Petroleum Policy and Management Project
The 3rd Workshop Indonesia Kutei Basin Case Study

Field Developments and Technical Solutions
Marginal Fields- Norwegian Experiences

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Marginal Fields – A Definition

What is a marginal field?

- Is it a small oil field? Only a definition of size?
- Or a small gas field without access to a pipeline or market?
- Or is it a discovery in ultra deep waters and harsh environment?
- Or can it be an old field in its tail-end production?
- Or can it be all above and many, many more?

A broad definition:

- A marginal field is a discovery or producing field that under current conditions is not economical to develop or to continue to produce.
  1. Lack of economic incitement like oil price forecasts or fiscal environment
  2. Tariffs and lack of cooperation that prohibits use of existing infrastructure
  3. Technical challenges, lack of infrastructure and associated development costs
  4. Lack of persistence. Grey stones for some are diamantes for others
Therefore, marginal fields include:

- Revival of ageing fields in mature gas and oil provinces by integrating production strategies and sharing of facilities and infrastructure across licenses.
- Tie-in of new discoveries to existing infrastructure and sharing of processing capacity.
- Stand-alone fields.
Knowledge and technology - the difference

- Development of 48 fields on the Norwegian Continental Shelf provides the opportunity to further exploit resources in the vicinity of producing fields.
- Increased recovery, extended lifetimes and tie-in of resources to existing infrastructure has the potential to provide considerable added value in the future.

Development perspectives for the Norwegian Continental Shelf

"NCS needs plans for 50-100 years or more. - Produce more of the oil and gas in place at better profit margins!"

"Closing the gap must to a large extent rely on development of new knowledge and technology"
Developments offshore Norway

Development of infrastructure has made increasing recovery of petroleum resources possible.
• Sharing of processing and transport capacity has allowed successive tie-in of new discoveries.
• A similar development will take place further north as new major field developments provide tie-in possibilities for smaller discoveries.
Late life OPEX kills the goose
Ambitious goals by the Norwegian government to increase recovery from all oil and gas fields:
- 50% recovery from oil fields
- 70% recovery from gas fields

And

Conoco Phillips where:
- Ekofisk 2010 is a vision for the future development of the Ekofisk Area.
- It is a general and proactive vision where resources, technology, skills, employees and organization are viewed as a whole.
- The Ekofisk 2010 vision is a tool for the efforts to create smart future-oriented operations for the Ekofisk Area.
Ekofisk- Reviving the field

- **Recovery Factor**
  - Increased understanding of the behavior of the chalk reservoir has increased the expected recovery factor from 17% in 1971 to nearly 50% today.
  - And knowledge pays off. 1% increased recovery results in 60 mill additional barrels of oil i.e. a small oil field of its own!
  - Water Injection in the chalk reservoir was a technology breakthrough for restructuring the field. Water injection capacity is 1 mill bopd.

- **Ekofisk Growth**
  - The last of several rehabilitation projects that prepares the field for an additional 30 years of life
  - Increases field recovery by another 182 million bbls oil equivalents
  - Investments of more than USD 1 bill including
    - Well head platform and 25 infill wells
    - Increased processing capacity and debottlenecking onshore and offshore
    - Centralized power distribution
    - Increased export capacity to 700000 bopd
    - Modernize the operations- e-technology

- **Ekofisk Cessation**
  - Remove 14 redundant steel jacket platforms
  - Decommission and clean the Ekofisk tank
Increased recovery

Ekofisk field - fractured chalk reservoir

- Depletion
- Waterflooding
- Optimization

www.tf.no
Tampen 2020
• Integrate production and operations in the area
• Modernise and de-bottleneck existing installations including sub-sea
• More wells

Statfjord Late Life, From oil to gas field
The first Tampen 2020 project:
• Convert the Statfjord installations from oil with associated gas to gas with associated oil and condensate
• Reduce reservoir pressures and platform inlet pressures
• New 32” x 23km gas pipeline to Brent for gas export to UK
• Increase recovery factor of the field to 70-75% (from 54%), adding to the recoverable resources
  • 1000 billion cuft of gas
  • 25 million bbls of oil
  • 60 million bbls of condensate
• Investment more than USD 2 billion

Statfjord Late Life
1000 bbls o.e./d

Senfase
Basisprofil
**Tie-in to Existing Infrastructure**

**Kristin Oil and Condensate**
- 10 km tie-in of multi phase flow to Oseberg
- Separate service and control umbilical
- 15,000 bopd
- Start production 2002

**Platform and Subsea Development**
- 18'x27 km gas pipeline loop, 700 mill cuft/d, to Åsgard export pipeline
- 12’x22 km condensate pipeline, 125,000 bopd, to Åsgard C for storage
- Start production 2005

**Mikkel Gas and Condensate**
- 37 km multi phase flow to Åsgard B via Midgard template
- Separate service and control umbilical
- 26,000 boepd
- Start production 2003

**Subsea Development**
- 16 km integrated umbilical w/service, control and 6” multi phase production line to Heimdal
- 8,000 boepd
- Start production 2002

**Tune Oil**
- 10 km tie-in of multi phase flow to Oseberg
- Separate service and control umbilical
- 15,000 bopd
- Start production 2002

**Vale Oil and Gas**
- 18”x27 km gas pipeline loop, 700 mill cuft/d, to Åsgard export pipeline
- 12”x22 km condensate pipeline, 125,000 bopd, to Åsgard C for storage
- Start production 2005
Stand Alone Fields

Valhall
Process, drilling and LQ platforms
WI platform later

Norne
FPSO and Subsea

Varg
FPSO and well head platform
Drilling by jack-up

Ormen Lange
Subsea Development
Onshore processing
Yesterdays marginal fields may be “gold mines” today and todays marginal fields will be economical viable tomorrow through technical advancement and sharing of solutions between oil regions, oil companies and technology providers.

- Infrastructure becomes available
- Floating and ultra deep water platforms
- Transfer of well streams over long distances
- Seafloor processing and compression
- Horisontal smart wells
- Improved materials
- Operational practices
- And much, much more

People are the key!
In order to promote the use of new technology offshore Norway, the Norwegian Government sponsors a technology program called DEMO 2000 with the intent to bridge the gap between research and commercial solutions. Oil companies and suppliers participate and fund the research gap-programs together with DEMO 2000.

Objectives

- Continued Cost-Effective Development of the Norwegian Continental Shelf Using New Technology
- Improved Confidence in Cost and Schedule During Project Execution
- Development of New Products and Services for a Global E&P Market
Key Technology Areas

Drilling and Wells
Better and less costly wells and drilling

Subsurface Technology
Improved imaging and reservoir characterization for increased recovery

Deep Water
Floaters, risers, positioning, deep water solutions

Seafloor Processing
Cost-effective satellite tiebacks to infrastructure and to shore

Stand Alone Oil Fields
Simultaneous drilling, storage and production

So Far – 100 Projects

Stand Alone Gas Fields
LNG processing, storage and offloading
For all water depths and harsh environments

FPSO

TLP

Jacket Structure

Semi Sub
The future is here

Snøhvit
Under Construction
Start up 2005

160 km

Ormen Lange
Under Construction
Start up 2007

• Subsea installations in deep waters and harsh environments
• Multiphase flow over long distances
• Remote well control
• Flow assurance
  • Sand production
  • Wax
  • Hydrates
  • Corrosion

Maka
Popeye
East Spar
North Alexandra
Midgard
Westman Hub
Ormen Lange
Holma
Snøhvit

Transfer length [km]

Condensate gas ratio (CGR) [Sm³/MSm³]

Operating
Planned
( Red = Statoil operated)
Sub sea wells, sub sea multiphase transportation to shore
Pressure maintenance and gas compression systems, light well intervention
Modular sub sea production systems, sub sea processing
Ready for use

Subsea separation
• Project soon ready for implementation
• Oil 40,000 bopd
• Water 180,000 bwpd
To be Qualified

Project phases:
1. Maturing technology (2 years)
2. Design and build pilot (3 years)
3. Pilot testing (2 years)

Key design data:
1. 1100 meters design water depth
2. 120 km step-out
3. 60 MSm³/d of gas production
4. 7 200 Sm³/d of condensate production
5. 52 MW total electrical power
6. 4 x 12.5 MW electrical driven compressors + utilities

Subsea compression
The future is almost here

Downhole separation

**H-Sep**
The No Pollution Option

- No water discharge to sea
- Very limited use of well chemicals
- Minimal produced water to surface
- Low energy consumption (min. CO₂)

“Smart” well - field technology

- 5% Reduced well interventions (OpEx)
- 7% Accelerated production
- 13% Reduced well-cost (CapEx)
- 22% Reduced surface facilities (CapEx)
- 53% Improved ultimate rec.

*Relative Business Impact*

**Shell:**
“Smart wells should give 300-500 mill. $ added value per year, and a 25-35% improved life-cycle value”
What are the gaps
Where do we go
- Clearer now?