PL 1165 – Licence status report

Summary

The PL1165 licence (block 6507/09) is in the Norwegian Sea, in the northern part of the Ellingråsa graben (Figure 1). The nearest producing field, Heidrun, is 18 km to the west from the licence.

The licence was awarded in the TFO2021 round with Equinor Energy as operator (60%) and AkerBP (40%) as partner. At the APA stage, the main prospect was Kjell Bjarne, the 4-way faulted closure, comprising the Åre, Tilje, Ile, Garn formations, while additional prospectivity was associated with the Late Jurassic syn-rift deposits.

The screening of the hydrocarbon potential within the Båt and Fangst Gp, as well as Rogn Fm of the Viking Gp intervals was performed during the licence period. After detailed work and evaluation of the prospects and leads on the EQ22M12 seismic data (new reprocessing was a part of the fulfilled work program in the licence), Chloris became the primary prospect in the licence. Recommendation for a drill decision was presented to the partnership, which was not approved. With no new partner found to support the decision to drill, the operator has made a decision to surrender the licence.

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1 Licence history

Licence: PL1165

Awarded: 11.03.2022

Licence period: Expires 11.06.2025
Initial period: 2 years; + 9 months extension; + 6 months extension

Licence group:		
	Equinor Energy AS	60% (Operator)
	Aker BP ASA	40%
	Aker BP ASA dropped the licence	11.12.2024

Licence area: 123 km^2

Work programme:
G&G studies
Purchasing of the additional part of the PGS19M02 data and field data and P-up for HT07
Reprocessing of the 3d seismic
Decision to drill or drop

Meetings held:

25.04.2022	EC/MCN№1 startup meeting
08.09.2022	EC work meeting №1
30.11.2022	EC/MCN№2 meeting
02.11.2023	EC/MCN№3 meeting
23.01.2024	EC work meeting №2
21.06.2024	EC work meeting №3
05.11.2024	EC/MCN№4

Work performed:

2022:	Licence start-up. G&G studies
2023:	Reprocessing (EQ22M12), seismic interpretation, G&G studies, prospect evaluation
2024:	G&G studies, final prospect evaluation
2025:	Seeking a new partner

Reason for surrender:

The partner did not support the decision to drill, no new partner entered the licence. As a result, the decision to surrender the licence was made.

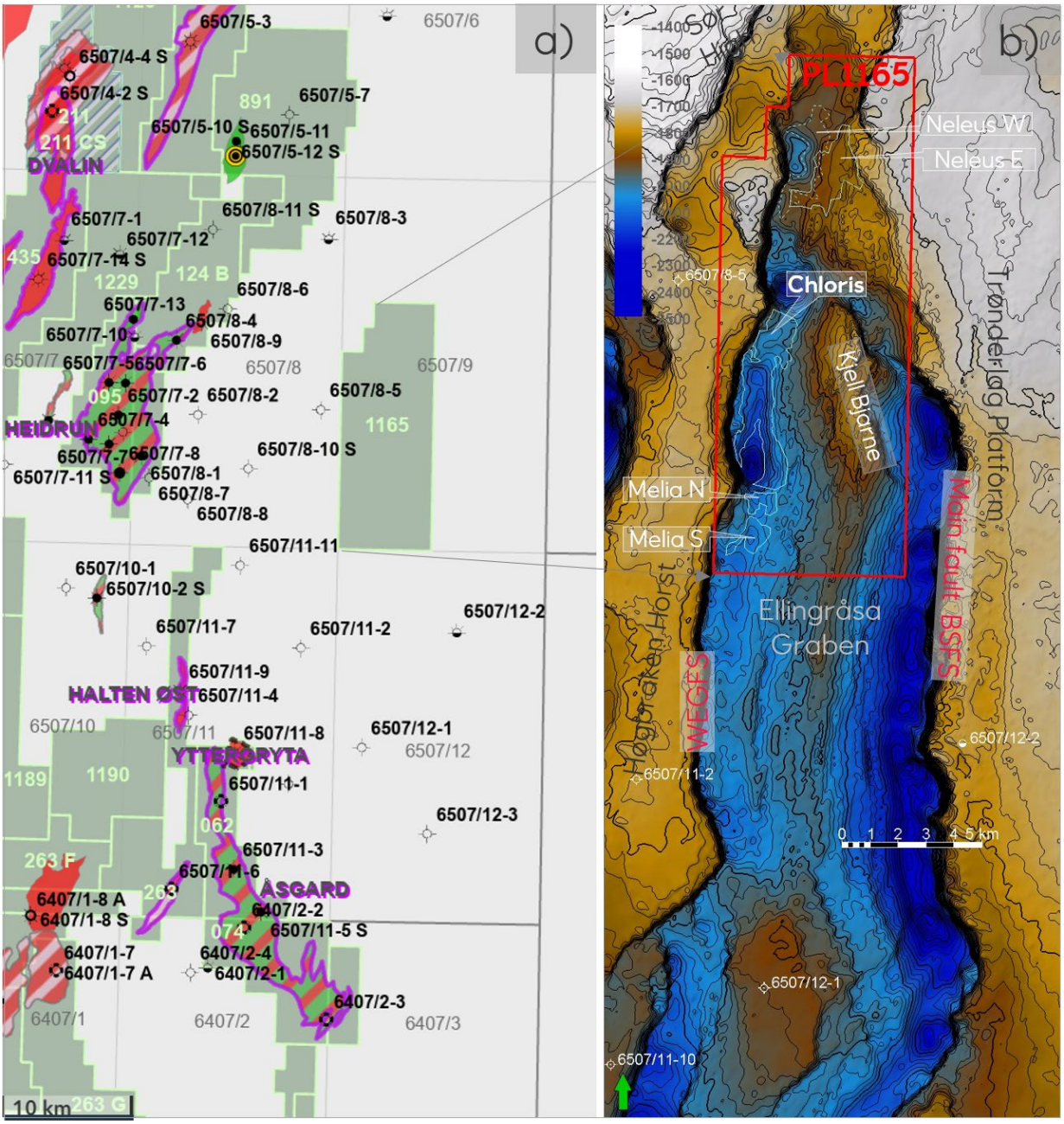

Figure 1. a) Location map of the licence with fields, discoveries and exploration wells (left); b) top Spekk TWT map with the structural elements, and prospects within the licence

2 Database overviews

2.1 Seismic data

The reprocessed EQ22M12 3D seismic survey was a part of the fulfilled licence work program. The list of the seismic surveys within the licence common database, as well as the input data for the reprocessing, is shown in **Table 1**.

Seismic survey input for EQ22M12 reprocessed data	Survey type	Year	NPDID
HT07-FINAL (all stacks / field data)	3D	2007	4440
HVG2011/PGS18M01-PGS16909NWS (all stacks / field data P-UP)	3D	2011 / 2018	7379
PGS19M02 (PGS19002) (all stacks / field data P-UP)	3D	2019	9000
PGS14002/ PGS18M01-PGS16909NWS (all stacks / field data P-UP)	3D	2014 /2018	7993

Table 1. Seismic surveys in the licence common database

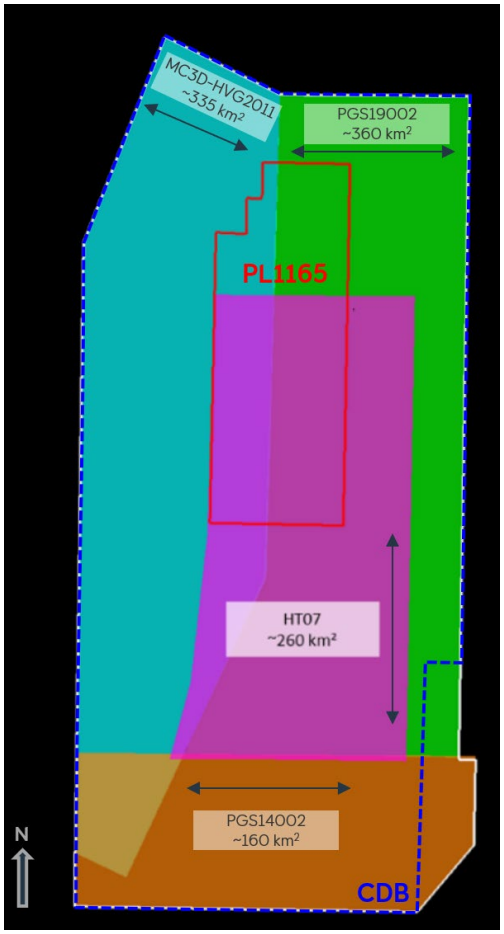

Figure 2. Location of the EQ22M12 reprocessed seismic survey is within the white bold line outline (all shaded polygons) and dashed blue line polygon is the common database outline for seismic. Underlying seismic surveys, contributed to EQ22M12, Acquisition shooting directions indicated for each survey.

2.2 Well data

List of the wellbores in the licence common database is shown in Table 2

Well	Year	Drilling operator	Discovery/Field/Well name	Status	Age at TD	NPDID
6407/1-6 S	2013	Wintershall Norge AS	6407/1-6 S	Gas/condenste	Early Jurassic	7086
6407/1-7	2014	Wintershall Norge AS	6407/1-7	Gas/condenste	Early Cretaceous	7412
6407/2-1	1982	Saga Petroleum ASA		Shows	Late Triassic	76
6407/2-2	1983	Saga Petroleum ASA	6507/11-1 Midgard	Gas/condenste	Late Triassic	16
6407/2-3	1987	Saga Petroleum ASA	6507/11-1 Midgard	Gas/condenste	Early Jurassic	935
6407/2-4	2009	Det norske oljeselskap ASA (old)		Dry	Middle Jurassic	6106
6407/2-5 S	2009	StatoilHydro Petroleum AS	6407/2-5 S (Nona)	Oil/gas	Early Jurassic	6151
6507/11-1	1981	Saga Petroleum ASA	6507/11-1 Midgard	Gas/condenste	Late Triassic	68
6507/11-10	2010	Det norske oljeselskap ASA		Dry	Early Jurassic	6122
6507/11-11	2015	Tullow Oil Norge AS		Dry	Middle Jurassic	7697
6507/11-2	1982	Saga Petroleum ASA		Dry	Late Triassic	51
6507/11-3	1985	Saga Petroleum ASA	6507/11-1 Midgard	Oil/gas	Late Triassic	470
6507/11-4	1987	Saga Petroleum ASA		Dry	Early Jurassic	1055
6507/11-5 S	1997	Den norske stats oljeselskap a.s	6507/11-1 Midgard	Oil/gas	Early Jurassic	3193
6507/11-6	2001	Norsk Hydro Produksjon AS	6507/11-6 Sigrid	Gas/condenste	Early Jurassic	4321
6507/11-7	2007	Norsk Hydro Produksjon AS		Dry	Early Cretaceous	5430
6507/11-8	2007	Statoil ASA (old)	6507/11-8	Gas	Early Jurassic	5562
6507/11-9	2008	StatoilHydro Petroleum AS	6507/11-9 (Natalia)	Gas	Early Jurassic	5766
6507/12-1	1980	Saga Petroleum ASA		Dry	Triassic	202
6507/12-2	1981	Saga Petroleum ASA		Shows	Middle Triassic	437
6507/12-3	1985	Saga Petroleum ASA		Dry	Early Jurassic	485
6507/3-11 S	2015	E.ON E&P Norge AS		Dry	Early Jurassic	7730
6507/3-2	1997	Den norske stats oljeselskap a.s		Dry	Triassic	2954
6507/3-7	2009	StatoilHydro Petroleum AS	6507/3-7 (Idun Nord)	Gas	Early Jurassic	6123
6507/3-8	2009	Statoil Petroleum AS	6507/3-8 (Gjøk)	Oil/gas	Early Jurassic	6258
6507/5-1	1998	Amoco Norway Oil Company	6507/5-1 Skarv	Oil/gas/condenste	Early Jurassic	3683
6507/5-3	2000	BP Amoco Norge AS	6507/5-3 Ærfugl	Gas	Early Cretaceous	4059
6507/5-7	2014	E.ON E&P Norge AS		Dry	Early Jurassic	7428
6507/6-1	1986	Saga Petroleum ASA		Gas shows	Early Triassic	910
6507/6-2	1991	Saga Petroleum ASA		Oil shows	Late Triassic	1520
6507/6-3	2008	StatoilHydro ASA		Dry	Early Jurassic	5922
6507/6-4 A	2012	E.ON Ruhrgas Norge AS		Dry	Permian	6753
6507/6-4 S	2011	E.ON Ruhrgas Norge AS		Dry	Late Triassic	6725
6507/8-1	1986	Den norske stats oljeselskap a.s	6507/7-2 Heidrun	Oil/gas	Early Jurassic	933
6507/8-2	1987	Den norske stats oljeselskap a.s		Dry	Late Triassic	1076
6507/8-3	1988	Den norske stats oljeselskap a.s		Gas shows	Late Triassic	1309
6507/8-4	1990	Den norske stats oljeselskap a.s	6507/8-4 Heidrun Nord	Oil/gas	Late Triassic	1340
6507/8-5	1991	Den norske stats oljeselskap a.s		Dry	Early Jurassic	1749
6507/8-6	1993	Den norske stats oljeselskap a.s		Dry	Late Triassic	2183
6507/8-7	2004	Statoil ASA (old)		Dry	Early Jurassic	4854
6507/8-8	2011	Nexen Exploration Norge AS		Dry	Early Jurassic	6538
6507/8-9	2017	Statoil Petroleum AS	6507/8-9 (Carmen)	Gas	Early Jurassic	8218
6507/8-D-3 AHT2	2001	Statoil ASA (old)		Oil	Early Jurassic	
6508/5-1	1987	A/S Norske Shell		Dry	Late Triassic	1044

Table 2. Well database, the key wells located within EQ22M12 3D seismic survey are in bold font

3 Results of geological and geophysical studies

- Seismic reprocessing
- Seismic interpretation and mapping
- Petroleum system analysis, including the geochem data study
- Geophysical observations and AVO assessment
- Biostratigraphy study
- Prospect evaluation

3.1 Seismic reprocessing of EQ22M12

The PL1165 area was covered by several 3d seismic surveys (**Table 1** and **Figure 2**) and none of them alone covered the entire licence. The reprocessing of the 3d seismic data was included into the licence work program to get a dataset across merged survey area. The reprocessing started from nav-seis merged field data (P-UP for PGS19002, MC3D-HVG2011, PGS14002 and hydrophone data for HT07) using a state of-the-art pre-stack depth migration (PSDM) workflow including full waveform imaging (FWI) velocity model building. Pre-processed data from all surveys were matched & merged and referenced to a common grid prior to application of tilted transverse anisotropy (TTI) Kirchhoff PSDM.

The main processing objectives of the reprocessing were:

- to deliver a harmonized and consistent dataset across the merged survey area that allows a reliable structural interpretation and AVO analysis
- pre-processing through comprehensive modern deghosting, denoise and demultiple techniques
- TTI anisotropy velocity model building through full waveform imaging (FWI) and tomographic velocity updates

The final reprocessed data were superior to the vintage data and were used in the PL1165 licence seismic interpretation, prospects mapping, and consistent AVO analysis.

3.2 Seismic interpretation and mapping

The initial screening of the area was made on the PGS18 and HT07 data, and later on the PGS19 data. When the EQ22M12 data were delivered, the final interpretation and mapping were performed with the focus on Jurassic Båt, Fangst and Viking Groups. The interpretation of the key horizons was made in time domain and the resulting TWT maps were depth converted, using the depth conversion model, based on the EQ22M12 velocities. The maps were used for the basin model update and the prospect resource evaluation.

3.3 Petroleum system analysis

Petroleum system analysis included modelling of the source rock maturation and HC migration. Input for the model was the set of the horizons interpreted on the EQ22M12 seismic dataset.

A geochemical study was performed on 13 samples from 6507/12-1 and 6507/12-2 wells, including biomarker analysis.

As a result, multiple migration scenarios to the prospects within the licence were modelled and improved, but the HC migration remains to be the highest risk for the prospects in the licence.

3.4 Geophysical observations and AVO assessment

Fluid substitution modelling was made for Middle and Late Jurassic levels in the licence, using parameters from 6507/12-1, 6507/12-2, 6507/12-3, 6507/8-5, 6507/8-6, 6507/11-10, 6507/11-11, 6507/11-7, 6507/6-3, 6507/5-1, 6507/9-5 wells and testing light oil, heavy oil and gas as a fluid type. It showed that any HC fluid would show the AI contrast for the Middle Jurassic level. In the Late Jurassic level, the contrast might vary from strong to relatively weak due to the properties of the overlying package – depending on whether it is the hot shale of Spekk Fm or Melke Fm properties.

The AVO work was done on the reprocessed seismic dataset. The S- and P-impedance were used to discriminate between lithology and fluid effects. The Middle Jurassic screening did not identify any significant AVO anomalies, including Kjell Bjarne structure (main prospect at the APA stage), while the prospects located in the Late Jurassic interval have been interpreted as class III AVO, where the brightest and most consistent was the Chloris anomaly. The AVO cubes were also used to make the top and base anomaly interpretations.

3.5 Biostratigraphy study

For the biostratigraphy study of the Late Jurassic – lower part of the Early Cretaceous three wells were selected: 6507/12-1, 6507/8-6, 6507/11-11. Neither of the wells encountered the reservoir in the Late Jurassic due to their locations at the highs, where the syn-rift reservoir deposition was not expected. The wells were used to tie the interpretation of the stratigraphic definition of the Melke and Spekk Fms – which defines the top and the base of the gross package for the Chloris reservoir, and potential top and base seals.

3.6 Prospect evaluation

For the Chloris prospect evaluation, the top and the base reservoir interpretation was made on the AVO EQ22M12 TWT cubes. The depth conversion model input were the velocities from the EQ22M12 survey. The depth conversion models with PGS18 and PGS19 velocities were used for the depth conversion uncertainty estimation. More detailed description of the main prospect and remaining prospectivity can be found in the next section.

4 Prospect update report

The Kjell Bjarne structure (for the location see Figure 1) was the main prospect at the APA application. Neither the fluid substitution modelling, no AVO interpretations provided support for hydrocarbons in the structure. At the same time, several class III AVO anomalies were identified in the Late Jurassic package, where the Chloris anomaly was the largest and the strongest, and became the main prospect in the licence.

Chloris prospect

The reservoir is interpreted to be the syn-rift sandstones, deposited in the trough immediately to the east from the Western Ellingråsa Graben Fault system (Figure 1). By the time of the reservoir deposition the WEGFS was active, and the Høgbraken Horst – Sør High were a footwall, and the mentioned trough was being downthrown – the latter is supported by the thickening of the gross package in the trough and thinning towards the Kjell Bjarne structure.

The syn-rift deposition of the Cloris reservoir belongs, as interpreted, to the Spekk stratigraphic interval, and the Spekk shales serve as a top seal. The base seal is represented by the Spekk and Melke Fm shales.

The prospect is stratigraphic, where the depth top reservoir is dipping from the north to the south (Figure 3).

The prospect got a DHI uplift, as an AVO anomaly was observed, and its shutoff is consistent to a depth contour.

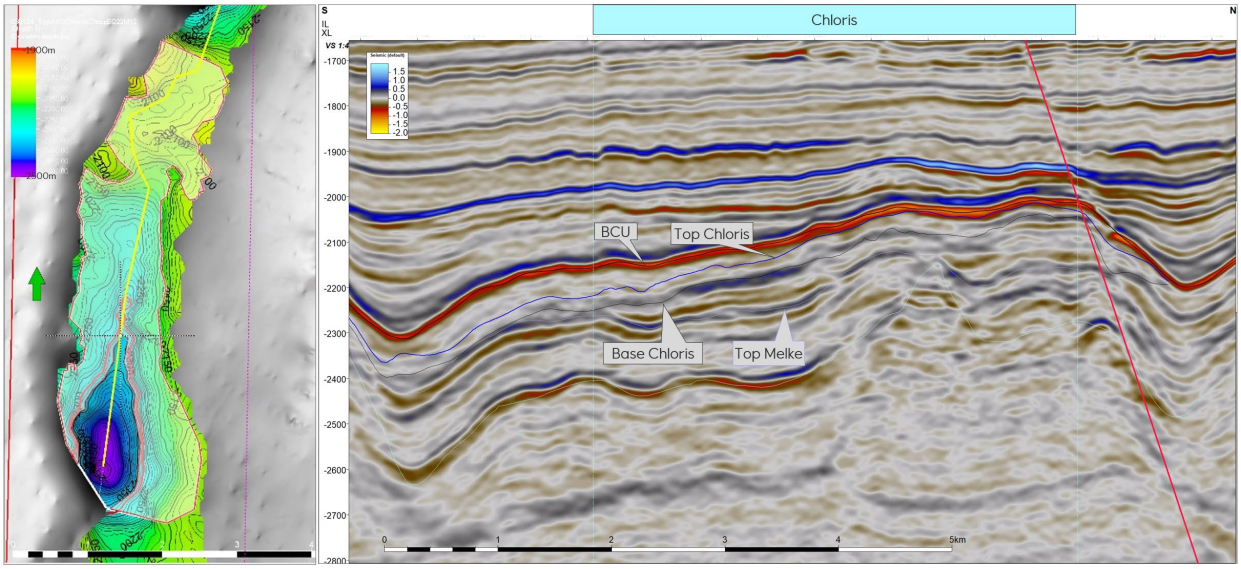

Figure 3. Left: top reservoir depth map with the composite line location, right: composite line along the Chloris (full stack, twt)

As no analogues of the reservoir in the licence vicinity were found, the regional depth trend was used to estimate the petrophysical parameters. Fluid parameters included the range from the nearby wells (light oil and gas; possible biodegradation also was included into the range).

The resource and risk assessment for the oil and gas case are in Appendix, Table 3 and Table 4.

Remaining prospectivity

Neleus West and East, Melia North and South are additional prospects which show similar AVO characteristics in the licence. All four prospects are stratigraphic and are within the same reservoir fairway as the Chloris prospect. No QC was performed for these prospects.

5 Technical evaluation

The proposed development solution for the main case (oil) consists of the four-slot template with two producers and two injectors. The template is tied back to Heidrun. The Chloris prospect was evaluated as having positive economy.

6 Conclusion

The work program for PL1165 has been fulfilled. The main prospect, Chloris, has been evaluated through the number of the geological and geophysical studies. The technical evaluation has shown a positive economy.

Proving hydrocarbons in the prospect would de-risk the geological risk assessment and potentially improve input parameters for the technical economical valuation of the remaining prospectivity within the licence. The decision to drill the well was made by the operator. The partner did not support the decision to drill, no new partner entered the licence. As a result, the decision to surrender the licence was made by the operator.

7 Appendix

Table 3. Chloris prospect – oil case

Block		Prospect name		Discovery/Prosp/Lead		Prosp ID (or New!)	NPD will insert value	NPD approved (Y/N)	
Play name	NPD will insert value	New Play (Y/N)	Yes	Outside play (Y/N)					
Oil, Gas or O&G case:	Oil	Reported by company	Equinor Energy AS	Reference document	0			Assessment year	2024
This is case no.:	1 of 2	Structural element	Ellingråsa Graben	Type of trap	Stratigraphic	Water depth [m MSL] (>0)	290	Seismic database (2D/3D)	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)	3.90	13.00	13.80	23.90				
	Gas [10^9 Sm^3] (>0.00)					0.39	1.45	1.40	2.48
Recoverable resources	Oil [10^6 Sm^3] (>0.00)	1.53	5.54	5.52	9.65				
	Gas [10^9 Sm^3] (>0.00)					0.15	0.35	0.56	1.00
Reservoir Chrono (from)	Late Jurassic	Reservoir litho (from)	Rogn Fm	Source Rock, chrono primary	Late Jurssic	Source Rock, litho primary	Spekk	Seal, Chrono	Late Jurassic
Reservoir Chrono (to)	Late Jurassic	Reservoir litho (to)	Rogn Fm	Source Rock, chrono secondary	Late Jurassic	Source Rock, litho secondary	Spekk	Seal, Litho	Viking Gp
Probability [fraction]									
Total (oil + gas + oil & gas case) (0.00-1.00)	0.14	Oil case (0.00-1.00)	0.60	Gas case (0.00-1.00)	0.40	Oil & Gas case (0.00-1.00)	0.00		
Reservoir (P1) (0.00-1.00)	0.60	Trap (P2) (0.00-1.00)	0.40	Charge (P3) (0.00-1.00)	0.30	Retention (P4) (0.00-1.00)			

Parametres:	Low (P90)	Base	High (P10)	*Comments*
Depth to top of prospect [m MSL] (> 0)	2040	2040	2040	
Area of closure [km^2] (> 0.0)	2.3	5.0	6.0	
Reservoir thickness [m] (> 0)	20	43	60	
HC column in prospect [m] (> 0)	130	239	306	
Gross rock vol. [10^9 m^3] (> 0.000)	0.060	0.175	0.230	
Net / Gross [fraction] (0.00-1.00)	0.46	0.68	0.86	
Porosity [fraction] (0.00-1.00)	0.20	0.23	0.26	
Permeability [mD] (> 0.0)	146.0	146.0	146.0	
Water Saturation [fraction] (0.00-1.00)	0.26	0.32	0.39	
Bg [Rm3/Sm3] (< 1.0000)				
1/Bo [Sm3/Rm3] (< 1.00)	0.85	0.77	0.70	
GOR, free gas [Sm^3/Sm^3] (> 0)				
GOR, oil [Sm^3/Sm^3] (> 0)	70	103	137	
Recov. factor, oil main phase [fraction] (0.00-1.00)	0.32	0.40	0.48	
Recov. factor, gas ass. phase [fraction] (0.00-1.00)	0.32	0.40	0.48	
Recov. factor, gas main phase [fraction] (0.00-1.00)				
Recov. factor, liquid ass. phase [fraction] (0.00-1.00)				

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

Table 4. Chloris prospect – gas case

Block	0	Prospect name	0	Discovery/Prosp/Lead		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:	Gas	Reported by company	Equinor Energy AS	Reference document	0			Assessment year	2024
This is case no.:	2 of 2	Structural element	Ellingråsa Graben	Type of trap	Stratigraphic	Water depth [m MSL] (>0)	290	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)					0.13	0.36	0.43	0.74
	Gas [10^9 Sm^3] (>0.00)	1.50	4.80	4.80	8.00				
Recoverable resources	Oil [10^6 Sm^3] (>0.00)					0.07	0.21	0.24	0.42
	Gas [10^9 Sm^3] (>0.00)	0.90	2.77	2.90	4.86				
Reservoir Chrono (from)	Late Jurassic	Reservoir litho (from)	Rogn Fm	Source Rock, chrono primary	Late Jurssic	Source Rock, litho primary	Spekk	Seal, Chrono	Late Jurassic
Reservoir Chrono (to)	Late Jurassic	Reservoir litho (to)	Rogn Fm	Source Rock, chrono secondary	Late Jurassic	Source Rock, litho secondary	Spekk	Seal, Litho	Viking Gp
Probability [fraction]									
Total (oil + gas + oil & gas case) (0.00-1.00)	0.14	Oil case (0.00-1.00)	0.60	Gas case (0.00-1.00)	0.40	Oil & Gas case (0.00-1.00)	0.00		
Reservoir (P1) (0.00-1.00)	0.60	Trap (P2) (0.00-1.00)	0.40	Charge (P3) (0.00-1.00)	0.30	Retention (P4) (0.00-1.00)	0.00		
Parametres:	Low (P90)	Base	High (P10)	*Comments*					
Depth to top of prospect [m MSL] (> 0)	2040	2040	2040						
Area of closure [km^2] (> 0.0)	2.3	5.0	6.0						
Reservoir thickness [m] (> 0)	20	43	60						
HC column in prospect [m] (> 0)	130	239	306						
Gross rock vol. [10^9 m^3] (> 0.000)	0.060	0.175	0.230						
Net / Gross [fraction] (0.00-1.00)	0.46	0.68	0.86						
Porosity [fraction] (0.00-1.00)	0.20	0.23	0.26						
Permeability [mD] (> 0.0)	146.0	146.0	146.0						
Water Saturation [fraction] (0.00-1.00)									
Bg [Rm3/Sm3] (< 1.0000)	0.0045	0.0042	0.0039						
1/Bo [Sm3/Rm3] (< 1.00)									
GOR, free gas [Sm^3/Sm^3] (> 0)	70	103	137						
GOR, oil [Sm^3/Sm^3] (> 0)									
Recov. factor, oil main phase [fraction] (0.00-1.00)									
Recov. factor, gas ass. phase [fraction] (0.00-1.00)									
Recov. factor, gas main phase [fraction] (0.00-1.00)	0.52	0.60	0.68						
Recov. factor, liquid ass. phase [fraction] (0.00-1.00)	0.47	0.55	0.63	For NPD use:					
Temperature, top res [°C] (>0)				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)				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