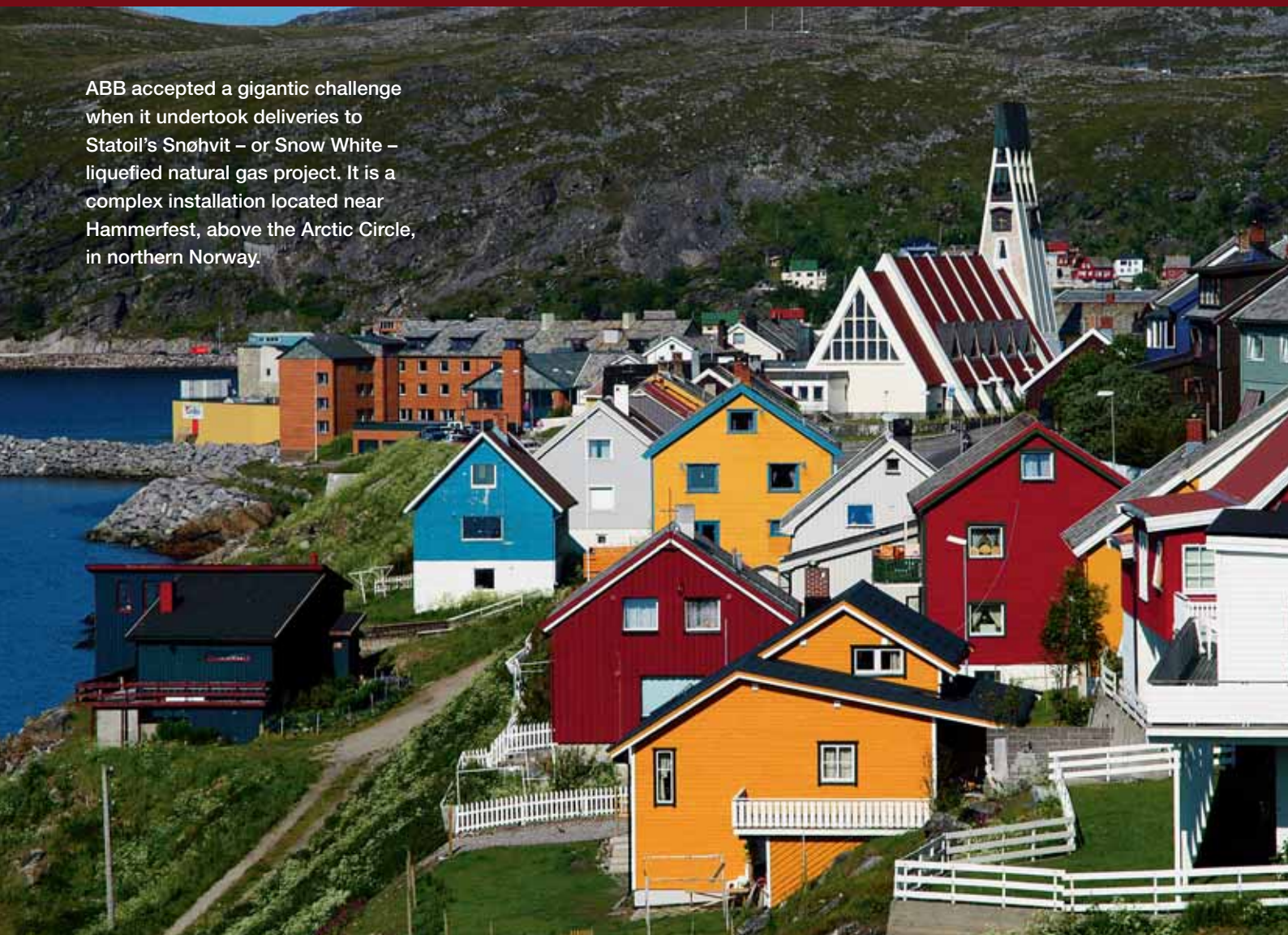


The Arctic challenge

The enormous Snøhvit project beyond the Arctic Circle is a challenge for ABB engineers

Peter Tubaas

ABB accepted a gigantic challenge when it undertook deliveries to Statoil's Snøhvit – or Snow White – liquefied natural gas project. It is a complex installation located near Hammerfest, above the Arctic Circle, in northern Norway.



Ingenuity and energy

Named after the famous fairytale character – the vast Snøhvit gas field might become a true fairytale itself, and not only for Statoil **Factbox**. It is located in a part of Norway that has traditionally been dependent on the fishing industry and the installation will be a boost for the local community. As a major contractor, ABB will also benefit, along with other companies involved in the project. The road has been long and winding since Statoil discovered the field in the early 1980ies, but the project is due to be commissioned in the summer of 2006.

ABB and LNG

The global centre of excellence for the Liquefied Natural Gas (LNG) business is hosted by a department within ABB in Oslo, Norway. It is from here that most of the Snøhvit project has been coordinated. The automation system was designed and fully tested at ABB's department in Bergen.

ABB's role in the project is highly significant. ABB supplied the gas processing plant with a range of electrical equipment and control systems. In the initial contract, the customer specified short delivery times combined with high-quality products, solutions and services. ABB met these requirements, delivering first-rate equipment and services, on time, throughout the project.

"Snøhvit is an example of excellent co-operation with the customer. Thanks to thorough planning and close dialogue with Statoil, we have been on schedule from day one. It has been a most challenging project, which has brought [out] the best [in] ABB's employees and products," says Sturle Rippe, project manager for the Snøhvit safety and automation system (SAS) deliveries.

Snøhvit background

The past four years have turned the uninhabited island of Melkøya **1**, not far from the town of Hammerfest, into the largest building site in Northern Europe, and the largest construction project that Norway has ever seen.

In a few years' time, gas from the Snøhvit field, approximately 140 kilometers offshore in the Barents Sea, will be flowing into the gas processing plant for treatment and shipping to the global LNG market. The core products of the plant are liquefied natural gas (LNG, 5.75 billion m³ / year), liquefied petroleum gases (LPG, 247,000 tonnes/year) and condensate (747,000 tonnes/year). All products are exported by ship.

Snøhvit is the first development in the Barents Sea. The oil and gas fields were discovered in the early 1980ies. Combined with the adjacent Albatross and Askeladd fields, Snøhvit contains more than 300 billion m³ of natural gas. Gas will be extracted from the seabed using subsea solutions, which are operated remotely from Melkøya. The subsea control system was delivered by ABB in the UK (now Vetco Aibel). The Top side of the subsea control system, which is an integrated part of the overall SAS, was delivered by ABB at Stord in Norway.

Safety systems have long been an integral part of ABB's technology. The objective of such systems is to monitor hazardous situations and to handle any safety-related issues, safely and securely.

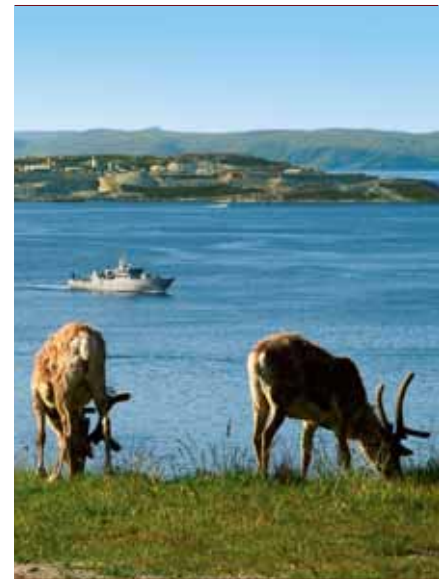
Arctic challenges

Snøhvit is an extremely complex installation, which, combined with hostile weather conditions, presented ABB with a number of challenges.

At 70 degrees north, Hammerfest **2** is well above the Arctic Circle and claims to be the most northerly city in the world. The equipment used in the Snøhvit project will be exposed to severe conditions.

"The climate has been a major issue for us. Outdoor equipment has to meet extreme requirements. A lot of installations have sensitive electronics. All of the equipment [has been] tested in all conditions and we are con-

1 Reindeer with Melkøya in the background
[Photo: Marit Hommedal/Statoil]



2 Map of northern Norway



Men at work on the Snøhvit installation
[Photo: Marit Hommedal/Statoil]



vinced it will withstand the cold and moist weather in the Barents region”, ensures Sturle Riple.

In complete control

By working closely with customers over the years, ABB has developed a proven methodology for the delivery of integrated automation systems, including a complete range of standard and specialized products and systems addressing the industry’s particular requirements and challenges.

Safety systems have long been an integral part of ABB’s technology. The objective of such systems is to monitor hazardous situations and to handle any safety-related issues, safely and securely. The first integrated safety and control system was supplied by ABB in the mid 1980ies. The current Industrial^{IT} 800xA, which is now the leading automation system in the oil and gas industry, has a secure safety system at its core.

No system is more critical to the processing plant than the combined safety and automation system. The number of signals running through the Snøhvit process plant is enormous; the control system has to handle more

than 30,000 signals simultaneously. An unscheduled halt in production is extremely expensive. Therefore, ABB’s control systems are constructed and tested to provide the highest level of security and minimal downtime.

“We tested the complete system in Bergen before we shipped it to Hammerfest in December 2005. The equipment is now fully installed and powered up on site”, says Sturle Riple.

The installed ABB 800xA system is fully redundant on all levels.

Process overview

The process of the Statoil’s Snøhvit field is extensive, encompassing subsea control processing, complex LNG processes, storage and loading of the final products.

The philosophy of Statoil has been to provide its operators with “a single window” into this large process plant. To accomplish this, the 800xA Extended Automation system from ABB was chosen as the operator interface for the safety and automation systems.

High reliability and availability were additional criteria required of the Snøhvit automation system. The installed ABB 800xA system is therefore fully redundant on all levels, ie, it contains redundant Profibuses, controllers, network, 800xA servers and clients.

Ergonomics

The project phase has lasted more than four-years, during which emphasis has been placed on providing operators with the best possible ergonomic environment. Under normal production conditions, this large and complex plant will be controlled by only three operators, located in a single control room. A fourth operator will be mobilized during loading.

A large projection screen, forming a 1.5-m × 16-m curve in front of the operators, displays key, top-level process information from the 800xA system. Eight ceiling-mounted projectors are

used to display information from the 800xA system projects in one continuous graphic. Video information from the plant’s closed circuit television system is also integrated into the display, allowing process information and live video to be presented alongside project data on the screen.

The purpose of such a large screen is to provide operators with a complete process and status overview, enabling optimum cooperation between operators. Special symbols have been developed in the 800xA system so that information can be delivered in a way that speeds the identification of abnormal process situations. The large-screen layout and symbols are based on the Rich Information Display concept developed by the Institute for Energy Technology (IFE) in Halden, Norway.

Alarm functionality

To reduce the workload of the operators, the built-in alarm management functions in the 800xA systems have been used extensively. The alarm management is based on the following key points: prioritization of alarms, routing of alarms to the responsible operator, easy access to alarm classification information, group alarms, trip alarms, and alarm suppression.

From the alarm list, the operator can access detailed alarm classification information by just clicking on the Alarm classification object in the context menu of the 800xA system. The alarm classification window, which then appears, provides information such as time to react, possible causes and consequences of the problem, and suggests corrective actions to be taken by the operator.

Plant power demand

The total annual power requirement of the Snøhvit plant is approx 1,65 TWh. The plant has five gas turbines, generating 5 × 50 MW of electrical power. These drive three liquefaction compressors. Exhaust heat is used to meet process temperature requirements.

All electrical equipment, including the electrical control and supervision sys-

Factbox Statoil

Statoil is an integrated oil and gas company based in Stavanger, Norway. It is engaged in exploration and production in 15 different countries and operates 24 oil and gas fields on the Norwegian Continental Shelf. It is represented in 33 countries.

The company accounts for 60 percent of all Norwegian petroleum production and, as operator of 23 seabed facilities, it is a leader in subsea production.

The company operates approximately 2,000 service stations in the Scandinavian countries, Poland, the Baltic states, Russia and Ireland.

Statoil is one of the world’s most environmentally-efficient producers and transporters of oil and gas.

In 2005, the group had 25,644 employees and its total revenues came to NOK 393 billion (approximately \$65.5 billion).

Ingenuity and energy

tem (ECSS), was delivered by ABB as a single package. Originally, four separate purchase orders had been issued: high-voltage switchgear, medium-voltage switchgear, low-voltage switchgear and ECSS. These were later merged into one to help meet the different interface challenges associated with such a large electrical scope.

Electrical power requirements

ABB's electrical deliveries to Snøhvit are vast and consist mainly of systems based on ABB's wide portfolio of electronic components. They include high-voltage, medium-voltage and low-voltage switchgear and ECSS. The delivery represents a full range of electrical distribution and drive solutions, all delivered in accordance with oil and gas industry standards. These

solutions generate customer benefits in terms of lower operating costs and reduced emissions, while at the same time increasing safety.

The high voltage switchgear is of the EXK-0 type, which is rated for 145 kV. The installation includes a medium-voltage switchgear, UniGear ZS1, with three switchgears rated for 11 kV and one for 6,6 kV. Both switchgears are equipped with an optical arc detection system.

ABB has delivered a total of 28 low-voltage switchgears of the MNS type to Snøhvit, rated for 690 V and 400 V. They consist of 500 cubicles with 2500 consumers. Many are equipped with intelligent motor starters, which provide the customer with all of the

necessary system-critical information. Troubleshooting and correction of errors will be quicker and can be performed remotely, ie, with fewer resources on site.

To ensure the highest level of security, the high-voltage and medium-voltage panels, as well as the low-voltage equipment, are equipped with ABB's protection and control unit, the REF542.

The ECSS is at the heart of the electro system and communicates with the vast range of equipment using serial links and Ethernet. It is also linked with the automation system and third-party deliveries. The system consists of 48 AC800M controllers. With more than 43,000 signals being processed at any one time, the ECSS provides a wide range of functions, enabling stable power to be supplied to the LNG facility.

3 Overview of the liquefied natural gas factory on Melkøya, northern Norway
[Photo: Eiliv Leren/Statoil]



Changing requirements

Meeting the strict requirements of the LNG business in such a short time was the biggest challenge for ABB. The time available to design and complete the deliveries was limited and, when the contract was signed, the design of the electrical installations was very preliminary. The scope of electrical equipment, especially low-voltage switchgear, increased tremendously during the project phase.

Due to Snøhvit's remote location and challenging climate, the equipment had to be extremely reliable, and yet compact enough to fit within the limited space available. Additional constraints were placed on electrical equipment because they had to be pre-installed on a barge. This was done in the quiet Mediterranean Sea to avoid the impact of the weather in Northern Norway. The barge was then transported to Melkøya, where it was cemented into a prepared dock and connected to the rest of the facility.

Snøhvit is a challenging project and all of the different operations systems must interact with each other to ensure safe operations and maximum efficiency. This requires thorough planning. ABB has delivered all of the

engineering services, including a wide range of necessary studies conducted in cooperation with ABB in Germany. ABB also ran tests on all of the modules and the systems prior to installation, and also on site after installation.

Power management

To prevent multimillion-dollar shut-downs, liquefied natural gas complexes must have a reliable and stable energy supply. In areas where the public electricity supply is unreliable, or non-existent, LNG companies rely heavily on their own power generation capabilities; if an inconsistent power supply causes a single unscheduled trip, several days of production will be lost, at a cost of more than \$10 million.

In response to this problem, almost every new LNG facility now includes a power management system (PMS). But most systems begin and end with SCADA (supervisory control and data acquisition), which simply isn't enough. An effective power management system must achieve several goals. It must withstand large disturbances, from inside or outside the system, while maintaining stable operation. It must balance energy demands with the available energy supply, thus preventing disturbances and black-outs. It is necessary to ensure that the

plant power system design is correct, in order to control energy costs, enhance safety and mitigate environmental and health impacts.

ABB has now delivered and commissioned more than 30 Power Management Systems, demonstrating that the PMS substantially improves plant uptime, efficiency and reliability.

The power management system should monitor equipment continuously to ensure optimal performance and stability over time. The extremely fast dynamic properties of the electrical process require quick response times – on the order of milliseconds – to prevent protection relays from issuing trip commands that lead to equipment overload and eventual shut-down.

If a system is capable of handling all these criteria, the return on investment for an LNG facility can be measured in weeks, not years. The principal gains can be made in the areas of power generation efficiency, import

and usage under varying operating conditions, and minimized capital expenditure on the power system.

For example, ABB's Industrial^{IT} Power Management System (PMS) contains not only traditional SCADA functionality, but also a full complement of electrical solutions, including power control and load shedding. ABB has now delivered and commissioned more than 30 Power Management Systems, demonstrating that the PMS substantially improves plant uptime, efficiency and reliability. These results have a very positive impact on both capital and operational expenditure.

Experience counts

With the global demand for fossil fuels continuing to outpace supply, the production and delivery of oil and gas have never been more challenging. Customers like Statoil rely on experienced and proven companies, such as ABB, to meet the demands of these difficult endeavors.

With more than 50 years of experience, in over 40 countries, ABB is the premiere supplier of the critical systems and technologies that make the supply of oil and gas possible. Innovation through experience and a proven ability to handle large projects in automation, telecommunication and electrification distinguish ABB as a leading supplier to the industry.

"We are proud of what we have achieved in such a short time and we are sure that Statoil once again will be pleased with our deliveries", concludes Riple.

Process maintenance [Photo: Marit Hommedal/Statoil]



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