DEA

PL694 RELINQUISHMENT REPORT

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Per Roar Slaatsveen

DEA

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PL694 Relinquishment report: Review of Database, Studies performed and prospectivity in the licence.	Norwegian Petroleum Directorate PL694 MC/EC committee members RDN Exploration Manager

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1 KEY LICENSE HISTORY

Award and Participates

PL694 is situated on the Utgard High in the Norwegian Sea and comprises blocks 6607/4,5 & 6 (Figure 1). The license was awarded February 8, 2013, to RWE DEA Norge (now DEA, 40%, operator), Lundin (20%), Marathon Oil (now Det Norske, 20%) and Petoro (20%). Figure 1 shows that PL694 borders DEA operated PL653 (block 6607/3) towards the north. The two licenses have the same partnership, except Petoro is not partner in PL653, and they share the same prospectivity. The G&G work in the two licenses have been combined and common license meetings have been arranged for efficient exchange of exploration ideas and mapping results.

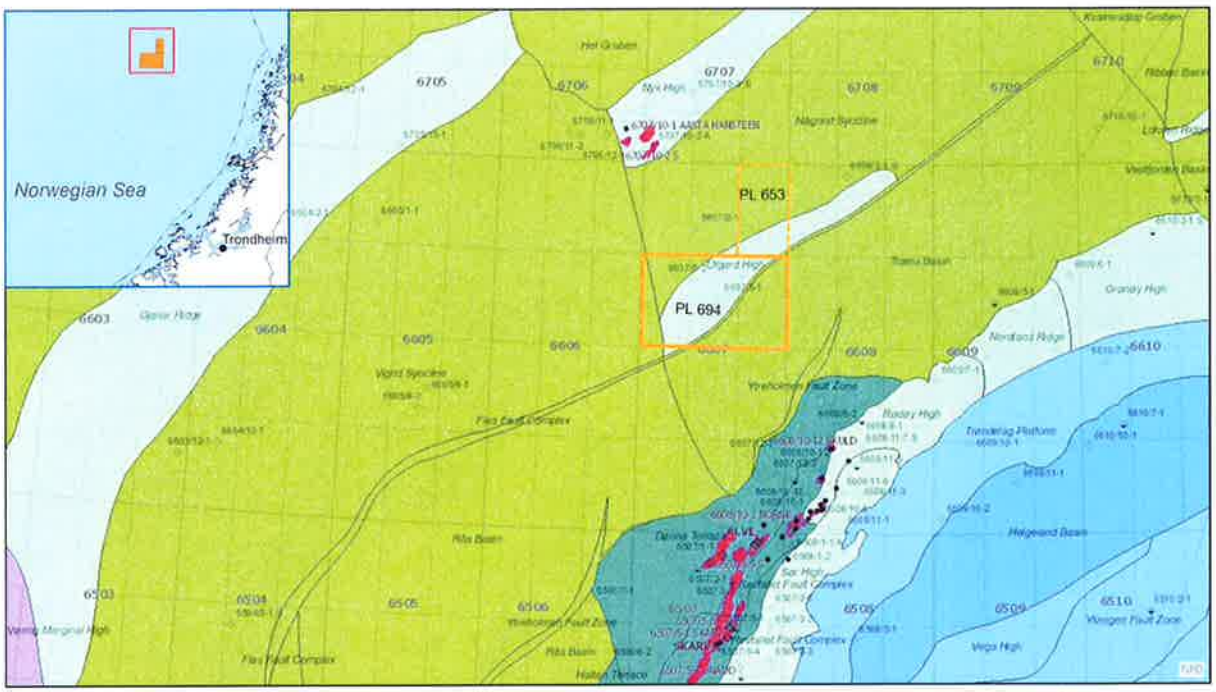

Figure 1 *Location of PL694 on the Utgard High in the Norwegian Sea, 32 km south of the Aasta Hansteen gas field*

Initial work obligations

The initial work obligations were 3D reprocessing, 3D acquisition and G&G work. The DoD decision was initially set to 8 February, 2016, but was extended with one year to 8 February, 2017.

Instead of reprocessing old 3D seismic in parts of the license, new broadband 3D seismic covering the whole license was acquired in 2013 (RD1301). The RD 1301 survey was merged with the PL653 3D seismic survey (RD1202) in 2015, including reprocessing of the RD1202 survey. Seismic resolution below base Tertiary has been a challenge in this area. The broadband 3D seismic shows significant improvement but imaging problems still remain challenging in parts of the licenses.

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 License meetings that have been held in the PL694 and PL653 (common meetings).

Table 1 License meetings in PL694/PL653

Meeting	Date	Content
MC mtg	26.02.2013	License Kick off meeting
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 was defined and presented to the license as a drilling target early 2014. In the November 2014 MC/EC mtg, 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 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 seismic 3D database is shown in Figure 2. New broadband 3D seismic covering the whole license was acquired in 2013 (RD1301). The RD 1301 survey was later merged with the PL653 3D seismic survey (RD1202) in 2015, including reprocessing of the RD1202 survey. Gravity and Magnetic data were acquired together with both seismic surveys.

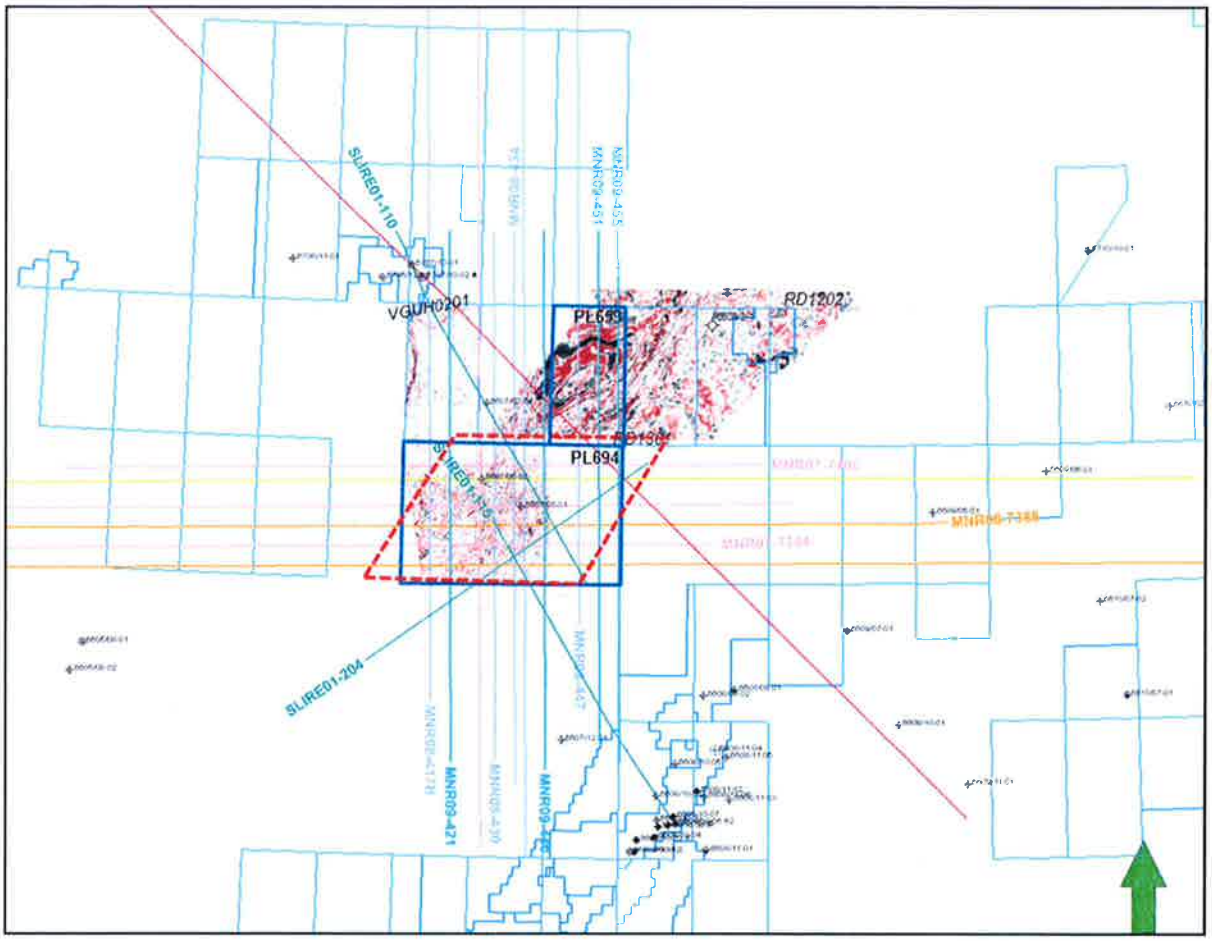

Figure 2 *Seismic and Well Database; 3D seismic surveys RD1202 and VGUH0201 are shown as time slices, 3D RD1301 outline is shown in red. All MNR/AMR 2D lines crossing the license were recommended as part of the common database, extent as shown in the figure. Chosen lines from 2D survey SLRE01 were also 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 PL330 and PL653 with Geostreamer by PGS during the summer 2012. The 3D survey was shot in E-W direction and covers approximately 1300 km^2. 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 2).
During 2013 3D broadband survey RD1301 (1250 km^2) 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 was 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 together.

2D seismic data base

All MNR/AMR 2D lines crossing the license were recommended as part of the common database, extent as shown in Figure 2. Chosen lines from 2D survey SLRE01 were also included.

Included 2D lines are: (color as shown in Figure 2): 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)

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 new tie well has been the 6608/2-1S well, drilled in PL330 by the same partnership in 2013. This well reached TD in Early Cretaceous Lyr Formation at 5600m and found no reservoir sands.

3 REVIEW OF GEOLOGICAL FRAMEWORK

Studies performed

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

Table 2. Studies performed in PL694/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 PL694, blocks 6607/4,5 & 6, and PL653, block 6607/3, have resulted in definition of several prospects within the Nise play. The prospects are shown in Figure 3 and listed with recoverable volume estimates in Table 3. The Kelvin prospect is only partly situated in PL653, mainly outside the licenses. 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.

Figure 4 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.

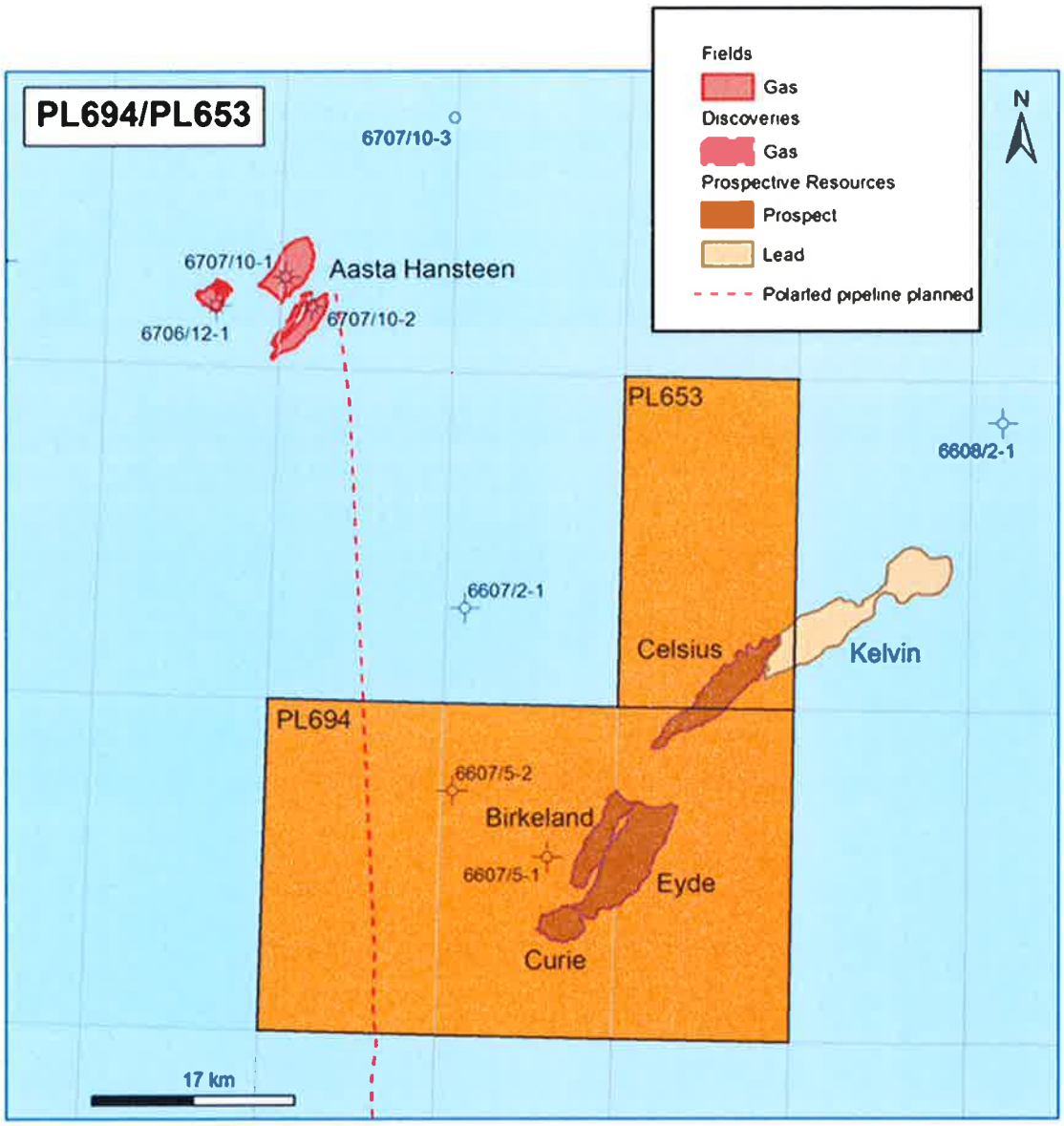

Figure 3 PL653 & PL694 Nise prospects overview map 2016

Table 3. Estimated Recoverable Resources in PL653 & PL694 Nise prospects. The Kelvin prospect is only partly situated in PL653, mainly outside of 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

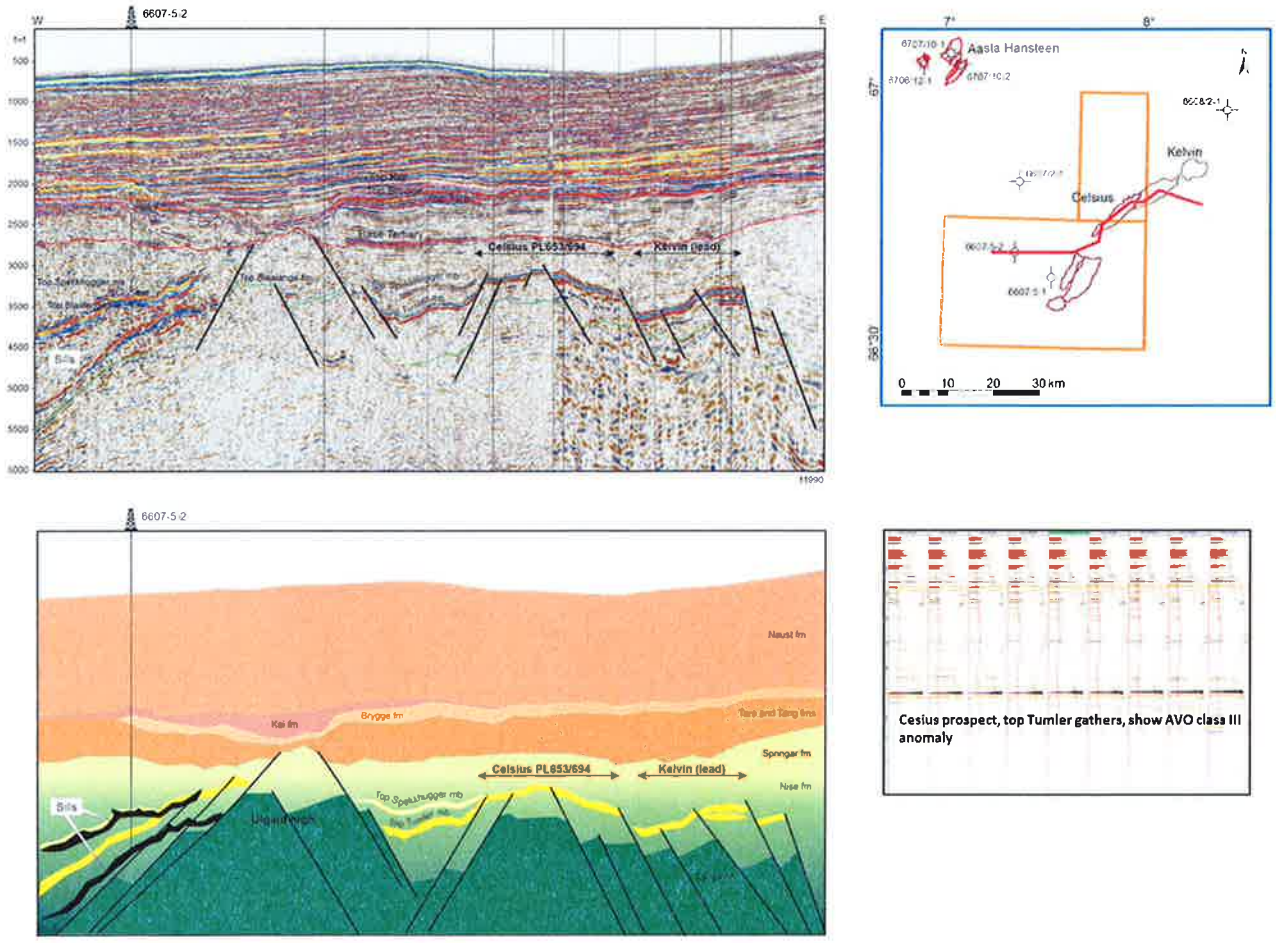

Figure 4 Seismic randomline with corresponding geoseismic section across the Celsius and Kelvin prospects. The line ties to well 6607/5-2 in the west. The Top Tumler reservoir gathers show AVO class III anomaly.

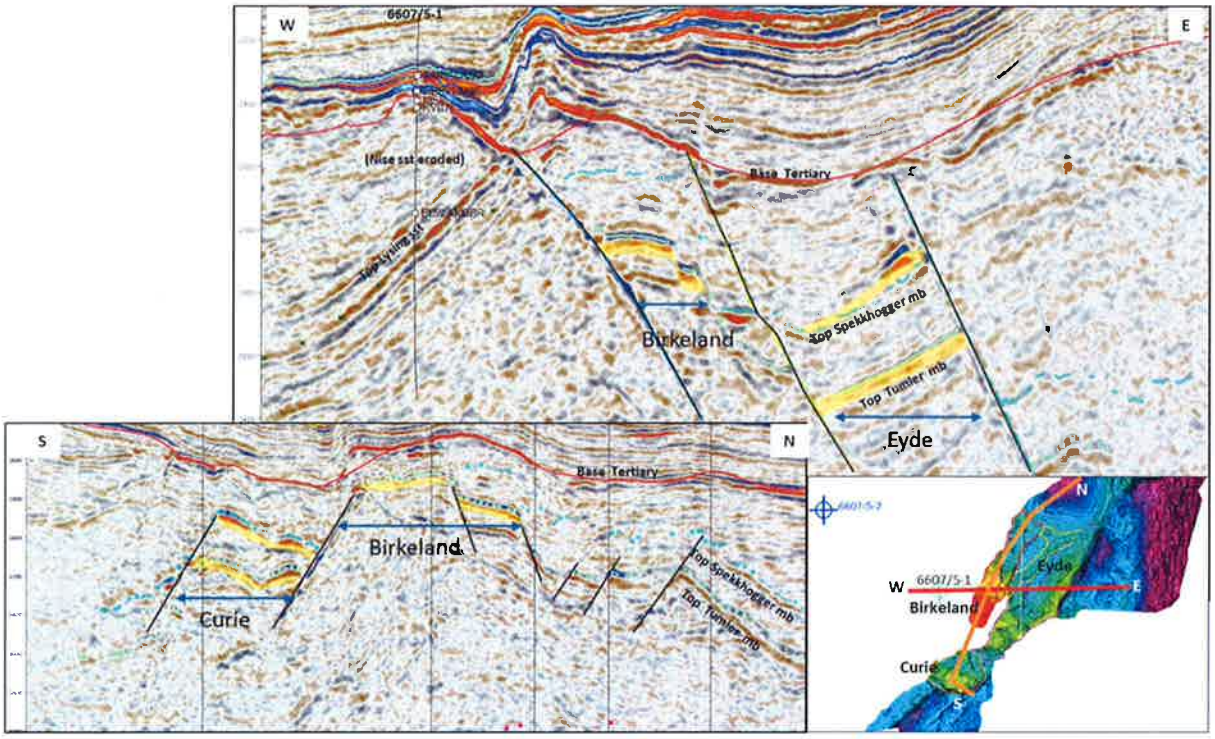

Figure 5 Interpreted cross sections of the Birkeland, Eyde and Curie prospects

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

Reservoir development

The understanding of the distribution of the Nise formation turbidite system, 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. However clear indications of reservoir presence in the Curie prospect from the 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 further north on the east flank. Considerable efforts have been made to understand the Nise reservoir development and the resulting model is illustrated and explained in Figure 6 below.

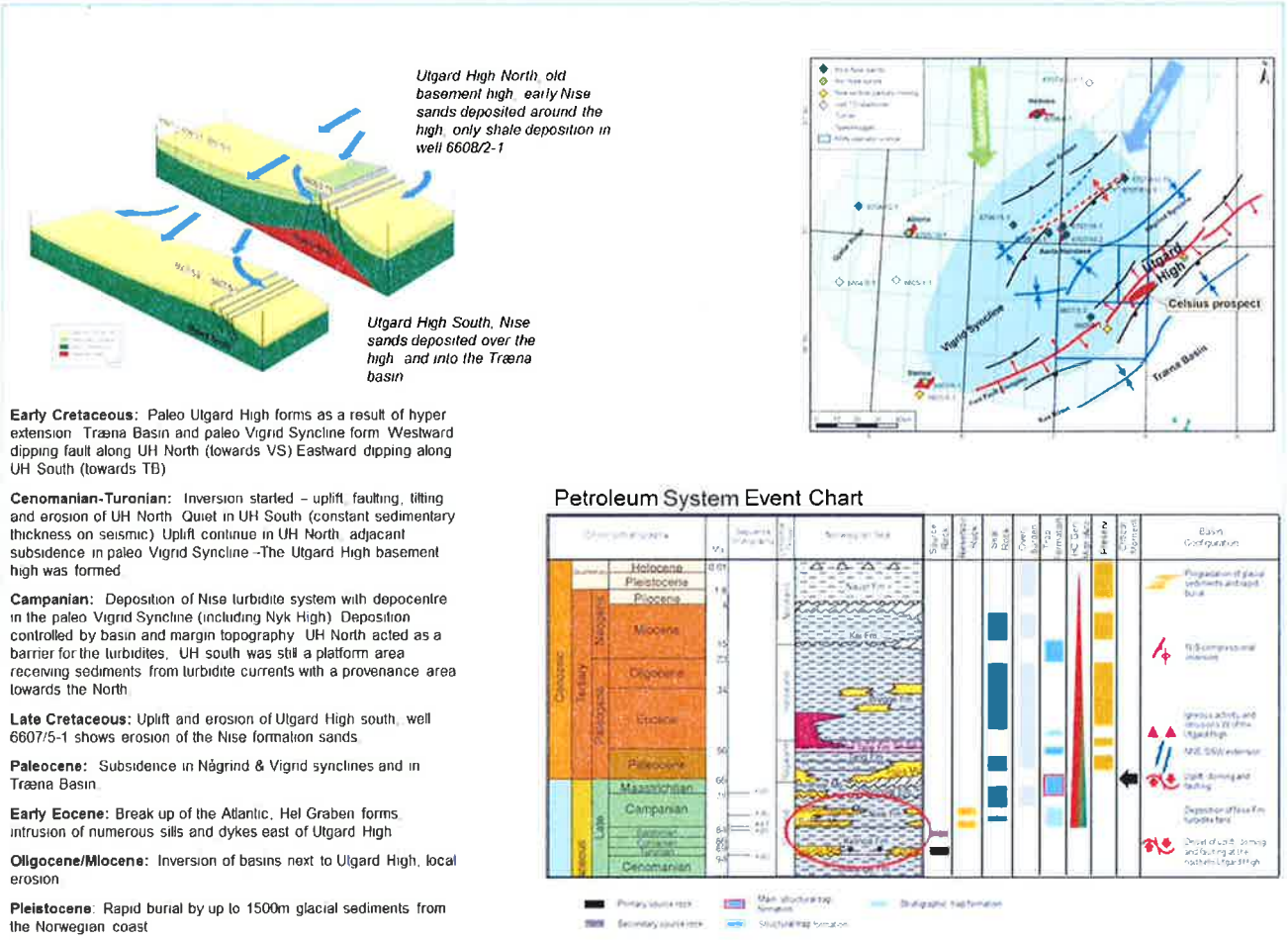

Figure 6 Nise Reservoir development around the Utgard High

Prospect definition and mapping

Figure 6 shows an overview of the prospects and leads presented in the APA 2012 application.

Mapping of the new and more extensive 3D seismic data acquired by the license has firmed up the definition of the prospects and leads applied for in 2012, the current prospect map is shown in Figure 3. The estimated resources have been reduced considerably in the Curie prospect especially, but also in the Birkeland and Eyde prospects. The Nobel prospect has been screened out, the same is the case for the Wisting and Wegener prospects. The Celsius prospect has been upgraded from lead status to a drillable prospect during the license period.

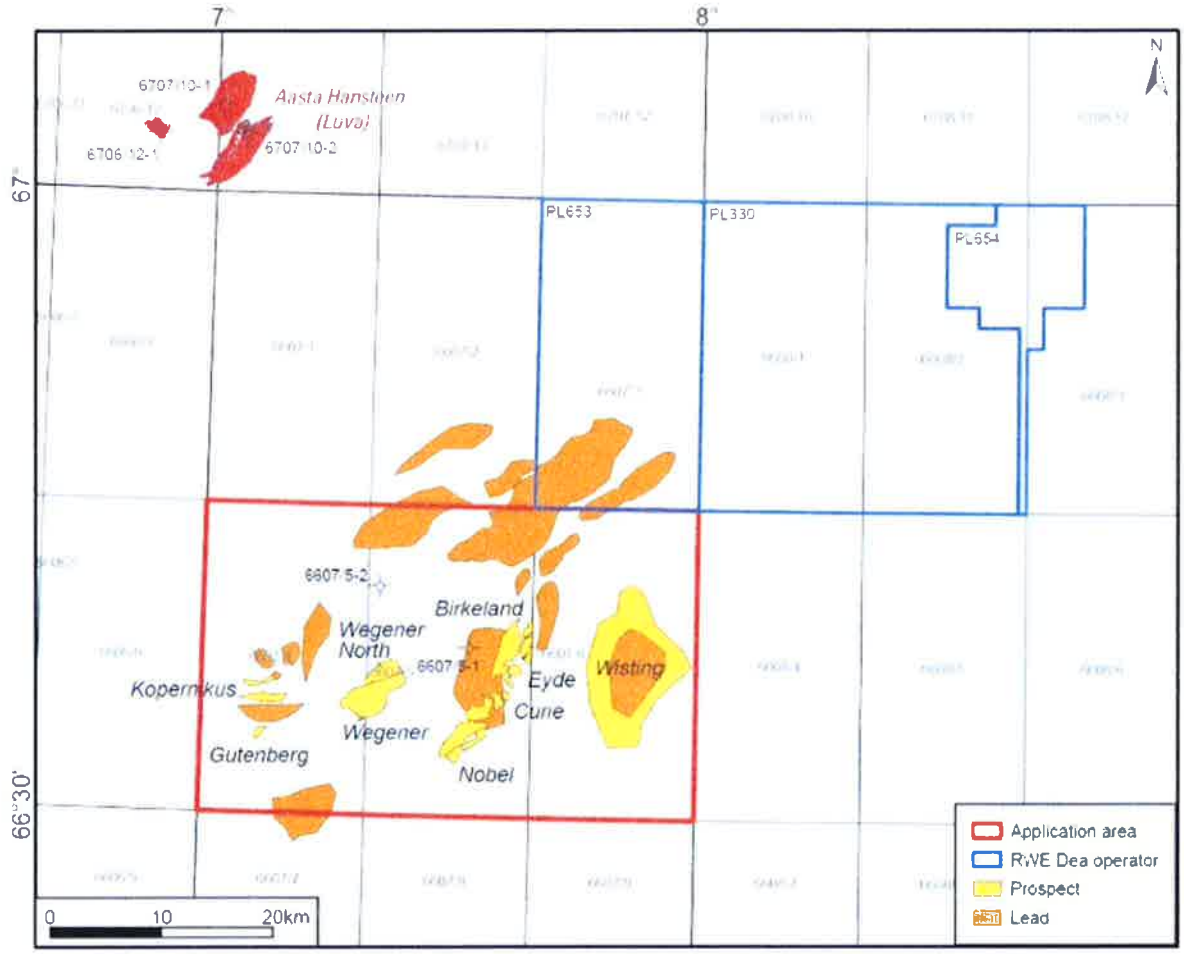

Figure 7 Identified prospects and leads from APA 2012 application

4 PROSPECT UPDATE

Review of prospect and/or leads

As described in section 3, three of the mapped prospects from the 2012 application are still defined as prospects; these are the Curie, Eyde and Birkeland prospects. One of the leads from 2012 is upgraded to a drillable prospect, Celsius, based on mapping of the acquired RD1202 and RD1301 3D surveys. The 2012 application database only consisted of the VGUH0201 3D, in addition to 2D seismic data.

The Curie and Nobel prospects, as mapped in 2012, consisted of a cluster of segmented structures where Curie was defined on the foot-wall and Nobel on the hanging-wall part of a down-faulted block from the Utgard High South. Both prospects were strongly amplitude driven. The traps were combined structural and stratigraphic, based on amplitude brightening believed to be caused by hydrocarbons. The Birkeland and Eyde prospects were defined in a similar setting just north of the Curie and Nobel cluster. A top Nise reservoir depth map with 2012 prospect outlines is shown in Figure 7.

The 2016 Top Nise reservoir map with prospect outlines is shown in Figure 8. The new broadband 3D seismic surveys show higher seismic resolution than the VGUH0201 3D survey. The data also show amplitude brightening more restricted to structural closures than seen earlier. The stronger amplitude conformance to structure strengthens the assumption that the amplitude brightening is related to hydrocarbon fill. The observations on the new seismic led to downgrading of the stratigraphic prospects and leads defined on the Western side of the Utgard High, as they are no longer amplitude supported.

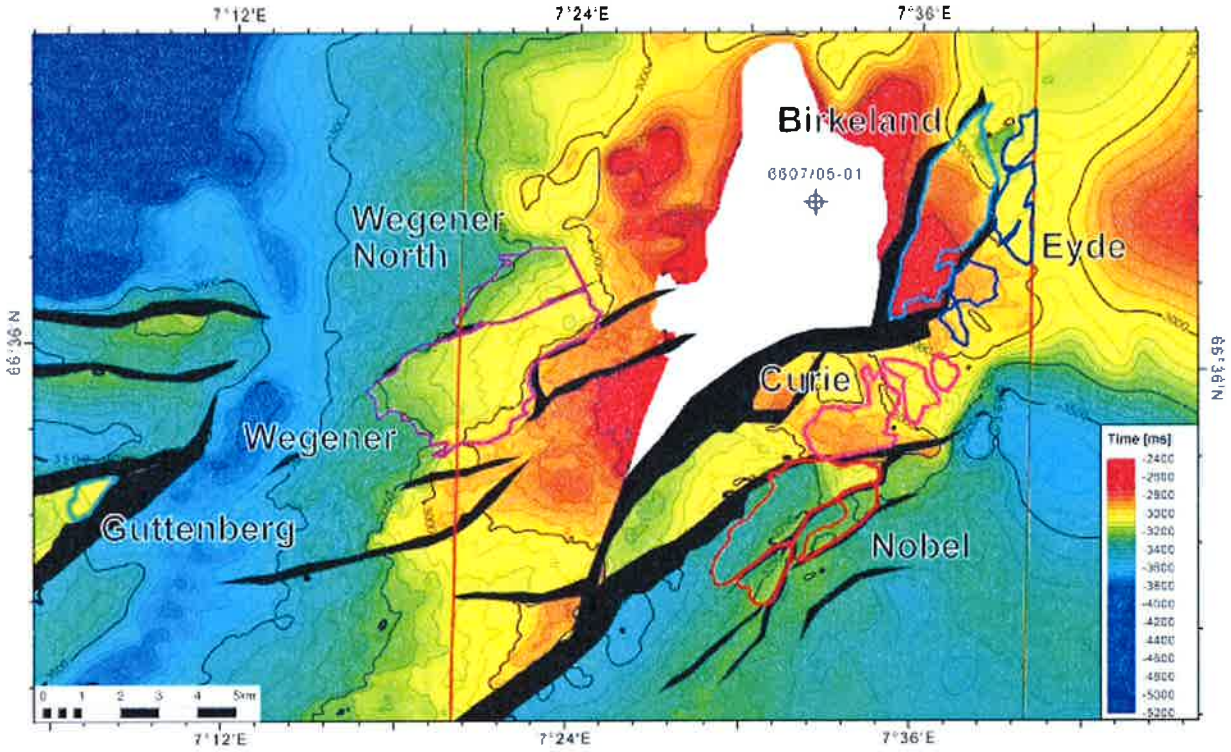

Figure 8 *Top Nise reservoir depth map showing 2012 prospect outlines within PL694 (the map area is limited by the VGUH0201 3D extension and does not show the defined leads extending into PL653 towards the north as shown in Figure 6)*

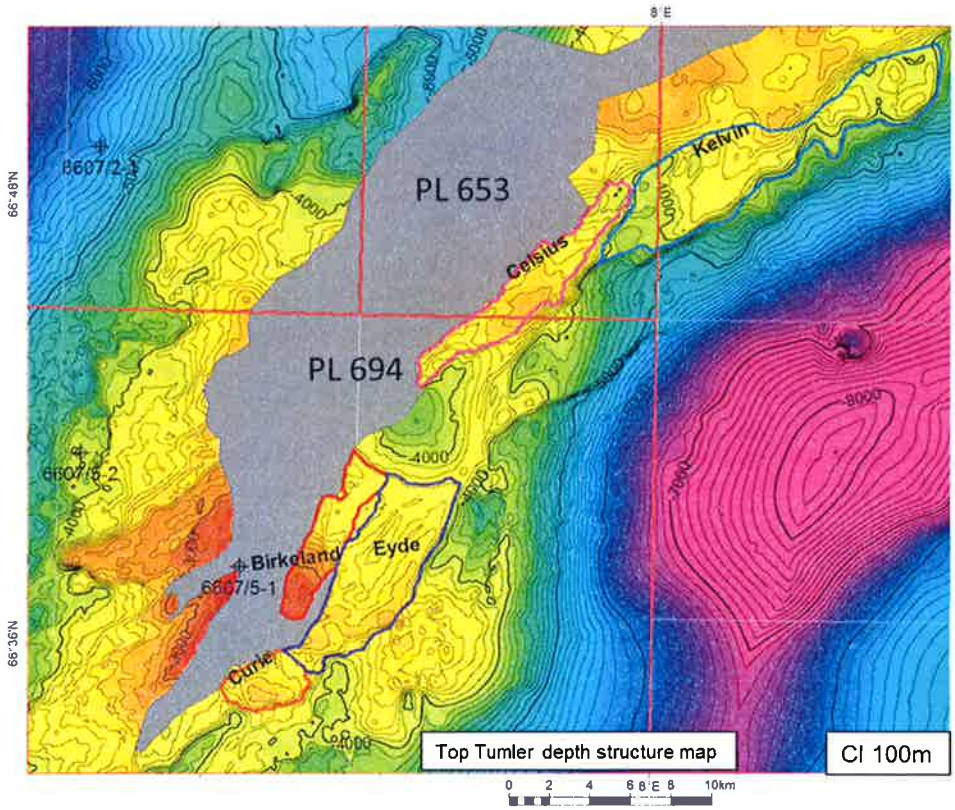

Figure 9 Top Nise reservoir depth map showing prospect outlines as mapped in 2016

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

	From application APA 2012		Updated based on new data and evaluation (2012 - 2016)	
Prospect	Recoverable Gas $10^9 Sm^3$ (Pmean)	Risk % (after DHI uplift)	Recoverable Gas $10^9 Sm^3$ (Pmean)	Risk % (after DHI uplift)
Curie	18,60	46	7,20	39
Nobel	16,20	46		
Wegener	39,30	46		
Eyde	14,00	46	6,50	39
Birkeland	6,90	46	11,00	39
Gutenberg	3,00	46		
Kopernikus	5,60	38		
Wisting	42,90	16		
Celsius	Lead		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*

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 de-hydration, 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.

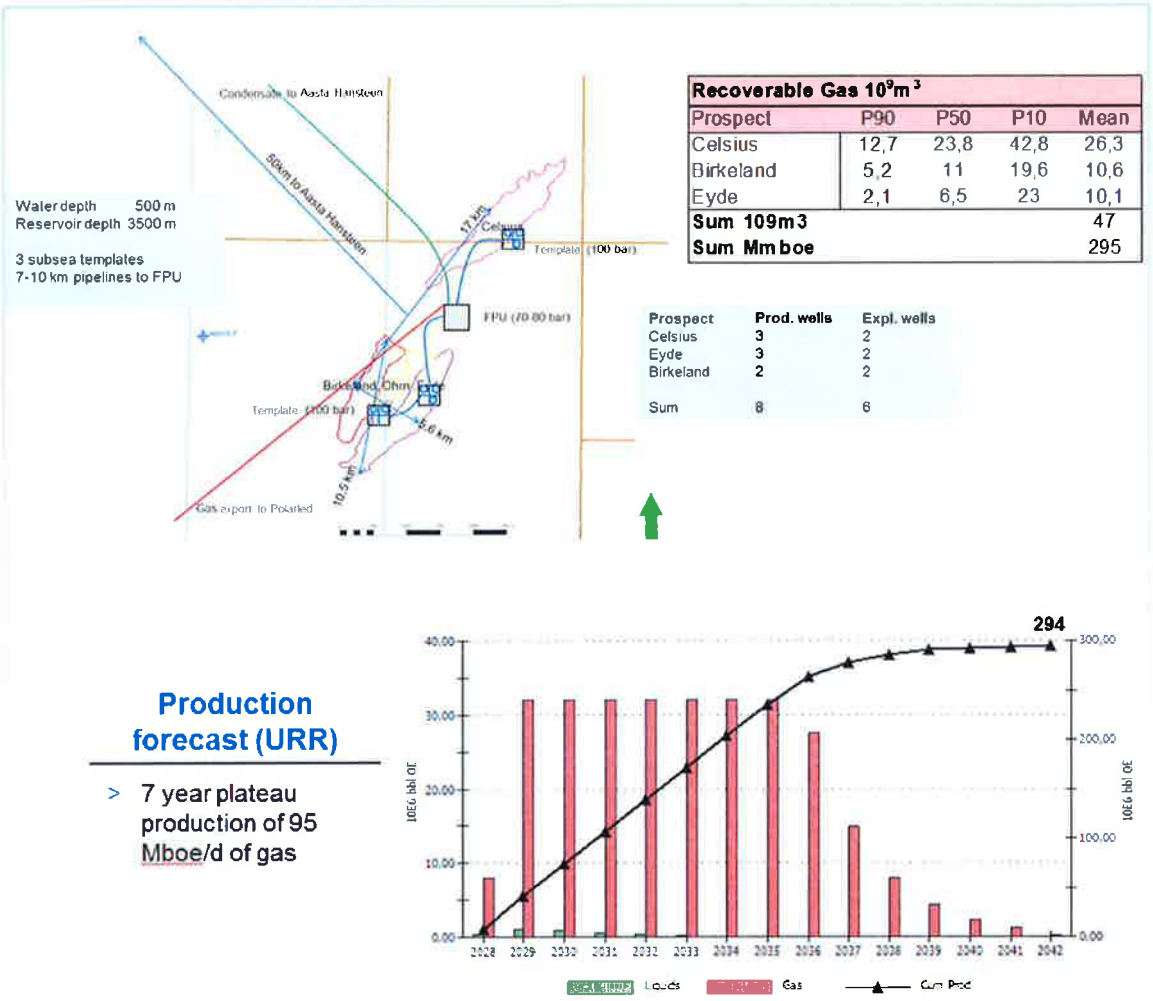

Figure 10 PL694/PL653 Area development scenario overview

6 CONCLUSIONS

DEA has worked the Nise play in the Utgard High area with the aim of proving up gas to utilize the available capacity in the Polarled pipeline. Interesting potential has been mapped and evaluated within the Nise play. The main identified prospect is the Celsius prospect with P50 recoverable reserves of 23.8 GSm^3 gas. A successful discovery in the Celsius prospect will decrease the risk considerably on four other identified prospects. An area development solution with subsea completed wells tied back to a floating production unit (FPU) was chosen as the development concept. The economy in the current market is marginal to negative for a gas development project of this size, however the area should have interesting potential in a different market situation.

DEA wanted to drill the Celsius prospect in 2015 but did not get partner approval. DEA's approach has since then been to find replacement partners to the license. This has not been possible under the current market conditions, and a decision has been made to relinquish the license.