Ormen Lange, new key provider of natural gas to Europe
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Abstract
Ormen Lange is the name of the second-largest Norwegian gas field and was discovered and identified by Hydro in 1997. The Ormen Lange field comprises four key project features: The offshore subsea solution, approximately 100 km off the northwest coast of Norway, with templates, manifolds and pipelines; the onshore process and gas export facilities at Nyhamna, on the coast of Møre and Romsdal County; the gas export transportation system between Norway and the UK, through a tie-in to the Sleipner field installation as a distribution connector; and the Easington gas reception terminal in the UK. The Ormen Lange field development project is of vital importance, not only to its owners, but also to Norway—making the country the third-biggest exporter of natural gas worldwide. On December 4, 2003, a plan for development and operation (PDO) was submitted to the Norwegian authorities, to embark on the project’s execution phase. The project has been subjected to extraordinary, and in particular technical and commercial challenges which have required the development of and a focus on new management systems and systematic work processes. This paper provides an introduction to the elements that collectively represent the entire Ormen Lange field development, including the key technical and commercial challenges, as well as the management strategy, utilizing systematic work processes to achieve alignment and efficient progress while preserving the environment, personal health and assets.

Introduction
The Ormen Lange field is the first deepwater project on the Norwegian Continental Shelf, and is currently the largest oil and gas development worldwide. Through this project we have moved offshore developments out of the medium depth waters in the North Sea to the new and exciting deepwater areas of the Norwegian Sea. When Ormen Lange comes onstream in October 2007, it will have also contributed to significantly improving the Norwegian gas export infrastructure by increasing volume capacity by 25%. The field’s annual gas production of 21.4 billion cm is equivalent to total end consumption of energy in Norway. If all the gas is exported only to the UK, it will cover between 15 to 20% of the country’s total near-future gas demand. The giant serpent, Ormen Lange, reaching all the way from Nyhamna in Norway to Easington on the east coast of England, will be the longest and largest subsea pipeline ever built, with 42” and 44” diameters and a length exceeding 1,200 km. This development, as a whole, is not near the end. It’s not even close to the beginning of the end. It has, by submission of the PDO to the Norwegian authorities on December 4, 2003, merely commenced on the end of the beginning!
Most of the oil and gas fields - on the Norwegian continental shelf (NCS) are named after characters drawn from Norse Viking mythology. Ormen Lange is no exception. During the Viking period, it was believed that the world was an island surrounded by an endless sea on all sides. Deep within that sea lived a giant serpent that was so long it encircled the whole Viking world, and gave name to the biggest and most famous Norwegian Viking ship “Ormen Lange.” The name “Langeled,” used for the gas export system part of Ormen Lange, means “the long and windy road”.

![Fig. 2. The giant serpent Ormen Lange as it enters the UK on a dark night in 2006.](image)

**This is Ormen Lange**

The Ormen Lange field, discovered by Hydro in 1997, is located in the Norwegian Sea, 100 km off the northwest coast of Norway. The water depth is 850 to 1,100 meters, making Ormen Lange the first real Norwegian development at these water depths. With recoverable gas estimated at 397 billion Sm³ and 28.5 million Sm³ of condensate, Ormen Lange is the second largest gas field in Norway.

Nyhanna, on the west coast of Norway, has been selected as the site for an onshore processing plant. From Nyhamna, the gas will be exported in a new pipeline, via the Sleipner riser platform in the North Sea, to Easington on the east coast of England.

The total investment cost for the Ormen Lange project development, from reservoir to market, is estimated at NOK 66 billion (2003) (USD 9.4 billion) – approx. NOK 46.5 billion (USD 6.6 billion) for the field development and approx. NOK 19.5 billion (USD 2.8 billion) for the transport system. The major part of the investments will take place in 2005 and 2006.

The development plan for the Ormen Lange field offers improved economics when compared with the concept selection basis of a year ago, even though the upfront investment cost has increased. This is due to an increase in recoverable reserves, increased production levels, higher processing capacity, higher transport capacity and more flexibility and robustness in the proposed concept.

Ormen Lange is planned as a subsea development, producing directly to Nyhamna for well stream processing, gas compression and condensate offloading to tankers. The annual gas export plateau will be approximately 21 billion Sm³ and the daily export capacity up to 70 million Sm³.

To maintain production when reservoir pressure declines, an offshore compression facility is planned for installation on the field with a planned start-up date in 2016. However, a subsea compression solution will be evaluated, in parallel, as a cost-effective alternative to a compression platform.

The PDO includes two main subprojects:

- Offshore production system.
- Onshore plant at Nyhamna.

**Partners in the Ormen Lange field are:**

- Hydro: 18.0728%
- Shell: 17.0375%
- Petoro: 36.4750%
Hydro is operator for the planning and development phase. Shell will take over as operator when Ormen Lange comes on-stream in October 2007. Shell will also be responsible for drilling the production wells.

Subject to the Norwegian parliament’s (Stortinget) approval of the plans, construction work at Nyhamna will start in April 2004.

**Langeled.** The Langeled joint venture, comprising Ormen Lange owners, ConocoPhillips and Gassco, has been established to construct, operate and own the transportation system from Nyhamna to Easington. The planned Langeled transportation system has a total pipeline length of approximately 1,200 km. It will be the longest subsea gas pipeline system in the world. The southern part of the transportation system will be operational to transport other Norwegian natural gas in October 2006. The northern leg will be operational in October 2007, when the Ormen Lange field comes onstream.

The transportation system as outlined in the plan for investment and operation (PIO) includes:
- Northern pipeline, 42” diameter from Nyhamna to the Sleipner riser platform.
- Subsea valve station in the Sleipner area, risers and modifications on the Sleipner riser platform.
- Southern pipeline, 44” diameter from Sleipner to Easington, England.
- Terminal Easington.

Hydro is operator of Langeled in the planning and development phase. The operator will organize a common project for execution of the transportation system and the field development to secure the integrity of the Ormen Lange project from reservoir to market. The plan is to include Langeled into Gassled. Gassco will take over operation of Langeled from the start of operations.

Statoil has the management of the gas export pipeline project in cooperation with Hydro. The project organization will be staffed with personnel from both Statoil and Hydro.

The participating interests in Langeled Joint Venture are:
- Hydro: 18.0728%
- Shell: 17.0375%
- Petoro: 36.4750%
- Statoil: 10.8441%
- Dong: 10.3420%
- ExxonMobil: 7.2286%

**Focus on health, safety and environment (HSE)**

Our objective is to complete the Ormen Lange development without injury to personnel or damage to the environment. The Ormen Lange field will be developed while preserving the environment, personal health and protecting our assets. Possible HSE impacts are evaluated for all major decisions. Potential impacts are assessed against acceptance criteria, and the evaluation is documented in project records. The Ormen Lange acceptance criteria are aligned with legal requirements and corporate strategies of the participating companies. In order to
ensure no injuries occur, there is focus on safety during all operations and focus on HSE in all contracts. This includes management inspections, close cooperation with and support to contractors, and preparing for operations through desktop exercises, hazops and safe job analysis.

Basic principles underlying the project’s technical solutions are: the ALARP principle (As Low As Reasonably Possible) to ensure safety in design and operations, and define mitigating actions; the application of best available techniques (BAT), to limit environmental impact, and to minimize and control discharges to the sea, in accordance with SFT’s definition of “zero discharge;” and a focus on energy efficiency.

The project has had regular communication with regulatory bodies in order to discuss solutions. The main technical solutions have been documented in the impact assessments (IAs) and further documented in discharge permit applications. Both have been subject to public hearings.

In order to avoid environmental damage, the project is investigating pipeline routes outside the areas of seabed corals and will perform environmental baseline studies and monitoring, both in connection with offshore drilling operations and in the vicinity of the Nyhamna onshore process plant.

**The challenges**

All required technology qualifications are defined in a qualification program and are planned to be executed in due time for implementation on Ormen Lange.

The technology qualification program is based on using the best of future obtainable technology when closing the technology gaps for the key challenges within the Ormen Lange development.

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**Fig. 4. The Ormen Lange field is located beneath the harsh Norwegian Sea with its occasional 30 meter high waves and more than 40 meter per second winds.**

- Deep water with subzero temperatures, which may cause gas hydratization and corresponding ice plugs within the multiphase flow pipelines.
- Irregular and uneven seabed, which introduces particular requirements for the import pipeline routings at 900 meters depth.
- Strong sea currents, 30 meter high waves and winds at 40 m/sec.
- Reservoir pressure propelled multiphase transport over a distance of 120 km and a vertical lift of 1,000 meters.
The Ormen Lange development will be based on proven and robust technology that satisfies all safety, environmental and health requirements in addition to commercial requirements.

The Ormen Lange project will, in parallel to the qualification program, pursue alternative solutions to improve safety, environment, economy and operations. This includes support of selected research activities which may be utilized by other projects, even if Ormen Lange decides not to implement the results.

The Ormen Lange gas field is located within the slide scar from the Storegga slide. This gigantic submarine slide occurred about 8,200 years ago, and caused large waves (tsunamis) that reached the coastline. Extensive work has been performed to evaluate present stability conditions in the vicinity of the Ormen Lange gas field and to explain prehistoric instability. The Storegga area has experienced repeated sliding through the last 1.7 million years, a period dominated by repeated glacial and inter-glacial cycles. Since all the soft unstable clays were removed from the Storegga margin during the last slide, it is concluded that a new cycle with sedimentation of soft clays and deposition of glacial sediments in the upper slopes are necessary to create a new unstable situation in the Storegga area. The risk analysis documents that it is safe to develop the Ormen Lange field close to the main headwall of the Storegga slide.

Managing the giant Ormen Lange development in an efficient and sustainable way

Objectives and terms of reference for the Ormen Lange development project are based on pursuing the optimum balance between best economics, environmental and safety solutions and society considerations.
In this framework, the basis for making a decision is based on input from all three criteria: economics, environment and society. The weighing of the criteria is done by systematic management work processes like the governance process, the risk management process and the stakeholder management process, being used throughout the development. The use of these management processes provide benefits leading to a sound decision based on the full range of sustainable development considerations.

The Ormen Lange governance process is made available to the entire partnership and features well-defined decision gates and milestones. Independent, mandatory reviews have been implemented throughout the project cycles, and in particular before passing each decision gate, where the potential to create/erode value, and influence the outcome, is greatest.

The Ormen Lange governance process contains the following key decision gates:

- **Decision Gate no. 1:** Is there a basis to initiate a project?
- **Decision Gate no. 2:** Is the project effectively framed in relation to uncertainties? Do we have a realistic plan towards next Decision Gate?
- **Decision Gate no. 3:** Do we have an asset and a basis for selecting the right concept? Is there a realistic plan towards next Decision Gate?
- **Decision Gate no. 4:** Do we possess the optimum plans and resources to start project execution?

Within the Ormen Lange risk management process, the key risks are systematically and pro-actively identified, evaluated and followed up in order to minimize negative impact and maximize benefit. A continuous and systematic top-down and bottom-up risk identification – and mitigation process - has been performed during
all stages of the Ormen Lange development. Potential threats to project objectives have been identified and mitigated in a timely manner. The Ormen Lange risk management process has been implemented from an early stage of the project by the license holders and the project team. It has become a natural part of the daily management work processes, not something undertaken “on-the-side.” For each significant risk identified, a “risk owner” has been appointed within the management teams, regardless of whether the risk belonged within the technological, commercial, HSE, stakeholder, or any other part of the project. Plans have then been established for deleting or mitigating each key risk identified.

![Risk Evaluation Diagram](attachment:Risk_Evaluation.png)

**Fig. 10. Key features of the Ormen Lange risk management process.**

The Ormen Lange project is a large undertaking which is of significant interest to several key stakeholders in society outside the project and owner group. The early recognition of this circumstance revealed the demand for a systematic approach to stakeholder management as a part of the Ormen Lange governance process and risk management system. Ever since the beginning in early 2000, one of the Ormen Lange project’s key objectives has been to adopt a proactive and transparent relationship towards society and its key stakeholders. Since early 2001, the project management and management committee have evaluated processes every three months to determine:

- Which project development topics should be recognized to be of significant interest to key third party stakeholders?
- Who are these key stakeholders?
- What are the possible downsides of failing to actively inform and communicate with these stakeholders? What are the upsides?
- How should we communicate with the different stakeholders/stakeholder groups?

Based on a Hydro proposal, and in accordance with the management committee decision, an Ormen Lange communication plan was established in 2001 to plan for, coordinate and follow up communication with our key stakeholders. The intention of the communication plan is to achieve increased understanding and acceptance of the project objectives among those who can significantly influence the outcome of the approval processes.

For each of the key issues identified in the communication plan, the following breakdown was developed:

- What should be the desired outcome/objective of our communication for this certain issue?
- Who are the key stakeholders to be approached?
- What should be our communication strategy (how/by which means should we communicate)?
- What is our position on this issue?
- Finally establishing the key issue communication schedule: Who does what to whom when?
What are the key communication issues and our corresponding goals?

Who are our key stakeholders, and what are their goals, knowledge and attitudes?

What are the probable risks if communication strategy fails?

Adjust

By which measures and strategies should we communicate?

Implementation:
- Action Plans:
  - Who does and says what to whom when and where?
  - By which measures and strategies should we communicate?

Evaluate our efforts

Fig. 11. The continuous work process used for the Ormen Lange stakeholder management.

The key challenges ahead

By April 1, 2004, we will hopefully have received all necessary sanctions from the Norwegian parliament, which is also a significant co-investor through its different ownerships, either directly through the government-owned company Petoro, or its share ownerships in Hydro and Statoil. Receiving the sanctions is an important milestone for the project.

But, as mentioned before and shown below, this is not the end of the exciting Ormen Lange development, and not even the beginning of the end, but the end of the beginning:

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<th>Activity Description</th>
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Fig. 12. The Ormen Lange master schedule.

Ormen Lange, including its gas export pipeline sub-project Langeled, is now facing a challenging execution period. The initial physical work has already started and the organizations have been restructured to fit this new phase. Contracts and commitments for a value of more than one-third of the entire investment have already been established with some of our key contractors worldwide. Within the next three and a half years, the current sole operator from reservoir to market, Norsk Hydro ASA, will have, in close cooperation with the partners, established the framework for a smooth transfer of operatorship to Shell and Gassco. And society watches us all the time - harboring huge expectations for the project now embarking on the execution phase of a sustainable development covering nearly one-fifth of the entire gas energy demand in the UK for the next 20 years. His majesty, King Harald 5th of Norway, has already announced his presence at the opening of the Ormen Lange field on October 1st 2007.

And in accordance with our vision, the Ormen Lange field keeps going further. Thank you for your attention.