



# PL653 RELINQUISHMENT REPORT

Ref.: R-020382





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## Table of Contents

<b>1</b>	<b>KEY LICENSE HISTORY .....</b>	<b>4</b>
<b>2</b>	<b>DATABASE .....</b>	<b>6</b>
<b>3</b>	<b>REVIEW OF GEOLOGICAL FRAMEWORK .....</b>	<b>9</b>
<b>4</b>	<b>PROSPECT UPDATE.....</b>	<b>13</b>
<b>5</b>	<b>TECHNICAL EVALUATIONS.....</b>	<b>15</b>
<b>6</b>	<b>CONCLUSIONS .....</b>	<b>16</b>

## List of Figures

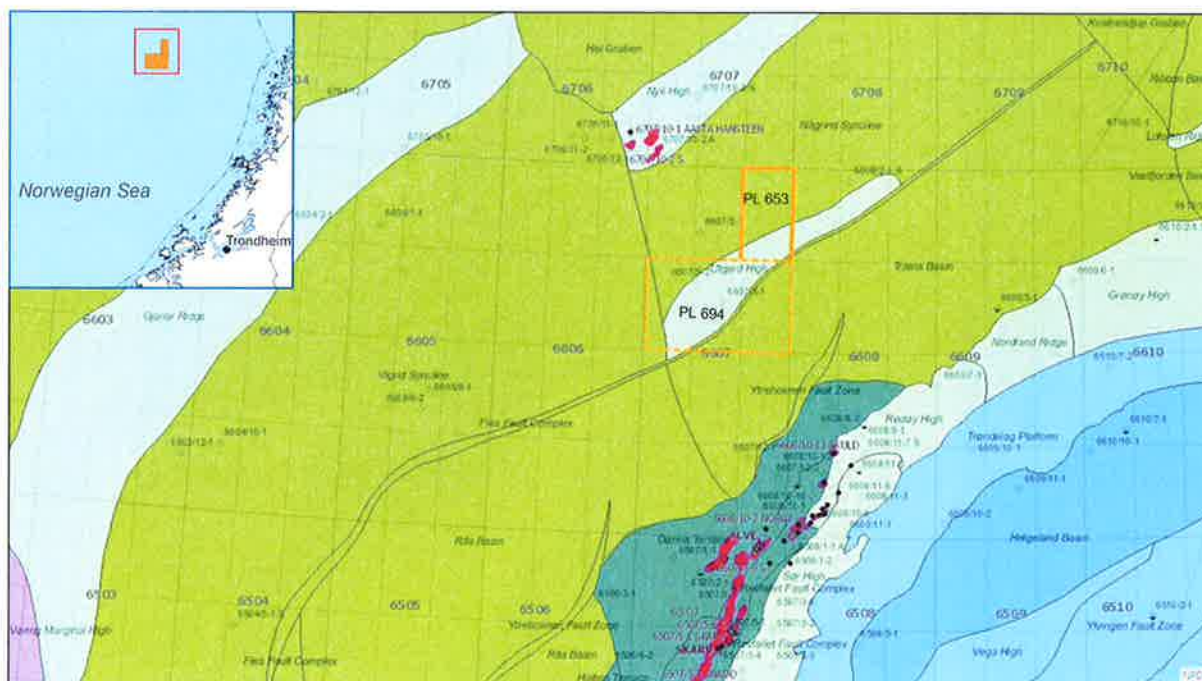
Figure 1	Location of PL653 on the Utgard High in the Norwegian Sea .....	4
Figure 2	<i>Seismic database from APA 2011 application .....</i>	<i>6</i>
Figure 3	New Seismic and Well Database for PL653 and PL694 .....	7
Figure 4	<i>PL653 &amp; PL694 Nise prospects overview map .....</i>	<i>10</i>
Figure 5	Seismic randomline with corresponding geoseismic section across .....	11
Figure 6	Nise Reservoir development around the Utgard High.....	12
Figure 7	Identified leads from APA 2011 application. ....	13
Figure 8	Top Nise reservoir depth map .....	14
Figure 9	<i>PL694/PL653 Area development scenario overview.....</i>	<i>16</i>

## 1 KEY LICENSE HISTORY

### ***Award and Participates***

PL653 is situated on the northwestern part of the Utgard High in the Norwegian Sea, and comprises block 6607/3 (Figure 1). The license was awarded February 3, 2012, to RWE DEA Norge (now DEA Norge, 40%, operator), Lundin (30%) and Marathon Oil (now AkerBP, 30%). Figure 1 shows that PL653 borders DEA operated PL694 (block 6607/4,5,6) towards the south. The two licenses have the same partnership, except Petoro is partner only in PL694, and the two licenses currently share the same prospectivity. The G&G work in the two licenses have been combined and common license meetings have been arranged.

PL653 was originally applied for as an upside to PL330 which comprised blocks 6608/1&2 directly to the east of PL653. The focus at that time was on Jurassic potential which was tested by the dry 6608/2-1S well in PL330 in 2013. PL330 was relinquished in 2014 as a result of this well. Exploration focus in PL653 was then shifted to the Cretaceous Nise play, which was mainly defined within the PL694 blocks (awarded in APA 2012).



**Figure 1** The figure shows the location of PL653 on the Utgard High in the Norwegian Sea, 30 km southeast of the Aasta Hansteen gas field

### ***Initial work obligations***

The initial work obligations were 3D acquisition and G&G work. The DoD decision was initially set to 3 February 2015, but was aligned with PL694 and extended two times, each with one year, to 8 February 2017.

New broadband 3D seismic covering PL653 and the relinquished PL330, was acquired in 2012 (RD1202). This survey was reprocessed and merged with the PL694 broadband 3D



(RD 1301) in 2015. Seismic resolution below base Tertiary has been a challenge in this area. The broadband 3D seismic shows significant improvement, but imaging the deeper parts is still challenging in parts of the area.

Regional and sub-regional mapping including all relevant and mappable seismic markers have been finalized and used for structural reconstructions, reservoir development analysis and basin modelling studies. Detailed prospect mapping and prospect analysis, including detailed geophysical modelling and analysis, have been performed and presented to partners.

The initial work obligations are completed and have resulted in a relinquishment decision.

**Overview of meetings held**

Table 1 shows an overview over the PL653 relevant license meetings that have been held. License PL653 has been administrated together with PL330 (2012) and PL694 (2013-2016).

*Table 1 License meetings in PL653*

Meeting	Date	Content
MC document	01.06.2012	Establishment of license
MC / EC mtg	21.11.2013	Seismic acquisition and processing of 3D RD1301, Work program & Budget
Work mtg	29.04.2014	New 3D RD1301 Interpretation & APA 2014 recommendation
MC / EC mtg	27.05.2014	Prospect overview and way forward towards DoD decision planned for 15.10.2014
Work mtg	22.08.2014	Presentation of drillable prospect: Celsius, site survey recommendation and APA 2014 recommendation to apply for block 6608/1 (Kelvin prospect)
MC / EC mtg	03.11.2014	Presentation of G&G work and results, recommended work program including a site survey & budget for 2015.

**Reason for relinquishment**

The Celsius prospect, which straddles the border between PL653 and PL694, was defined and presented to the license as a drilling target early 2014. In the November 2014 MC/EC meeting, DEA recommended to include a site survey over the Celsius prospect in the firm 2015 budget. The partners did not approve. In order to prepare for a possible drill decision on the Celsius prospect in 2015, DEA acquired a site survey over the Celsius prospect on 100% own cost in January 2015. It became clear during early 2015, that the partners did not want to pursue the defined prospectivity in PL653/PL694, and that the only way forward for reaching a drilling decision, was to find replacement partners. DEA invited some companies to a data room in 2015 without success. DEA wanted to continue this process into 2016, and the partners agreed to apply for an extension of the DoD decision, with the intension of finding replacement partners. The current market situation has however made the farm-out process difficult and DEA has therefore, in agreement with the license partners decided to relinquish the license.

## 2 DATABASE

### 3D seismic data base

The main 3D database used for the APA 2011 application consisted of 3D surveys RD0601R10, NE04 and VGUH0201 (Figure 2). 3D surveys NLGS95 and ST01M07 were released datasets used for regional evaluation.

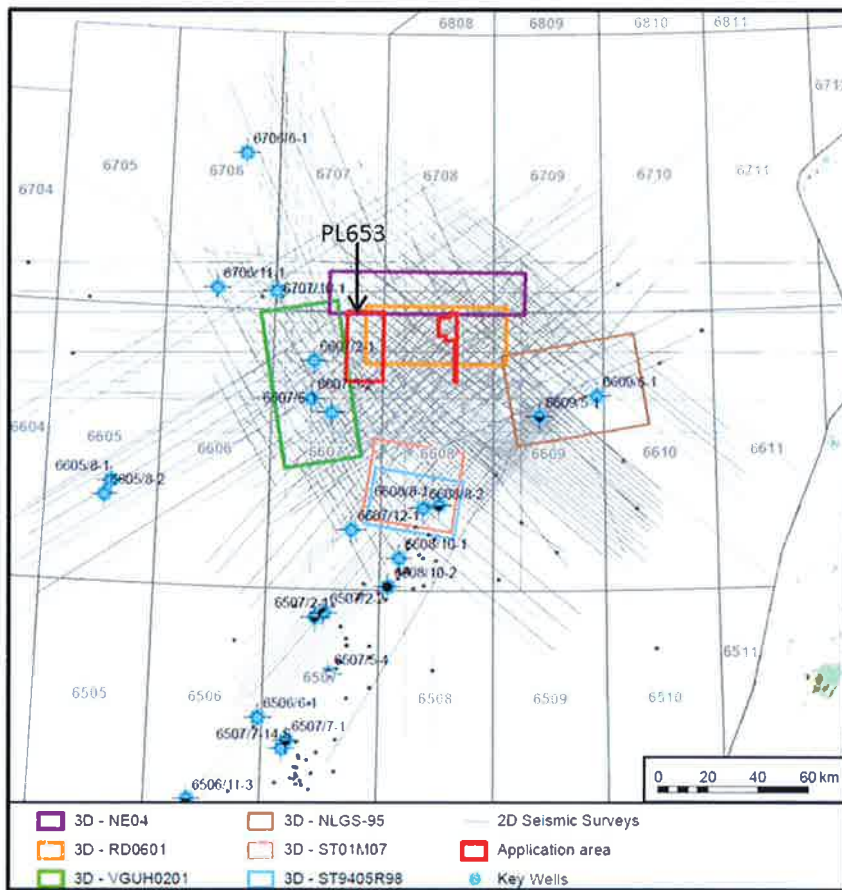
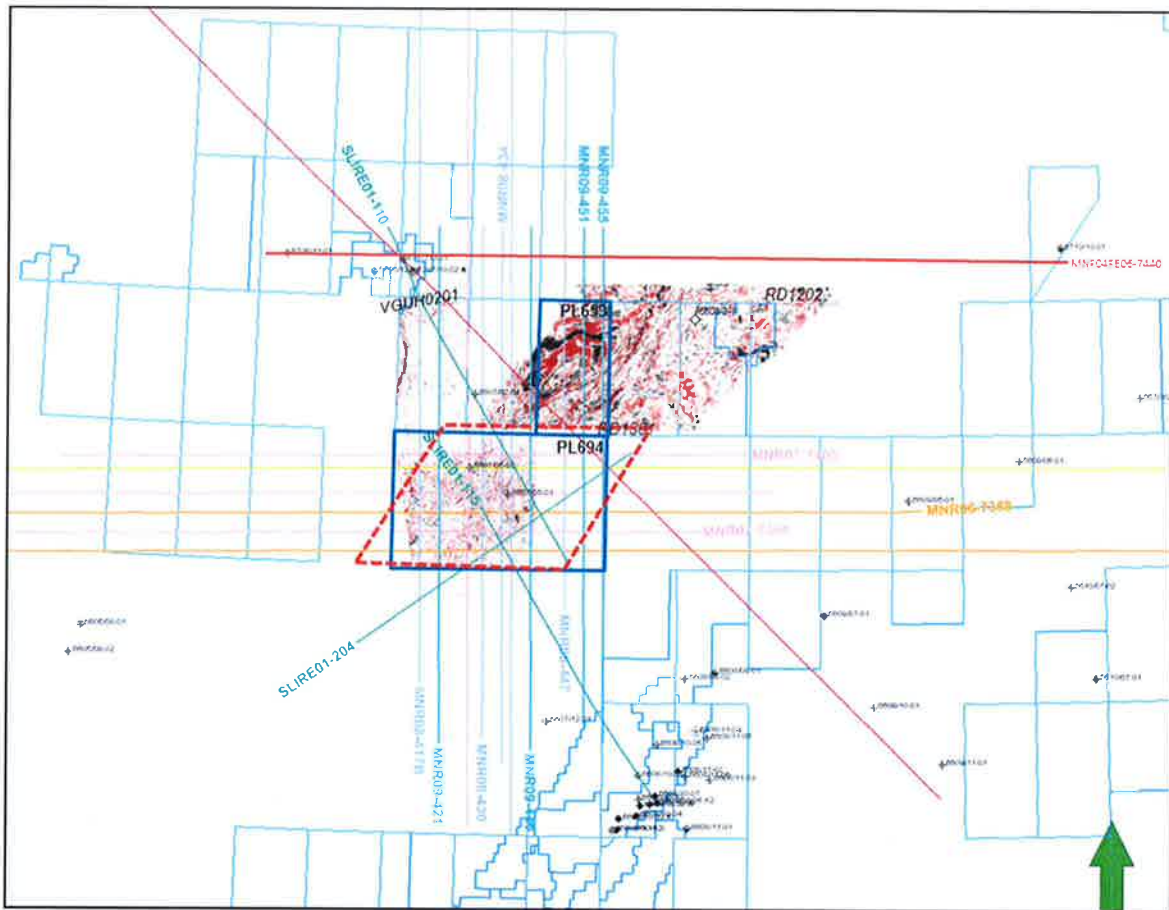


Figure 2 Seismic database from APA 2011 application

The new seismic 3D database is shown in Figure 3. New broadband 3D seismic covering PL653 and PL330 was acquired in 2012 (RD1202). The RD1202 survey was later reprocessed and merged with the PL694 3D seismic survey (RD1301) in 2015. Gravity and Magnetic data were acquired together with both seismic surveys.



**Figure 3** New Seismic and Well Database for PL653 and PL694: 3D seismic surveys RD1202 and VGUH0201 are shown as time slices, 3D RD1301 outline is shown in red. All MNR/AMR 2D lines crossing the PL694 license were recommended as part of the common database, in addition was MNR04RE06-7440 recommended for PL653 database, as it ties to important wells in the Aasta Hansteen area. Chosen lines from 2D survey SLRE01 were also included. All wells in the area are released and are included in the database (the most recent wells in the Aasta Hansteen area excluded). An important new well has been the 6608/2-1S well, drilled in PL330 in 2013 with the same partner group (Marathon later acquired by Det Norske)

### **3D survey acquisition and processing in the Utgard High licenses**

RD1202 3D survey was acquired within PL653 and PL330 with Geostreamer by PGS during summer 2012. The 3D survey was shot in E-W direction and covers approximately 1300 km<sup>2</sup>. The water depth in the area is varying from 250m to more than 1000m. RD1202 was originally processed by PGS and Schlumberger Geosolutions in Gatwick. Due to a hard water bottom the data was contaminated by strong multiple energy, which especially covered the target zone from 2-4 seconds. Well 6608/2-1S was drilled in PL330 in 2013 and is located inside RD1202 (Figure 3).

During 2013 3D broadband survey RD1301 (1250 km<sup>2</sup>) was acquired in PL694 by Western Geco. The survey was processed by Schlumberger Geosolutions in Stavanger. The key challenges to address were:



- 1) Shallow scattered noise/ diffractions (and multiples thereof) at and near the seafloor.
- 2) In the deeper section, there is an anomalous unit (termed the 'Ooze') that significantly attenuates signal and is associated with the generation of multiple energy. The Ooze has variable topography and thickness.

The results from the survey were very good, and the new developed demultiple technique XIMP had been a key process in the improved imaging. It was therefore decided to re-process the RD1202 survey using the same methods as for RD1301, and to merge the two surveys. Significant improvement of the RD1202 was achieved, specially related to resolution and amplitude.

### ***2D seismic data base***

The MNR/AMR 2D lines crossing the PL694 license were recommended as part of the common database for PL694 and PL653, extent as shown in Figure 3. In addition, MNR04RE06-7440 was recommended for inclusion in the PL653 database, as it ties to important wells in the Aasta Hansteen area. Chosen lines from 2D survey SLRE01 were also included.

Included 2D lines are: (colour as shown in Figure 3): MNR04RE06-7440, MNR06- 7380, 7388, MNR05-7397, MNR08-417B, 430, 434, 436, 447, MNR07-7384,7392, 7400, 427, MNR09- 421,440, 451,455, MNR11-90764 and SLRE01 (110,115,204).

In addition, all available, released 2D surveys were used for sub-regional and regional evaluations (Figure 2 shows the 2D surveys available in 2011).

### ***Well data base***

All wells in the area were released and included in the database (the most recent wells in the Aasta Hansteen area excluded). An important tie well has been the 6608/2-1S well, drilled in PL330 by the same partnership in 2013 (Marathons share has later been purchased by Det Norske). This well reached TD in Early Cretaceous Lyr formation at 5600m and found no reservoir sands.



### 3 REVIEW OF GEOLOGICAL

#### **Studies performed**

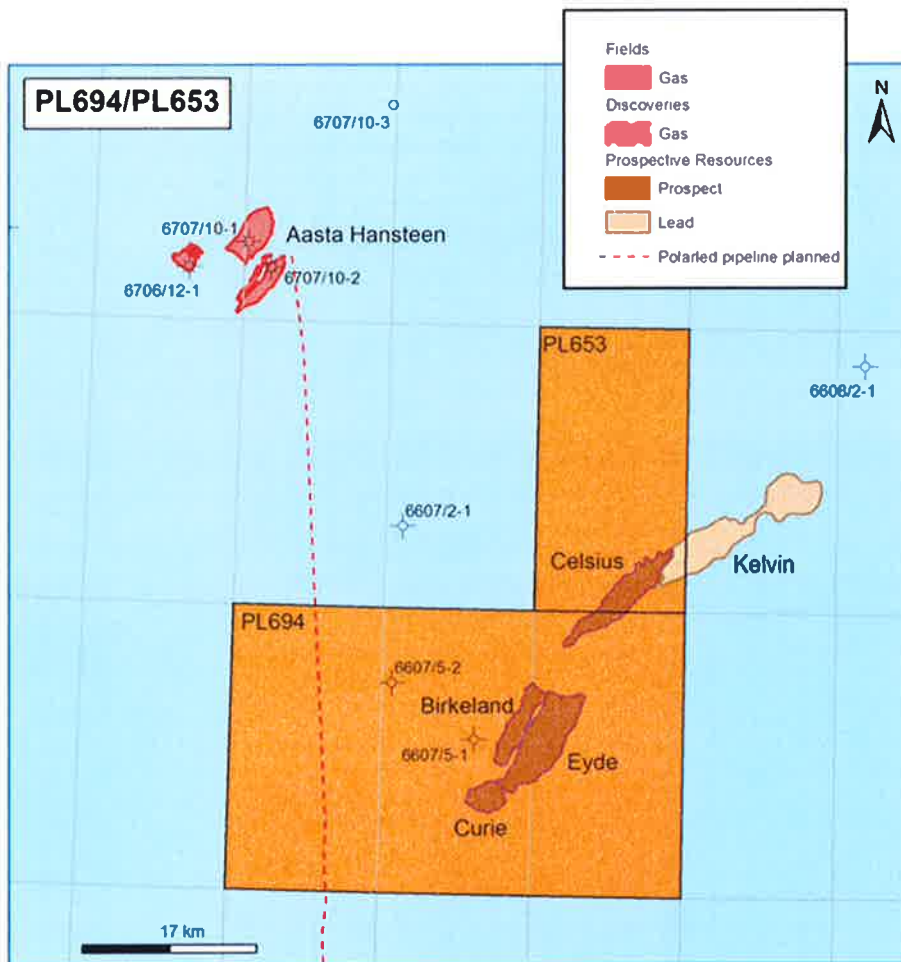
The studies performed in licenses PL653 and PL694 are presented in Table 2.

Table 2 Studies performed in PL694 and PL653

Study	Supplier	Reason /Content
AVO & Seismic Inversion	(RPS Energy)	Analysis of the observed hydrocarbon response in the Spekkhogger and Tumler sandstones and modelling of other possible fluid fills, thicknesses and facies at the frequency of the observed data
Biostratigraphic interpretation of 12 wells in the Vøring Basin, Norwegian Sea	APT	The Upper Cretaceous play in the Vøring Basin has been matured by several wells over many years, resulting in the introduction of new member and formation names. Age from biostratigraphy is needed to identify and correlate the members/ formations within the basin.
Petrophysical interpretation of 9 wells in the Vøring basin	Internal	Used for predicting prospect reservoir parameters
Core study of Utgard well cores	Internal	Used for predicting prospect reservoir facies and reservoir parameters
Surface geochemical survey over the Aasta Hansteen field gas structures.	Conwy Valley Consortium (CVC)	Mainly to calibrate the method for use in exploration
Site survey RWE15300	Fugro	Site survey including environmental study (SSS, CPT and ROV) over the Celsius prospect

#### **Results of block evaluation**

The evaluation of PL653, block 6607/3, and PL694, blocks 6607/4,5 & 6, have resulted in definition of several prospects within the Nise play. The prospects are shown in Figure 4 and listed with recoverable volume estimates in table 3. The Kelvin prospect is partly situated outside of PL653. The Celsius prospect is straddling the border between the two licenses and is the main prospect defined. The Birkeland, Eyde and Curie prospects are defined in PL694. A decision to drill the Celsius prospect in 2015 was recommended by the operator, but was not supported by the partners.



Coordinate System: ED 1950 UTM Zone 32N

Figure 4 PL653 & PL694 Nise prospects overview map

Table 3 Estimated Recoverable Resources in PL653 & PL694 Nise prospects. The Kelvin prospect is only partly situated in the licenses

Recoverable gas BCM				
Prospect	P90	P50	P10	Mean
Celsius	12.7	23.8	42.8	26.3
Birkeland	5.2	11	19.6	10.6
Curie	3.7	7.2	12.9	7.8
Eyde	2.1	6.5	23	10.1
Kelvin	10.8	24.2	55.9	29.4
SUM				84.2

Figure 5 shows a seismic random line with corresponding geoseismic section across Celsius and Kelvin prospects. The line crosses the Utgard High towards the West and ties to well 6607/5-2. The interpreted Top Tumler sandstone is represented by a negative acoustic impedance, high amplitude reflector, clearly showing the opposite phase of the sills in the west. The Top Tumler gathers show AVO class III anomaly.

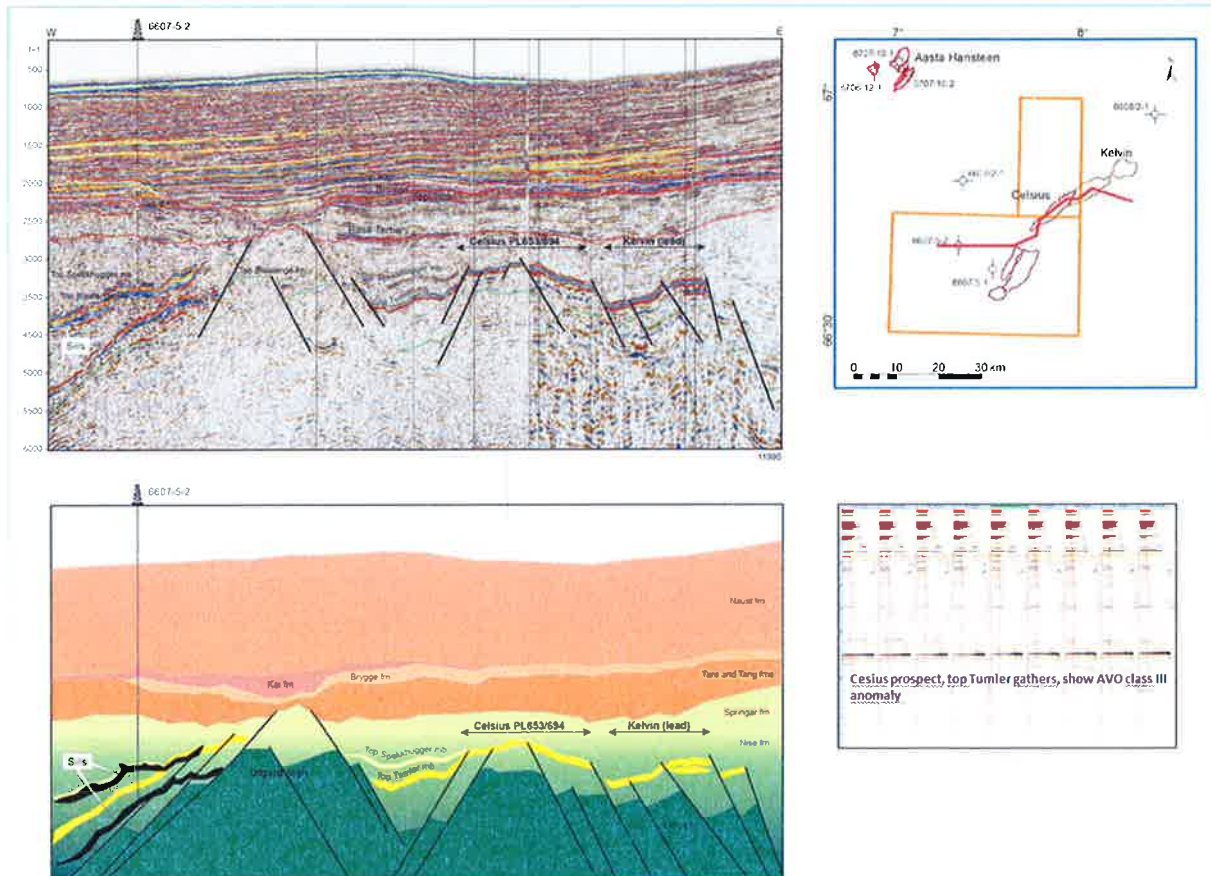


Figure 5 Seismic randomline with corresponding geoseismic section across the Celsius and Kelvin prospects. The line ties to well 6607/5-2 in the west. The Top Tumler reservoir gathers show AVO class III anomaly

**Major changes in understanding and expectations based on new data and evaluations, compared to original license application.**

**Nise Reservoir development**

The understanding of the Nise formation turbidite system distribution, defined by the early Campanian Tumler member (K87) and the Middle Campanian Spekkhogger member, has developed considerably during the license work. After well 6608/2-1S was drilled in 2013, it became evident that no Nise sands were present on the Utgard High North, and that potential Jurassic strata would be too deeply buried to be of interest for hydrocarbon exploration. However clear indications of reservoir presence in the Curie prospect from the PL694 license application work (based on 3D survey VGUH0201), was further strengthened by the new 3D survey RD1301. The new seismic data also indicated presence of Nise reservoir in the Celsius and Kelvin prospects, defined partly within PL653. Considerable

efforts have been made to understand the Nise reservoir development and the resulting model is illustrated and explained in Figure 6 below.

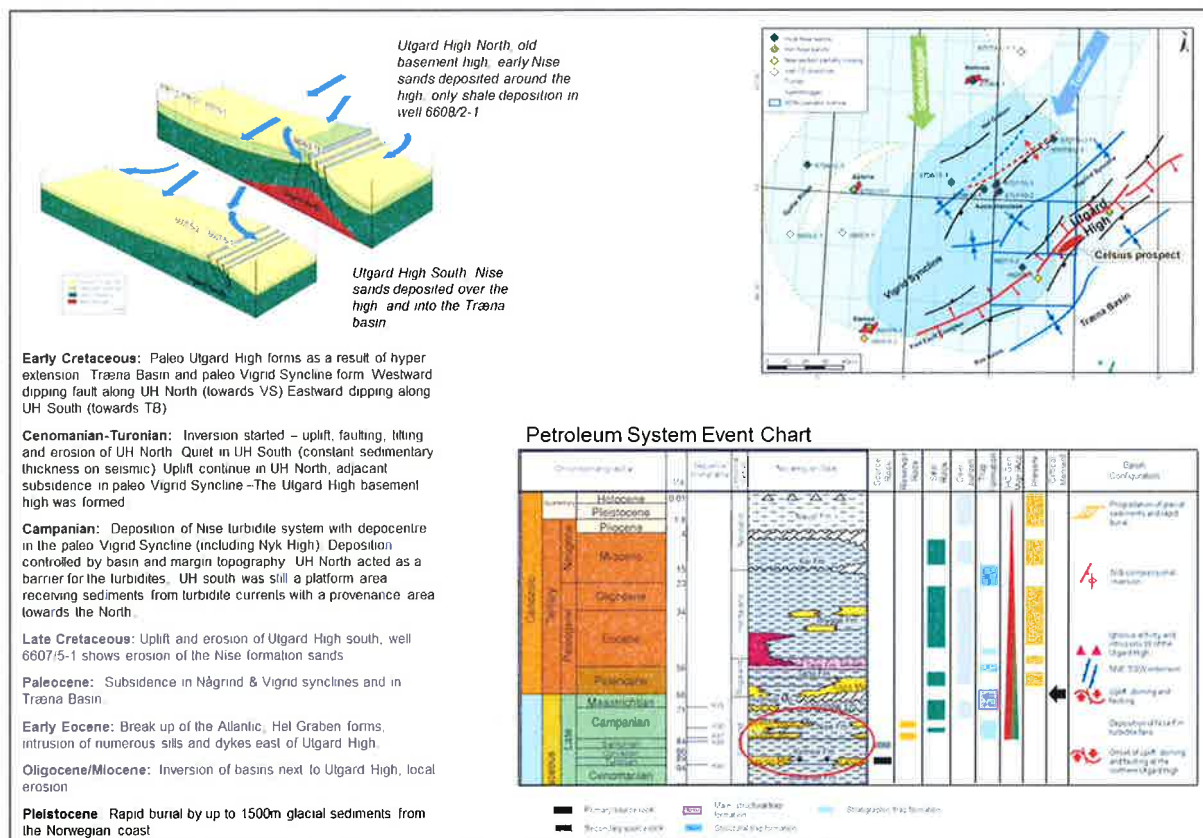
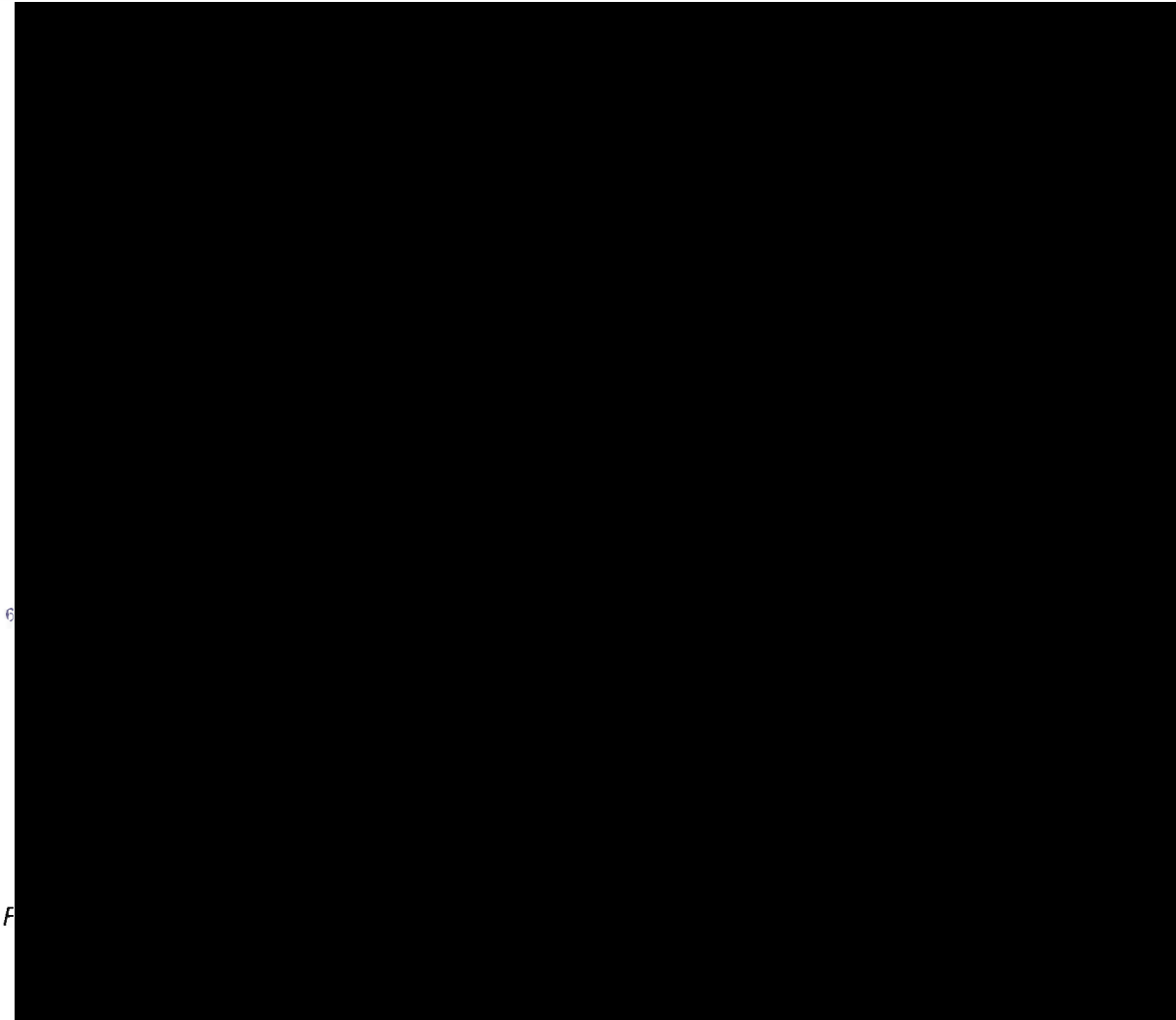


Figure 6 Nise Reservoir development around the Utgard High

### Prospect definition and mapping

Figure 7 shows an overview of the leads presented in the APA 2011 application. PL653 was originally applied for as an upside to PL330 which comprised blocks 6608/1&2 directly to the east of PL653. The focus at that time was on Jurassic potential which was tested by the dry well 6608/2-1S in 2013. PL330 was relinquished in 2014 as a result of this well. Exploration focus in PL653 was then shifted to the Cretaceous Nise play, which was mainly defined within the PL694 blocks (awarded in APA 2012).

Mapping of the new and more extensive 3D seismic data acquired in 2013 over the PL694 license, firmed up the definition of the prospects and leads applied for in APA 2012 (PL694). The current prospect map is shown in Figure 4. The Jurassic Livingstone and Darwin leads from APA2011 are screened out and the Cretaceous Celsius and Kelvin prospects have been defined within PL653. Three more Cretaceous prospects are defined within PL694.



## 4 PROSPECT UPDATE

### ***Review of prospect and/or leads***

The mapped Jurassic leads from the 2011 application were screened out due to the results of the 6608/2-1S well which reached TD in Early Cretaceous Lyr Formation at 5600m. Potential Jurassic strata in PL653 will be buried even deeper and are therefore considered to be too deeply buried for hydrocarbon exploration. Exploration focus in PL653 was then shifted to the Cretaceous Nise play, which was mainly defined within the PL694 blocks awarded in APA 2012. The 2012 application database only consisted of the VGUH0201 3D, in addition to 2D seismic data (see Figures 2 and 3). One of the leads from the PL694 application was partly situated in PL653, and is now upgraded to a drillable prospect, Celsius, based on mapping of the acquired RD1202 and RD1301 3D surveys. The Kelvin prospect, partly situated in PL653, has also been defined through the license work.

The 2016 Top Nise reservoir map with prospect outlines is shown in Figure 8. (The update of Nise prospectivity from the APA 2012 PL694 application is described in the PL694 relinquishment report).

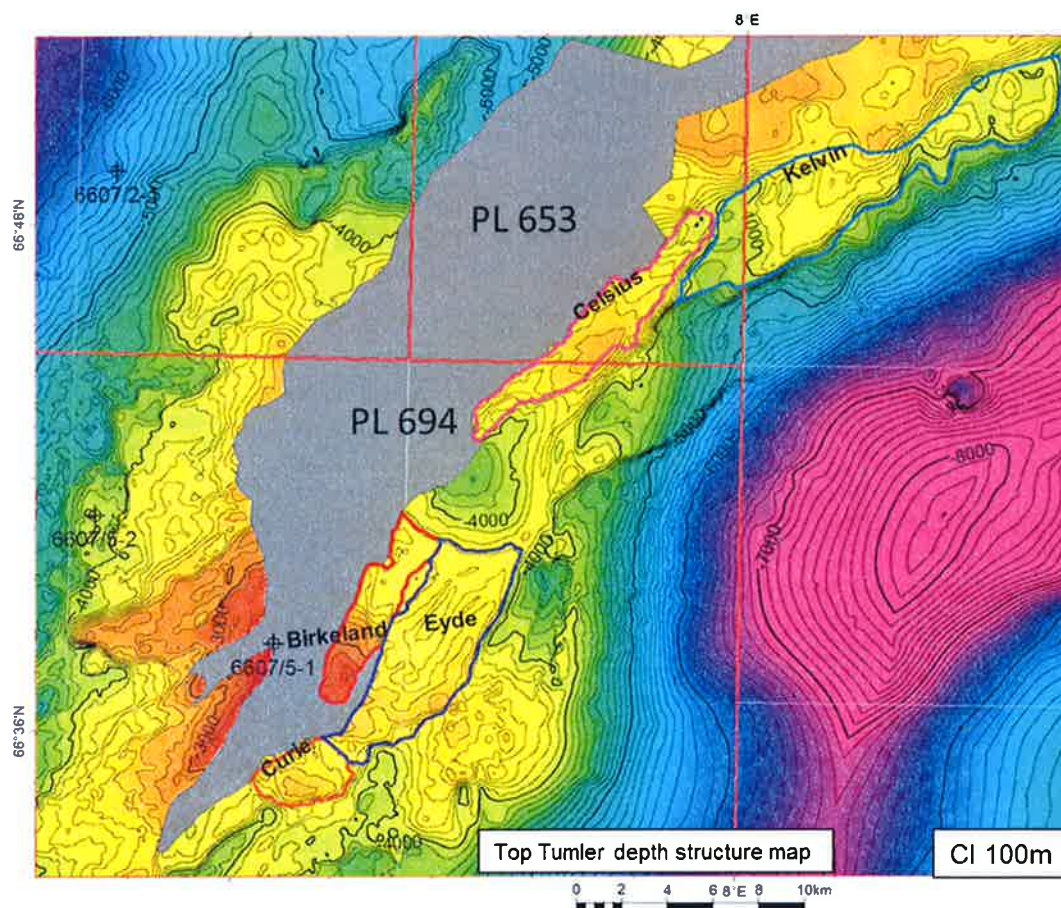


Figure 8 Top Nise reservoir depth map showing prospect outlines as mapped in 2016

Table 4 changes in prospect resource volumes and probability

Prospect /Lead	From application APA 2011		Updated based on new data and evaluation (2012 - 2016)	
	Recoverable OE 10 <sup>6</sup> Sm <sup>3</sup> (P50)	Risk %	Recoverable Gas 10 <sup>9</sup> Sm <sup>3</sup> (Pmean)	Risk % (after DHI uplift)
Livingstone lead	52	-		
Darwin lead	30	-		
Celsius			23,80	39
Kelvin*			24,20	35

\*Kelvin prospect is mainly situated in open acreage, would be of interest for a potential area development solution

Table 4 shows changes in prospect resource volumes and probability estimates between the APA 2011 application, and later license work based on new seismic 3D data and new evaluation (2012-2016). All the prospects/leads are updated. The Celsius and Kelvin prospects were not defined in APA 2011. The two Jurassic leads from 2011 were later screened out.

## 5 TECHNICAL EVALUATIONS

### ***Development Concept***

Screening of a subsea development concept for Celsius via a subsea tie-back to Aasta Hansteen revealed a number of potential challenges. The key challenge related to high minimum wellhead pressures (150 – 170 bar) needed on Celsius in order to meet a delivery pressure of 85 Bar at Aasta Hansteen. This implied a potentially low recovery factor of 55 %, which makes it challenging to pass the economic threshold for a development. Additional flow assurance issues were identified due the requirement for multiphase flow and negative slope from Celsius (450m water depth) to Aasta Hansteen (1200m water depth).

A different approach including development of multiple prospects in PL653 & PL694 area, local infrastructure and optimized utilization of the Aasta Hansteen facilities (operational and export) has been proposed as an alternative development strategy.

The representative base case for this development scenario is 295 MMboe gas recovered from multiple prospects e.g. Celsius, Birkeland and Eyde (see development scenario overview in Figure 9). Subsea completed wells are tied back to a floating production unit (FPU). A fluid composition similar to the Zidane discovery and 8 deviated gas production wells located in three 4-slot templates are assumed. The FPU is located in 450 m water depth between the prospects in PL694. The gas export is taking place via Polarled pipeline to Nyhamna terminal, and condensate is transferred to the Aasta Hansteen platform. A spread moored FPU equipped to handle 100 Mboe/d gas, simple separation, gas dehydration, compression and metering is assumed. The gas export pipeline is connected to a pre-installed Tee at Polarled (kilometre point KP 59). Stabilisation, storage and offloading of condensate are assumed at Aasta Hansteen.

### ***Cost and Timing Assumptions***

In total 3 exploration wells and 3 appraisal wells have been assumed in years 2018-2023 with production start in 2029. Development costs are benchmarked against existing NCS installations (Aasta Hansteen in particular). Tariffs are assumed for the gas via Polarled, Nyhamna and onwards to market, and for the condensate at Aasta Hansteen.

The project currently shows marginal economy.

