Knik Tribe & Siemens Present

A Liquefied Natural Gas Solution to Interior Gas Utility

INTERIOR GAS UTILITY

CLEAN LOW COST NATURAL GAS FOR THE INTERIOR

August 17, 2018

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1.0 Executive Summary

Siemens and the Knik Tribe have partnered to provide the Interior Gas Utility (IGU) an innovative solution to fulfill their stated mission of providing clean-burning natural gas to the residents of Fairbanks North Star Borough as soon as possible. With ever-decreasing air quality in the region — now is the time for creative, calculated, and proven research and engineering expertise to change the energy future for all Alaskans.

Through an innovative virtual Liquefied Natural Gas (LNG) pipeline infrastructure, clean, firm supply of natural gas can be a reality in about 12 months, once terms and conditions are agreed to by all parties. And perhaps the single greatest benefit to IGU and its customers is that no capital investment from IGU is required to build this new LNG capacity.

The Siemens/Knik Tribe team will build, own, operate and maintain a new liquefaction plant in Houston Alaska, while aligning the supply and service contracts necessary to support operation and safely transport LNG via the Alaska Railroad to IGU's storage facility in Fairbanks. More importantly, Siemens is minimizing IGU's both operational and financial risk in the project by ensuring success through a performance based contract.

As detailed in this unsolicited proposal, implementing this virtual LNG pipeline project to deliver firm, cost advantaged natural gas to the IGU community can help achieve necessary residential and commercial conversions, in the shortest timeframe possible. This will not only immediately improve the lives of those in the interior, but it will also fundamentally recast the energy and environmental landscape for the betterment of all Alaskans for decades to come.

2.0 Introduction

IGU's stated mission is "to provide low cost, clean burning, natural gas to the most people in the Fairbanks North Star Borough as possible, as soon as possible". Siemens, a technology leader and manufacturer, in partnership with Knik Tribe (collectively referred to herein as Knik Team) is submitting this unsolicited proposal to the IGU for consideration to addresses IGU's immediate need for increased LNG capacity to the Fairbanks North Star Borough, also known as the interior.

This solution will provide IGU with scalable firm utility-grade LNG supply and reliability which is essential to their critical customers. More importantly, this proposed solution and performance based contract, will significantly reduce IGU's operation and financial risk, as it will not require IGU to invest in the infrastructure. IGU can instead focus its limited resources on the essential functions of a gas utility and invest in building distribution networks and managing conversions and incentive programs as necessary. This project provides a complete and competitive LNG value chain that is utility grade reliability and of the highest level of safety.

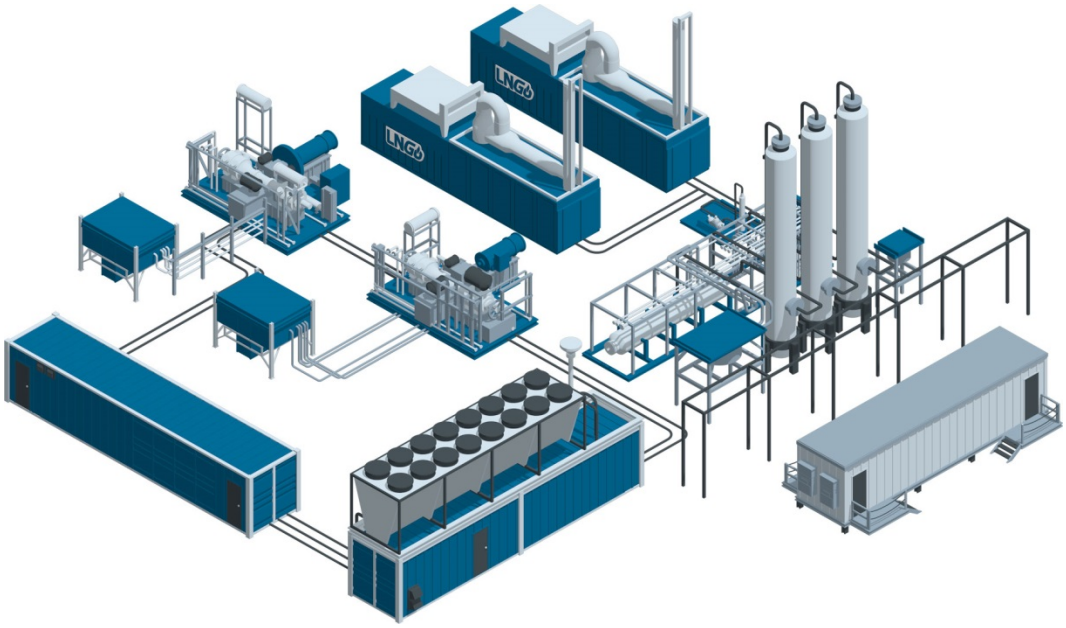


Figure 1: Example of LNG*o* Installation

3.0 Value Proposition

As an emerging utility, IGU has enormous responsibility focusing on building and operating critical distribution infrastructure, securing LNG supply and establishing their automated, digital architecture to run a solvent business operation. This proposal seeks to alleviate IGU from the additional complexity and risk associated with LNG production, especially one that is over 300 hundreds miles away. The following is a brief overview of the value that this proposal provides over the current contemplated solution.

3.1 Firm Supply

If a gas utility does not meet the reliability criteria, large and/or critical customers will not be willing to convert to LNG for heat or power. The proposed solution provides utility-grade firm LNG supply to IGU and the community, with contingency backup plans and no single point of failure with its redundant systems that can operate independently.

3.2 Scalability of Solution

The modular scalable system of the LN*Go* provides for an efficient approach that matches production to demand. Each 30,000 gallons per day (gpd) system can be operated independently, as opposed to operating too large of a facility partially. Additional capacity can be added, when appropriate.

3.3 Speed

The required Front End Engineering and Design (FEED) has already been completed for this project. The proposed modular technology is designed and ready to be factory-assembled inside a dedicated Siemens' plant. It will then be shipped in CONEX containers to be deployed, onto a prepared site in Houston and quickly connected and commissioned. Within 12 months of contract, the LN*Go* system can be fully operational producing LNG ready for the interior; which is at least a year or more ahead of current expansion plans. This additional capacity will help IGU begin to convert new customers, address "pent up demand" and start to positively impact the interior's air quality concerns sooner.

3.4 Removes Financial Risks

***Negates Bonding*.** This proposal alleviates the need for IGU to go further into debt by investing in building increased LNG capacity. Instead, IGU has the freedom to seek smaller incremental financing to support the build out of the gas distribution network and/or fund conversion, as necessary.

Cost overruns. This Knik Team proposed solutions, and ultimately final contract, will provide a known "not to exceed" cost, reducing IGU's financial liability. There will be no construction project overruns or unexpected operational expenses to anticipate. Instead, guaranteed performance will be part of the terms and condition of the contract.

3.5 REMOVES OPERATIONAL RISKS

Technical Expertise. Siemens has extensive experience in the oil and gas industry, addressing the full spectrum of solution and product requirements in upstream, midstream and downstream applications around the world for decades.

Safety. Siemens has a proven track record of a safety conscious organization with incident rates well below industry standards for reportable incidences. We espouse a Zero Harm Culture.

Delivery. Leveraging the Alaska Railroad for delivery improves reliability and eliminates additional risk associated with trucking, especially when originating from a plant located within congested safety corridors and a significant distance from the Highway.

Additional production from that site will only further exacerbate an already tenuous situation within the community and amplifies the risks. Lastly, leveraging rail based transport of LNG from the Houston site will not only support the expansion of the Fairbanks natural gas system, but will provide the opportunity for remote Alaskan communities, industries, and the Department of Defense to transition from diesel or coal fueled power generation and heating to cleaner burning natural gas.

Staffing/Training. Siemens will manage staffing for the operations and maintenance of the LNG facility. Siemens will be providing technical training to grow and develop necessary skills to local personnel to become future operators of the Knik Tribe owned liquefaction plant, thereby removing this burden from IGU.

3.6 AFFORDABILITY/PRICE REDUCTIONS

There will be concerted efforts by the Siemens/ Knik Team to continue to reduce the cost of delivered LNG before and after the plant begins operations, as all stakeholders will benefit. These savings will be realized by IGU in the form of an amendment to their LSA. These price adjustments could be a result of feedstock price reductions or increased LNG production, or both, and can occur multiple times over the course of the LSA.

Feedstock Supply. Knik Tribe is currently executing a plan, separate from this proposal, which could significantly reduce future feedstock prices. Strategically locating the LNG plant in an area with suspected natural gas reserves may allow Natural Gas (NG) to be procured with minimal transportation costs, essentially providing access to economic wellhead pricing to everyone's benefit.

Growth. Economies of scale are achieved when volume demands increase, whether it is due to IGU's conversions or the addition of large industrial customers inside or outside of IGU's service market. However, this growth can provide opportunity for price reduction to all subscribing/serviced customers of the Knik LNG facility. Siemens is highly adept at driving this demand for additional LNG, not only for heat but also for power, which provides even greater production stability. Siemens developed a detailed plan to attract additional subscribers, once IGU commits to being the anchor customer of the LNG plant, even before it is operational.

4.0 Project Offer

Knik Tribe is offering a firm supply of LNG to IGU; to liquefy natural gas, load the LNG into rail car mounted ISO containers and off-load the LNG from the ISO containers into an IGU 5.2 million gallon storage facility. Project capital costs and associated financing and operating costs are recovered by way of a monthly fixed fee and a dollar per delivered thousand cubic feet ($/Mcf) basis. This proposal includes sufficient equipment and services to meet the initial Cardno Study Base Case load predictions. Under this proposal, there will be no need for IGU to increase their current debt for additional LNG capacity.

Liquefaction and transportation services will be sited in Houston, AK on a portion of Knikatnu Incorporated's Heavy Industrial zoned 3,300 acres (leased to Knik Tribe). This location has direct access to Alaska Railroad and the Parks Highway. Knik Tribe will own the assets required and Siemens will provide technical operations services. A discussion of the systems and equipment planned, transportation logistics and system redundancy can be found in the Technical Section 5.0.

4.1 Load Profile

The LNG load profile used in our analysis was provided by IGU. To establish this load profile, IGU has applied the Cardno Study Willingness-to-Convert Base Case predictive model, based on $2.75 delivered oil. See Table 1 for the first five (5) years of modeled loads.

Year	Annual Mcf
1	1,269,982
2	1,517,689
3	1,843,125
4	2,714,116
5	2,968,030

Table 1: Modeled Loads

One significant advantage of the Siemens LN*Go* system is that plant capacity and associated capital costs can be closely matched to current and near future predicted loads, thereby keeping the cost of delivered LNG as low as possible. Investing in larger systems before the load is accurately predicted, and before there is ample revenue stream to support a larger than needed system, drives initial capital investment up, reduces plant efficiency by having to run at part load and increases delivered NG costs, thereby negatively impacting critical initial conversion rates.

As load growth dictates, it is practical and economically advantageous to add up to two (2) additional LN*Go* systems. As load grows beyond the capacity of four LN*Go*(s), it becomes practical and economically advantageous to add larger 100,000 or 150,000 gpd plants. Siemens modeled this modular plant expansion and determined that the economics significantly improves; the $/Mcf decline as liquefaction assets are added to meet growing loads. Simply put, the fixed costs to establish an LNG plant (permitting, site work, railroad siding and track, NG pipeline, office and storage buildings, off-loading systems in Fairbanks, etc.) and the fixed costs to own and operate the plant (snow removal, road and track maintenance, management and administration, site security, etc.) are distributed over more liquefied cubic feet of gas. Those dollars, divided by more LNG volume produced, drives the fixed dollars per Mcf down.

The two (2) LN*Go* systems, proposed herein, will satisfy IGU's loads for the first three (3) years of the predicted load. This load growth may be faster or may take longer than anticipated. Nonetheless, through ongoing consultation with IGU, we will look at predictive indices and determine when additional liquefaction assets will be required. Both IGU and Knik Tribe will be incentivized to grow loads, as quickly as possible; as economies of scale drives down LNG price for IGU and translates into a larger project for Knik Tribe, where more people are employed and share in the revenue.

As additional LNG assets are needed, we anticipate that the current Liquefaction Services Agreement (LSA) will be modified to include larger LNG quantity guarantees and improve the delivered $/Mcf. There may also be other operating cost reductions that can later be modified into the LSA, for example dedicated cryogenic rail cars that carry a larger volume may reduce the delivered $/Mcf.

4.1.1 Feedstock

There are currently three (3) options for the project's NG feedstock, as follows.

1. IGU purchases pipeline NG to satisfy IGU loads. Our model currently uses the IGU prescribed $7.72 /Mcf value used in IGU's modeling of the Titan II Expansion Plan.
2. Knik Team negotiates and purchases pipeline NG to satisfy IGU loads and other industrial customer's loads.
3. Knik Tribe develops onsite wellhead gas to directly support the LNG plant (backed up by pipeline) to satisfy IGU loads and other customer loads.

Knik Tribe and Siemens are actively pursuing pipeline NG and direct wellhead NG. This feedstock diversity can reduce both risk and LNG price. We have several Non-Disclosure Agreements (NDAs) executed and are operating in a confidential manner with current Enstar pipeline suppliers to obtain favorable pricing on P1 certified reserve, using a creative approach. As these negotiations are still in progress, we cannot yet disclose these details. However, we are also exploring the onsite gas potential, which may yield long term NG feedstock in the range of $3.00 to $5.00 per Mcf. We are being conservative with the wellhead NG value and are using $4.00/Mcf in our analysis. We are keenly aware that lower cost feedstock reduces the total cost of LNG, which in turn lowers NG costs to consumers, thereby driving faster conversion and increased load growth.

4.1.2 Delivered Cost of LNG

We have modeled a number of different load profiles and feedstock costs and are presenting just five (5) scenarios;

1. IGU loads, as discussed above, using the IGU purchased $/Mcf of $7.72. Note that we are using $7.72/Mcf feedstock cost, as this is the value used in the Titan Expansion plan proforma. However, we do not see this as a reasonable cost of feedstock.
2. IGU loads, as discussed above, using Knik Team's negotiated $5.00/Mcf pipeline feedstock.
3. IGU loads, as discussed above, using Knik Tribe provided $4.00/Mcf wellhead gas as feedstock.

4. IGU loads, as discussed above, plus an additional co-located industrial LNG operation using Knik Tribe provided $5.00/Mcf pipeline feedstock.
5. IGU loads, as discussed above, plus an additional co-located industrial LNG operation using Knik Tribe provided $4.00/Mcf wellhead gas as feedstock.

Table 2 lists the modeled $/Mcf delivered and offloaded to the Fairbanks storage tank.

Load	$/Mcf Feedstock	*Delivered $/Mcf 3 year average
IGU with IGU purchased pipeline	$7.72	$17.98
IGU with Knik Tribe purchased pipeline	$5.00	$15.02
IGU with Knik Tribe wellhead	$4.00	$13.93
IGU plus industrial, Knik Tribe purchased pipeline	$5.00	$12.04
IGU plus industrial, Knik Tribe wellhead	$4.00	$10.96
*** These prices are preliminary values NTE 10% increase (with potential of greater than 10% decrease)**		

Table 2: Modeled $/Mcf Delivered and Offloaded

We are aggressively working to add an additional industrial LNG load to the project; thereby improving overall economies of scale. We are also seeking the lowest cost source of secure NG feedstock. These cost savings will be reflected in the delivered cost of LNG to IGU. We anticipate being able to disclose progress on these two portions of the project development in the next 45 to 60 days and certainly prior to a final contact.

As noted, the current proposal is for two LNG*o* units, this being the most cost effective approach to meeting the current and near future NG loads. Siemens did however create an operational model to calculate the capital and operating expenses required to meet the Cardno "Base Case" demand curve over a 20 year term. This model calculates LNG production (and associated capital and operating expenses) on a 20 year month-by-month basis and adds new LNG assets, as needed, to ensure that the LNG level within the IGU storage tank in Fairbanks remains between the acceptable maximum and minimum capacities.

The Time Series chart (Figure 2) shows the results of the model. This model factors in escalation of all operating expenses except finance, which of course is fixed at the time of closing. The blue curve shows that, in real terms, the effects of economies of scale outweigh those of escalation for just over 15 years. The future cost of LNG delivered to the tank in Fairbanks does not exceed the Year 1 cost until Year 16. Even in the final year of the term, the LNG price is only 6.5% higher than the Year 1 cost. For reference, a second curve is shown; the brown curve shows the effects of escalation on the Year 1 cost. If escalation were the only factor affecting LNG price, in Year 20 LNG would be 45.7% more expensive than in Year 1 – the area between the two curves is the savings due to economies of scale.

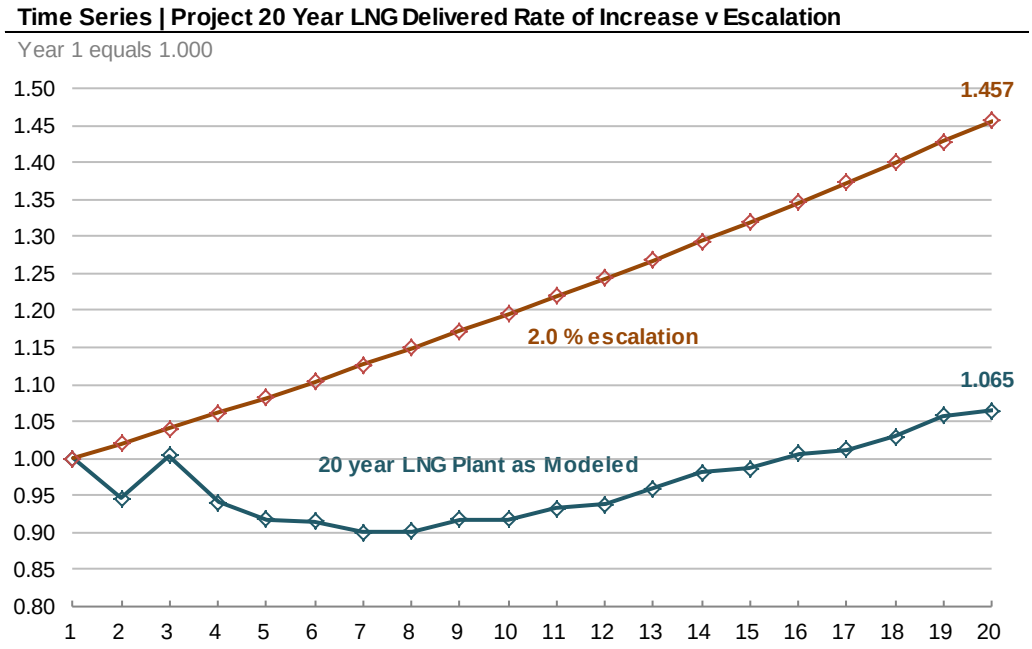


Figure 2: Time Series Chart

Figure 2 shows the value of capturing economies of scale. Figure 3 expands this idea by showing the value of maximizing demand from the start and of capturing the resulting economies of scale as quickly as possible, as early in the process as possible. The three blue curves represent scenarios with IGU as the only off-taker for the entire 20 year term. There are two main differences between the three blue curves, one obvious and one more subtle. The obvious difference is initial feedstock price; starting with $7.72/Mcf (lightest blue) to $4.00/Mcf (very dark blue). The more subtle difference is where the final Year 20 price ends with respect to the Year 1 price. Feedstock prices are subject to escalation, so the higher the ratio of feedstock price to total price, the more effect escalation ultimately has on final price. Note that in the $7.72/Mcf case, the Year 20 price is 1.065 times the Year 1 price. For the $5.00/Mcf and $4.00/Mcf cases, the corresponding values are: 0.997 and 0.966, respectively – the Year 20 price is actually less than the Year 1 price.

The two "IGU + Industrial off-taker" curves illustrate two different points about economies of scale and its effect on price. First: The faster you can achieve it, the better. By bringing on a separate off-taker right from the start, IGU can take advantage of the economies of scale right from the start. The dark blue and maroon curves have the same starting feedstock price, $4.00/Mcf, but the Year 1 price on the maroon curve is significantly less expensive than the dark blue. By Year 9, both curves have achieved about all the economies of scale to be had, and starting in Year 10, price increases in line with inflation only. Second: even after both curves reach a point where the only effect on price is inflation (Year 12), the "IGU +" scenarios are still significantly less on a $/Mcf basis than the "IGU only" scenarios – maximizing initial demand achieves a degree of economy that the "IGU only" scenarios can never capture.

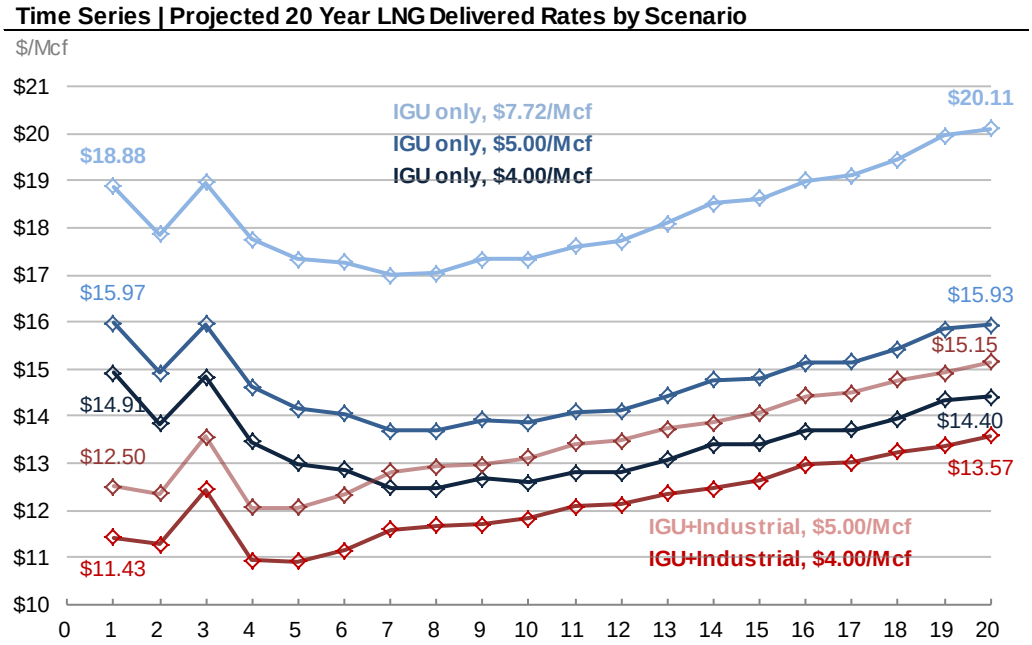


Figure 3: Value of Maximizing Demand

As described previously, Siemens is leveraging their expertise and aggressively employing a number of strategies to not only bring lower cost NG feedstock to the project, but also drive demand for the benefit of all stakeholders.

4.1.3 Liquefaction Services Agreement

The Liquefaction Services Agreement (LSA) is the contract by which all parties will operate. The primary LSA will be between IGU (receiver of LNG) and Knik Tribe (producer of LNG) and will comprise of the complete and exclusive terms and conditions between the parties. Additionally, there will be flow-down of Knik Tribe's LSA responsibilities to Siemens, by way of a contract between Knik Tribe and Siemens.

We are providing the Draft LSA Terms Sheet and Compensation for Services sections of the LSA, under a separately marked "Confidential" cover to protect pre-decisional/pre-negotiated contract terms. Agreeing to the specific LSA components and structure, as outlined in the Terms Sheet, is the first step to finalizing an LSA, which in turn permits finalizing a number of project structures and pricing components. The final development and pricing of this project will depend upon agreed upon terms and conditions between the parties. Once a general agreement is reached, the full LSA can be adjusted and the balance of work to move this project to fruition can be completed; finalize operating costs and secure financing, to name a few.

The LSA will include Services and Scope, Sale and Purchase of Services, Compensation for Services, Term of Contract, Receipt of Feedstock (if applicable), Feedstock Specifications, Delivery of/Receipt of LNG, LNG Specifications, Payment Terms, Covenants Related to Secured Financing, Knik Tribe and IGU Liabilities, Force Majeure, Termination, Dispute Resolution and Confidentiality and Representations.

In our recommended approach to Compensation for Services, there will be two components, a Monthly Baseload Service Fee and a Liquefaction Production Fee. The Baseload Fee is comprised of fixed costs that do not vary based on actual LNG production. These costs include project financing, security, site lighting, general management, property taxes, snow removal, etc. Production Fee is on a unit produced basis and includes costs that are directly related to the volume of LNG that is produced; plant operations labor, operations and maintenance of the equipment, equipment overhauls, etc. Note that the pricing above reflects both the Baseload Fee and Production Fee, as well as transportation.

4.1.4 Team Structure

- Knik Tribe will be the asset owner, with Siemens supporting
- Knikatnu Incorporated is the Industrial Park land owner in which the Knik LNG Plant will reside
- Siemens is currently the project developer working in close collaboration with Knik Tribe
- Siemens completed the Front End Engineering Design (FEED) for the LNG Plant
- Knik Tribe will enter into an LSA with IGU
- Siemens will enter into a contract with Knik Tribe through the contract term. This flow-down of LSA responsibilities ensures long term firm supply of LNG to IGU through competent and reliable operation of the proposed and future capacity liquefaction plant
- Siemens will support Knik Tribe in structuring and securing project financing
- Knik Tribe will contract with Siemens to perform final engineering, procurement, construction, commissioning and staff training
- IGU will enter into a service agreement with Alaska Railroad for transportation of LNG. Siemens will pre-negotiate terms and include that pricing in overall delivery cost to the IGU storage tank

Knik Tribe and Siemens are well positioned to provide firm supply of LNG to IGU.

The Knik Tribal Council *is a federally recognized tribal government. Comprising over 1,500 tribal citizens, Knik Tribal Council serves their Tribal Members and all other Native Americans and Alaska Natives within their service area. The tribal government includes the following departments: a Housing/Community Services Department, Tribal Development Department, Finance Department, Information Technology Department and Administration Department. Knik Tribal Council serves the ten thousand Alaska Native and Native American people living within the Knik service area.*

Siemens *is a global powerhouse focusing on electrification, automation and digitalization with its eight divisions and two separately managed business. Siemens Power and Gas Division has provided the oil and gas industry the right technologies and solutions to promote plant reliability, efficiency, safety and effectiveness for decades. Siemens and the Dresser-Rand business have the combined experience to address LNG needs, including gas turbine-driven LNG facilities; all-electric LNG; floating LNG; small and mid-sized LNG facilities; and a modular micro-scale LNG production plant. Please refer to Attachment 1 for a broader view of Siemens' Oil and Gas Technologies and Solutions.*

5.0 Technical

5.1 LNG*o*

i. **Description**: LNG*o* incorporates premier, proven Dresser-Rand / Siemens engineered product technologies (non-lubricated compressors, engines, motors and drives) and high-end components (e.g. robust stainless heat exchangers), plus integrated controls and safety systems (incl. gas leak detection) in a modular package for LNG production. An integrated basic gas conditioning module (CO_2 & H_2O) is included in the package. The 20 year plant design life and worldwide service and support network ensures operational success for decades. The modularized plant design results in shorter construction times (order to operation ~12months), scalability and space efficient plant design (~190' x 150') with flexibility in compression and layout. LNG*o* is fully capable of 100 percent unmanned operations for periods of time if allowed by local regulation. Please refer to Attachment 2 for additional detail on this technology.

ii. **Power**: The proposed LNG*o* High Pressure (HP) unit includes lean burn Power Modules (natural gas engines) to provide all process power for grid independence. In the LNG*o*-HP process, feed gas serves as power fuel, process refrigerant and liquefied product. Reductions in pipe and material handling sizing is achieved by utilizing methane (CH_4) as the primary refrigerant; it also removes any make-up refrigerant requirements. The environmentally conscious as process is fully air-cooled and self-powered, consuming tail gas from gas conditioning module. Not all natural gas powered generators can utilize this "waste" or "tail" gas, which contains the excess water and CO_2 cleaned out of the feedstock gas – it is sometimes flared off instead. In normal operation, no flaring of tail gas is required with the LNG*o*-HP units; in an emergency shutdown, however, some flaring may be required, so flares have been included for safety purposes.

iii. **Regulatory / Site Applicability**: The plant is tailored to meet all required national codes and standards governed by Pipeline and Hazardous Materials Safety Administration (PHMSA) and National Fire Protection Association (NFPA) (i.e. CFR 193, NFPA 59A, etc.) and is built to Artic configuration (good to low ambient temperature of – 40 deg. C / -40 deg. F). Full production is achieved up to a +37.7 deg. C / +100 deg. F ambient. The LNG*o*-HP is capable of a turn-down capacity to less than 50%– two LNG*o*s can therefore produce any volume between ~ 10,000 and 60,000 gallons per day of LNG. Provisions are made for Boil Off Gas (BOG) return during loading operations and light-ends accumulation management (e.g. H_2, He, N_2,) giving long term performance stability through a variety of conditions.

5.2 STORAGE AND TRANSPORTATION

i. **Alaska Railroad**: Under their current agreement with the Federal Railroad Administration (FRA), Alaska Railroad (AK RR) can transport LNG via the railroad every fourth day. The transport of LNG via rail is further limited to using ISO containers placed on flat-bed RR cars, two ISOs per RR car. AK RR is in discussions with the FRA to get these provisions modified in the following ways:

- AK RR is requesting permission to run more LNG cars per train
- AK RR is requesting permission to run LNG trains more often than every fourth day
- AK RR would ultimately like to get permission to utilize dedicated cryogenic rail cars to transport LNG, in addition to LNG in ISO containers

It is understood that these permissions may not all be granted at one time; Knik Tribes' proposal has been engineered to work within the AK RR's current constraints. The granting of any or all of the permissions above will simply make LNG transportation easier and, in all probability, less expensive.

Figure 4. LN*Go* Railroad Transport

ii. **LNG Loading and Unloading**: As noted above, the current plan is one LNG train every four days. In order to maximize their efficiency, Alaska Railroad will not wait for rail cars to be loaded with LNG at the Plant site; Knik Tribe' agreement with AK RR is that they will deliver X number of empty cars back from Fairbanks, and immediately pick up Y number of full cars for transport to Fairbanks.

The minimum number of ISO containers required is therefore equal to enough carrying capacity to handle two times the maximum Plant output (half are full, half are empty). Thus, for a nominal 60,000 gallon per day (gpd) Plant, with deliveries every four days, Knik Tribe must own or lease a minimum of 48 ISO containers:

*4 days between deliveries * 60,000 gpd / 10,300gal per ISO = 23.3 ISO containers, rounded up to 24: times two (48) to account for how AK RR logistics must work*

The current Knik Tribe proposal in fact includes 50 ISO containers (48 plus two spares), and as currently envisioned, they are owned, rather than leased.

As currently envisioned, the proposed Project is also carrying the costs of a dedicated rail siding at IGU's Fairbanks storage site, as well as an LNG transfer station to get the LNG into the IGU tank. AK RR may share some of the cost of the siding, but for now, the Project is carrying the capital costs related to unloading in Fairbanks. The Project financials also include the operating costs related to unloading LNG from the ISO containers to the tank. Ultimately, it may be more cost effective for IGU employees to do this unloading, but until such an agreement comes into place, the costs are carried within the Project's operating costs.

iii. **LNG transport**: Unlike compressed natural gas, LNG is not stored or transported under high pressure; 75 psig is about as high as most LNG storage systems operate at, and some operate at atmospheric pressure. On the other hand, LNG is very cold, 260 deg F below zero at atmospheric pressure. Thus cryogenic tanks must be used to store and transport LNG. Three potential modes of LNG transport are described below; the site selected by Knik Tribe (leased from Knikatnu Inc.) to construct the proposed liquefaction plant will be designed to be able to deliver 100 percent of Plant output utilizing any or all of these modes. All three modes share a common LNG tank shape, called a "bullet tank" (a long cylinder with belled-out end caps). All three use stainless steel double walled tanks, with insulation and a vacuum between the walls to keep the LNG as cold as possible. The differences are mainly in capacity and versatility:

- LNG trucks: Nominal capacity, ~ 12,500 gallons of LNG. The tank cannot be removed from the truck chassis in normal operations; the application of LNG trucks is therefore limited to locations that can be reached by reasonably good roads. This may be seasonal, depending on the roads.
- ISO Containers: Nominal capacity, ~ 10,300 gallons of LNG. ISO is simply the International Organization for Standardization, which certifies the tanks for use with LNG (LNG trucks also carry ISO certifications). Used in the context of LNG, and as used herein, "ISO container" refers to a bullet tank that has been built into a metal chassis or frame that mimics the dimensions and connection points of a 20 or 40 foot shipping container (and can be stacked as such). The entire tank/chassis can be picked up using a crane or lift and placed on a rail car, flat-bed truck trailer, barge, or any other mode of transport large enough to handle shipping containers.

The main form of transport that Knik Tribe has proposed herein is the use of LNG ISO containers on rail cars, two 40 foot ISO containers per 90 foot flat-bed rail car.

The ability to be used with multiple modes of transport ("multimodal" is the industry term) provides significant flexibility to the LNG delivery process. As proposed herein, however, in normal operations, AK RR would provide Knik Tribe with "X" flat-bed rail cars, upon which "2 times X" ISO containers would sit; these containers would rarely be lifted off their rail cars. However, if IGU were to decide to serve an area not connected to their natural gas distribution system, and not directly served by rail, ISO containers could be shipped to Fairbanks by rail, and transferred to flat-bed trucks (or even barges) for final distribution. This is the versatility of ISO containers.

- LNG Rail Car: Nominal capacity, ~ 30,000 gallons of LNG. Unlike setting two ISO containers on a 90 foot flat-bed rail car, these are rail cars built specifically to handle cryogenic fluids, utilizing purpose-built tanks that utilize the entire footprint of the car; thus the higher capacity. These cars are already used on many railroads to carry cryogenic fluids other than LNG; they simply have not yet been permitted specifically for AK RR, and specifically for LNG.

  Because the capacity of these LNG cars is 150% that of two ISO containers on a flat-bed car, LNG transportation costs to Fairbanks are expected to decrease by as much as one third when these dedicated LNG cars become available. Although Knik Tribe anticipates these cars will be permitted at some time in the future, all our operating Models assume delivery via ISO containers throughout the term.

iv. **On Site Storage**: Because of the limitation on deliveries imposed by AK RR's current agreement with the FRA, the proposed Plant must be able to store four days or more of maximum plant output. The current proposal includes approximately 4.4 days storage at maximum Plant output, in stationary on-site LNG bullet tanks. Even with the railroad, however, delays are possible. Although it is not the intent to routinely store LNG in the ISO containers, it is certainly possible. Because the project owns ISO container with a combined capacity totaling two times the maximum Plant output, the Plant could, if required, store more than 12 days' worth of maximum Plant output.

5.3 LNG Production, Demand, and Fairbanks Storage

i. **IGU Tank**: IGU has a 5.25 million gallon storage tank currently under construction in Fairbanks; this tank would be the site for delivery from the Knik Tribe Plant to IGU, whether by rail or truck. This volume of LNG storage will allows the LNG producer to decouple production from demand; daily overages in production go into the tank, underages are made up from the tank. Even a tank this large has limits; Siemens has modeled the tank capacity as: 1) maximum useable volume = 98 percent of total volume, and 2) minimum volume = 5 days' worth of peak demand.

ii. **Operational Modelling**: Siemens has created a very detailed operational Model of the proposed liquefaction Plant. This Model calculates the required capital expense and associated financing costs of the proposed Plant, as well as all of the Plant's

fixed and variable operating costs as a function of output, in dollars and dollars per Mcf. This Model is used to ensure that the rate of LNG delivery from the Plant maximizes the utilization of the IGU tank. In large part, this means over-producing as much as possible in the summer to store volume for the winter, within the volumetric limits of the tank.

iii. **Demand Modelling Resolution**: Because of the significant variance in Fairbanks' natural gas demand between winter and summer (consumption in the highest month is more than 4.0 times that of the lowest month), Siemens determined that basing the Project financials on yearly natural gas demand values would incur significant risk for Knik Tribe and for IGU. IGU provided Siemens with monthly natural gas demand values for six and half years; Siemens was able to use this data to increase the resolution of the operating Model from annual to monthly. Annual natural gas demand increases are modeled per the agreed-upon Base Case and Low Gas Case, but within each year, monthly variations in demand are calculated using the historical IGU data. Demand and production (and all related operational expenses) are calculated on a month-by-month basis, with the LNG excess (or shortfall) going to (or coming from) the IGU tank. Without using a monthly demand profile, Siemens found it impossible to accurately balance supply and demand, and thus determine the LN*Go* utilization rates and operating costs.

iv. **Asset Degradation**: The performance of mechanical devices degrades with usage. Even with periodic overhauls, overall performance degrades as run time increases. The Siemens Model tracks the run hours of each LN*Go* unit as the demand profile changes month by month. Both output capacity (gpd of Plant capacity) and LN*Go* efficiency (Mcf of LNG out divided by Mcf of natural gas in) are assumed to degrade at rates consistent with industry standards. Each month, if an LN*Go* unit is assigned to run in the Model, it calculates the up-to-date capacity and efficiency of the selected unit based on run hours since inception and applies those values to the calculations.

5.4 CONTINUATION OF SERVICE

i. **Alternate Delivery Options**: As noted above, the proposed Plant will be designed to allow for delivery of the full output capacity of the Plant via LNG truck, if required. The length of the road from the Plant to the Parks Highway is less than three miles, and is (or will be) paved and maintained in good shape; it does not travel through any residential areas or designated safety corridors.

Within the Project financials, Knik Tribe is carrying the cost of the dual mode loading station (trucks and rail) on site and the on-site roads required to accommodate delivery via LNG trucks. However, Knik Tribe is not carrying the cost of the LNG trucks themselves; IGU already owns several LNG trucks, and the operational know-how to obtain or rent more if needed.

ii. **Storage**: Storage is the best insurance against unexpected interruptions to service, or even to allow for scheduled interruptions. In addition to the 5.25 million gallon tank in Fairbanks, IGU has access to 2 x 75,000 gallon tanks that are being

relocated to North Pole. Finally, as noted above, with enough notice, the Knik Tribe Plant has the ability to store up to 720,000 gallons of LNG in stationary tanks and ISO containers.

iii. **Electricity Outages**: All process power for the proposed Plant is generated by natural gas fueled engines. Electricity is used only for site lighting, security cameras, life safety systems, and building lighting and power. The actual amount of electricity used in normal operations is very small, and thus easily backed up with an engine generator running on No. 1 oil.

iv. **Natural Gas Interruptions**: An interruption in natural gas supply to the site shuts down the Plant; no feedstock equals no output. In the event of a prolonged outage of natural gas, IGU would need to look to other sources of LNG. Knik Tribe is actively determining the viability of producing on site wellhead gas directly. This would not only significantly lower the cost of feedstock; it would eliminate the Enstar Beluga pipeline as a single point of failure, as there would be diversity in the source of feedstock and further security to the operations. Note that the Titan Plant is fed from the same pipeline the Knik Tribe Plant will be using. So in the event of an interruption, it is likely that Titan would not have access to natural gas either, although it is possible, as Titan is closer to the source of the gas injection into the pipeline. In such a case, Titan could provide at least some output, if it is operational.

v. **Future Expansion**: The current proposal includes two LN*Go* units to meet the initial year one IGU projected natural gas demand. However, Siemens has used our operational Model to project the need for LNG assets for the entire 20 year term described by the Cardno demand curves. The Model calculates the associated capital and operational expenses over the 20 year term.

The LN*Go* units provide Knik Tribe with a liquefaction asset that can be rapidly deployed to meet demand, and which minimizes over-capacity; however, Knik Tribe recognizes that as overall LNG demand volume increases, higher-capacity liquefaction assets will be required. The 20 year operational Model therefore includes a mix of LN*Go* units with larger, Siemens-Partnered liquefaction assets. This proposed mix of available transportation modes and LNG assets ensures IGU a reliable and redundant source of LNG for many years to come.

5.5 Utility Grade

i. **Standards / Minimums**: Distributed LNG equipment operations include some of the most challenging process environments for equipment to operate in, due to extreme temperatures, both ambient and process, combined with remote and often exposed locations. The range of operating conditions are such that specific standards have been developed by Pipeline and Hazardous Materials Safety Administration (PHMSA) and National Fire Protection Association (NFPA) and other agencies to ensure that equipment that is compliant will provide safe and reliable operations. The standards known as NFPA 59A and Code of Federal Regulations (CFR) 193 provide the basis of specifications for LNG equipment to operate in diverse and challenging conditions of both process and environment.

LNG equipment that meets these standards has a basis to operate more reliably and have a long equipment life expectancy.

ii. **Utility Grade**: Utility grade equipment and operations considers details beyond the mandated standards and uses the highest quality components and more expensive design, beyond what is required to ensure the LNG production. This provides the assurance that the equipment is designed for the conditions in a given region and will provide the lowest maintenance, and the highest operational safety and performance for the full financial horizon considered.

This proposal achieves the extraordinary requirements for utility-grade by layering equipment for flexibility and redundancy, utilizing state of the art equipment, controls and communication. Additionally this proposal is exercising rail-transport to provide long term end to end efficiency. All equipment requires parts for maintenance; costing consideration for on-location high-value spares is included in this proposal. Furthermore, being the end-customer currently owns liquefaction in the form of the Titan 1 plant, these assets in the owner's purview could be utilized for a final layer of LNG production insurance should the holding costs of the Titan 1 plant and LNG demand require it.

iii. **Firm Supply**: The term "firm" has meaning in the context of natural gas; barring force majeure events, a firm client will not be curtailed. In the attached draft LSA, Knik Tribe if offering a firm commitment to IGU to deliver a specified amount of gas per annum, even if that means buying LNG on the market and delivering it to IGU. To summarize the sections above, the elements that allow Knik Tribe to offer this firm capacity to IGU include:

- A Utility Grade LNG Plant:
  - Built to exceed existing LNG facility standards
  - Multiple units
  - On-site process power generation
  - On-site critical spare parts
- Multiple transportation modes
  - Primary mode is rail, utilizing ISO containers – lowest cost, highest reliability and best safety record
  - Looking to switch some capacity to dedicated cryogenic rail cars as AK RR gets the required certifications – lower costs even more
  - ISO containers can be loaded onto flat-bed trucks, and plant has easy access directly to Parks Highway
  - Dedicated LNG trucks (both client-owned and locally available – not included in this proposal)

- LNG storage
  - IGU 5.25 million gallon tank
  - North Pole 150,000 gallon tank
  - Plant On-site stationary storage; initially 264,000 gallons, increasing to 528,000 gallons over the 20 year term
  - ISO containers, either on-site or in transit; can carry/store up to 516,000 gallons (as proposed), 1,550,000 gallons (as Modeled over 20 years)
  - Total system (as proposed herein): IGU (5.4 million gal) + Knik Tribe (780,000 gallons) = 6.18 million gallons of system storage

6.0 Next Steps

Siemens and the Knik Tribe look forward to the collaboration with IGU and across all stakeholders to deliver firm, cost advantaged natural gas the Alaskans in the interior deserve. However as an important milestone in our business model, we need some level of commitment from IGU in order to continue to expend resource on the development of this project. That level of commitment would be in the form of a signed Memorandum of Understanding (MOU). The following steps outline the key activities necessary for our continued engagement, as well as a target date for LNG delivery.

Date	Step
2018	
August 21	Provide IGU a proposal
September 5	IGU reviews and submit written comments as well as identify a negotiating team (2 weeks)
September 6-14	Siemens review of IGU's issues and concern
September 18-20	In-person workshop with negotiating team to resolve proposal (format and specific details on agenda to be coordinated)
If proposal concerns are satisfactorily resolved then establish terms of MOU and begin collaboration on Liquefaction Service Agreement (LSA) during workshop	
October 2	Board votes/approves MOU
October 2	Knik Tribe's structure financing process underway
October 2	Knik team firms up guaranteed $/Mcf by negotiating all supply and services contracts associated with project
December 4	Siemens/Knik Tribe provides status update
On or Before December 30	Execute contract(s)
***2019**	Upon contract signing, subcontractors notified, site work begins, full project planning and execution
January 1, 2020	Target Date for LNG delivery to begin (12 months from contract)

***Or sooner**

In closing, Siemens has extensive experience and solutions not only in the oil and gas industry but also in assisting and directly supporting utility companies across the globe in optimizing their business practices and operations, and improving their bottom line. For example, one of Siemens' core competencies is in the area of Utility Energy Savings Contracts (UESC). Siemens has partnered with numerous utilities to assist in providing energy efficiencies to large industrial customers such as DoD by facilitating third party financing and using the energy savings to pay for the conversion. Under this program, these conversion efforts would be administered through unique contracts in which Siemens can establish on behalf of IGU, thus providing IGU with a revenue stream. Another example is our data management systems to ensure real time monitoring of the performance of your distribution systems and your customer's meters. Simply

put, Siemens seeks to partner with IGU on multiple technological fronts to enable IGU to realize their mission in the most responsible and economical way possible.

Attachment 1: Siemens Oil & Gas Technology

SIEMENS

Technology. Engineering. Solutions.

Proven performance for the challenges of the oil and gas industry

siemens.com/oil-gas


Underground Gas Storage
Refineries
Engineering and Consulting
Oil Sands
Life-Cycle Services
Software Solutions
Tankfarms
Offshore Drilling
Offshore Production

Sustainable energy solutions – we accept the challenge.

Oil and gas will continue to be the backbone of the global energy supply, and natural gas will become even more important in decades to come. The industry's challenge is to employ the right technologies, ensuring reliable production and sustainable supply. Our products, systems, and solutions promote the effectiveness and efficiency of a plant's processes to achieve maximum success.

“Technologies, solutions, and related services for maximum plant safety, efficiency, and availability – and innovative technical solutions for the sustainability challenge the oil and gas industry faces tomorrow – that’s what we’re working on.”

Lisa Davis, member of the Managing Board of Siemens AG

As one of the global technology leaders and key partners of the industry, Siemens offers a threefold approach to this challenge – with solutions along the entire oil and gas value chain, services throughout the plant lifecycle, and made-to-measure products and technologies for power, automation and IT, water technologies, compression, and drives.

Our technologies contribute to extending global resources ever further, enabling exploration in harsh deep-sea and arctic environments, increasing the use of unconventional resources, and improving production from existing fields. Needless to say, our technologies and solutions fully comply with all environmental, health, and safety requirements.

To Siemens, sustainability is a matter of leveraging the right technology, one that will help us improve a plant’s CAPEX and OPEX as well as its environmental performance.

Siemens has long been supplying its industrial automation, power generation, and power distribution strengths and experience to the oil and gas industry. With the acquisition of Dresser-Rand and the Rolls-Royce gas turbine and compressor business, we are increasing our competencies and our portfolio to address the full spectrum of solution and product requirements in upstream, midstream, and downstream applications. Our “all electric oil and gas” concept takes the production and transportation of hydrocarbons to an even cleaner, more efficient, and safer next level.

Collaboration is the foundation of an in-depth understanding of our customers and their needs. Based on our technological expertise in electrification, automation, digitalization, and process solutions both in the oil & gas and in many other industries, we put a lot of effort into our partnerships – with outstanding results for our customers.

Contributing our technical and engineering expertise

Our unique range of products and solutions, decades of experience in the implementation of complex projects, and thousands of installations worldwide make us one of the most important technology partners for the oil and gas industry. Siemens is renowned for reliable, innovative, efficient, and eco-friendly products, systems, and solutions throughout the entire value-adding process, and for the entire lifecycle of an investment. Our comprehensive solutions deliver the highest reliability, performance, and economic efficiency.

Our early involvement in project development helps minimize technical risk and allows us to mutually develop the CAPEX and OPEX balance. Our customers' lasting success is our motivation to further intensify our engagement in the oil and gas industry. With our competitive Oil & Gas portfolio we create innovations that make the difference.

A good example: our integrated plug-and-play platform solutions for complete functionalities, developed in close collaboration with our customers to solve today's and tomorrow's challenges.

Boosting performance

With a portfolio that extends from power generation, transmission, and distribution to automation and IT, compression, and water treatment, Siemens is a strong and in many fields even unique strategic partner. We consequently strive to become the leading electrical, rotating equipment, and process automation provider in the oil and gas industry – with reliable best-in-class products, solutions, and services. This is our vision.

Close collaboration from day one

As more and more technology per barrel is required, oil and gas projects are becoming increasingly complex, calling for an integrated approach with a single interface to the customer. Exchanging technologies, creating partnerships with our customers, and intensifying our collaborations go hand in hand right from the beginning of our projects. This includes helping our customers access our diverse portfolio more efficiently, and streamlining project execution – from start to finish.

Fully committed to EHS

Our EHS guidelines are an integral part of our process house, and the rules are being implemented in every project. As a consequence, many of our projects represent not only track records for on-time delivery, but achieve highest levels of safety, too.

Technology

Leading technologies are the basis of successful solutions. With our unique range of products and systems, decades of experience, and thousands of installations worldwide, we are one of the most important technology partners for the oil and gas industry. We stand for reliable, innovative, efficient, and environmentally friendly products, systems, and solutions throughout the entire value-adding process for oil and gas.

Power and electrification

Siemens is a global powerhouse positioned along the electrification value chain – from power generation and transmission to distribution and the efficient application of electrical energy. Our wealth of knowledge and experience in utility and industrial power generation results in dependable, economical, and environmentally friendly solutions for any stage, process, and application.

Power generation unit

E-motor for e-LNG plant

Main and distribution switchboard

Rotating equipment and water technologies

Siemens is a leading rotating equipment company. Our strength is matching and integrating rotating equipment, controls, and other auxiliaries into operating packages that precisely meet our customers' processes and power requirements. Our water-processing systems operate in production fields around the globe. Based on this broad experience, we can meet the industry's needs in wastewater and produced water treatment and for water injection.

Compact, lightweight, aeroderivative gas turbine

E-drives for pump station

Reverse osmosis water treatment unit

Automation and digitalization

Automation and digitalization are among the central focus areas of Siemens. We offer an unprecedentedly comprehensive spectrum of products, systems, and integrated solutions. As a leading software supplier, Siemens optimizes the entire value-added chain from production through transmission to refining of hydrocarbons.

XHQ operation intelligence system

SIMATIC PC S7 automation system

Touch panel for drilling automation

Leading technologies – the basis for successful solutions

A solid foundation for our wide range of high-performance products: leading technological expertise in electrical engineering, power generation, transmission and distribution, rotating equipment, automation, instrumentation and IT, water treatment, and our own product development and production facilities.

Aeroderivative gas turbine

Compression and pumping

We seek to provide lowest total cost of ownership solutions for your oil and gas production, gas processing, refining, petrochemical, and environmental facilities. Available with a wide range of power ratings, our solutions are designed to match the needs of all stages and aspects of gas and oil transmission. Our custom designed machines meet specific customer requirements, e.g. in solutions with extended operating area to cope with daily or seasonal swings in demand. In addition, we offer a range of pre-engineered standard packages for compression and pumping, while all our solutions undergo elaborate testing of all string components before delivery to your site, ensuring that tight project schedules won't be obstructed by unforeseen problems.

The result of more than a century of design and manufacturing expertise, our compressors have established an outstanding record for performance, efficiency, reliability, and low maintenance in the most demanding upstream, midstream, and downstream applications, including process and separable gas-field compressors manufactured to stringent specifications.

With the integration of Dresser-Rand we added a great number of powerful centrifugal, axial, reciprocating and rotary screw compressors to our portfolio, as well as thousands of turbo machinery units in operation, adding up experience from our customers. The innovative design and superior components give Dresser-Rand DATUM® centrifugal compressor line their competitive edge of improved efficiency, reduced emissions, low noise, and easy and fast maintenance.

Industrial and aeroderivative gas turbines for all on- and offshore needs

Our gas turbines play a critical role for establishing a reliable offshore power source. With their Dry Low Emission (DLE) combustion systems they help reduce environmental impact in power generation. However, our gas turbines in offshore operations usually have to cope with associated gas for fuel, posing a number of additional challenges for operators, as its composition may change from field to field, well to well, and over time. Additionally, there may be an insufficient supply of associated gas to fuel a power plant over the lifetime of a field. More than 450 Siemens gas turbines with DLE combustors provide reliable power for oil and gas, 60 of them in offshore operations. And pioneering aeroderivative gas turbines, Rolls-Royce has delivered over 5,200 high-efficiency industrial gas turbines to over 500 customers in more than 80 countries, achieving over 145 million hours of operating experience.

For most efficient operation: Siemens automation and control systems

Siemens is a worldwide leader in the fields of automation systems, low-voltage switchgear, and industrial software. We offer a comprehensive spectrum of products, systems, and integrated solutions in the field of electrical equipment unprecedented in the industry. With increasing

Compressor train STC-SV

STC-ECO: optimized efficiency, minimized maintenance in compression

Single-lift e-house for production platform

competition as a common reality of many industries, outperforming others in terms of speed, productivity, or ease of operations management is often determined by the quality and range of the employed 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 are seamlessly integrated, from automation to ERP and MES levels. They deliver comprehensive and dependable real-time operations intelligence, considered best-in-class by many majors in the oil and gas industry. Dedicated plant packages are available for a range of applications, including pipeline operations and tank farms.

E-houses and modules: modular one-stop plug-and-play solutions

Why would you buy from multiple equipment suppliers when we can offer you a fully integrated module from a single source? We have developed modular one-stop solutions for electrical substations, power generation, and process gas compression equipment, including automation systems, drives, and switchgears, among other components. Tailored to the requirements of your operation, these fully integrated, single-lift packages are manufactured off-site and delivered as plug-and-play systems.

Prefab e-house for offshore and onshore applications

Our full range of e-house solutions creates the link from power generation to the consumer terminals or sockets. It covers MV gas- and air-insulated switchgear, LV switchgear, power and distribution transformers, the cable connections and bus ducts, the motor control center, and all protection and energy automation. The modular components are standardized and perfectly matched.

Compact, clean, and reliable – power generation modules

Efficient power generation and environmental compatibility are of high importance for oil and gas plants. Strict requirements in terms of safety and reliability have to be met. Siemens' program of lightweight heavy-duty industrial gas turbines is the perfect fit for these demanding applications.

Efficient, fully integrated, and safe – compression modules

Compression applications are found along the entire oil and gas value chain. Their design determines operational costs as well as environmental performance and safety to a great extent. Siemens offers a broad array of compressors of different types matching the diverse needs of the industry, fully integrated into plug-and-play compressor modules. These fully tested modules include the compressor, gas turbine or motor with variable speed drives, process equipment, and the electrical and control system.

Automation control room

HV transformer

Main Motors and Drives Contractor (MMDC)

From the first feasibility study at the outset through to commissioning, most oil and gas projects require large capital expenditures and years for project realization. Throughout this process, the project's progress may be impaired by multiple challenges.
To manage these, Siemens has developed the MMDC concept. It is a comprehensive concept that enables us to assume responsibility for the project's overall success – from the feasibility study through planning to the technical realization of all rotating equipment and the power supply, automation, and electric equipment. MMDC encompasses the installation of the products and systems as well as comprehensive services across the entire lifecycle.

Better from the start: tools for improved planning and operation

With our broad portfolio of software solutions, we can ensure perfectly coordinated planning, engineering, installation, and operation of your production assets. The exchange of all required information throughout the asset lifecycle makes for transparent processes. From initial planning with the Oil and Gas Manager and lifecycle engineering with COMOS to real-time information with XHQ, we support planners, builders, and operators of onshore and offshore oil and gas production sites around the world.

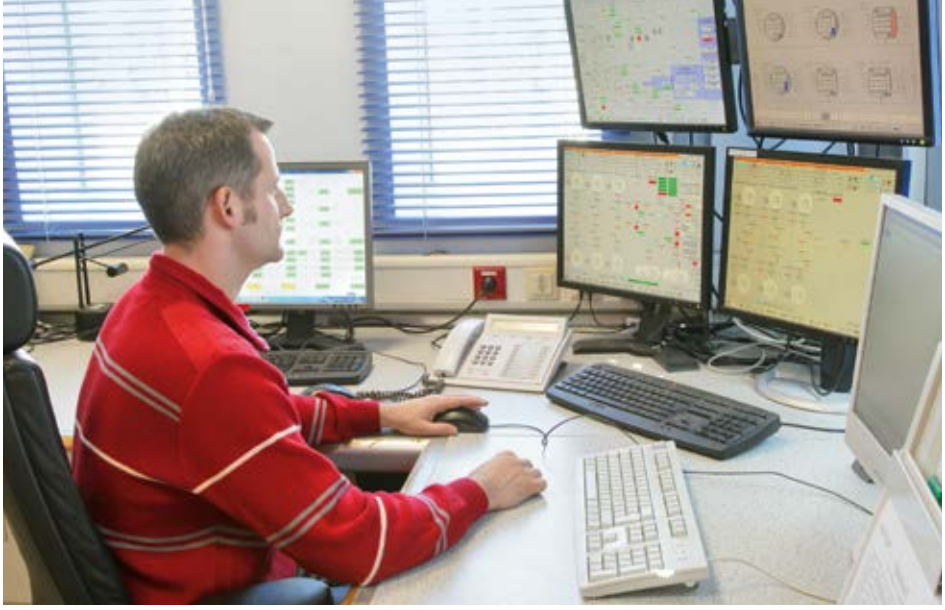
Monitoring your asset security: facility and communication technology

With our comprehensive set of security solutions, you can take appropriate measures to protect your facilities (including pipelines) against unlawful attacks.

Centralized and decentralized power solutions for onshore and offshore plants

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. Prompted by the surging power demand from oil and gas facilities, design and engineering tasks such as providing reliable power generation, fuel flexibility, modular designs, service-friendliness, and the reduction of lifecycle costs are becoming paramount in importance. They result in 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 4 to 375 MW are designed to address the specific requirements of your particular application. They are efficient, reliable, and environmentally compatible, and offer the best possible return on investment.

To fully supply the high rated current and short-circuit demand, our air- (up to 38 kV) and gas-insulated medium-voltage (MV) switchgear (up to 40.5 kV) are maintenance-free and operate independent of pollution and humidity. Air-insulated switchgear in withdrawable design has fused contactor feeder panels with only half the width of a circuit-breaker panel. Both the air-insulated and the gas-insulated switchgear have an extremely good safety record with high reliability and availability.



Gas storage monitoring system

Efficient water technologies for all needs

Produced water treatment made to measure:
Along with oil and gas, water is brought along to the surface. Our product portfolio includes a complete range of solutions for cleaning this produced water prior to discharge or reinjection. Primary produced water treatment removes sand and separates oil and water. Our liquid/liquid hydrocyclones are field-proven for efficient, optimized deoiling. For sand cleaning, our solid/liquid hydrocyclones allow for as little as 5-micron removal of sand. All our hydrocyclones are offered in a variety of sizes and materials.
Secondary produced water treatment is accomplished with compact dissolved gas flotation or induced gas flotation in various configurations. The vertical or horizontal dissolved gas flotation units offer increased treatment efficiency and reduced float volume compared to induced gas flotation. Tertiary produced water treatment is achieved with our walnut-shell filters, media filters, adsorption filters, or other compact cartridge filters.

Highly economical process water treatment:
Process water quality and reusability are an important factor in production, and the cost and availability of raw water is becoming more of an everyday concern. Along with increasingly tighter restrictions on wastewater discharge, this means that the entire process water handling system must be properly designed, maintained, and run.

Water solutions from Siemens can help you produce more product less expensively, with fewer complications and restrictions.

Comprehensive wastewater treatment solutions from one source:
In wastewater treatment, Siemens is uniquely equipped to handle all requirements, ready to address concerns of safety, toxicity, and hazardous materials control and VOC containment. Whether it's oil/water separation, biological treatment, recycle/reuse, or in-process treatment: We deliver complete and economical solutions and services, such as laboratory and pilot studies, wastewater equipment design and supply, and wastewater treatment process evaluations.

SIVACON power distribution switchboard

Single-lift offshore wastewater system

Solutions

Siemens offers a broad portfolio of solutions along the entire oil and gas value chain. Our competencies in power engineering, rotating equipment, water technology, and automation and IT make it happen. Integrated functionalities, standardization, and modularization are special drivers to fulfill the technical and economic challenges and to achieve excellence in the relevant processes.

Upstream

From exploration to field development and production, Siemens stands for cost-saving, integrated equipment and solutions. This includes subsea, on-, and offshore operations, from wellhead to export.

Offshore drilling

FPSO

Subsea exploration

Jacking system

Midstream

The Siemens midstream solution portfolio comprises energy generation and distribution, compression and pumping, automation and control, telecommunications, industrial IT, safety, and lifecycle services for gas and liquid pipelines, LNG concepts, and storage facilities.

Pipeline pump station

All-electric main refrigeration train for LNG plant

Boil-off gas compression (STC SV)

Downstream

Siemens' large range of field-proven compressors and drives offers state-of-the-art compression solutions for just about any refinery and petrochemical process; for example, fluid catalytic cracking, hydrocracking, coking, platforming, sulfur recovery, and hydro- treating.

Refining

Air separation

Petrochemical processes

Balancing CAPEX and OPEX along the entire value chain

Having Siemens experts involved early in the concept phase is the best possible start for a performance-driven solution. The result is the finest technical solutions offering high productivity, low lifecycle costs, and reduced project risks. Considerable cost savings both on CAPEX and OPEX are achieved through customized package solutions that encompass entire functionalities.

Economical offshore drilling

We stand for innovative solution packages for offshore drilling that secure reliable operation and availability. Our solutions are based on broad expertise in electrical, instrumentation, and telecommunication (EIT), rotating equipment, and water treatment solutions, as well as years of hands-on experience in the oil and gas business and marine applications.

Our scope of supply covers the entire lifecycle of equipment and assets, thus ensuring long-term reliability and ideal investment protection. Moreover, thanks to long-standing business partnerships with leading shipyards, naval architects, and drilling service operators, we understand the needs and demands of the markets – and how to deliver exacting solutions.

Utmost reliability for offshore production and processing

For all types of mobile units and jack-up rigs, we deliver proven solution packages for reliable operation and high availability – from power supply (including fault-tolerant systems) through drives for all applications to integrated process solutions for gas and water, as well as automation and management systems and marine systems.

Floating Production Units (FPUs) also call for the highest operational efficiency as well as an integrated design of all topside solutions. We can provide this, thanks to our cutting-edge technologies, our wealth of experience in furnishing FPUs, and our comprehensive lifecycle services, safeguarding the highest performance of all components at any time.

Technology for offshore drilling and production

Underground gas storage equipment

Electric drive for drillship

Enabling products and systems for subsea operations

The key to subsea success: products, systems, and lifecycle services for deepwater developments

Siemens enables enhanced recovery in the most challenging locations, covering everything from connectors and sensors to topside and onshore power supply, in-field subsea power distribution, control, surveillance, and processing technologies. Our portfolio includes subsea products, systems, and exemplary service and support.

Our subsea products include market-leading brands like Tronic, Matre, and Bennex. The reliable Tronic line of DigiTRON, SpecTRON, FoeTRON, and ElecTRON products provides electrical and fiber-optic connector systems for subsea power and communications. Our Matre wellhead pressure sensors, pressure temperature sensors, and differential pressure transducers are renowned for delivering optimal performance and reliability. The Siemens subsea offering also includes high-performance Bennex equipment for power solutions, fiber-optic, and seismic applications.

Reliable, optimized onshore production and processing

From wellhead to export, the Siemens Oil & Gas portfolio includes equipment for all stages of onshore production, including gas lift, gas treatment, export gas compression, and power supply. Dedicated compression solutions are available for dirty-gas applications, tight-gas production, and for mature fields requiring a wide operating area. Completely integrated facility automation and control systems provide for consistent operations management from the local control room to the dispatching center. Moreover, the Siemens scope of supply covers the entire lifecycle of equipment and assets, ensuring long-term reliability and ideal investment protection.

Comprehensive solutions for unconventional gas

Tight gas, shale gas, and coal-bed methane will help meet the growing demand for natural gas in many regions of the world. With our unconventional gas portfolio, you can rely on tested and field-proven equipment for all production stages, including gas lift, gas treatment, gas gathering, export gas compression, power supply, water treatment, and the LNG process. Precisely adapted system components with proven performance right from start-up are the basis for all of our solutions. An integrated electrical solution from Siemens reduces the number of interfaces and therefore your production risks.

Underground gas storage

LNG compressor train

Safe and efficient gas and liquid pipelines

Pipelines are indispensable for the safe, reliable, and efficient transportation of oil and gas and represent a fundamental lifeline for every national economy. Siemens serves the customer as an independent consultant for partial FEED activities and as a provider of integrated solutions for gas pipeline machinery, automation, electrical, security, and communication systems. This enables Siemens to supply true one-stop solutions, which make a decisive contribution to the optimization of the total cost of ownership.

The clever solution: liquified natural gas (LNG)

Partly due to growing global demand, LNG is becoming increasingly popular. To make LNG even more attractive, we have developed improvements to the reliability, efficiency, and environmental impact of the entire LNG process chain, allowing the cost-effective use of existing natural gas deposits anywhere in the world. Especially for LNG receiving terminals we offer a comprehensive energy supply, automation, drive, and IT approach – all from a single source. Dedicated plant packages include integrated automation and control solutions for unloading (jetty, berthing, mooring), storage plant, storage tanks, boil-off gas compression, vaporizer systems, and send-out.

What's more, Siemens delivers boil-off gas (BOG) compression solutions of unparalleled performance. Documented by references, their innovative designs as well as their extraordinary durability and extended operating life made Siemens the worldwide market leader in BOG recovery technology.

Pump station for liquid pipeline

Tank farms and terminals

Tank farms play an important role in the logistics of crude oil and natural gas. Like underground gas storage, they can help reduce the impact of demand spikes, and are also an important energy trading tool. We can simplify your tank farm and terminal operations and reduce your operating costs. Integrating these assets into one of our supervisory control and data acquisition (SCADA) systems allows you to closely monitor all automated processes, providing quick problem identification and isolation, saving you time and money. Our portfolio includes automated loading systems, tank gauging, distribution planning, and batch management, blending, and rebranding facilities.

Reliable and economical: gas storage

Underground gas storage facilities are an essential part of all natural-gas planning

Rotating equipment for gas-to-liquid process

and logistics. With a capacity of billions of cubic meters, they smooth out daily and seasonal swings in demand, and ensure that there will always be enough gas for customers at any time of year. Siemens solutions for underground gas storage include the full scope of rotating and electrical equipment needed to operate the facility. Compressors, gas turbines and e-drives are available with a wide range of power ratings to match specific volume flows and dynamics. Our globally recognized automation and control technology integrates all assets, ensuring maximum availability and efficiency of the complete station, and allowing fully remote-controlled operation.

Gas-to-liquid – a well-developed future technology

With rising crude oil prices and tightening environmental specifications for sulfur and aromatics in diesel fuel, gas-to-liquid (GTL) plants become ever more profitable. Their economics can be further improved by optimizing plant efficiency and availability. Siemens is a prime supplier to many GTL projects around the world, providing high-power, high-volume compressor trains for such processes as the gas reforming stage or for the cryogenic separation process used to convert natural gas to syngas. What's more, with power generation and distribution, water management, automation and control, industrial IT, and lifecycle services all from a single source, we provide a host of solutions helping to integrate utilities, run plants at optimal levels of efficiency, and ensure maximum availability.

New levels of safety and efficiency for the refining and petrochemical industry

Keeping process safety up and operating costs down, and ensuring a reliable and continuous power supply: Those are the major challenges in the refining industry today. We answer them with our comprehensive technology portfolio, featuring field-proven compressors and drive solutions for just about any refinery process, from fluid catalytic cracking, hydrocracking, and coking to platforming, sulfur recovery, and hydrotreating.

This is complemented by our range of fire and gas systems, emergency shutdown safety systems, and our pressure relief systems management service, while our economical and dependable power supply solutions guarantee power throughout your plant, right down to the motors and consumer terminals.

As a market leader in rotating equipment for methanol, olefin, and ammonia production, we can offer compressor trains for virtually all your needs, including crack gas, refrigeration, feed gas, synthesis gas, charge gas, recycle gas, natural gas, and CO_2. To help you operate your processes and plants with maximum efficiency, our distributed control systems (DCS) integrate all associated process instrumentation and integrated data visualization software.

Lifecycle Management

Technical equipment can only contribute to the bottom line when it is fully available and accessible at all times. Siemens Lifecycle Management offers solutions to engineering and maintaining the robustness of the equipment and adapting to the latest and ever-evolving technology developments. Siemens' services cover the spectrum, from front-end engineering through EPC functions to operation services.

Consulting and FEED

With our wide range of consulting services and extensive technological portfolio, we can guide our customers through all stages of a project, from initial concept development and front-end engineering design to project execution and operation.

Front-end engineering design

Consulting

Project management

Modernization and upgrade

Life extension of an existing installation often is the most cost-effective means of continued operation.
We provide our customers with the latest OEM-proven technology for extended economic viability of the asset.

Turbine service

Plant upgrade

After-sales services

From training to help desk support, and from maintenance to plant operations, we offer the full spectrum of services totally aligned with our customers' operations, including remote control and online collaboration.

Inspection and repair

Maintenance

Operations service

Consulting, engineering, and services along the lifecycle

Our technical reputation is firmly supported by Siemens Lifecycle Management with a best-in-class global customer support structure, local support offices, and remote services. This ensures fully fledged and qualified support even at the most remote location. Our service agreements ensure 24/7 availability of competent services wherever you need us.

The Siemens Lifecycle Management concept offers solutions to maintaining the robustness of your equipment and adapting it to the latest technology developments. It extends from front-end engineering (FEED) via EPC functions to operation services, and includes basic maintenance and spare-part services, modernizations, and upgrades as well as cybersecurity concepts, advanced process control, and loop tuning assistance.

All consulting services can be integrated into a fully aligned operations concept, including remote control rooms and online collaboration. Our capabilities, tools, and experience help ensure rapid, configurable, and auditable transitions from initial concept development and front-end engineering design to project execution and operation.

Efficiency starts with the right decisions: expert consultancy from Siemens

Optimal support for your individual goals: consulting services

Siemens Oil & Gas Consulting offers agile, accurate, and flexible field development planning, concept selection and design, and FEED for onshore and offshore upstream projects. Our capabilities, tools, and experience speed up the transition from concept to EPC stage, covering all aspects of technical definition, capital expenses, and operational cost estimates.

Relief system management

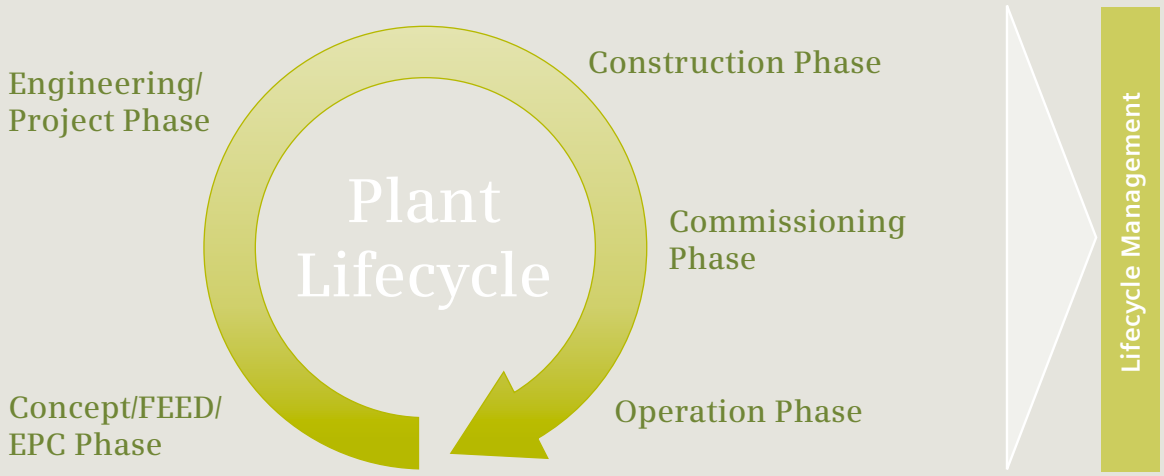
More than 3,000 baseline studies conducted worldwide underscore our comprehensive expertise to analyze, design, document, and manage your pressure relief systems, the final protection layer when other control mechanisms have failed.

Process safety management

As process facilities around the world age, our process safety expertise helps optimize mechanical integrity and provides strategic and proactive analyses of the condition of process equipment, evaluating its remaining life, reliability, and lifecycle costs.

Subsea engineering and consulting

To achieve the biggest cost benefits, we concentrate on the initial conceptual, feasibility, pre-FEED, and FEED stages, providing objective assistance with technology evaluation and selection for the development of subsea oil and gas production fields. In addition, we can help you with all the details, from studies, design, procurement, and assembly to testing and installation.



Excellence from day one: tools for improved planning and operation
Planning and calculating with the Oil and Gas Manager reduces development time and costs and integrates design preferences, benchmarks, and past project experience that drive consistency and traceability of results.

XHQ eliminates operational inefficiency by targeted aggregating and processing of operating data, and linking it in real time with business-relevant data to achieve the highest levels of plant performance, enabling better, faster, more informed decision making at all levels. COMOS leads the way from "Integrated Engineering" to "Integrated Operations" by integrating project assets over the entire lifecycle of an installation into a unified data platform. This provides plant engineers, construction companies, and operators with a seamless flow of project-relevant data across all business levels and all project stages. Our Product Lifecycle software goes beyond the benefits of computer-aided design and program management, enabling an essential environment for immersive engineering, testing, and construction management of onshore and offshore assets.

Enterprise Asset Performance Management (EAPM) is a one-stop shopping tool providing asset lifecycle information as well as standard calculated operational, safety, and risk-control performance indicators to decision makers and specialists. This helps ensure improved operations, maintenance, reliability, and business processes along with compliance and safety practices.

After-sales services: more than a must
Choosing us as the service provider for your project ensures the efficient maintenance of the machines, appropriate retrofitting, and support for your employees. Our services span the entire product and system lifecycle, saving you both money and time and increasing the annual hours of machine and system operation.

Besides a full range of services from our local and regional organizations, from on-call services to all-inclusive operation and maintenance, our centralized support center offers you wide-ranging after-sales support services customized to your long-term operation plan on a 24/7 basis. For even more peace of mind, all our rotating and electrical equipment can be connected to our Global Service and Diagnostic Centers for continuous online performance monitoring.

Modernizations and upgrades: reliable performance for years to come
Operating a facility with outdated technology can result in loss of efficiency and incremental loss of production. Upgrading equipment directly increases production performance, reliability, and operator safety. Replacing outdated, obsolete technology, we upgrade existing components or equipment with state-of-the-art features and designs to provide optimum customer value and system efficiency.

Innovations

Innovative applications from Siemens are the result of extensive, market-oriented research and development programs with a view to providing key enabling technologies for emerging processes and applications. The underlying philosophy behind all of its development activities is to provide its customers with the best possible products, services, and value for money.

CAPEX

Highest possible CAPEX productivity calls for highly efficient solutions. Our innovations help you achieve outstanding results, and allow production in harsh environments, as well as a better exploitation of reservoirs and a more efficient transport and conversion of hydrocarbons.

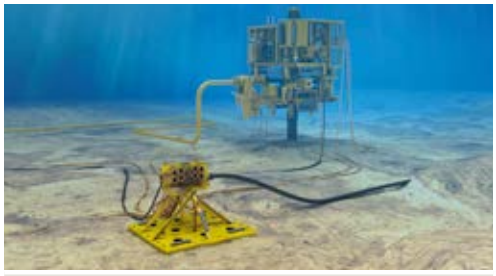
Single-lift packaged solution

Containerized artic wellhead compressor

Gear unit for jack-up rig

OPEX

Operational excellence includes aspects such as availability, HSE, and flexibility to respond to market changes in highly integrated markets. Integrated automation and IT are levers to achieve best overall results.



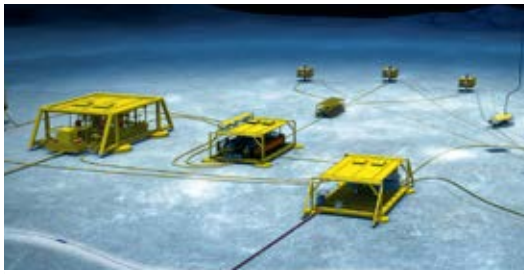
Subsea power distribution

Highly efficient gas turbine SGT 700

Less environmental impact

Energy sustainability is the key challenge. We need to secure a reliable and affordable energy supply for the growing world population. This must be combined with the environmental consequences. We accept this challenge.

Electromagnetic heating for oil sands



Subsea power grid

Driving innovations for oil and gas

Siemens has been a renowned driver of technical innovation for more than 160 years. The oil and gas industry needs innovative, safe technology for exploration and production in harsh environments, to better exploit existing reservoirs and to protect the environment. A few examples illustrate our broad array of activities.

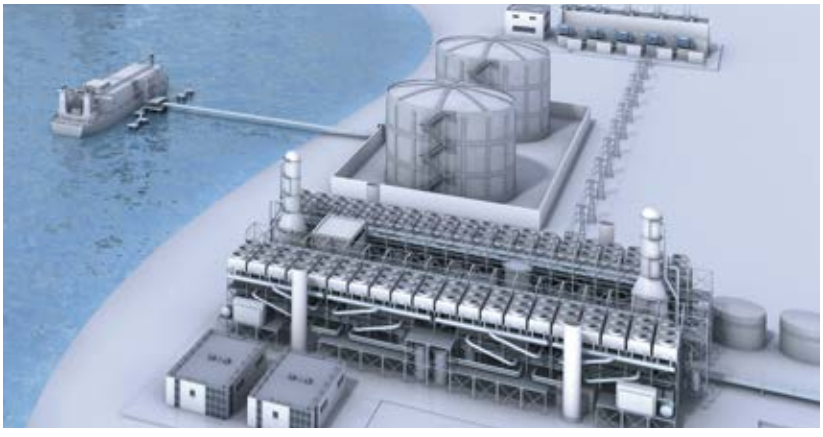
Efficiency at its best: our all-electric concept

With energy efficiency as a key factor for cost reduction and environmental concerns in mind, we have developed the all-electric concept, a solution that combines environmental and efficiency aspects ideally. With centralized, highly efficient power generation and an electric drive of rotating equipment at the core of this concept, decentralized maintenance expenses are perceptibly reduced, and emissions are concentrated in one place, where they can best be kept under control. In addition, the concept requires less energy, so that more product is available for sale.

Siemens e-LNG technologies, which use an electric motor drive for the liquefaction train, help lower operating and maintenance costs while providing higher availability, outstanding energy efficiency, and environmental compatibility. All-electric LNG plants powered by Siemens stand out as an economical and ecological approach – even though the majority of today's refrigeration compressors in LNG liquefaction trains are driven by gas turbines. The electric drives' higher availability quickly compensates for the higher initial investment in the required thermal power plant.

In pipeline projects, too, environmental demands are steadily moving into the foreground. With the all-electric concept, we have developed a solution that optimally combines both environmental and efficiency factors. Siemens' all-electric concept will unlock the efficiency potentials of your facility – whether it is newly installed or as part of a modernization. The additional investments are usually amortized within a few years.

LNG concepts: all-electric LNG, small and midsize plants



Enabling large-scale subsea processing: the subsea power grid

Subsea processing facilities are critical to boosting recovery volumes. They consist of multiple components, including pumps and compressors, all of which require power. Today, however, there are limited means for transmitting power underwater over long distances. Single power feeders are typically run from topside facilities to each specific consumer on the sea floor. These solutions add complexity and costs to subsea operations; in addition, they are simply not viable options for long step-outs, or for situations that require higher power outputs or that serve a large number of power consumers.

Opening up new subsea production opportunities: the Siemens subsea power grid

Minimizing environmental impact – maximizing production: electromagnetic heating of oil sands

Seawater reverse osmosis

Already a premier provider of subsea solutions to the oil and gas industry, Siemens is in the advanced stages of developing its subsea power grid, designed to optimize power distribution to subsea processing equipment. Our groundbreaking technology represents a radical departure from more conventional approaches to subsea power distribution, such as running single power feeders from land or placing power equipment on floating facilities. It holds the potential to make previously unrecoverable hydrocarbon resources available.

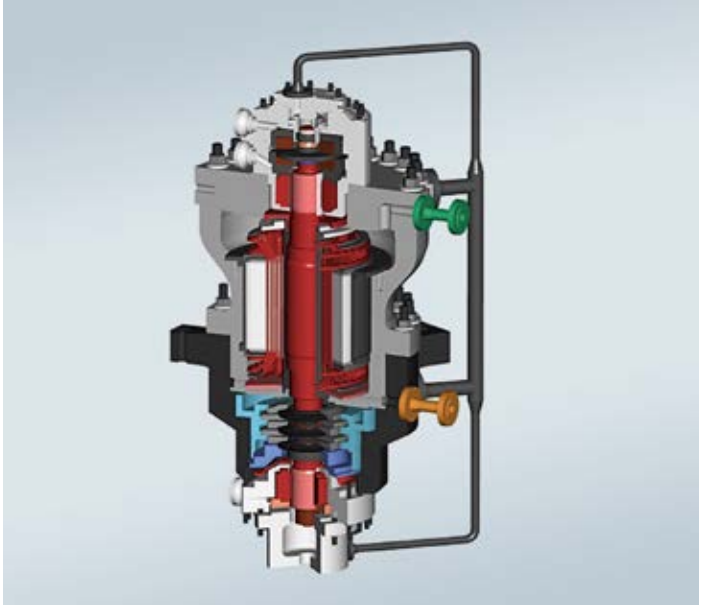
The Siemens subsea power grid is based on our proven, high-quality industrial components: transformers, switchgear, and variable-speed drives. These power components can be installed on a common base frame distributed at the seabed, and all components in the Siemens subsea power grid are retrievable.

Electromagnetic heating for oil sands (EMSAGD)

Over 40 percent of Canada's oil production is from oil sands. However, the technologies used until now require great amounts of energy, pollute large volumes of water, and involve the destruction of large surface areas. Siemens has improved the steam-assisted gravity drainage (SAGD) process. Operating as an electromagnetic underground heating, this in situ technique dispenses with the need to dig up large areas. Using electrical induction to heat the bitumen to the precise viscosity makes oil extraction easier to target, improves the extraction rate with less water and energy, and leaves the surface largely untouched.

Most effective water filtration: the Monosep™ walnut-shell filter system

The Siemens Monosep high-flow walnut-shell filter was developed for advanced filtration with a high oil-loading capacity to improve water treatment. The Monosep high-flow walnut-shell filtration system has proven to be effective for removing free oil, grease, and suspended solids in upstream and downstream produced water. The simplified proprietary filter design requires no moving equipment to perform backwashes, and greatly reduces the volume of backwash water produced compared with other walnut-shell filter designs. In addition, the filter's design helps reduce weight and footprint and lowers the cost of multiple filtration systems. A new proprietary media offers the potential for a filter to be able to withstand significantly higher oil loading and longer loading durations before requiring a backwash.



The hermetically sealed STC-ECO, suitable for dirty gas compression

Electric rack-and-pinion drive

Powerful and reliable dirty gas compression

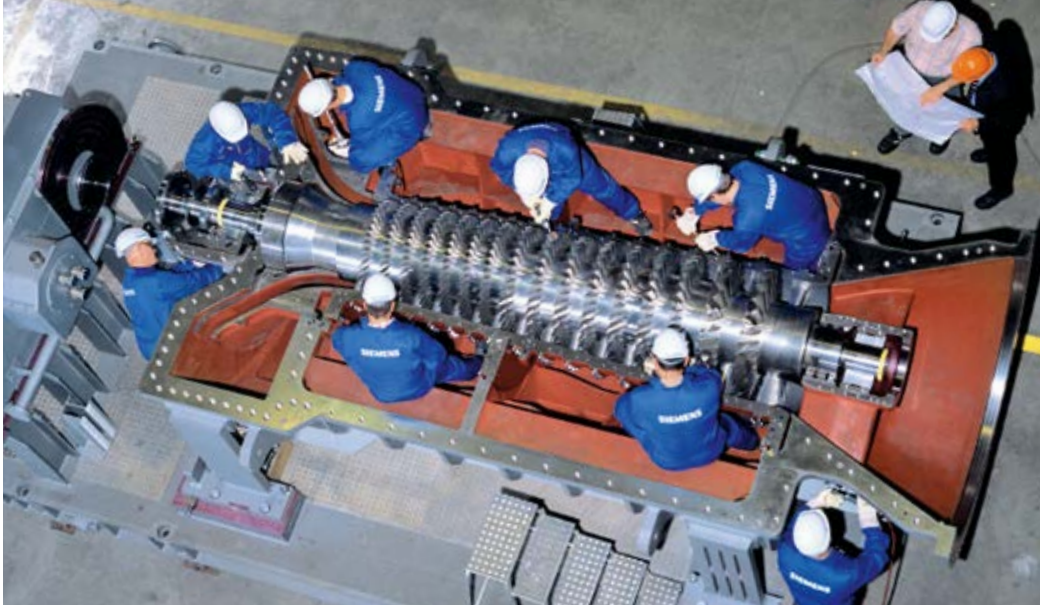
Unlike a conventional compressor, the STC-ECO is hermetically sealed and canned. This means that no contact between key components (like the motor stator and the magnetic bearings) is made with contaminated gases. This results in lower service requirements and 5-year maintenance intervals, offering superior availability and unparalleled lifetime value.

The sealless STC-ECO has been specially designed to meet the requirements of the most demanding upstream oil and gas applications. These applications have either suffered from poor seal reliability – notably upstream of the glycol dehydrator – or involve hazardous and toxic gases, containing H_2S, mercury, CO_2, etc.
The STC-ECO helps increase uptime and provides zero emission compression. Its focus applications include field depletion, gas and oil separation, gas gathering, gas lift, and many others.

Low-voltage offshore drives: reducing fuel, emissions, and weight

Our BlueDrive CLEAN systems represent a spectrum of new technologies that significantly reduce fuel, emissions, weight, and size of equipment and improve fault tolerance and uptime. We have developed a range of standard offshore low-voltage drives that can fit all essential applications on an offshore vessel. These drives, ranging from 75 to 5,500 kW, ensure a high degree of standardization, which results in minimized maintenance costs, easy servicing, and extensive spare part interchangeability.

Siemens BlueDrive CLEAN Production is a compact electrical variable-frequency drive solution designed for offshore needs. It is a standardized system for a wide range of applications that provides control over any electrically driven process, ensuring the highest levels of flexibility, safety, and reliability.



Highly efficient compressors

Less fuel, fewer emissions, more performance: power and drive systems for offshore drilling

High rig rates, increasingly stringent environmental regulations, and space constraints are among the challenges that offshore operators contend with on a daily basis. Siemens mitigates these challenges with a range of highly innovative technologies. These include the DP closed-ring power system and the BlueDrive CLEAN offshore drive system.

Our fault-tolerant DP closed-ring power system for mobile offshore drilling units ensures a redundant power supply to vital consumers like drilling and thruster drives. It minimizes the number of engines online, for optimized operational performance. Specific advantages of its unique design include reduced fuel consumption, lower emissions, and diesel engines that run at a higher load level. The highly compact BlueDrive CLEAN offshore drive system is widely used in the marine and offshore oil and gas industries. Applications include drilling, thrusters, and electrical jacking. Regardless of the application, BlueDrive CLEAN delivers field-proven dependability and a space-saving design.

Safe, efficient, and clean: diesel-electric propulsion system BlueDrive Plus C™

Siemens' BlueDrive Plus C™ diesel-electric propulsion system offers an attractive alternative to more conventional propulsion systems for offshore service vessels. The system is built to maximize fuel efficiency and significantly reduce emissions of greenhouse gases. In addition, its innovative design helps reduce engine maintenance costs and total energy consumption compared with other diesel-electric propulsion systems.

Modular LNG production plant

Dresser-Rand's LNGo™ system is a modularized, re-deployable natural gas liquefaction plant capable of producing 6,000 gallons of LNG per day. This point of-use production plant is a standardized product made up of four packaged skids: a power module, compressor module, process module and a conditioning module. Inlet natural gas is converted to LNG product and used as a process refrigerant. A small portion of the inlet gas is used to power the plant. With a small footprint, low emissions, skid-mounted portability, and no external power utility requirement, liquefied natural gas is ready at hand with the LNGo system.

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Attachment 2: LNG*o* Technology Brochure

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Attachment 3: Liquefaction Services Agreement (LSA)

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