EDISON

Exploration watch

Barents Sea - frontier drilling in 2017

The Barents Sea to the north of Norway is estimated to contain almost half of the recoverable undiscovered resources remaining in the Norwegian Continental Shelf (NCS). At present only two fields, Statoil's Snøhvit and Eni's Goliat, are in production but a number of discoveries since 2011 have the potential to be standalone developments and are currently being appraised. The recent 23rd licensing round awarded acreage exclusively in the Barents and for the first time included the frontier South East Barents. Statoil has already indicated that it plans to drill the high-risk/high-reward Korpfjell prospect located in PL859 in this frontier area as part of a five- to seven-well Barents exploration programme in 2017.

23rd licensing round: South East Barents

Ten licences were awarded in the 23rd round announced in May 2016. Most licences were located around existing discoveries Wisting and Alta, although three were awarded in the South East Barents close to Norway's maritime boundary with Russia. The licence that generated most interest from companies is reported to have been PL859, the most northerly and largest (covering 12 blocks) of the licences on offer. Operator Statoil has announced that it plans to drill the Korpfjell prospect here in 2017, while partner Lundin has identified a structural closure on the licence that it estimates to be more than four times the size of that seen in Johan Sverdrup.

Three potential developments

Statoil's Johan Castberg, OMV's Wisting and Lundin's Alta/Gohta fields have all been discovered since 2011 and have the potential to be developed. Appraisal drilling is ongoing at Wisting and Alta/Gohta, while Statoil has been working to reduce costs at Johan Castberg before a concept selection delayed from 2015 into H216. Although the Barents is located in the Arctic, the region is ice-free year round due to the effects of the Gulf Stream and water depths are less than 500m. However, reservoirs can be very shallow, raising separate challenges. OMV successfully drilled the horizontal Wisting Central II appraisal well in 2016, demonstrating that the well trajectory can be drilled from vertical to horizontal within a 250m section.

Key activity 2016/17

Lundin is planning to drill two exploration wells, Neiden and Filicudi, in its focus area of the Loppa High once it completes work on ongoing appraisal well Alta-3. Eni will drill its Bone prospect (also known as Dazzler by partner Faroe) in late 2016/early 2017. Statoil is planning to drill between five and seven wells across the Barents in 2017, with the Korpfjell well expected to attract considerable interest.

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Engie

Eni

Faroe Petroleum

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OMV

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EXPLORATION WATCH
A periodic look ahead from our in-house petroleum engineer, Elaine Reynolds, focusing on interesting exploration activities with significant potential impact on E&P equities.

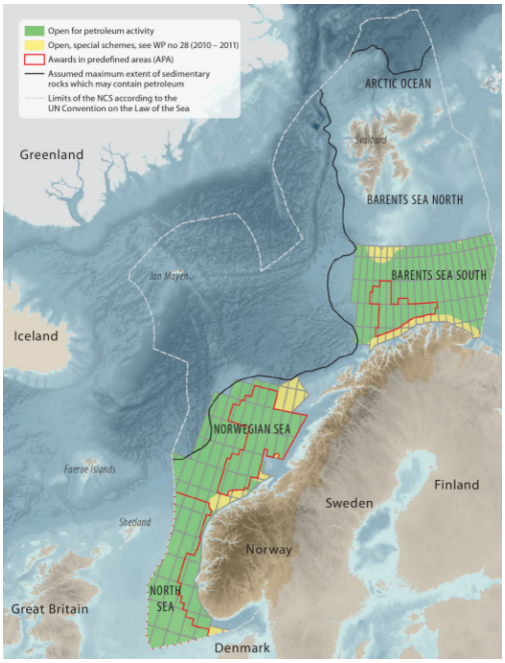
Barents Sea: Increasing focus of interest

The Barents Sea sits in the Arctic Ocean to the north of Norway and extends east to Russia. Although drilling has been carried out in the southern section of the Norwegian Barents since 1980, only two fields, Snøhvit and Goliat, are on stream to date. However, a number of significant discoveries have been made since 2011 so that three fields, Statoil's Johan Castberg, OMV's Wisting and Lundin's Alta/Gohta, have the potential to be standalone developments. These are currently either undergoing further appraisal or, in the case of Johan Castberg, approaching concept selection.

These successes have regenerated interest in the region and in 2016 10 licences were awarded across 57 blocks in the 23rd Norwegian licensing round. The awards were exclusively in the Barents and for the first time included three exploration licences in the frontier South East Barents. The most hotly contested of these three licences was PL859, where Statoil is already planning to drill the high-risk/high-reward Korpfjell prospect in 2017. The remaining awards are primarily focused on areas north of Alta/Gohta and surrounding Wisting.

Exploration drilling hit a historical high for the Barents in 2014 with 12 wells and in that year the region accounted for the largest number of discoveries and the biggest resources proven in the NCS. In 2016 this figure is likely to be substantially lower at four wells, but this should pick up in 2017, with Statoil planning five to seven wells in the Barents out of its 17 wells planned in total on the NCS.

Exhibit 1: NCS map



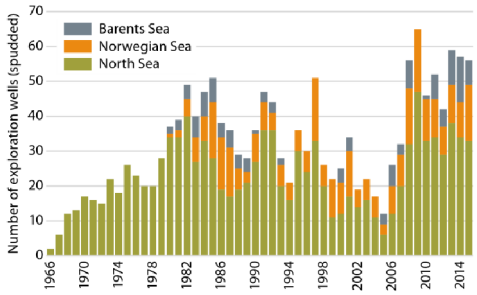
Source: NPD

The Norwegian Continental Shelf: Underexplored

The NCS covers an area of over 2m km^2, which is six times larger than mainland Norway. Around two-thirds of this area is believed to contain sedimentary rocks with the potential to contain hydrocarbons and around 570,000km^2 is currently open for exploration. Although exploration began here in 1966, the NCS is estimated to contain an undiscovered potential of 18.4bnboe and is significantly less densely explored than the UKCS, with more than three times as many wells drilled in the UK than in Norway.

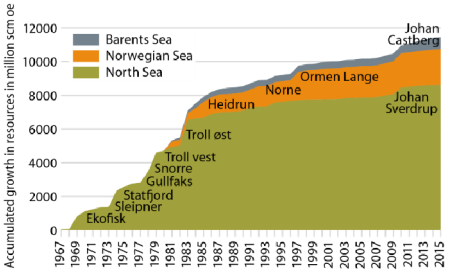
The region is split into three key areas of interest: the North Sea, the Norwegian Sea and the southern part of the Barents Sea (Exhibit 1). The North Sea is the most explored part of the NCS and the largest part of its resources have been proven here. Since it is the most mature part of the NCS, discovery sizes now tend to be in the 10-200mmboe range with an average of around 50mmboe, and so the challenge here is to develop these resources effectively by tying back to existing infrastructure. Although the largest discoveries were made early in the exploration of the North Sea, there are still exceptions, most notably the 2010 discovery of the giant Johan Sverdrup field.

Exhibit 2: Exploration drilling on NCS



Source: NPD

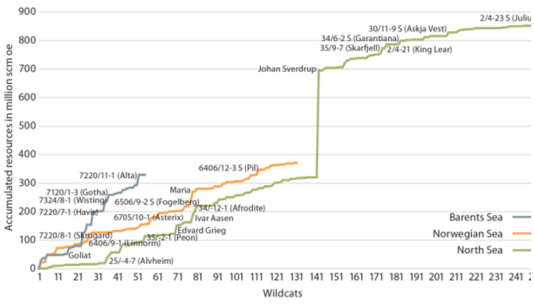
Exhibit 3: Resource growth on NCS



Source: NPD

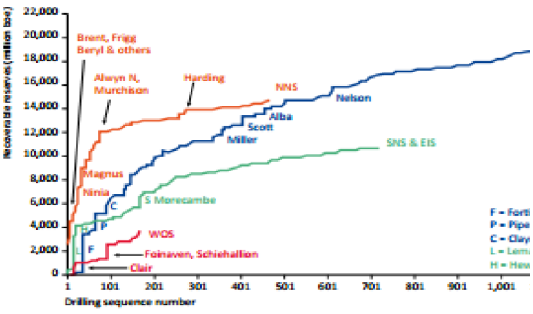
In 2005, Norway introduced a new tax initiative to encourage exploration activity on the NCS. Since that time the Norwegian government has provided a rebate in the following year equal to 78% of the capex spent in the previous year in exploration drilling. This has successfully boosted exploration and appraisal drilling in the NCS over the last 10 years (Exhibit 2), from a low of 12 wells in 2005 to between 50 and 60 wells over the last three years. Over the same period in the UKCS, exploration and appraisal drilling peaked at 111 wells in 2007 and declined thereafter to 26 wells in 2015.

Exhibit 4: NCS creaming curves



Source: NPD

Exhibit 5: UKCS creaming curves



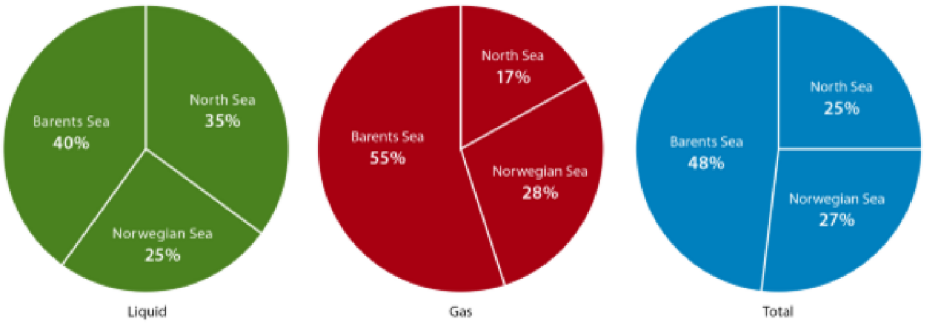
Source: DECC

The basin creaming curves demonstrate that the Norwegian Sea and Barents Sea are in the early stages of their life cycles relative to the UK North Sea (with the exception of West of Shetland). Exploration activity has therefore shifted towards these areas of the NCS in recent years, and the Barents Sea in particular is an increasing focus of interest following the successful appraisal of the 180mmbbl Goliat field between 2003 and 2007.

Barents Sea: Half of NCS undiscovered resources

The Norwegian Petroleum Directorate (NPD) estimates that almost half of recoverable undiscovered resources remaining in the NCS are expected to be proven in the Barents Sea, with the remainder split almost equally between the North Sea and the Norwegian Sea.

Exhibit 6: Recoverable undiscovered resources for each region of NCS

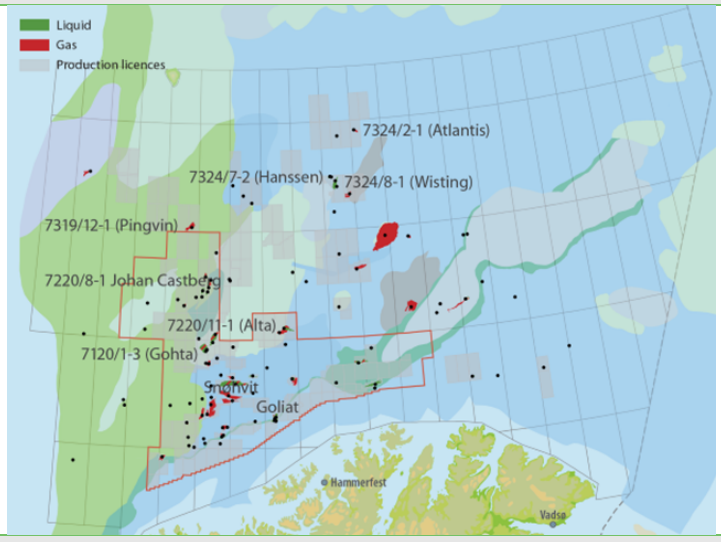


Source: NPD

Although the Barents is located at a similar latitude to the frozen seas north of Alaska, the Gulf Stream keeps the sea ice-free all year round and water depths are less than 500m. However, the weather in the region can change rapidly and the freezing temperatures and strong winds are operationally challenging. In 2015, the Barents Sea Exploration Collaboration (BaSEC) was initiated with a view to developing common operational and cost-effective solutions over a three-year period. Participants include Statoil, Lundin, Eni, OMV and Engie.

Exploration began here in 1980, although to date there are only two fields on stream: the Statoil-operated Snøhvit gas development and Goliat operated by Eni. Snøhvit began producing through a subsea production facility in 2007, 23 years after discovery. Goliat, discovered in 2000, is the first oil development in the Barents and has been producing since March 2016 from the most northern offshore production facility in the world to date. There have been issues with gas leaks at the Goliat FPSO, with the latest resulting in a shutdown enforced by the Petroleum Safety Authority (PSA) in September 2016.

Exhibit 7: Barents Sea discoveries



Source: NPD

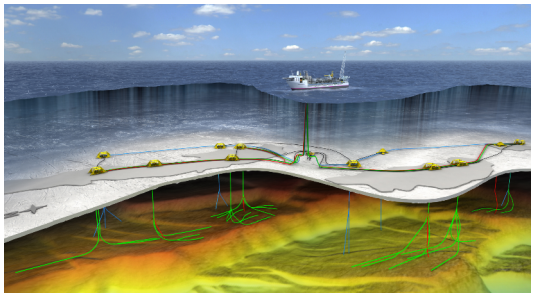
However, a number of significant discoveries have been made since 2011, and in 2014 the Barents Sea accounted for the largest number of discoveries and the biggest resources proven in the NCS.

The discoveries, Statoil's Johan Castberg, Lundin Petroleum's Alta/Gohta and the OMV operated Wisting, all have the potential to become standalone projects.

Johan Castberg: FDP planned in 2017

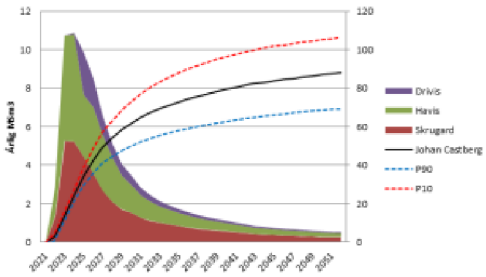
Johan Castberg is at the most advanced stage of the three projects, with a final development plan expected next year and potential production in 2022. It is located 100km north of Snøhvit in 350-400m of water and holds 400-600mmbbls resources. The field combines the Skrugard, Havis and Davis discoveries, all made since 2011. Operator Statoil delayed concept selection from 2015 into H216 as it looked to cut development costs. The current development plan is to produce via an FPSO at rates up to 190,000b/d. Cost estimates are reported to have been cut from $11.3bn to $6bn due to a combination of streamlining the design and low industry costs.

Exhibit 8: Johan Castberg schematic



Source: Statoil

Exhibit 9: Johan Castberg production profile

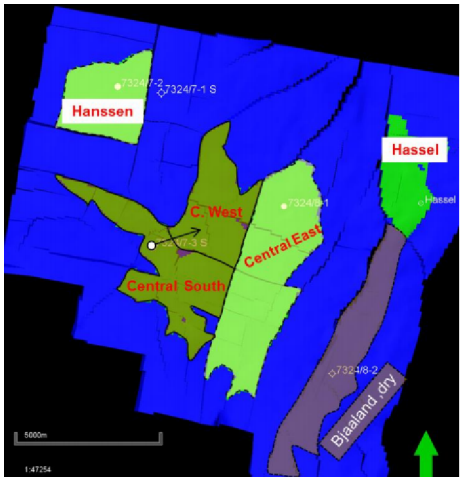


Source: Statoil

Wisting: Shallow reservoir

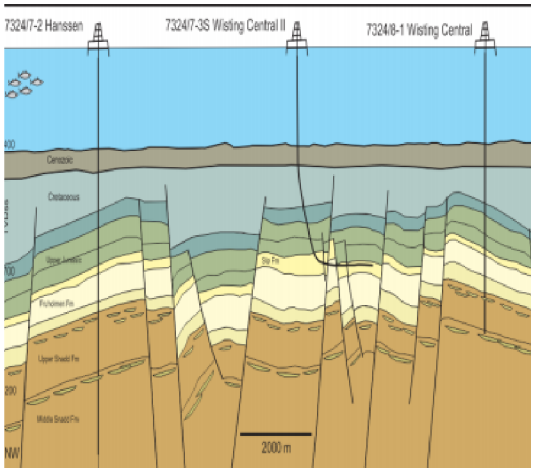
Wisting was discovered in 2013 with the Wisting Central well. Located in the frontier Hoop area in around 400m of water and some 310km north of Hammerfest, it is estimated to contain 200-500mmboe recoverable resources.

Exhibit 10: Wisting



Source: OMV

Exhibit 11: Wisting cross section



Source: OMV

At 250m, the Jurassic/Triassic Realgrunnen reservoir is very shallow and so the reservoir pressure and temperature are subsequently low at just over 1,000psi and 17° C. The field consists of six major segments, five of which have been evaluated with only Hassel undrilled. In H116, OMV continued its appraisal of the field with the drilling and testing of the Wisting Central II well. The well was designed to confirm the presence of hydrocarbons in the Central South and Central West sections of the field and to verify the free water level (FWL). The well was the first horizontal well to be drilled in the Barents and was challenging as the well trajectory needed to reach its horizontal

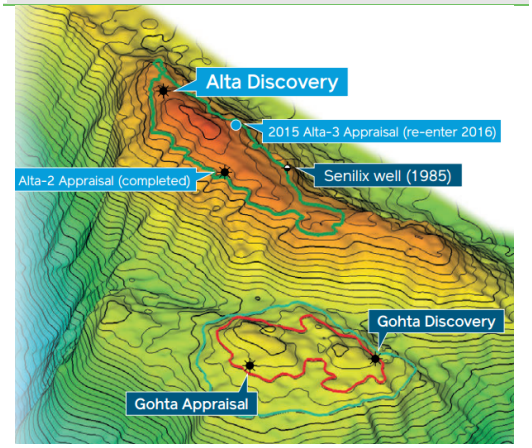
inclination within 250m of spudding. The well was successfully drilled and tested at over 5,000b/d through an Electrical Submersible Pump (ESP). OMV is updating its reservoir model incorporating data from the horizontal well and expects to be able to increase its recoverable resource estimate based on increased volumes in the Central South and West areas.

In May 2016, OMV was awarded a 25% WI in licence PL855 to the north of Wisting as part of the 23rd licencing round. Although OMV operates Wisting, partner Statoil has been awarded the operatorship and 35% of PL855. In September 2016 Statoil also increased its stake in Wisting to 35% after taking over Tullow Oil's 15% share of the field.

Alta/Gohta: Appraisal ongoing

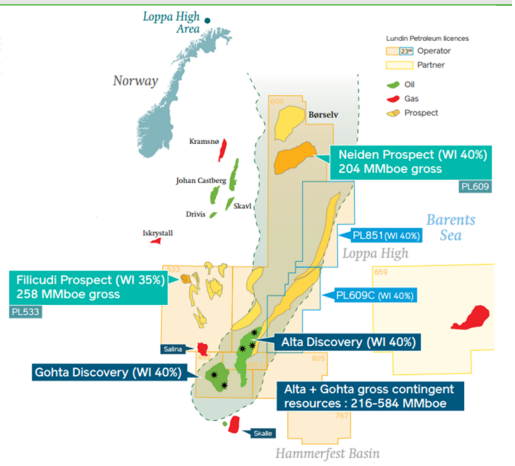
Alta and Gohta sit in the southern part of the Loppa High area of the Southern Barents, which is on trend with Johan Castberg to the west. Lundin discovered Gohta in 2013 followed by Alta in 2014. Together, they are estimated to contain gross contingent resources of 216-584mmboe, of which 125-400mmboe is attributed to Alta. In 2015 Alta was appraised, with two appraisal wells on the western and eastern flanks of the structure, and a re-entry to deepen and test of the one of these, Alta-3, is currently ongoing. The discovery well was tested at 3,300b/d and all three wells drilled to date are in pressure communication. The company is carrying out a development feasibility study this year for Alta and expects this to be followed by further appraisal. Meanwhile, an appraisal well is planned for Gohta 3.8km to the north-west of the discovery well at the end of 2016. This would be the first of six possible additional well options that Lundin can drill with the Leiv Eiriksson rig.

Exhibit 12: Alta/Gohta



Source: Lundin Petroleum

Exhibit 13: Filicudi and Neiden prospect locations



Source: Lundin Petroleum

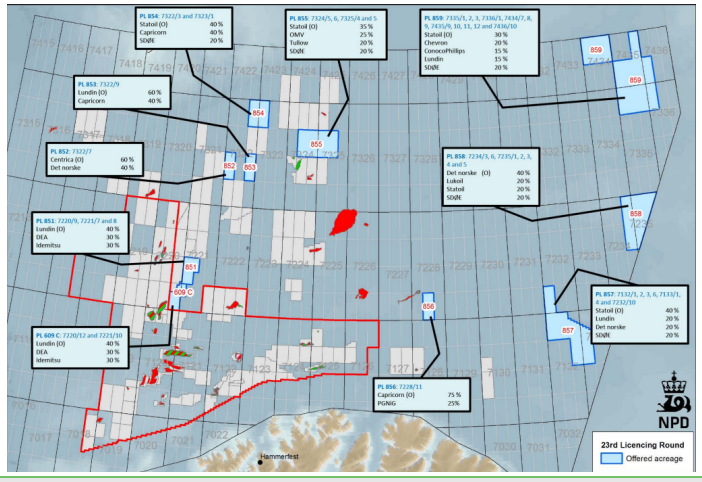
The Alta/Gohta discoveries have opened up this region for further exploration and Lundin is planning to drill two exploration wells, Neiden and Filicudi, in the area once the Alta-3 well is completed. Neiden is a carbonate prospect on trend with Alta/Gohta and targeting gross unrisked resources of 204mmboe with a CoS of 30%. The well was drilled to just above reservoir depth in 2015. Filicudi sits between Alta/Gohta and Johan Castberg to the north. The company is targeting a double flat spot on seismic similar to that seen in Johan Castberg and is estimating gross unrisked prospective resources of 258mmboe with a CoS of 25%. Success in Filicudi would open up a number of further prospects with a total trend potential of more than 1blnbbls prospective resources, including Filicudi South, Formica and Salina W.

23rd licensing round: Opening up of South East Barents

Norway's 23rd licensing round offered acreage in the Barents Sea and was the first to open up new exploration acreage on the NCS since 1994. The licence awards were announced in May 2016,

with 10 production licences awarded to 14 companies (one of these, Tullow, has subsequently pulled out of Norway, selling its licence stakes to Statoil). Six of the awards were in the areas surrounding Alta and Wisting, while three licences were located in the newly opened South East Barents close to Norway's maritime boundary with Russia.

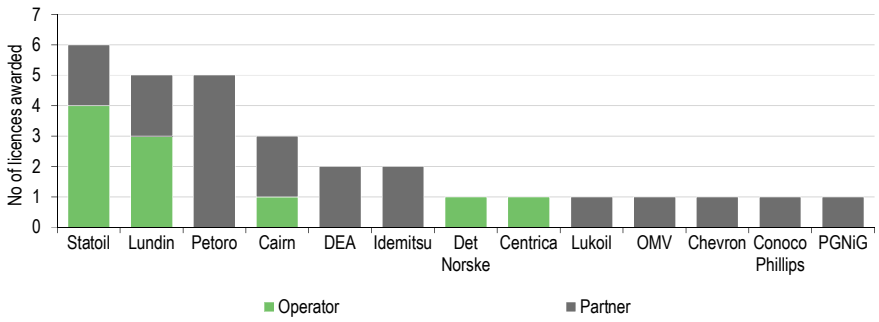
Exhibit 14: 23rd round licence award locations



Source: NPD

Statoil and Lundin were awarded the greatest number of licences and are the dominant operators of the new acreage, with seven operatorships between them. Cairn (operating here as Capricorn) is a new entrant to the region, having picked up three licences including one as operator. The company already has Arctic experience from its Greenland programme, making it well placed to operate in this harsh environment. The awards also saw the return of Chevron to Norwegian waters with one non-operated licence, PL859, in the South East Barents. The company left the Barents in 2011 and had pulled out of Norway in 2015.

Exhibit 15: Companies awarded licences in 23rd round

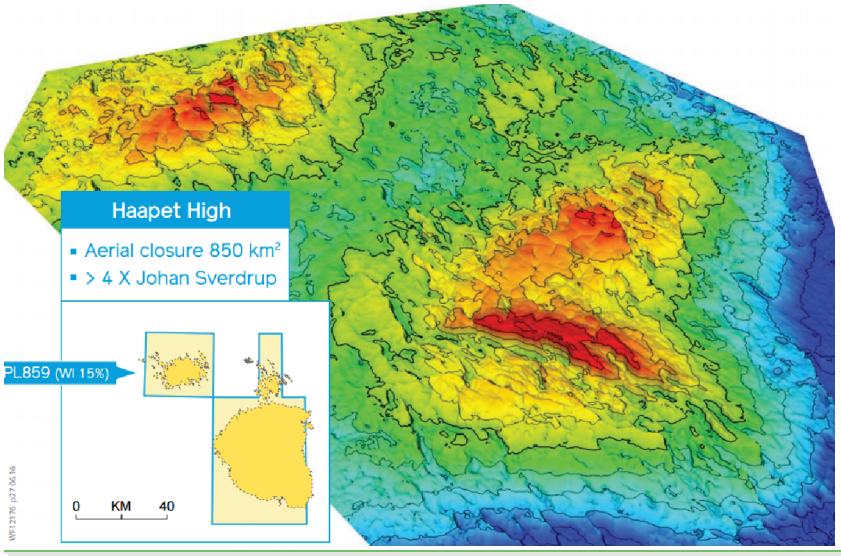


Source: Edison Investment Research, NPD

PL859 generating most interest: Korpfjell drilling in 2017

According to the NPD, PL859 was the most sought-after licence in the round. The licence is very large, covering 12 blocks and is at the north-eastern margin of the Barents. It contains drill-ready prospects based on 3D seismic acquired in 2014 and was awarded to a group of experienced Barents players: Statoil, Det Norske, Lundin, ConocoPhillips and Chevron. Operator Statoil has already announced plans to drill the Korpfjell prospect in 2017, which it describes as being high-risk/high-reward, while partner Lundin believes a structural closure in the licence to be 850km^2 and over four times the size of that seen in Johan Sverdrup. Lundin also sees a 570km^2 aerial closure in the Signalhornet Dome in PL857, the most southerly of the three frontier licences, and describes the potential of the region as being in the order of multi-billion barrels.

Exhibit 16: PL859 map



Source: Lundin

As in Wisting, the reservoir at Korpfjell is shallow, so while it will be the most northerly well drilled in the Barents, Statoil estimates that the well will cost $25m and sees it as one of the most competitive in its global portfolio. In addition to drilling Korpfjell, Statoil announced at the end of August 2016 that it is planning to drill a further four to six exploration wells in the Barents in 2017. These are expected to include Blåmann in the Goliat area and Koigen Central on the Stappen High, around 100km north-west of Johan Castberg.

Also located on the Stappen High is Faroe's Dazzler prospect, due to be drilled in late 2016/early 2017. Operated by Eni, where it is known as two prospects, Bigorna and Bone, Faroe holds a 20% WI and estimates that Dazzler contains over 230mmboe gross prospective resources with a 15% CoS. Faroe also participated in one of only two exploration wells drilled so far this year in the Barents. The Kvalross/Kvaltann well, south of Wisting and operated by Wintershall, encountered hydrocarbon shown in poor quality reservoir in the Lower Tertiary Klappmyss and water-wet, good-quality sands in the Triassic Snadd.

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