

Into the wild

Margarita Panina, Siemens, Russia, and Navneet Jindal, Siemens, Singapore, explain how an LNG facility in remote Siberia is overcoming harsh conditions with cost-effective design and development.

According to the US Geological Survey (USGS), approximately 30% of the world's undiscovered natural gas is in the Arctic region.[1] While extracting gas from these reserves is no small task, neither is developing the infrastructure to safely and cost-effectively deliver it to destination markets. Developing LNG plants in such harsh and remote operating environments presents unique challenges in an already complicated undertaking. Siemens has extensive experience helping operators overcome the adversities of Arctic LNG development, with a focus on design and power solutions. One example where the benefits of these solutions have been on display is the Yamal LNG project in Russia (Figure 1).

About Yamal

The Yamal LNG project is one of the world's largest LNG facilities and features an integrated natural gas liquefaction complex with a capacity of 16.5 million tpy. It is currently being developed from gas reserves within the South Tambey Field near Sabetta, northeast of the Yamal Peninsula in Siberia. The production complex will consist of three process liquefaction trains with a capacity of 5.5 million tpy each. Plans outlined for the Yamal LNG project include the construction of an LNG plant, a processing facility for gas and condensate treatment, gas transmission pipelines and well sites. A power plant with a designed capacity of 376 MW is also being constructed to support the LNG plant's operations with electricity and heat.

The Yamal Peninsula is estimated to hold some of the largest gas reserves on the planet. However, it is also known for its inhospitable conditions, which makes developing the infrastructure to capitalise on these resources a daunting challenge. For example, the region is primarily made up of marshes, which presents many difficulties for drilling and

construction operations. Adding to this is the fact that, for a significant portion of the year, daylight is limited. The Yamal Peninsula is also highly remote, with virtually no local workforce. This is especially the case when it comes to the type of specialised personnel that is required to execute large scale oil and gas projects. Owing to the harsh environmental conditions and limited infrastructure in the region, the construction of the Yamal LNG facility is being carried out in offsite locations using modularisation.

Selecting equipment for harsh climates

Siemens has played a crucial role in the development of the Yamal LNG project, supplying critical components for the 376 MW power station, including eight SGT-800 industrial gas turbines, as well as nine step-up transformers. Four of the turbines are equipped with waste heat recovery units. The SGT-800 industrial gas turbine (Figure 2) is especially qualified for harsh climatic conditions, such as those in areas north of the Arctic Circle with temperatures below -50°C.

Short installation and commissioning time was required onsite due to the extremely remote location and the cold climate. To facilitate this, all eight SGT-800 gas turbines went through factory testing at a Siemens test facility in Finspång, Sweden (Figure 3). For the first unit, a string test was performed in order to verify operation of the turbine package, including the generator. For the other seven units, the core engines were tested in the factory's mechanical running test (MRT) facility. All eight turbines were manufactured and dispatched to the site on time. Seven of the turbines are currently in operation, with the eighth set to come online later this year.

Siemens and Yamal also signed an equipment maintenance contract for the facility's power plant. The contract allows for stepwise expansion of gas turbine maintenance localisation in Russia, customer personnel training and training simulators and programs. As part of the contract, the gas turbines will be linked with a Moscow-based remote centre for equipment monitoring. The contract is one of the only agreements in which the field developers decided on maintenance of an LNG plant's equipment for the entire project base period of 22 years.

Modular e-houses

In addition to the turbines and maintenance contract, Siemens supplied 29 modular e-houses (Figure 4) for Yamal, including the world's longest and heaviest building with dimensions of 90 m x 40 m and weighing 2500 t. Siemens facilities all over the globe procured the major electrical and automation equipment for the e-houses. The engineering was carried out by the team in Singapore, while the Siemens fabrication yard in Batam, Indonesia, was used for the construction of the modules. The e-houses were delivered in five separate batches, the last of which arrived safely and on time in May 2017.

As pre-fabricated electrical substations, fully equipped with medium-voltage switchgear, low-voltage switchboards, busbar trunking systems and auxiliary equipment, e-houses are the optimal approach to install electrical power and control equipment for a fast and reliable power supply in harsh environments. The e-houses for Yamal were developed, manufactured, assembled and pre-tested at the construction yard, then connected and put into operation onsite.

Various types of e-houses are available to suit any application requirement. A standard e-house, for instance, consists of one module on a pre-cast foundation, whereas a mobile substation is an e-house module on wheels or support that can be relocated with its foundation. Multi-modular e-houses are also available. They consist of several modules that are placed on a foundation, either on top of or next to each other. This enables transportation of large houses and ensures optimal use of available space. E-houses can be installed on raised platforms to protect



Figure 1. Yamal LNG facility, with the power plant in the centre (courtesy of Yamal LNG).

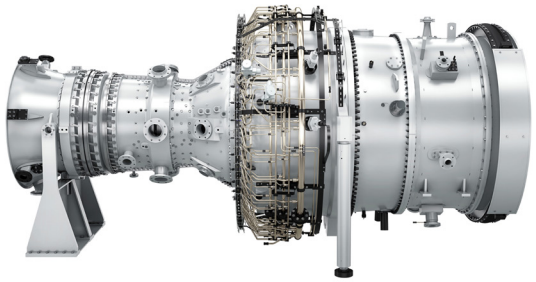


Figure 2. Siemens SGT-800 industrial gas turbine.



Figure 3. String test at Siemens' test facility in Finspång, Sweden.



Figure 4. E-House module at Yamal site.

them from flooding, and to allow for installation of cable tray and bus duct systems underneath the structure, thereby minimising the need for excavation.

Modularised 'plug and play' e-houses can provide many benefits to LNG projects, particularly those located in harsh environments. Some of these include the following.

Cost savings

E-houses are standardised solutions that can offer cost-saving potential of up to 20%. Much of these savings are attributable to lower planning costs and reduced civil work onsite. Savings are also realised by pre-fabricating modules offsite in a controlled environment, which reduces dependency on expensive skilled labour in remote areas and ensures the quality of the equipment being built.

Shorter schedules and reduced construction risk

Because e-houses arrive fully equipped and pre-tested, there is no risk of construction or commissioning delays due to uncontrollable factors, such as inclement weather. As 'plug and play' solutions, e-houses can often be rapidly installed and brought into operation, reducing lead times by as much as 25%. Minimising the need for onsite work also reduces the likelihood of interference or overlapping between onsite activities, which can be problematic with large scale projects such as LNG facilities.

Improved EHS performance

Another added benefit of using 'plug and play' e-houses for LNG projects in harsh climates is improved environmental, health and safety (EHS) performance. At the Yamal LNG project, for instance, all 29 modules (which were some of the largest and heaviest ever built for an LNG project) were delivered with lower than 0.1 total recordable injury rate (TRIR – the number of reportable cases suffered by the workforce for every 200 000 hours worked), which is significantly lower than industry averages. Overall, the Yamal project achieved more than 15 million safe working hours.

Looking ahead

In the coming years, as operators increasingly venture into remote regions of the world to capitalise on abundant oil and gas resources, the demand for innovative equipment solutions and associated infrastructure that can improve safety, reduce costs and mitigate risk will increase immensely.

While modular e-houses have been employed in the oil and gas industry for many years, they are becoming an increasingly popular option in remote areas, such as the Arctic, where harsh conditions and limited access to skilled labour can increase project cost and complexity. In these cases, conventional site-built power substations are often too expensive or time-consuming. In other cases, the project schedule or the actual space does not allow for site-built construction, and building permits for conventional buildings are not available. E-houses are the ideal solution in all these cases. They can be installed rapidly, thus reducing interferences with other activities, and can easily be adapted to virtually any situation and application.

The Yamal LNG project in Siberia is a prime example of the many benefits that can be achieved when world class best practices and global integration of knowledge and expertise are combined with innovative equipment solutions, such as 'plug and play' modular e-houses. The strategies employed by Siemens and other key stakeholders to successfully deliver this mega-project on time and with record EHS performance can be used as a basis for the development of future LNG projects, particularly those that are being proposed in highly remote and inhospitable regions. LNG

Reference

1. Source: MAP: Undiscovered Artic Oil and gas and Potential Trade Routes. https://www.brookings.edu/blog/brookings-now/2014/03/26/map-undiscovered-arctic-oil-and-gas-and-potential-trade-routes/.

The described technologies in this article now belong to the Siemens Energy portfolio.