Higher efficiency – lower emissions: E-LNG

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Boil-off gas for LNG production plants and receiving terminals

Plant efficiency is the key objective for Siemens’ market leading boil-off gas (BOG) compression solutions. During storage, a portion of liquefied gas vaporizes, and our BOG technology feeds it back into the cooling cycle or burns it as fuel to power the gas turbines for increased efficiency.

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World’s first GT-driven cryogenic-temperature boil-off gas turbo compressor

Siemens Energy has won a contract to supply turbo compressors and mechanical-drive gas turbines to a major LNG project in Malaysia. The project will help improve overall plant efficiency and minimize gas flaring at the Petronas Bintulu LNG Plant in Sarawak, East Malaysia.

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Gas is fueling the world economy and its importance will continue to rise, using gas from both conventional and unconventional sources. The market for liquefied natural gas (LNG) will continue its dynamic growth in the coming years. Today, already one quarter of internationally traded natural gas is LNG, and this trend is forecast to continue rising.

To make LNG even more attractive, improvements in reliability, efficiency, and environmental impact of the entire LNG process chain are required to allow cost-effective use of this resource. As a leading technology supplier, Siemens is at the forefront of this development. Especially in the area of natural gas liquefaction, we see considerable room for improvement in overall efficiency. Our components equip all kinds of concepts: All-Electric LNG, Mechanical drive LNG, Floating LNG, Receiving Terminals and small and midsized LNG facilities. All-Electric LNG refers to the electric motor drives for the liquefaction train. They make it possible to lower operating and maintenance costs while providing higher availability, outstanding energy efficiency, with minimal environmental impact. With our modular LNG solutions, we offer cost-effective systems for small and mid-sized plants. Backed by global engineering and project management expertise as well as extensive experience in the implementation of complex projects, we offer comprehensive solutions for the entire natural gas value chain, from the wellhead through to boil-off-gas compression solutions.

With decades of experience in the oil and gas industry, we are among the world leaders when it comes to power plants, mechanical drives, electric motors and compressors as well as solutions for high-efficiency energy distribution. You can rely on our services and performance in all project phases, including project execution based on our own products, interface management, and long-term servicing of your LNG plant.
Higher availability – lower emissions: E-LNG

In the past few decades a large number of plants have been erected worldwide using classic compressor technology driven by directly-coupled heavy duty gas turbines. This approach limits LNG production due to maintenance requirements of the gas turbines and the lack of spinning redundancy. An improved concept offering higher productivity is based on large fully electrical compressor trains which allow process control with reduced energy consumption: All Electric LNG. The corresponding reduced maintenance improves the LNG plant availability significantly.

Power Generation efficiency can be increased using gas turbines in combined cycle. As well as the electrical demand the LNG process requires large amounts of process steam which a gas turbine power plant can also supply. LNG plants very often have no grid connection, i.e. the LNG plant must be supplied under island conditions, so a reliable and efficient power plant is essential.

E-LNG plants powered by Siemens consist of the most reliable components for compressors and drive strings available on the market today, and need a reliable and efficient power plant. Efficient and environmentally sound power generation is the basis for E-LNG success. To manage the large amounts of electric power required by the refrigeration-compressor drivers and short-circuit currents in the electrical system, E-LNG plants require state-of-the-art high-voltage transmission systems.

For this reason, the high-voltage power transmission and distribution system forms an integral part of Siemens’ all-electric LNG concept and its electrical distribution system. It is fully protected with microprocessor-based relays and centrally controlled and monitored by its superimposed electrical network monitoring and control (ENMC) system, which provides maintenance-free operation for over 10 years.

All-electric LNG opens up new possibilities for controlling the entire liquefaction process. Thanks to the variable speed electric drive, the capacity of the compression and refrigeration train no longer depends on the size of the gas turbines. Whenever a change in capacity is required – for example, to meet the growing demands of the LNG spot market – the variable-speed drive can be fine-tuned to meet individual process requirements provide extra flexibility. Because the commercially available gas turbines are only available with incremental capacities, a conventional LNG gas turbine solution would create extra costs in comparison.

In addition, Siemens compressors with adjustable inlet guide vanes (IGV) have earned a reputation for excellence, beginning with their position of global market leader for boil-off gas compression.

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Mid-size LNG plants perfectly answer the demands of the LNG spot market, giving new players the opportunity to take the stage. For Siemens, mid-size LNG isn’t simply LNG tonnage reduced to a smaller scale: Mid-size LNG uses unique business and engineering solutions to become successful and to deliver on the potential rewards. It offers lower CAPEX as well as higher return-on-investment in certain situations compared to traditional LNG plants.

To achieve this, Siemens offers a modular concept with pre-engineered, proven, and fully-tested solution packages for power supply and plant control, as well as a basic design integrating four trains to enable the highest availability and flexibility.

FLNG – systems for modern floating plants

While the consumption of natural gas steadily rises, a growing number of deep-sea and stranded gas reservoirs at sea will be exploited. As a result, the offshore processing of natural gas for transportation will become increasingly attractive as the more economical reservoirs dry out. The FLNG concept involves implementing the entire LNG process chain on a vessel, along with storage tanks. The floating plant can be moored to an oil rig, process the gas produced by the well, and store it for dispatch by scheduled LNG tankers.

To keep safety high and operating and maintenance costs low, special requirements for these offshore installations must be met. Robustness is key, as well as space-saving designs for all equipment. The drive system can be all-electric or operate using gas or steam turbines.

Components for world’s first FLNG vessel Prelude
Siemens has been awarded contracts to supply a variety of components for the world’s first floating liquefied natural gas (FLNG) facility. This includes a compact compressor solution, water treatment solution, medium-voltage switchgear, transformers, and an integrated control system for the on-board power supply. The FLNG platform will incorporate a Siemens electrochlorination system to treat 1,650 million liters per day (438 MGD), and will be the largest offshore unit ever sold by Siemens. The electrochlorination system produces sodium hypochlorite on-site via the electrolysis of seawater, which is then used to disinfect the water circuit and prevent marine and biological fouling within the circuit.
Plant efficiency is the key objective for Siemens’ market-leading boil-off gas (BOG) compression solutions. During storage, a portion the liquefied gas vaporizes, and our BOG technology feeds it back into the cooling cycle or burns it as fuel to power the gas turbines for increased efficiency. More than one hundred machines using Siemens BOG recovery technology have been supplied to LNG production plants and receiving terminals worldwide.

**BOG and end flash gas compression stages in a single compressor train**

In conventional LNG plants on land, end flash gas and boil off gas is fed back into the process or to a fuel-gas supply pipeline from a separate end flash gas compressor and a separate BOG compressor train. Siemens has developed an optimized solution for LNG vessels that involves merging both the BOG and end flash gas compression stages in a single compressor train. The captured gas is fed from only one compressor train to be used as fuel for on-board power generation and process steam production. The train with two compressor process stages is driven directly by a Siemens SST-600 steam turbine. Thanks to the combination of two originally separate compressors into a single-casing compressor solution with two process stages, the compressor train’s space requirement and weight are considerably reduced. Because there are large variations in the amount of BOG and end flash gas in daily operations, and their volume will also fluctuate significantly over the life of the natural gas field, the flexibility and availability of the compressor train is of considerable importance. The required flexibility is achieved through the combination of speed control of the steam turbine and the variable-inlet guide vanes (IGV) on the compressor.

There are certain points within the liquefaction and loading process at which the liquefied natural gas reverts to the gaseous phase. One of these is at the end of the chilling process where the gas, which is still at high pressure (between 39 and 42 bar), is decreased to atmospheric pressure. In the process, about ten percent of the already liquefied natural gas returns to the gaseous state. This gas which is called “flash gas” is fed to the end flash gas compressor for further use. In addition, a certain proportion of the liquefied natural gas evaporates while being pumped into the LNG storage tanks as well as during loading onto LNG vessels as a result of unavoidable heat input. This is known as the boil-off gas (BOG). In conventional LNG plants on land, each of these two natural gas streams is fed to the process or to a fuel gas supply pipeline from a separate end flash gas compressor and a separate BOG compressor train.«
World’s first GT-driven cryogenic-temperature boil-off gas turbocompressor

Siemens Energy has won a contract to supply turbo compressors and mechanical-drive gas turbines to a major LNG project in Malaysia. The project will help improve overall plant efficiency and minimize gas flaring at the Petronas Bintulu LNG Plant in Sarawak, East Malaysia.

The goal of this project is to re-liquefy excessive BOG evaporating out of the LNG storage tanks, which is currently flared. It will deploy the world’s first gas turbine-driven cryogenic-temperature BOG turbo compressor from Siemens. Instead of being flared, the boil-off gas will be re-liquefied, converted into LNG, and routed back to the LNG storage tanks. The project benefits are immense, because it will not only increase the LNG production rate and improve plant efficiency but also significantly minimize greenhouse gas emissions.

The LNG project in Sarawak is being implemented by MLNG (Malaysia LNG), a subsidiary of Petronas. Engineering, procurement, and construction management (EPC) is contracted to Munich-based LINDE Engineering. These companies are pioneering world-scale BOG re-liquefaction in LNG plants and are implementing Siemens technology to improve plant efficiency and achieve international emission standards.

The scope of supply covers the engineering, manufacturing, and testing of a tandem-casing, cryogenic-temperature BOG turbo compressor and a single-casing LNG-refrigerant turbo compressor. Both compressors will be directly driven by Siemens SGT-700 mechanical-drive gas turbines. Project completion is expected in April 2014, and the plant will begin operation in October 2014.

The compressor is equipped with variable inlet guide vane (IGV) control technology, which provides maximum flexibility capable of handling the BOG volume fluctuation range. Load balancing between BOG compressor and LNG mixed refrigerant compressor permits the utilization of identical mechanical-drive gas turbines. The Siemens SGT-700 gas turbine burns natural gas with up to 40 percent N₂ (nitrogen) content, while still minimizing atmospheric emissions through the use of a Dry Low Emissions combustion system. Furthermore, the Siemens solution reduces the installation space of the rotating equipment significantly.

SGT-750: High efficiency – low maintenance

The SGT-750 sets the standard in efficiency for industrial gas turbines in this power range. By achieving 38.7 percent efficiency in power generation applications and a full 40 percent in mechanical-drive applications, the SGT-750 helps you cut fuel consumption to even lower levels, still keeping – and improving – all the benefits of a robust, easy-to-service industrial design.

When put to work in either simple-cycle or combined cycle power generation plants, the SGT-750 demonstrates its remarkable flexibility. Its fast start-up and cycling capability both support intermediate to continuous operation with improved turndown capability, high efficiency, and low emission levels. With just 17 scheduled maintenance days in 17 years, you can trust our SGT-750 to deliver profitable results, day in and day out.
Technologies for your LNG success

With a unique range of products and solutions, decades of experience, and thousands of installations worldwide, Siemens is one of the most important technology partners for the oil and gas industry. We stand for reliable, innovative, efficient, and environment-friendly products, systems, and solutions throughout the entire value-adding process for oil and gas. Our foremost goal is always the lasting success of our customers.

Our leading technological expertise in electrical engineering, power generation, transmission, and distribution, rotating equipment, automation, water treatment, and our own product development and production facilities provide a solid foundation for our wide range of high-performance products. Backed by global engineering and project management expertise as well as extensive experience in the implementation of complex projects, we offer comprehensive solutions for the entire lifecycle of your investment. These include everything from studies and front-end engineering design to construction, installation, and commissioning of our technology, as well as comprehensive after-sales service.

Our early involvement in the concept phase results in the best possible technical solutions, thereby limiting project risks. Packages for entire functionalities reduce interface conflicts to help reduce a plant’s CAPEX and OPEX.

Leading solutions for centralized and decentralized power – onshore and offshore

Siemens draws on a wealth of knowledge and experience in utility and industrial power generation, resulting in dependable, economical, and eco-friendly solutions for any stage, process, and application in the oil and gas industry – and for supplying private households and other industries, too.

Prompted by the surging power demand from oil and gas facilities, reliable power generation, fuel flexibility, modular designs, service-friendliness, and the reduction of lifecycle costs are becoming engineering and design tasks of paramount importance, leading to all-electric plant models and the replacement of mechanical drives with sophisticated e-drives. Our steam turbines from 45 kW upward and our 15 gas turbine models with capacities from four to 375 MW are designed to address the specific requirements of your particular application. They are efficient, reliable, and environmentally friendly and offer the best possible return-on-investment. You’ll profit from our pretested modularized packages, including gas-turbine, generator, and auxiliary systems plus installation, project management, and operations services – or from our turnkey installation capability.

Compact HV substations

Processes in the oil and gas industry are becoming more and more complex and power-hungry. Today the use of HV substations (>52 kV) is often mandatory in order to provide the necessary electrical energy for LNG plants. Our top-quality gas-insulated switchgear offers the highest safety standards for operating personnel and also provides extremely high reliability. It also has garnered important approvals from the oil and gas industry. The space-saving modular design of the switchgear enables tailor-made customer solutions and requires a minimum of maintenance efforts.

Customized energy automation solutions

Our efficient energy management and control system covers the full range of applications from high- and medium-voltage power transmission and distribution systems through transformers to low-voltage switchgear and motor control centers. We protect your plant and installations against potential damage and at the same time guarantee a consistent quality of electrical power supply – which safeguards your production process. What’s more, our automation system also enables you to react quickly and effectively to unforeseeable events in your electrical network to prevent possible interruptions of operation. These energy automation products, systems, and solutions are well-established in the market and have gotten essential approvals from the oil and gas industry.

Optimized compression solutions for all your needs.

Siemens’ innovative compressor designs result in minimized operating costs as well as exceptional environmental performance and safety. In addition, their high availability and long maintenance intervals translate into unrivalled lifetime value. To meet specific customer requirements, we can customize machines to create solutions with extended operating ranges to cope with daily or seasonal production swings. In addition, pre-engineered standard packages are available for boil-off gas compression applications. Whether off-the-shelf or custom-built, Siemens’ compression solutions undergo elaborate testing of all train components before delivery to your site, ensuring that unforeseen problems will not impede tight project schedules.
Compression solutions for special LNG needs:

**Compressors for main refrigeration loops**
- Propane compressors up to 90 MW
- Mixed-refrigerant compressors up to 90 MW, horizontally or vertically split, upward or downward nozzles, skid-mounted with integrated or separate lube oil systems
- End-flash gas compressors up to 40 MW

**Boil-off gas compression**
- Compressors up to 40 MW, single and tandem casing
- Field instrumentation and analytics
- Pressure transmitters
- Temperature transmitters
- Flow meters
- Level measurement instruments
- Gas analyzers
- Remote terminal units
- Level measurement in LNG storage tanks and for pump control
- Level switches for detection of minimum and maximum tank levels
- Valve positioner for valve control
- Chromatograph for determination of gas composition and quality; measurement of calorific value
- Moisture and dew-point measurement in natural gas

**Drives – electrical and mechanical**
Siemens is the world’s leading supplier of electrical motors and variable-frequency drive (VFD) products, systems, and services for the oil and gas industry. Our integrated technologies cover all electrical and mechanical components in the entire drive train, including gearless high-speed direct-drive systems. Our strength is matching and integrating rotating equipment, controls, and other auxiliaries into operating packages that precisely meet your process and power requirements. This enables component interactions – especially between the main rotating parts – to be reliably predicted and controlled. Siemens manages all interfaces and guarantees your system’s performance as required and specified.

**Drives for main refrigeration loops**
- Gas turbines of up to 160 MW (ISO), steam turbines up to 150 MW
- Electrical variable-speed drive systems (VSDS) of 75 to 90 MW as main drives
- Electrical variable-speed drive systems (VSDS) from 10 to 40 MW as starter/helper motor, or modular starter/helper motor/generator packages for gas turbines
- Water-air cooled or water-water cooled electrical systems for all known environments

**Integrated automation systems for the most efficient applications**
Siemens is a worldwide leader in the fields of automation systems, low-voltage switchgear, and industrial software. We are able to offer an unprecedentedly comprehensive spectrum of products, systems, and integrated solutions in the field of electrical equipment for the oil and gas industry.

Outperforming others in terms of speed, productivity, and ease of operations management is often determined by the quality and scope of a plant’s industrial IT solutions. Siemens Industrial IT delivers the most advanced IT solutions for the oil and gas industry. Designed to ensure full interoperability with the business level, visibility for fast decision-making, and complete integration of the supply chain, Siemens IT solutions seamlessly integrate all elements from automation to the ERP and MES levels. They deliver comprehensive and dependable real-time operations intelligence, considered best-in-class by many principals in the oil and gas industry.