# PL 674 Relinquishment Report

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# 1 Key Licence History

PL 674 was originally awarded on 8th February 2013 as part of the APA2012 to E.ON E&P Norge AS (50%, Operator) and Petrolia Norway AS (50%). Subsequently, on the 31st October 2014, Petrolia Norway AS reduced its equity to 35% by transferring 15% to Lundin Norway. At the same time part of the licence was carved out stratigraphically to create PL674BS. Lundin Norway became Operator of PL 674BS.

**Initial work obligations and work periods:**

Within three years of award

1. Merge and reprocess existing 3D seismic data/Acquire new 3D seismic data over prospective area without 3D coverage
2. Relevant geological and geophysical (G&G) studies
3. Drill or drop decision

Within five years of award

1. Drill Exploration Well, Concretize (BoK) or drop license

Within 7 years from award

1. Perform conceptual studies , BoV or drop

Within 8 years of award

1. Prepare development plans and decide to submit PDO or drop.

Overview of meetings held:

EC/MC meetings

1. EC/MC meeting no.1 February 25, 2013
2. EC/MC meeting no.2 November 14, 2013
3. EC meeting September 08, 2014
4. EC/MC meeting no.3 November 20, 2014
5. EC/MC meeting no.4 November 9, 2015

Work meetings

1. Work meeting no.1 March 14, 2013
2. Work meeting no.2 April 19, 2013
3. Work meeting no.3 November 5, 2013
4. Work meeting no.4 April 24, 2014
5. Work meeting no.5 July 1, 2014
6. Work meeting no.6 January 15, 2015

**Reason for relinquishment:**

A full prospect evaluation of Bjønnholmen and Nøttehamn with volumetrics, risking, reservoir profiles, field development studies and economic studies were performed and presented to the partners in April 2014. Similar evaluaion results were presented for the Gloppe prospect in November 2014. For all 3 prospects, oil cases were run giving recoverable resources of approximatively 10,5 $10^6Sm^3$ for Bjønnholmen with a GCF of 31% , 4,7 $10^6Sm^3$ for Nøttehamn

with a GCF of 29% (dependent on Bjønnholmen being a success) and 15,6 $10^6Sm^3$ for Gloppe prospect with a GCF of 12%. The key risks associated with the prospects are the effectiveness of the trap for Gloppe prospect, due to the need for a stratigraphic trapping element, and the effectiveness of hydrocarbon generation and charge into all 3 prospects. Due to its proximity to the kitchen Bjønnholmen prospect was considered as the prime candidate for drilling. A site survey covering the prospect was shot in September 2014.

E.ON recommended to drill in Q2 2014. Due to a lack of support it was decided to acquire IP to de-risk charge within the area. As IP was inconclusive, E.ON recommended then to drop the license.

# 2 Database

## 2.1 Well Database

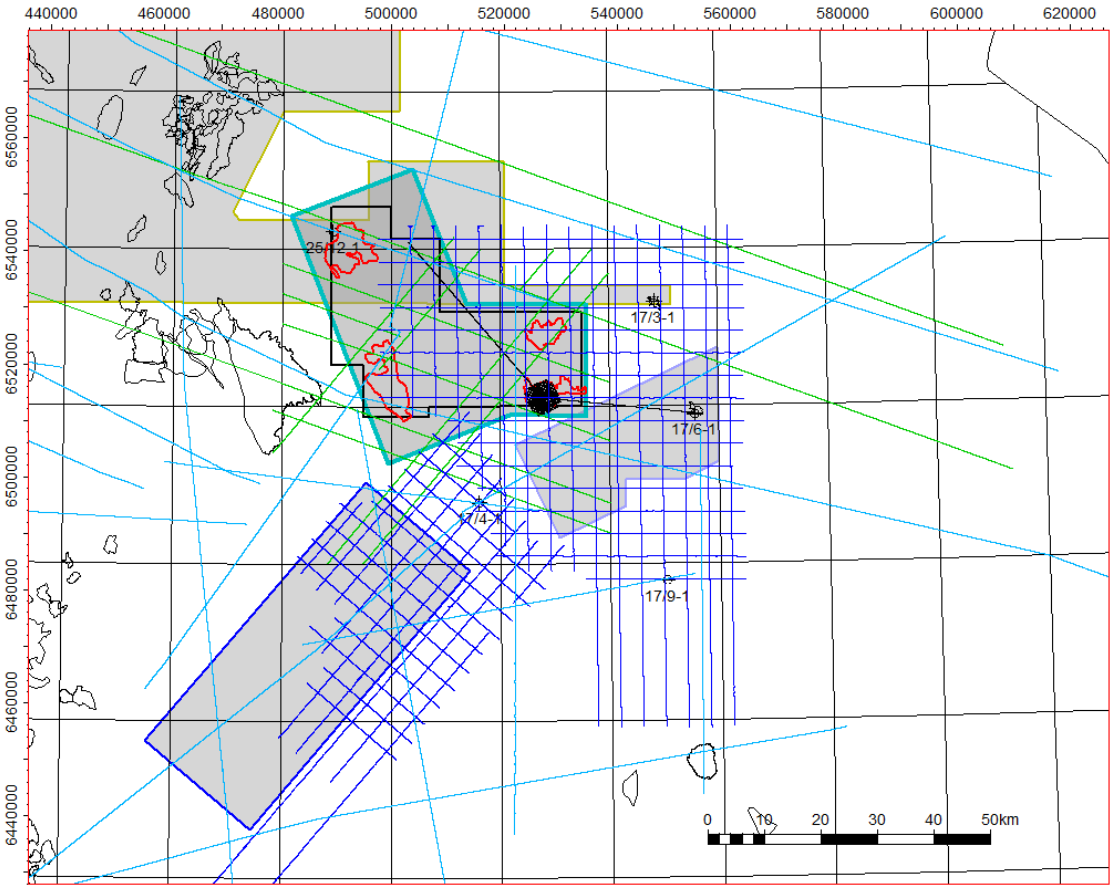
There were no new wells drilled in the area.

***Table 2.1 Well Database***

| Well name/ Status | License/ Operator | Com-pletion Date | TD (TVD RKB) | Age at TD | Comments |
|---|---|---|---|---|---|
| 16/2-6 Oil | 501 Lundin | 10.0-9.2010 - Released | 2158 | Late Perm / Zechstein | Johan Sverdrup/Avaldsnes - HC in Late Jurassic, Intra Draupne, Mid. Jurassic, Vestland Gp. |
| 17/4-1 Dry | 007 Elf | 26.0-8.1968 - Released | 3997 | Early Perm / Rotliegend | Minor gas shows, Tertiary and Draupne Fm.. Draupne TOC 2-7% w potential for oil and gas. |
| 16/6-1 Dry | 007 Elf | 09.0-1.1968 - Released | 2061 | Pre-Devonian / Basement | Gas shows, Tertiary. Draupne source rock shale with 6 % to 7 % TOC – immature in well. |
| 16/3-2 Dry | 007 Elf | 08.0-3.1976 - Released | 2019 | Pre-Devonian / Basement | Immature Draupne shale. 31 m Jurassic sst. No shows. |
| 16/3-3 Dry | 149 Esso | 06.0-8.1989 - Released | 1566 | Late Cret. /Tor Fm. | No reservoir, no shows. |
| 25/12-1 Dry | 010 Shell | 23.1-2.1973 - Released | 2865 | Devonian | Mid. Jurassic sands were encountered at 2244 m with porosity up to 30 %. No HC indications were present in the well, with the exception of characteristic gas indications in the Late Jurassic Draupne Fm. source rock interval, which at this location was found to be immature. |
| 16/2-5 Oil/ Gas | 265 Statoil | 13.0-5.2009 - Released | 2373 | Pre-Devoninan / Basement | Ragnarrock. No oil shows were observed above reservoir level. In the reservoir oil shows were seen down to 1981m |
| 17/3-1 Gas | 188 Elf | 20.0-8.1995 - Released | 2852 | Pre-Devoninan / Basement | The primary objective Sandnes Fm was encountered at 2387 . Only 2m of gas was found at the top reservoir. Triassic Smith Bank Fm was directly deposited on metamorphic basement. The secondary objective, the Rotliegendes was not present. |
| 17/6-1 Oil | 545 Noreco | 04.0-2.2011 - Released | 3065 | Late Triassic / Hegre | Svaneøgle. Sandnes and Bryne Fms. were penetrated at 2630 m. Total thickness of 96 m containing sst interbedded with clays and thin coal beds. Minor HC, Upper part Sandnes fm.. Bryne Fm had a better reservoir sand but was water bearing. |

## 2.2 Seismic Database

The partners supported the acquisition of a new 3D over the whole licence. By acquiring Dolph13033D, there was no need to re-process and merge the exisitng 3D which overlaped with Dolph13033. The most recent mapping of the licence is done on the Dolph-13033D (Utstord 3D survey). Other 3D surveys used include TA0701, ST0611 and MC3D (PGS Megamerge). Additional 2D surveys, such as NSR05, NSR06, NSR08, ST8107, GLD-92, HPS98 and GNSR-91 were used for interpretation to fill in the gaps were no 3D was available for regional interpretation for the Basin modelling study. Fig. 2.1



# 3 Review of Geological and Geophysical Framework

In order to be able to take a drill or drop decision, the following geological studies were undertaken.

***Table 3.1 G&G Special Studies***

| Year | Study | Author |
|---|---|---|
| 2014 | Sedimentological review of all the wells in the common database | E.ON |
| 2014 | Basin Modelling | E.ON |
| 2014 | Rock Physics/AVO study | Ikon |
| 2015 | IP acquisition | ORG |

The work carried out over the course of the initial license period was primarily to

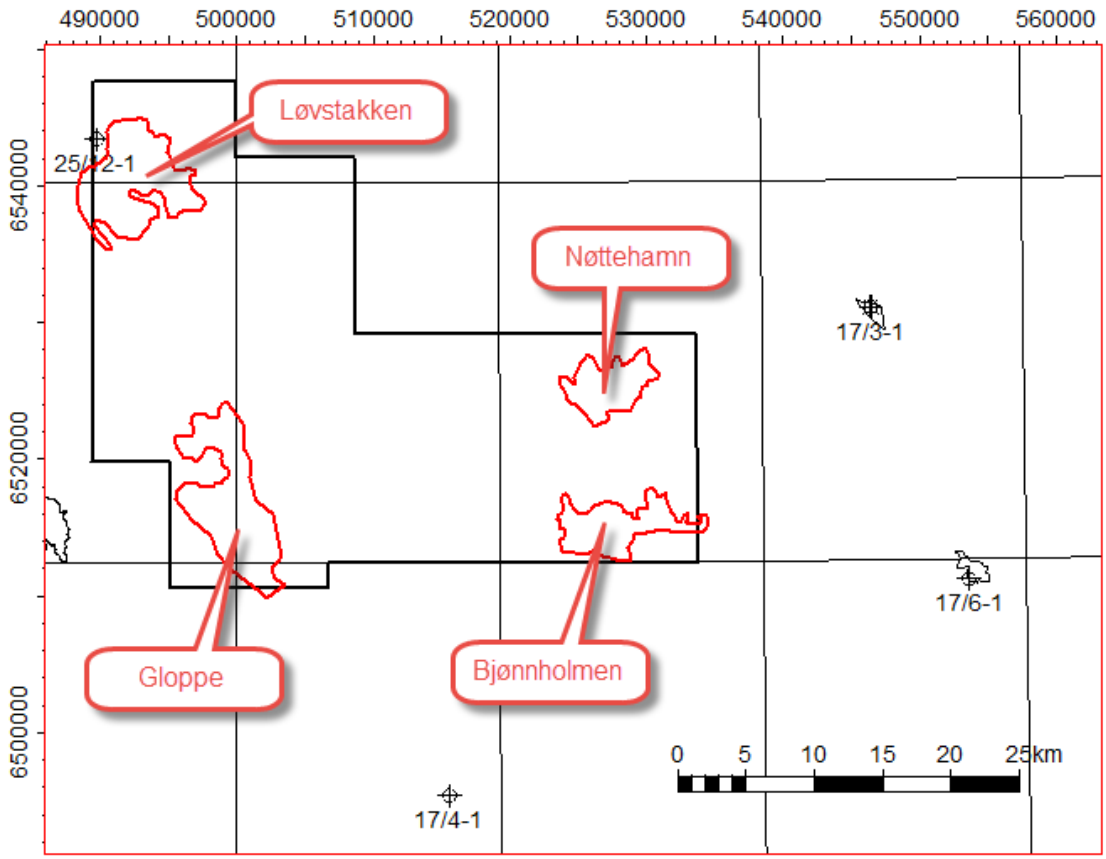
- Map the main reservoir intervals (Bryne and Sandnes) of the Vestland Group sub-regionally on both the 2013 Dolphin 3D as well as adjacent 3D and 2D datasets.
- Demonstrate a charge and migration story for the PL674 prospects. This includes a thorough geochemistry and basin modelling study. Refine Tau source rock maturity and the additional potentials and contribution from Egersund and Sauda Formations.
- Define drainage areas and potential HC volumes generated
- Determine rock properties of the Vestland Group rervoirs and non-reservoirs and their sensitivities to lithology, fluid and pressure variation
- De risk charge, presence and effectiveness within the area

Results of block evaluation

- The Rock physics and AVO modeling illustrate the possibility to see a class 1 or 2p response at Bjønnholmen for both oil and gas fill. Mapping of a dim spot over Bjønnholmen or Nøttehamn is difficult and seismic line inspection may indicate the presence of the Egersund Fm. on the eastern side, further complicating the Top Vestland response.
- The Basin modelling study demonstrates that source rocks in the area (primarily in the basin to the south) are marginally mature for oil. This is supported by the few oil discoveries in the area, most notably the Svanøgle well (17/6-1) and the Bream and Brisling discoveries further to the SE.
- With the main source kitchen located immediately to the south of the Bjønnholmen prospect, migration is considered to be a lower risk here than at Nøttehamn, which is likely to be on a fill-spill route from Bjønholmen.
- The IP survey results were inconclusive

# 4 Prospect update

The license is located east of the Utsira High. The focus of the work has been on the Middle Jurassic, Vestland Group. During the APA2012, E.ON identified two main prospects - Gloppe and Bjønnholmen and several leads while Petrolia Norway As identified one main prospect - Timbuktu (renamed Løvstakken after the license award) - and several leads in a separate license application. Both companies were merged into one license group with E.ON as the Operator, Lundin joined the license group in October 2014. Bjønnholmen was identified as the main prospect in the license with Nøttehamn and Gloppe as potential upsides Fig. 4.1.




In order to be able to take a drill or drop decision for PL674 the following geological and geophysical studies have been undertaken.

**Results of block evaluation**

The initial license period was spent primarily to aquire and actively follow the processing phase of the newly acquired 3D survey. The work done over the course of the license included detailed mapping of all the main horizons from Palaeocene to Basement with particular focus on the Vestland Group to investigate the presence and interplay between Sandnes and Bryne Formations.

The detailed mapping of pre-Cretaceous events was substantially improved with the Dolph-13033D dataset with better defined faults interpretation which was not possible in the APA application due to the lack of 3D seismic availability over the area. The detailed interpretation was incorporated into the semi-regional interpretation to investigate burial history, amount of uplift and erosion. Together faults interpretation and Top Vestland Group interpretation allowed for a more robust prospect definition that was subsequently used for volumetrics assessment.

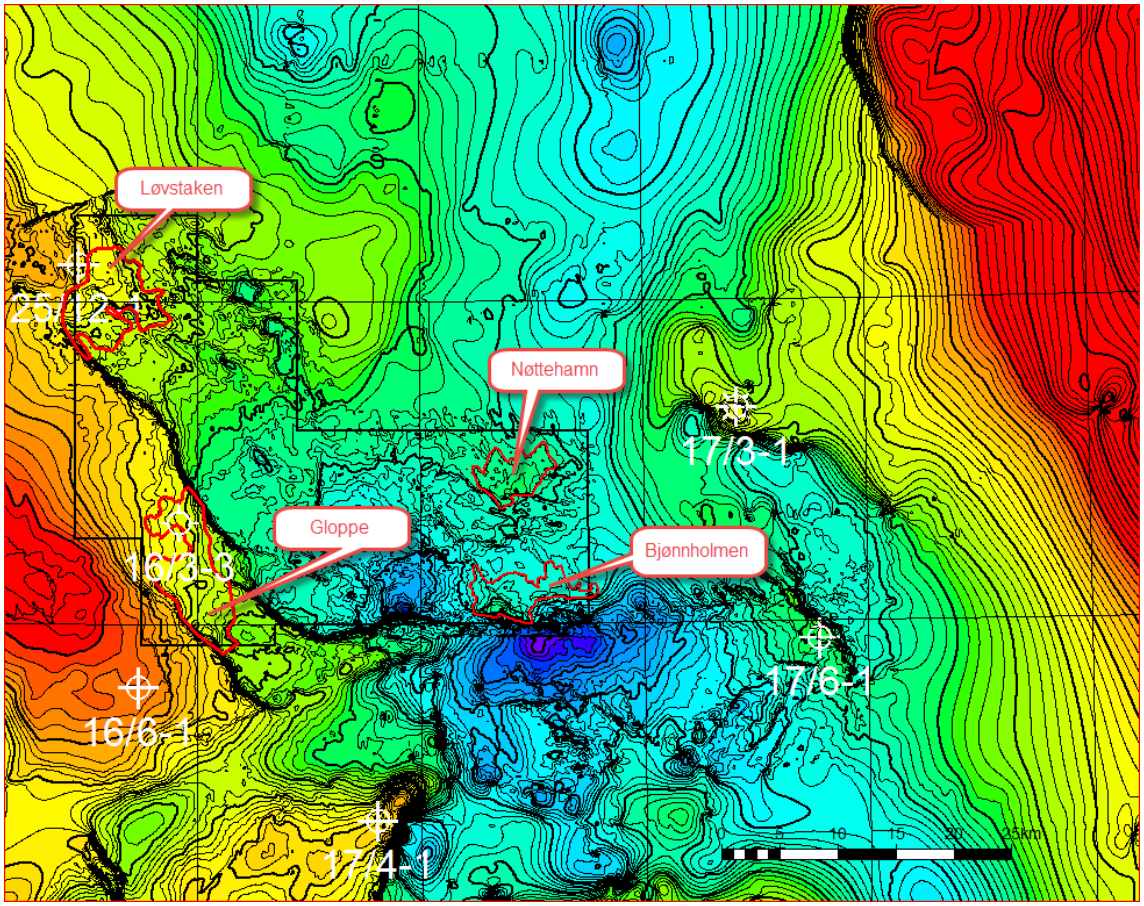
3 Depth conversion models were compared for the prospects: Aker Velocity cube 2013 (calibrated to wells), Constant velocity model: this model was used to QC the robustness of the structures. The latter model showed a flatter structure, however the structures remained valid. The thrid depth conversion model used was the DOLPH 13033D seismic velocity cube (calibrated but not smoothed). This model implied increasing higher velocities on the DOLPH 13033D than with the Aker Cube but the structures remain valid in this case too.

**Reservoir**

The Middle Jurassic sandstones of the Vestland Group were evaluated as the main reservoir levels in all three (Bjønnholmen, Nøttehamn and Gloppe) prospects. Current assumptions are supported by Ivar Aasen and Bream data. The reservoir properties combined Sandnes and Bryne together, were as follow - porosity 0,2 and N/G 0,55. Additionally a Geoteric study was undertaken to illustrate the presence of channels at Bryne level over the licence area.

**Trap**

Bjønnholmen prospect is a structural trap, 3 way dip closure against a Jurassic bounding fault while Nøttehamn prospect is a structural 4 way dip trap. Gloppe prospect is a combination of structural and startigraphic trap. The reservoir formation thicknesses were estimated by looking at nearby wells. The closest offset wells used were Svanøgle (17/6-1) and 17/3-1. The top seal is represnted by thick sequence of Upper Jurassic and Cretaceous shales. Fig. 4.2




**Source and migration**

Tau Formation 'hot shales' are present in offset wells with additional contribution from Egersund/Sauda Formations source rocks, where they are marginally mature for oil generation.

*Table 4.1 Prospect data*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Block | 25/12, 16/3, 16/6, 17/1, | Prospect name | Bjønnholmen | Discovery/Prosp/Lead | Prospect | Prosp ID (or New!) | NPD will insert value | NPD approved (Y/N) | |
| Play name | NPD will insert value | New Play (Y/N) | | Outside play (Y/N) | | | | | |
| Oil, Gas or O&G case: | | Reported by company | | Reference document | | | | Assessment year | |
| This is case no.: | | Structural element | | Type of trap | | Water depth [m MSL] (>0) | | Seismic database (2D/3D) | |
| **Resources IN PLACE and RECOVERABLE** | | **Main phase** | | | | **Associated phase** | | | |
| **Volumes, this case** | | Low (P90) | Base, Mode | Base, Mean | High (P10) | Low (P90) | Base, Mode | Base, Mean | High (P10) |
| In place resources | Oil [$10^6$ $Sm^3$] (>0.00) | 9,37 | 13,50 | 31,70 | 65,90 | | | | |
| | Gas [$10^9$ $Sm^3$] (>0.00) | | | | | 0,63 | 0,79 | 2,95 | 6,52 |
| Recoverable resources | Oil [$10^6$ $Sm^3$] (>0.00) | 3,22 | 4,78 | 12,90 | 27,80 | | | | |
| | Gas [$10^9$ $Sm^3$] (>0.00) | | | | | 0,23 | 0,33 | 1,21 | 2,73 |
| Reservoir Chrono (from) | Bajocian | Reservoir litho (from) | Vestland | Source Rock, chrono primary | Volgian-Ryazanian | Source Rock, litho primary | Tau | Seal, Chrono | Cretaceous |
| Reservoir Chrono (to) | Bathonian | Reservoir litho (to) | Skagerak | Source Rock, chrono secondary | | Source Rock, litho secondary | Sauda | Seal, Litho | |
| **Probability [fraction]** | | | | | | | | | |
| Total (oil + gas + oil & gas case ) (0.00-1.00) | 0,31 | Oil case (0.00-1.00) | 0,31 | Gas case (0.00-1.00) | | Oil & Gas case (0.00-1.00) | | | |
| Reservoir (P1) (0.00-1.00) | 0,65 | Trap (P2) (0.00-1.00) | 1,00 | Charge (P3) (0.00-1.00) | 0,60 | Retention (P4) (0.00-1.00) | 0,90 | | |

| **Parametres:** | Low (P90) | Base | High (P10) | *Comments* |
|---|---|---|---|---|
| Depth to top of prospect [m MSL] (> 0) | | 2670 | | |
| Area of closure [$km^2$] (> 0.0) | 4,0 | 11,8 | 26,3 | |
| Reservoir thickness [m] (> 0) | 80 | 110 | 140 | |
| HC column in prospect [m] (> 0) | | | | |
| Gross rock vol. [$10^9$ $m^3$] (> 0.000) | 1,260 | 1,420 | 1,590 | |
| Net / Gross [fraction] (0.00-1.00) | 0,44 | 0,55 | 0,70 | |
| Porosity [fraction] (0.00-1.00) | 0,17 | 0,21 | 0,25 | |
| Permeability [mD] (> 0.0) | | | | |
| Water Saturation [fraction] (0.00-1.00) | | | | |
| Bg [Rm3/Sm3] (< 1.0000) | | | | |
| 1/Bo [Sm3/Rm3] (< 1.00) | 0,80 | 0,86 | 0,91 | |
| GOR, free gas [$Sm^3/Sm^3$] (> 0) | | | | |
| GOR, oil [$Sm^3/Sm^3$] (> 0) | 40 | 60 | 80 | |
| Recov. factor, oil main phase [fraction] (0.00-1.00) | 0,28 | 0,35 | 0,42 | |
| Recov. factor, gas ass. phase [fraction] (0.00-1.00) | 0,28 | 0,35 | 0,42 | |
| Recov. factor, gas main phase [fraction] (0.00-1.00) | | | | |
| Recov. factor, liquid ass. phase [fraction] (0.00-1.00) | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| For NPD use: | | | | | | | |
| Temperature, top res [°C] (>0) | 120 | | Innrapp. av geolog-init: | NPD will insert value | Registrert - init: | NPD will insert value | Kart oppdatert | NPD will insert value |
| Pressure, top res [bar] (>0) | 290 | | Dato: | NPD will insert value | Registrert Dato: | NPD will insert value | Kart dato | NPD will insert value |
| Cut off criteria for N/G calculation | 1. | 2. | 3. | | | | Kart nr | NPD will insert value |

Short migration distance from oil prone source rocks in the Stord Basin into the prospect. The Geochemical report for Svanøgle (17/6-1) well to the east indicates that source and migration work.

All the summarised data can be found in Table 4.1.

# 5 Technical Evaluation

E.ON has performed a full evaluation regarding a possible development in case of discovery for Bjønnholmen. The development options included 4 possible host candidates,

- Johan Sverdrup (c.50km),
- Grane (67km),
- Edvard Grieg (69km)
- Ivar Aasen (74km).

All were rejected due to either distance or lack of available ullage.

It was concluded that a standalone FPSO would be selected (probably of Sevan type).

- Nøttehamn to be developed as a tie-back to Bjønnholmen.
- Gas re-injected, possible late-life blowdown

However economic analysis showed that an FPSO would most likely not be commercial and a leased FPSO would be marginal.

E.ON has also performed a full technical evaluation on the remaining potential prospectivity in the license. It was decided through an E.ON peer process to relinquish the license. The partners agreed to relinquish the license.

# 6 Conclusions

A full prospect evaluation of Bjønnholmen and Nøttehamn prospects with volumetrics, risking, reservoir profiles, field development studies and economic studies were performed and presented to the partnership in November 2014. The partnership agreed that Bjønnholmen was the best candidate to be drilled in order to possibly de-risk the other Vestland Gp. prospects in the licence. Bjønnholmen's oil case was run giving recoverable resources of approximately 10,5 $10^6 Sm^3$ OE and a GCF of 31%. The main risks associated with the prospects are the effectiveness of the trap for Gloppe prospect, due to the need for a stratigraphic trapping element, and the effectiveness of hydrocarbon generation and charge into all 3 prospects.

E.ON recommended to drop the license due to the lack of alignment within the licence on the expected resources for the main Bjønnholmen prospect, marginal economics for a success case and the failure of the IP acquisition to derisk charge within the area. All partners supported this decision.