Example of a field development
Ormen Lange

Statoil module – Field development, MEK 4450 - 2011
Magnus Nordsveen
Ormen Lange – a mega gas project

• Norway’s largest industrial project
• Total investments (field + pipeline): NOK\textsubscript{2003} 66 billion (10 billion USD)
• Statoil: Development Operator with 28 % equity, Shell Production Operator
• Project with 75 % Norwegian content in onshore plant
• 14 TCF reserves/2500 mmcf/d
Ormen Lange, Gas from deepwater Mid-Norway to UK market
Mega project on Time and Cost
The Storegga Slide:
• One big slide approximately 8200 year ago
• Back wall: 300 km
• Run out: ~800 km
• Slide area: 90,000 km²
• Volume: 3,500 km³
• 10 - 15 meter high tsunami waves along the coast
Key Project Milestones and Governance Process

- **Concept Screening**: Dec. 2000
- **Submit PDO/PIO**: Dec. 2003
- **Pre-Drilling Start**: 4Q 2005
- **Prod Start**: 4Q 2007

**Appraisal**: 1997-2002
- **Concept Selection**: Dec. 2002
- **PDO approval Contract Award**: Spring 2004
- **Marine Install.**: 2006/7
How we work

• Project organisation
• Many interfaces to other disciplines
• Design basis and other books follow the project
• Iterative process
• Internal and external studies
• Procurement strategy – several companies bid for the same job
• Regular meetings with partners
• Meetings with authorities
Multiple disciplines involved

Seismic - Reservoir  Drilling  Metocean data  Seabed survey  Subsea

Pipelines  Facilities  Flow assurance/fluids  Process  HSE & Cost estimation

Interfaces: Fishery activities, Environmental impact, Partners, Authorities
Screening and Selection Process (DG0 – DG2)

Full Process (FPO)

Semi/SPAR/TLP System

Condensate Handling

Subsea System

Future Compression

Selection process

Selection process

Selection process

Selection process

Selection process

Selection process

Selection process

Selection process

Selection process

Selection process

Selection process

Selection process

Selection process

Selected Concept

Offshore Processing

Onshore Processing

Transport

Site Selection

Onshore Site

Transport Selection

Mid 2002

Selected Concept

Concept Selection
Field Development Alternatives

1. Subsea System to Onshore Plant

2. Deepwater Platform to Onshore Plant

3. Shallow Water Platform

4. Deepwater Platform
Platform Alternatives

TLP w/compl.rig
(SPAR not shown)

SEMI

SSL
Picture in Phase II
Onshore Site Selection

Local authorities insisted on landing the gas in Norway to secure more economic benefits from the gas.

Several potential locations onshore had to be evaluated to satisfy national and local authorities.
Concept Selection Late 2002

**Alternative 1:**
Subsea Production Facilities in combination with Onshore Process Plant. Future Compression.

**Alternative 2:**
Full Process Offshore Platform
Key Project Milestones and Governance Process

- **Concept Screening**: Dec. 2000
- **Submit PDO/PIO**: Dec. 2003
- **Pre-Drilling Start**: 4Q 2005
- **Prod Start**: 4Q 2007

**Milestones**
- **1997 - 2002**: Appraisal
- **Dec. 2002**: Concept Selection
- **Spring 2004**: PDO approval
- **2006/7**: Marine Install.
Ormen Lange - execution project

- Field developments offshore
- Pipelines to shore
- Gas plant on land for processing and export compression
- 1200 km pipeline to UK
- Pre drilling of production wells
- Gas to UK markets
Main project challenges (1)

• Reservoir:
  —Sealing faults or not (field layout)
  —Risk of water production (offshore processing capability or not)

• Natural conditions:
  —Slide risk (is it safe to develop and produce the gas field in the Storegga slide)
  —Harsh environment (temperature below zero, strong current and rough weather conditions)
  —Rough seafloor and steep slopes in the slide area
  —Rough terrain in the near shore area
Main project challenges (2)

• **Technical issues:**
  – First deep water field in Norway
  – Technology gap and lack of experience in contractor marked regarding development in similar conditions
  – Longest export pipeline ever built (steel marked)
  – Short execution time for complex development including a large onshore gas processing plant

• **High exposure towards society:**
  – Site selection for potential onshore processing plant
  – Landing site shore facilities in UK
  – Agreement with UK authorities for gas pipeline and terminal in UK
  – Environmental issues like corals and influence on fishery

• **Alignment with partners and authorities during decision process**
Ormen Lange Field Location

- The ultimate challenge for pipelaying and marine operations
  - Pipelines and installations in slide area
  - 850 – 1100 metres water depth
    - Sub zero temperatures at sea bottom
Heavy lifts
Big bore well design

- Large bore, high flow capacity tubing
  - 10M m³/day pr. well maximum flow
  - Minimize required well interventions
  - Maintain well integrity

- Allow sand control
  - 300 micron wire-wrap sand screens (7” basepipe) in centralized 12 1/4” hole
  - 16/30 ScalePAC ceramic proppant gravel pack

- Down hole monitoring
  - Pressure/Temperature Gauge directly above upper TRSSSV
  - Pressure/Temperature Gauge directly above production packer
Storegga challenges

• Seafloor intervention tool – Spider and Jet prop excavator
• Mapping technology – HUGIN and new high accuracy multi beam echo sounders
Low temperatures:
Risk for hydrate and ice blockage

Hydrate plug
Hydrate and ice formation curves

Hydrate formation Temp (P, MEG)

Ice formation temperature as function of MEG

Press

Temp

200 bar

1 bar

50 wt% MEG

0 wt% MEG

Hydrate formation Temp (P, MEG )

Ice formation Temp (MEG)

Water

Ice

MEG wt%
Large slug catchers onshore

- Liquid accumulation at low production rates
- Potential for large liquid surges during rampup
- Design tool (OLGA) never verified for this steep inclination (~38 degrees)

Two slug catcher units with 1500 m3 capacity each
Execution project

• PDO approval April 2004
• First gas summer 2007
• Official opening according to plan 06.10 2007
• Only 40 months from PDO approval until first gas

How was this execution schedule possible?

• Very well defined concept selection and feed engineering for all 4 sub projects
• Realistic schedule with most of the offshore installation work completed already in 2006
• Built in schedule contingency where possible
• **No changes to the selected concepts required during execution!!!**
Success factors for the Ormen Lange project

• Detailed **stakeholder analyses** to be able to make good plans for external communication and interaction during the concept development
  — Local municipalities and politicians
  — Fishery
  — Authorities in Norway and UK
  — Partners
  — NGOs
  — Academia

• Shore site selection, pipeline route selection, archaeology, marine archaeology, fishery, coral protection
Success factors for the Ormen Lange project

Early gathering of seafloor and metocean data to define project challenges

Early focus on slide risk challenges to define work program and schedule to clarify risk situation
Success factors for the Ormen Lange project

• Early focus on site selection process and site selection parameters
• Allowed for a 2 year archaeological excavation onshore and in pipeline route prior to development
• Started up ahead of schedule and within budget
  • Well defined concept at time of decision
  • Successful contract strategy
  • Sound risk management
  • Active stakeholder management
References for Ormen Lange


• Papers: Search internet for Ormen Lange paper