

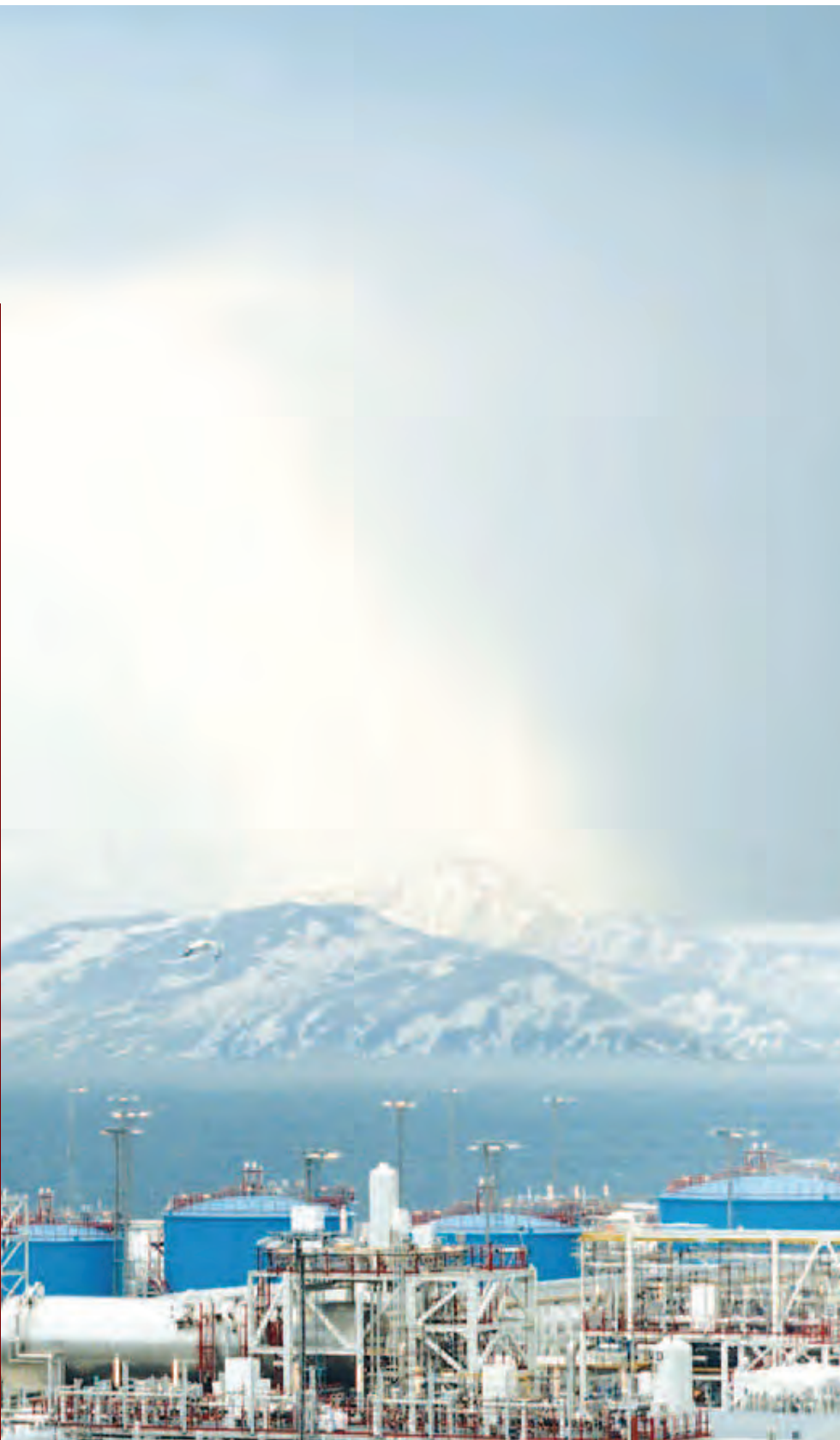
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70° 39' North — Sophisticated Wilderness

End of this year, Statoil's Melkøya Island LNG plant near Hammerfest, Norway, will start operation. It will be the world's northernmost LNG facility, and the first ever all-electric natural gas liquefaction plant. Four massive 65-megawatt (MW) Siemens variable speed drive systems (VSDS) work at the heart of the plant, together with a range of compressors for CO₂ re-injection, methane mix and other applications.

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Allegedly the world's northernmost town, Hammerfest has always been a point of interest for European tourists roaming the Scandinavian fjells and fjords. Once having crossed the Polar Circle, visiting Hammerfest has been and still is a must for many.

The town's traditional economic basis has been fish, not tourism. And, at times when there was still enough fish in the seas off Northern Norway, Hammerfestians were quite picky about what they had in their nets. Mackerel, a delicacy elsewhere, they considered 'yfish', or 'unfish', merely good enough for bait.

Today, however, the fruits of the sea would hardly provide a sustainable economic basis. Instead, while marvelling at the eternal beauty of the Bay with its glorious sunsets over melting winter snows, the visitor will notice that Hammerfest has become something of a boomtown. Here the excitement is gas — natural gas. Hammerfest has become the site of one of the most highly profiled infrastructure projects in recent times, as the mysterious ways of gods and men are beginning to resolve themselves recognizably into the world's most northerly LNG plant, which is due to come on line in December this year.

In Search of Snow White

It was between 1981 and 1984 when Statoil, the state-owned Norwegian oil and gas company, prospected three huge gas fields in the Barents Sea some 140 km off the North Norwegian coast. Baptized Snøhvit, Albatross and Askeladd, they were estimated at a cumulated volume of 317 billion standard cubic meters. While this was positive news, the remoteness of the fields required a fresh approach for bringing the gas to consumers. Adopting new technology has allowed Statoil to achieve what few people had thought possible — the first offshore development in the Barents Sea. Without surface installations, this Snøhvit project involves bringing huge volumes of natural gas to land for liquefaction and export from the first plant of its kind in Europe.



Photos: Florian Sander, Illustration: Ji-Young Ahn

Total capital investment of Snøhvit, as the overall project is labelled, will be in excess of 59 billion Kroner, equivalent to some 9.7 billion USD, including the development of the three fields, the subsea wellhead installations, the subsea pipeline to Hammerfest and the land plant. The latter is the most prestigious part of the project; it made Hammerfest a point of interest for the global oil and gas industry.

Barge Plant

Due to the geographical conditions in northern Norway, the majority of the gas liquefaction unit, with the refrigerant compression trains at its core, could not be assembled onsite. This led to the development of the barge concept by the Snøhvit project lead Statoil ASA, in which components were assembled on the barge, fitted in place, and the entire barge being subsequently shipped to Norway on a heavy lift ship.

Upon arrival at Melkøya Island on July 13, 2005, the barge was floated into land and the components were integrated into the site, a specially preconstructed dock which had been prepared to receive them. The raft, complete with components, was cemented into place to become

an integral part of the site. This neat and speedy arrangement is considerably more economical than building on land, and greatly reduces the need for steelwork. Two air compressors were shipped out separately and transported directly to Melkøya Island, as their function in the air separation unit is independent of the 'barge plant'.

Although the extreme weather conditions in northern Norway meant that the barge was assembled in Cadiz with its more moderate climate, the environmental conditions in southern Spain actually added to the challenges involved in the project. During the many months of installation work on the compressor packages, with the weather changing from frosty to tropical, and the works premises changing from dusty to muddy and vice versa, the challenge was to coordinate the work with many other vendors, disciplines and trades, whilst hundreds of workers swarmed in and out of the many decks and compartments on the barge. At the other extreme, installation of the air compressors at Melkøya was accompanied by heavy snow and frost, and the wind chill of wintertime.

Going 'Hot'

In December 2006, Statoil received approval from the Petroleum Safety Authority of Norway (PSA) to start operation of the Hammerfest LNG plant on Melkøya island. Authorization to receive the first wellstream from the field and to start normal production at Melkøya were also included.

As a result, four years of detailed and laborious preparations are about to reach their climax, and the formerly deserted island of Melkøya will never be quite the same again. Armies of precision-drilled engineers are making their final tests and measurements, and engineered supplies from all over the world are being linked, trimmed and primed for action.

Considering the total scale of the Snøhvit megaproject, Siemens role is quite humble, but nonetheless exhilarating, and challenging in terms of technology, management and coordination. In addition to the massive 65-MW VSDS electric motors driving the plant's refrigerant compressors, Siemens supplied six compressors used at various stages of the gas liquefaction process and for CO₂ re-injection.

The first offshore development in the Barents Sea:
The Snøhvit, Albatross and Askeladd fields,
some 140 kilometers off the North Norwegian coast.



Two of them together were the largest ever to leave the factory in Duisburg, Germany, when they were shipped in 2004. This was before Siemens invested in a new testbed for megascale compressors and drives which are currently in demand for the gas liquefaction industry.

The Siemens units were manufactured for the specific conditions prevailing in the Arctic region and are designed for ambient temperatures down to -22°C. Special technical features include glass reinforced plastic (GRP) water lines, the use of many high-quality stainless steel materials, winterization with heat tracing and weather protection, and demanding, accurately separated coating systems such as thermally sprayed aluminum. All compressors, apart from the air compressors, are equipped with dry gas seals, which require sophisticated, highly complicated seal gas systems with a lot of piping to and from the compressor.

Re-injecting CO₂

The compressors will be used at various stages in the gas liquefaction process, including CO₂ re-injection. In addition to the six production wells, drilling at the Snøhvit field included

one well for the re-injection of carbon dioxide — one of the main components of natural gas. Gas from the Snøhvit area contains five to eight percent CO₂, which will be separated out at the land plant.

The CO₂ will be compressed from 1 to 61 bar by the 24-XT-101 compressor, the largest of the turbo-compressors, with a capacity of approximately 100 tonnes of CO₂ per hour, at a rating of 10 MW. As it is then cooled to approximately 15°C, the CO₂ condenses to liquid, which is then pumped back in a separate line for underground storage beneath the seabed at the Snøhvit field. This has the advantage of saving CO₂ emissions tax, an important consideration in Norway.

The remaining Siemens compressors are used to process the various natural gas fractions. Four compressors are part of the 'barge plant', the core of the liquefaction process. The 60-XT-101 compressors will be used to supply air to the air separation unit that is a vital utility for the liquefaction plant. Nitrogen (N₂) is provided to the plant once it has been separated from the air.

Paving Future Avenues

Snøhvit is the first offshore project in the Barents Sea and will be the first LNG producer in Europe. Meticulous environmental standards have been incorporated into the development solution, which is highly researched, and the largest industrial development in the history of northern Norway. Statoil also aims to find new gas resources in the Barents Sea in order to increase the capacity of the onshore Hammerfest LNG plant. Parts of the Snøhvit gas will be exported to the USA, and U.S. authorities have approved a twofold increase in the receiving capacity at Cove Point, Maryland, LNG import terminal.

Statoil believes that LNG will become a considerable element in the group's marketing strategy. The global gas market is growing, and thanks to LNG technology the markets can be supplied with gas that will not be available as pipeline gas. The Snøhvit development is a first step for Statoil in the development of the gas resources in the far north. While carrying the name of a fairy tale character, Snøhvit has already become a fascinating part of reality.