruptible service:** gas service that is subject to interruption at the option of the pipeline or local distribution company (LDC).

**Interstate market:** the market for natural gas that is consumed outside the state in which it is produced or is transported by an interstate pipeline.

**Interstate Natural Gas Association of America (INGAA):** trade organisation that advocates regulatory, and legislative and individual positions of importance to the interstate natural gas pipeline industry in the US.

**Interstate pipeline:** a natural gas pipeline company in the US that is engaged in the transportation of natural gas across state boundaries and is, therefore, subject to FERC jurisdiction.

**Intrastate market:** the market for natural gas consumed in the same state as it is produced.

**Intrastate pipeline:** a natural gas pipeline company that is engaged in the transportation of natural gas within the state in which the gas is produced. Subject to regulatory oversight of the applicable state.

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**Japan Crude-Oil Cocktail (JCC):** quoted by the Japanese finance ministry, it is designed to represent the average CIF price of all imported crude oil and raw oil in a specified trading period. It is usually quoted on a monthly basis.

**Joule-Thomson (J-T) effect:** the change in temperature of a fluid that occurs when the fluid is allowed to expand in such a way that no external work is done and no heat transfer takes place. The case of most interest is cooling of a compressed gas upon J-T expansion. Note that the J-T effect is not limited to gases; also J-T expansion can, in some cases, produce an increase in temperature, rather than a decrease, although this is not frequently encountered.

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## Kilowatt (kW)

**Kilowatt (kW):** a measurement of electric power equal to 1,000 watts.

**Kilowatt year (kW-y):** a unit of electrical capacity equivalent to 1 kilowatt of power used for 8,760 hours.

**Kilowatt-hour (kWh):** the basic unit for pricing electricity, equal to 1 kW of power supplied continuously for one hour (or the amount of electricity needed to light 10 100-watt light bulbs for one hour).

**Knot:** unit of speed in navigation, which is the rate of one nautical mile (6,080 feet or 1,852 metres) per hour.

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## LNG feedgas requirements to LNG plant

**Laid-up tonnage:** ships not in active service; a ship that is out of commission for fitting out, awaiting better markets, needing work for classification. See *Layup*

**Laytime:** time allowed by the shipowner to the voyage charterer or bill of lading holder in which to load and/or discharge the cargo. It is expressed as a number of days or hours.

**Layup:** to dismantle or unrig a ship for a prolonged period of unemployment.

**Liquefaction plant:** facility which converts natural gas at ambient temperature and pressure to liquefied natural gas.

**Line pack:** creation of storage within the pipeline by increasing pressure above that which is required for transmission, but still within a safe limit.

**Liquefied natural gas (LNG):** an odourless, colourless, non-corrosive and non-toxic product of natural gas consisting primarily of methane (CH<sub>4</sub>) that is in liquid form at near atmospheric pressure.

**Liquefied petroleum gas (LPG):** gaseous hydrocarbons at normal temperatures and pressures, but that readily turn into liquids under moderate pressure at normal temperatures; for example, propane and butane.

**LNG cargo-containment systems:** the method of storing LNG during marine transport. One of four methods is normally employed: Self-Supporting Prismatic Type 'B' (Conch/IHI), Dual Membrane (Gaz Transport), Single Membrane (Technigaz), and Self-Supporting Spherical Type 'B' (Kværner Moss).

**LNG feedgas requirements to LNG plant:** The amount of gas reserves required to economically support the development

of an LNG liquefaction plant, allowing for gas lost in the process of production, liquefaction and transport of the LNG to end-markets (typically 10-15%).

**LNG markets:** there are two primary LNG markets: 1) the Atlantic basin includes Belgium, France, Italy, Spain, Portugal, Greece, Turkey and the east coast of the US; 2) the Pacific basin includes India, Japan (world's largest), South Korea, Taiwan, China and the west coast of the US.

**LNG project characteristics:** primary LNG project components are: 1) upstream development of long-term, natural gas supply for feedgas to an LNG plant; 2) downstream development of liquefaction, storage and loading facilities; 3) marine transportation; and 4) further downstream, development of receiving terminals for regasification and pipeline transportation to market. Defining economic characteristics of LNG projects include i. commercial activities organised around project components in which the buyer and seller are closely linked for 20-25 years; ii. significant front-end infrastructure investment for each tonne of LNG delivery capacity – the critical mass of infrastructure for an LNG project must be very large in order to achieve production quantities adequate for realisation of economies of scale and to secure project financing; and iii. long-term contracts based on large, proved gas reserves.

**LNG refrigerant (for liquefaction) cycles:** natural gas liquefaction requires removal of sensible and latent heat over a wide temperature range using a refrigerant. The refrigerant may be part of the natural gas feed (an open-cycle process), or a separate fluid continuously re-circulated through the liquefier (a closed-cycle process). Three general types of refrigeration cycle are used:

● **cascade refrigerant cycle:** feedstock natural gas is cooled, condensed and sub-cooled in heat exchange

with propane, ethylene (or ethane) and finally methane in three discrete stages. The three refrigerant circuits generally have multistage refrigerant expansion and compression, each typically operating at three evaporation-temperature levels. After compression, propane is condensed with cooling water or air, ethylene is condensed with evaporating propane and methane is condensed with evaporating ethylene.

● **expander cycle:** in its simplest form, process refrigeration in an expander cycle is provided by compression and expansion of a single-component gas stream. High-pressure cycle gas is cooled in counter-current heat exchange with returning cold-cycle gas. The cycle gas is expanded through an expansion turbine, reducing its temperature to a lower temperature than would be given by expansion through a Joule-Thomson valve.

● **mixed-refrigerant cycle (MRC):** uses a mixed refrigerant(s) instead of the multiple pure refrigerants in the cascade cycle. The mixture composition is specified so the liquid refrigerant evaporates over a temperature range similar to that of the natural gas being liquefied. A mixture of nitrogen and hydrocarbons (usually in the C1 to C5 range) is normally used to provide optimal refrigeration characteristics. MRC provides greater thermodynamic efficiency, lower power requirement and use of smaller machinery.

**LNG storage tanks:** vessels that are specially constructed to contain LNG. The tanks are generally constructed of nickel steel (steel containing 9% nickel) to withstand cryogenic temperatures and are insulated to maintain the LNG at  $-161^{\circ}\text{C}$ . Some of the stored LNG boils off and the resulting vapour is used as fuel gas for the plant. There are three main designs of LNG storage tanks: single containment, double containment and full containment. The difference in these systems lies in the functionality of the secondary containment, when the primary

containment is breached. For single containment, neither liquid nor vapour will be held by the secondary containment; for double containment, liquid will be contained and for full containment, liquid and vapour will be contained.

**LNG value chain:** in planning, funding and executing an LNG project, each element of the complex chain that links the natural gas in the ground to the ultimate consumer (from the wellhead to the burner tip) is considered. The main links are natural gas production, liquefaction, shipping, receiving terminal (including regasification), distribution of the regasified LNG and, lastly, consumption of the gas.

**Load balancing:** process of matching customers' demand for natural gas with producers' ability to supply.

**Loaded leg:** that portion (or subdivision) of a ship's voyage during which the ship is carrying cargo.

**Loading days:** the number of days allowed to load a cargo defined in the charter party.

**Local-distribution company (LDC):** a utility that takes natural gas from a local delivery point (generally called the city gate) and distributes it to local customers. A business entity that obtains its primary revenues from the operations of a local retail gas distribution.

**Long ton (L/T):** 2,240 pounds or 1,016.05 kilograms. See *Tonne, metric and Ton, long*

**Long-term gas contract:** a supply contract in the physical market covering natural gas deliveries.

**Looping:** laying additional pipeline beside and connected to an existing pipeline in order to increase the capacity of the system.



**Lost and unaccounted-for gas:** the difference between the quantity of natural gas received into a system and the quantity of natural gas delivered out of a system over a specific period of time.

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## Major interstate pipeline

**Major interstate pipeline:** in the US, a pipeline company whose combined sales for resale and gas system throughput, transported interstate or stored for a fee, exceeded 50 bcf in the previous year.

**Manifest:** document containing a full statement of the ship's cargo, extracted from the bill of lading.

**Manning scales:** the minimum number of officers and crew members that can be engaged on a ship to be considered as sufficient hands with practical ability to meet every possible eventuality at sea.

**Manufactured gas:** gas produced by certain processes from oil, coal or coke.

**Market centre:** an interchange where multiple pipelines or electric transmission lines interconnect and form a hub. See *Hub*.

**Market clearing price:** the price at which supply equals demand.

**Market-area storage:** storage or hub facilities located near natural gas users (markets).

**Market-based price:** the price for natural gas as determined by the decisions of many buyers and sellers in a market.

**Marketing affiliate:** a marketer who is owned or controlled by a pipeline company. See *FERC Order 497*.

**Master (Captain):** highest officer aboard ship who oversees all ship operations; has general charge of the vessel, overall responsibility. Handles all ship's records and communications, and receives and implements instructions from home office; takes command of vessel in inclement weather and in crowded or narrow waters. See *Crew*

**Maximum allowable operating pressure (MAOP):** the maximum gas pressure at which a pipeline system or process facility is allowed to operate.

**Maximum capacity of pipeline:** the maximum amount of natural gas a segment of pipeline can contain at a given time.

**Maximum daily quantity (MDQ):** the maximum daily quantity of natural gas that can be nominated for delivery to a customer's premises.

**Maximum demand:** the greatest of all demands of the load that has occurred within a specified period of time.

**mmBtu:** one million British thermal units.

**mcf, MCF, Mcf:** a measurement of volume denoting one thousand cubic feet of natural gas. 1,000 cf of gas = 1.03 mmBtu (also, 1 kWh = 3,412 Btu). See *note under cubic foot for alternative terminology*

**Megajoule (MJ or MMJ):** equivalent to one million joules, or 3.6 MJ = 1kWh.

**Megawatt (MW):** a unit of electricity equal to 1m watts, or 1,000 kilowatts.

**Meter:** a mechanical device for automatically measuring and recording quantities of gas.

**Methane (CH<sub>4</sub>):** the simplest hydrocarbon and the main constituent of natural gas, it is also known as C1 in the carbon complexity chain. See *Natural gas*

**Mid-term gas contract:** a supply contract in the physical market covering gas deliveries up to 18 months, although most mid-

term contracts are for one year or less. These contracts can be characterized by 1) variable prices, where the cost of the commodity is indexed over time to the futures price of some published spot price; 2) fixed reservation fee and service fee; and 3) mainly fixed volumes per day or per month with modest variation. These contracts are of long enough term to hedge price risk with financial instruments. These contracts are important for local distribution companies (LDCs) because they can extend over a heating season. See *Physical gas contract*

**mol%:** the molar composition of a sample of natural gas expressed as a percentage of the whole.

**Most-favoured nation clause:** a contract clause that recognises a status accorded by one nation to another in international trade. Typically this means that the receiving nation will be granted all trade advantages, such as low tariffs, that any other nation receives. They will, therefore, always be treated at least as well as other nations.

**mmt/y, Mtpa:** million tonnes a year/per annum.

**Multilateral institutions:** a major source of LNG financing for developing countries; includes Asian Development Bank (ADB), European Bank for Reconstruction and Development (EBRD), International Bank for Reconstruction and Development (IBRD) and the International Finance Corporation (IFC). See *Export-credit agencies (ECAs)*

**Must-take gas:** natural gas supplies committed to a purchaser under terms such as drainage protection or reservoir protection clauses or other provisions that absolutely obligate a purchaser to take natural gas from a supplier.

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**National Balancing Point (NBP):** a notional point on the UK Transco pipeline through which all gas is deemed to flow.

**National Energy Board:** Canadian regulatory body that oversees inter-provincial gas trade and pipelines. Located in Alberta.

**Native gas:** natural gas in place in a producing reservoir when the reservoir is converted into a gas-storage reservoir.

**Natural gas (natgas):** a naturally occurring mixture of hydrocarbon compounds and small quantities of various non-hydrocarbons existing in the gaseous phase or in solution with crude oil in natural underground reservoirs at reservoir conditions. The principal hydrocarbons usually contained in the mixture are methane, ethane, propane, butanes, and pentanes. Typical non-hydrocarbon bases that may be present in reservoir natural gas are carbon dioxide, helium, hydrogen sulphide, and nitrogen. Under reservoir conditions, natural gas and the liquefiable portions thereof occur either in a single gaseous phase in the reservoir or in solution with crude oil and are not distinguishable at that time as separate substances. The principal constituent is methane (CH<sub>4</sub>) and is the simplest of hydrocarbons.

**Natural-gas heating value:** the amount of thermal energy released by the complete combustion of 1 cf of natural gas. Higher Heating Value (HHV) or Gross Heating Value (GHV) assumes that the water vapour produced in the combustion process is condensed to liquid. Net Heating Value (NHV) assumes the vapour produced in the combustion process stays in the gaseous phase.

**Natural gas liquids (NGLs):** liquid hydrocarbons, such as ethane, propane, butane, pentane and natural gasoline, extracted from field gas.

**Natural-gas processing:** 1) the purification of field gas at gas-processing plants (or gas plants), or the fractionation of mixed natural gas liquids (NGLs) to natural gas products to meet specifications for use as pipeline quality gas. Gas processing includes removing liquids, solids, and vapours, absorbing impurities and odourising; 2) the process of separating NGLs by absorption, adsorption, refrigeration or cryogenics from a stream of natural gas.

**Natural-gas producer:** a natural gas producer is generally involved in exploration, drilling and refinement of natural gas.

**Natural-gas resource base:** an estimate of the amount of natural gas available, based on the combination of reserves, contingent resources and prospective resources. Reserves may include proved, probable and possible commercial reserves. Contingent resources include recoverable quantities from known accumulations that are not commercial. Prospective resources are those quantities of petroleum that are estimated to be recoverable from undiscovered accumulations.

**Natural-gas storage:** a means of providing a reserve of natural gas supplies to meet the seasonal demands of natural gas customers.

**Natural-gas transportation system:** the pipeline transportation system used to accept and transport natural gas.

**Net capacity (shipping):** the number of tonnes of cargo that a vessel can carry when loaded in salt water to her summer freeboard marks. Also called cargo-carrying capacity, cargo deadweight and useful deadweight.

**Net gas:** total produced natural gas times net working interest in natural gas production.

**Net tonnage:** the carrying capacity of vessels as prescribed by government regulations and determined by measuring the cubic contents of the space intended for revenue earning.

**Netback price:** the effective price to the producer of natural gas at a defined point, based on the market price for the natural gas less the charges for delivering the natural gas from the defined point to market.

**Nomination:** an order slip to an interstate pipeline, stating the volume of gas a supplier seeks to transport over a fixed period of time. Most nominations are now submitted electronically through pipeline EBB/Internet websites.

**Non-associated gas:** free natural gas not in contact with, or dissolved in, crude oil in the reservoir. LNG projects require large, proved reserves of non-associated gas to insure supply over long contract terms.

**Non-firm purchase:** purchase of a commodity such as natural gas on an as-available basis.

**No-notice service:** a pipeline delivery service that allows customers to receive gas on demand without making prior nominations to meet peak service needs and without paying daily balancing and scheduling penalties.

**Non-performance:** a contractual breach.

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**Odourising:** a process whereby an additive is injected to natural gas to provide a readily perceptible odour at a very low concentration in air as a warning indication of the presence of natural gas. Also called stenching.

**Offload (shipping):** discharge of cargo from a ship.

**Off-peak gas:** natural gas supplied during periods of relatively low system demands.

**Off-system supply:** natural gas supply purchased from an entity other than the delivering pipeline or local distribution company.

**Offtake point:** the point in a natural gas distribution system where natural gas is taken by supply pipe to a major customer.

**Ofgem:** UK regulatory body that oversees electricity and gas trade, pipelines and the power grid. Located in London. Combines the former Offer and Ofgas regulators.

**Oil equivalent gas (OEG):** See *Barrel of oil equivalent (boe)*

**Open-access transportation:** natural gas transportation service available to all shippers. Subject to capacity availability, in a manner that is not unduly discriminatory.

**Operating lease:** an agreement whereby the lessor conveys the right to use an asset for an agreed period of time to the lessee (in return for a payment or series of payments).

**Operational balancing agreements (OBAs):** agreements between pipelines and parties at delivery or receipt points, whereby the parties agree to specified procedures for balancing discrepancies between the nominated levels of service and the actual quantities.



**Operational-flow orders (OFOs):** orders that are issued by a pipeline to protect the operational integrity of the line.

**Outer continental shelf (OCS):** that portion of a continental land mass that constitutes the slope down to the ocean floor. The outer continental shelves are heavily sedimented and are believed to contain a large portion of the earth's undiscovered gas.

**Own-use exemption:** the exemption to applying fair-value accounting, under International Financial Reporting Standards, to contracts that were entered into and continue to be held for the purpose of the receipt or delivery of a non-financial item in accordance with the entity's expected purchase, sale or usage requirements.

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## P&I (shipping)

**P&I (shipping):** protection and indemnity insurance.

**Peak-day send-out:** the largest volume of natural gas delivered on any one day during the year.

**Peak-shaving (or peak-lopping):** the process of drawing gas during peak-use periods from storage or peak-load plants to supplement the normal amounts delivered to customers.

**Petrochemicals feedstock:** feedstock derived from petroleum, used to manufacture chemicals, synthetic rubber, and plastics.

**Physical contract:** a natural gas contract where delivery and receipt are expected.

**Pipeline constrained:** a condition in which the capacity of gas pipelines is less than the demand for throughput.

**Pipeline interconnection:** a point at which facilities of two or more pipelines interconnect.

**Pipeline-quality natural gas:** natural gas that meets the specifications of a pipeline.

**Pipeline:** a tube for the transportation of crude oil or natural gas between two points, either offshore or onshore.

**Postage-stamp rate:** transportation rate for a given area (can be a large part of a pipeline's system) that does not vary according to distance from the source of supply. Typically, postage stamps for letters are at a fixed price, regardless of destination.

**Pounds per square inch absolute (psia):** the total pressure in a system including atmospheric pressure.

**Pounds per square inch gauge (psig):** the pressure

measured by a pressure gauge. The following formula is used to convert gauge pressure to absolute pressure:  
 $P(\text{psia}) = P(\text{psig}) + \text{atmospheric pressure.}$

**Price indexation:** a practice whereby a contract price is linked to another, generally more liquid or less complex product price or economic indicator. This allows the resulting price to vary in accordance with another factor. Gas contract prices are often linked to major crude oil indices, derivative prices, such as certain fuel oil prices, or, less frequently, energy or economic growth indicators, such as a country's GDP.

**Production costs (lifting costs):** costs incurred to operate and maintain oil or gas wells and related equipment and facilities, including depreciation and applicable operating costs of support equipment and facilities and other costs of operating and maintaining those wells and related equipment and facilities. They become part of the cost of oil and gas produced.

**Production-sharing contract (PSC):** contract between a government and a company, granting the company a contractual right to explore and produce hydrocarbons in a specified area in enabling the company to recover its costs and a certain profit.

**Project financing:** most commonly used method to finance construction of industrial infrastructure, because of the non-recourse (to project sponsors) nature of the debt financing supporting the project. Typically, the developer pledges the value of the plant and part or all of its expected revenues as collateral to secure financing from private lenders. In the event of financial distress, the debt holders have recourse only to the project assets in place at that time.

**Project-financed pipeline:** pipeline funded by pledging only cash flow generated by the pipeline expected revenues to cover the principal and interest on the debt.

**Ratio of specific heats:** for gases, it is the ratio of the specific heat at constant pressure to the specific heat at constant volume. The ratio is important in thermodynamic equations, such as compressor horsepower calculations, and is given the symbol  $k$  where  $k = C_p/C_v$ . The ratio  $k$  lies between 1.2 and 1.4 for most gases.

**Real specific gravity:** the density ratio between a gas and air determined by measurement at the same temperature and pressure.

**REC (regional electricity company):** term used in the UK to describe electricity-distribution companies.

**Recoverable gas reserves:** the quantity of natural gas determined to be economically recoverable from a reservoir or reservoirs over a specific period of time.

**Regasification plant:** a plant that accepts deliveries of liquefied natural gas and vapourises it back to its gaseous form by applying heat so that the gas can be delivered into a pipeline system.

**Regulation:** the governmental function of controlling or directing economic entities through the process of rulemaking and adjudication; a rule or law established by the federal or state government that sets procedures.

**Regulatory out clause:** a contractual provision whereby a party is excused from performance because of the actions of a jurisdictional regulatory agency.

**Reliability:** a measure, expressed as a percentage, of the time (excluding routine maintenance time) a facility (for example, process plant, pipeline, transmission line or generating unit) is capable of providing service.

**Remote gas:** natural gas in fields where infrastructure for transportation of gas is some distance away, making production of the gas field more complex. See *Stranded gas*

**Reserves to production ratio (R/P):** an estimate used to project the productive life of an oil or gas field (or company) based upon the size of the field compared with the annual production capacity.

**Residue gas:** that portion of the natural gas stream that remains after the extraction of ethane and heavier liquids and liquefiable hydrocarbons, and impurities during processing, minus fuel, incidental losses, by-passed natural gas and natural gas reserved by a seller under a gas purchase agreement.

**Right of first refusal:** process that allows any long-term firm gas-transportation customer, including formerly bundled city-gate sales customers, to continue receiving firm gas-transportation service by paying up to the maximum rate and matching the length of a term offered by another customer who is seeking service.

**Rollover clause:** a contract clause that permits a contract to extend beyond the initial term.

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**Sale for resale:** a sale of natural gas to a customer who will in turn sell that gas to someone else.

**Sales and purchase agreement (SPA):** a definitive contract between a seller and buyer for the sale and purchase of a quantity of natural gas or LNG for delivery during a specified period at a specified price. See *Annual delivery programme (ADP)* and *Heads of agreement (HOA)*.

**Sales gas:** natural gas treated and conditioned to meet gas purchaser specifications.

**SCADA system (supervisory control and data acquisition):** a computerised automation system that brings together the following technologies: telemetry, telecontrol, supervisory control, and data acquisition, analysis and presentation. When a SCADA system is employed in an LNG process plant or pipeline, information from remote data gathering devices is made available to a central location. Moreover, information gathered can be used by a human operator as the basis for issuing commands to the remote locations.

**Scheduling:** process by which nominations are first consolidated by receipt point and by contract, and verified with upstream and downstream parties. If the verified capacity is greater than or equal to the total nominated quantities, all nominated quantities are scheduled. If verified capacity is less than nominated quantities, nominated quantities will be allocated according to scheduling priorities.

**Seaworthiness:** statement on the condition of the vessel for the trade or service in which it is employed.

**Seaworthiness certificate:** certificate issued by a classification society surveyor to allow a vessel to proceed after she has

met with a mishap that may have affected her seaworthiness. It is frequently issued to enable a vessel to proceed, after temporary repairs have been effected, to another port where permanent repairs are then carried out.

**Second mate:** ship's navigation officer; keeps charts (maps) up to date and monitors navigation equipment on bridge. See *Crew*

**Secondary market:** in the gas industry, this is the market for re-selling unneeded pipeline-transportation capacity.

**Send-out capacity:** the volume of natural gas that can be converted by a liquefaction facility and subsequently shipped over a specified period of time.

**Separator:** a vessel used to separate a multiphase mixture of fluids into its separate phases, for example, vapour, oil, water, solids.

**Ship-or-pay clause:** contract clause requiring payment for the transportation of the natural gas even in case the natural gas is not transported.

**Ship's agent:** person or firm that transacts all business in a port on behalf of shipowners or charterers. Also called shipping agent or agent.

**Shipper:** any gas-market participant that holds a contract to transport gas on a pipeline or local distribution company.

**Short-term supplies:** natural gas purchases usually involving 30-day, short-term contract or spot gas.

**Shrinkage:** the reduction in volume of wet natural gas caused by the removal of natural gas liquids, hydrogen sulphide, carbon dioxide, water vapour and other impurities from the gas.

**Sour gas:** natural gas that contains significant amounts of hydrogen sulphide (usually greater than 16 ppm) and possibly other objectionable sulphur compounds (mercaptans, carbonyl sulphide). Also called acid gas.

**Specific gravity:** the ratio of the density of a substance to the density of a reference substance, both at specified physical conditions. As applied to gas, air is the reference substance and the physical conditions are a specified temperature and atmospheric pressure.

**Spot gas:** natural gas that is available and purchased on a short-term basis and is furnished to customers on an as-available basis.

**Spot gas market:** short-term buying and selling of natural gas.

**Spot voyage:** a charter for a particular vessel to move a single cargo between specified loading port(s) and discharge port(s) in the immediate future.

**Standard metering:** base standard conditions, plus agreed corrections, to which all natural gas volumes are corrected for purposes of comparison and payment.

**Storage:** a means of maintaining a reserve of natural gas supplies to meet seasonal demands.

**Straddle plant:** a gas-processing plant constructed near a transmission pipeline downstream from the fields where the natural gas in the pipeline has been produced.

**Stranded gas:** gasfield located in area where there are no transportation services or markets within any economically reasonable distance. See *Remote gas*



**Supplier:** a party that sells a commodity (for example, natural gas).

**Suspended gas discovery:** a gasfield identified by a discovery well, but not being produced or developed.

**Sweet gas:** natural gas that contains such small amounts of hydrogen sulphide (and other sulphur compounds) and carbon dioxide that it can be transported or used without purifying, with no deleterious effect on piping and equipment.

**Swing gas:** natural gas bought on short notice to meet unexpected daily demands not covered under long-term contracts.

**Synthetic natural gas (SNG):** methane obtained from sources other than naturally occurring reservoirs of natural gas, such as by crushing and gasifying coal at high temperature, refining heavier hydrocarbons, or processing rubbish or other organic materials. Gases other than natural gas or liquid or solid hydrocarbons converted to a gaseous fuel of heat content, compatibility and quality equivalent in performance to that of natural gas.

**System capacity:** the physical limitation of a gas pipeline or storage system to flow gas to end-users. Also called normal system capacity.

**System supply:** natural gas supplies purchased, owned and sold by the supplier.

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**Tail gas:** the exhaust gas from any processing unit that is at a low pressure and is usually vented, treated for contaminant removal or combusted.

**Take-or-pay (TOP) clause:** contract clause in a sales and purchase agreement (SPA) requiring a minimum quantity of natural gas to be paid for, whether or not delivery is accepted by the purchaser.

**Taps:** Trans-Alaska Pipeline System, the line from Prudhoe Bay, on the North Slope, to the terminal port of Valdez, on the south coast of Alaska.

**Tariff gas:** additional natural gas sold to a customer if the total amount of natural gas needed exceeds their original estimate.

**tcf (trillion cubic feet):** volume measurement of natural gas approximately equivalent to one Quad. See *Btu*, *bcf*, and *mcf*

**Therm:** a unit of heating value equal to 100,000 Btu, in common use in the UK; about 56 therms are derived by setting fire to a barrel of crude oil; one therm has around the same heat content as 100 cf of natural gas.

**Third-party access (TPA):** obliges companies operating gas-transmission or -distribution networks to offer terms for the carriage of gas on their systems by other gas distribution companies or particular customers, subject to capacity availability. See *Open access*

**Throughput (pipeline):** the volume of gas flowing (or transported) through a pipeline.

**Throughput (processing):** average amount of raw material that is processed in a given period by a facility, such as a natural gas processing plant, a crude oil refinery or a

petrochemicals facility.

**Time charter:** a form of charter party issued when an LNG vessel is chartered for an agreed period of time. A time charter party is the contract between owner and charterer, and identifies the salient characteristics of the ship and the obligations of the shipowner; specifically the shipowner provides a ship capable of the specified performance and operates the ship according to that performance standard set by the charterer. The charterer pays the owner for the hire of the vessel at an agreed rate.

**Tolling agreement:** an agreement whereby one party owns (and bears the risks on) the inputs to and outputs from a process, as well as the rights to a portion of the process capacity (the tollee). Another party agrees to operate the process or facility and charges a tolling fee per unit of input that is transformed, or per unit of capacity to which rights are granted (the toller). Under an LNG liquefaction tolling agreement, one company sends a volume of feed gas to a liquefaction facility, wherein the gas is liquefied in return for a pre-established tolling charge.

**Tonne mile:** a measurement used in the economics of transportation to designate 1 tonne being moved 1 mile; useful to the shipper because it includes the distance to move a commodity in the calculation.

**Ton, long (LT):** a long ton is 2,240 pounds. Typically used as the unit measure for sulphur sales.

**Ton, short (ST):** a short ton is 2,000 pounds.

**Tonnage:** a shipping term referring to the total number of tonnes registered or carried or the ship's carrying capacity.

**Tonne, metric:** a metric tonne equals 1,000 kilograms or 2,204.6 pounds. The capacity of an LNG baseload plant is typically expressed in tonnes and the unit capital costs for producing LNG are expressed as \$/tonne.

**Trader:** gas merchant who purchases natural gas from a producer, supplier or another trader and resells it to a pipeline, utility or end-user, usually taking title and assisting in arranging transportation. See *marketer*

**Train (liquefaction):** an independent unit for gas liquefaction. An LNG plant may comprise one or more trains.

**Transfer pricing:** a transfer price is the amount of money that one unit of an organisation charges for goods and services to another unit of an organisation. Perhaps the most important aspect in this area is the Arm's Length Principle regularly challenged by fiscal authorities, a common principle in International Accounting Standards to see that a transfer price has been calculated and agreed according to normal, fair, equitable, business principles.

**Transmission:** the transport of large quantities of natural gas at high pressures, often through national or regional transmission systems.

**Transmission company:** company that obtains the major portion of its operating revenues from the operation of a natural gas transmission system and/or from mainline sales to industrial customers.

**Transmission line:** pipeline transporting natural gas from principal supply areas to distribution centres, large-volume customers or other transmission lines.

**Transportation:** the movement of natural gas for third parties

through pipeline facilities for a fee.

**Transportation contract:** contract setting forth the terms and conditions applicable to natural gas or electricity transportation services.

**Transporter:** pipeline company that transports natural gas for a shipper.

**Transport-or-pay contract:** a contract between a natural gas producer and a pipeline company that requires the pipeline company to pay for a set amount of natural gas whether or not the buyer takes delivery of the full amount.

**Treating plant:** facility that treats raw natural gas to remove undesirable impurities such as carbon dioxide, hydrogen sulphide and water vapour.

**Turnaround:** a period of brisk activity at a plant or receiving terminal when processing units, or portions of them, are shut down either for scheduled maintenance or for the installation of new equipment and systems.

**Turnback of capacity:** a situation that occurs when shipper contracts expire, without renewal or re-contracting. Shippers turn back all or part of their firm contracted capacity to the pipeline company.

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**Ultimate customer:** customer that purchases energy for consumption and not for resale. See *End-user*

**Unconventional gas:** natural gas that cannot be produced using existing technologies.

**USAC:** tanker market term for US Atlantic coast.

**USG:** tanker market term for US Gulf, more properly known as the Gulf of Mexico.

**Utilisation factor:** a ratio of the maximum demand of a system or part of a system to its rated capacity.

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**Vapour displacement:** release of vapours that had previously occupied space above liquid fuels stored in tanks. These releases occur when tanks are emptied and filled.

**Vapour pressure:** the pressure exerted by a vapour that is in equilibrium with a liquid.

**Variable price:** a contracted price that can change by the hour, day, month, etc.

**Volume flexibility:** provides a contractual option to buy or sell a non-financial item in a purchase and sales contract that can be settled net in cash or through another financial instrument. Such a contract, under International Financial Reporting Standards, can generally not apply the own use exemption to applying fair-value accounting to contracts. See *Own use exemption*.

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**Wellhead:** the equipment installed at the surface of the wellbore. A wellhead includes such equipment as the casinghead, tubing hanger, and various valves to control flow from the well.

**Wet gas:** a gas containing condensable hydrocarbons or other liquids. The term is subject to varying legal definitions as specified by applicable statutes. Natural gasoline, butane, pentane and other light hydrocarbons can be removed by chilling and pressure or extraction. Usually maximum allowable is 7 pounds/mmcf for water content and 0.02 gallons/mmcf for natural gasoline. Also known as associated gas.

**Wobbe Index:** it represents a measure of the heat released when a gas is burned at a constant pressure, and is defined as the gross calorific value divided by the square root of the density of the gas relative to the density of air.

**Working gas:** volume of natural gas expected to be cycled from a gas-storage facility.

**World-scale rates:** a schedule of nominal freight rates against which tanker rates for all voyages, at all market levels, can be compared and readily judged.

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# Fast-paced Growth in LNG: How PwC can help you

LNG is one of the fastest growing energy markets worldwide. Given the number of new LNG projects proposed or under construction, global production capacity could more than double by the end of the decade. According to the International Energy Agency, such fast growth will require \$250 billion to be invested in liquefaction plants, coastal regasification import terminals, and special LNG tankers over the next 30 years.

The players in the LNG market include integrated oil and gas companies, national oil companies and governments, independent upstream players, utilities, infrastructure and transportation companies, and private investors. The upstream and downstream players hail from all corners of the globe – Americas, Africa, Europe, Middle East and Asia Pacific. Although the economics of widespread use of LNG are becoming more attractive, there still remain a number of issues that need to be addressed to bring on many of the planned projects.

PricewaterhouseCoopers has been working with clients who are deeply involved in the LNG market across the globe and are at the leading edge of developments. We have worked with these clients across all stages of LNG projects:

## Market analysis and strategic options

- LNG capacity and phasing decisions
- Which markets should be served?
- Assessment of market trends and drivers
- Pipeline versus LNG supply analysis
- LNG Workshops

## Economic and commercial assessments of LNG projects

- Commercial feasibility analysis
- Netback calculations for entire value chain
- Which project will increase shareholder value the most?
- Return and risk assessment
- Risk mitigation
- Tariff calculation/setting along the value chain
- International tax and tax structuring

## Project development and structuring

- Partnering along the value chain
- Commercial principles and Heads of Terms
- Development of a suitable project structure
- Financial structuring
- Finance raising
- Refinancing procurement tenders
- Selection of EPC contractors

# How will we fuel the future?\*



As a leading service provider to the energy, utilities and mining sectors, PricewaterhouseCoopers helps clients with the business of fuels and resources. Whether companies are expanding into new markets and technologies or contemplating capital investments in plants and equipment, clients around the world count on our insight and experience.

To learn more, visit us at [www.pwc.com/energy](http://www.pwc.com/energy) and [www.pwc.com/utilities](http://www.pwc.com/utilities).

\*connectedthinking

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Spine text. The magenta keyline indicates a spine width of 6mm. Text should sit vertically centred within the spine so please adjust accordingly.