PL 643 Relinquishment Report

03.08.2016

VNG Norge

EDISON

LOTOS

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1 Key license history

Licence award and licencees

PL 643 was awarded February 3rd 2012 to a license group consisting of VNG Norge AS (operator, 40 % equity), Lotos Exploration and Production Norge AS (30 % equity) and Edison International SpA Norway Branch, now Edison Norge AS (30 % equity). VNG Norge applied with Lotos through an AMI with Hans Nord as the main prospect and Hans Nordøst as a lead, while Edison Norge AS applied with Nebbiolo and Malvasia as the main prospects and Sangiovese (same structure as Hans Nord) as a lead. PL 643 is located in the Norwegian Sea (Fig. 1.1) on the western Halten Terrace and covers an area of 407.303 km^2. The license acreage covers parts of blocks 6406/1, 4 and 5.

Work program

Initially, the AMI with Lotos and VNG Norge applied with a work programme to reprocess existing 3D seismic since Hans Nord was already covered by 3D seismic. Since the area where the Nebbiolo and Malvasia prospects was not covered by any 3D seismic, the PL643 licence was awarded with the following work programme:

1. Reprocess existing seismic
2. Acquire new seismic over the prospect area and perform G&G studies
3. Decide to drill an exploration well or to drop the license within three years from award (DOD)

Further work commitments were:

1. Within five years from award make a decision about concretization (BOK)
2. Within six years from award make a decision about continuation (BOV)
3. Within seven years from award submit a plan for development (PDO)

The initial drill or drop decision for the licence was set to be the 3rd February 2015. The licence fulfilled the work commitments, but due to delays in the seismic reprocessing there was limited time to finish the final evaluation of the licence. In addition, the neighbouring licence (PL 589) had decided to drill an analogue prospect which could affect the decision for PL643. In 2015, the structure in PL589 was drilled and made a discovery. Due to the importance of this well, the partnership decided to apply for another extension in order to include the results from the well in the evaluation of PL643. The second application was also accepted and a seven month extension was given (the new drill or drop date was set to 3rd May 2016).

Licence meetings

Regular license meetings were held at the VNG Stavanger office with occasional videolink to the VNG Oslo office. There were five Management Committee meetings and eight Exploration Committee meetings as according to Table 1.1.

Table 1.1 License meetings overview

Date	Management Committee Meeting	Exploration Committee Meeting
March 20th 2012	MC #1	EC #1
November 29th 2012	MC #2	EC #2
June 5th 2013		EC #3
September 19th 2013		EC #4
November 26th 2013	MC #3	EC #5
October 9th 2014	MC #4	EC #6

Date	Management Committee Meeting	Exploration Committee Meeting
May 6th 2015		EC #7
November 24th 2015	MC #5	EC #8

Reason for relinquishment

Although the Nebbiolo prospect has marginally positive economics, the prospect is considered high risk with the present price environment including the HPHT aspect. The license was therefore relinquished with support from all partners.

2 Database

Seismic database

The licence area is covered by multiple seismic surveys of varying vintage and quality. The original AMI dataset included the PGS Mega Merge and HTS99 3D datasets. The outlines can be seen in Fig. 2.1. The data were reprocessed post-stack as part of the licence work commitment and included the OMV2007, HWE95 and HTS99 surveys. Fifteen seismic 2D lines from the ST8501 survey were reprocessed by PSS Geo. Parts of a new multiclient broadseis survey, CGGV1301 were purchased and a PL 643 specific PSTM processing was performed. In addition, MNR (CFI) 2D lines were purchased.

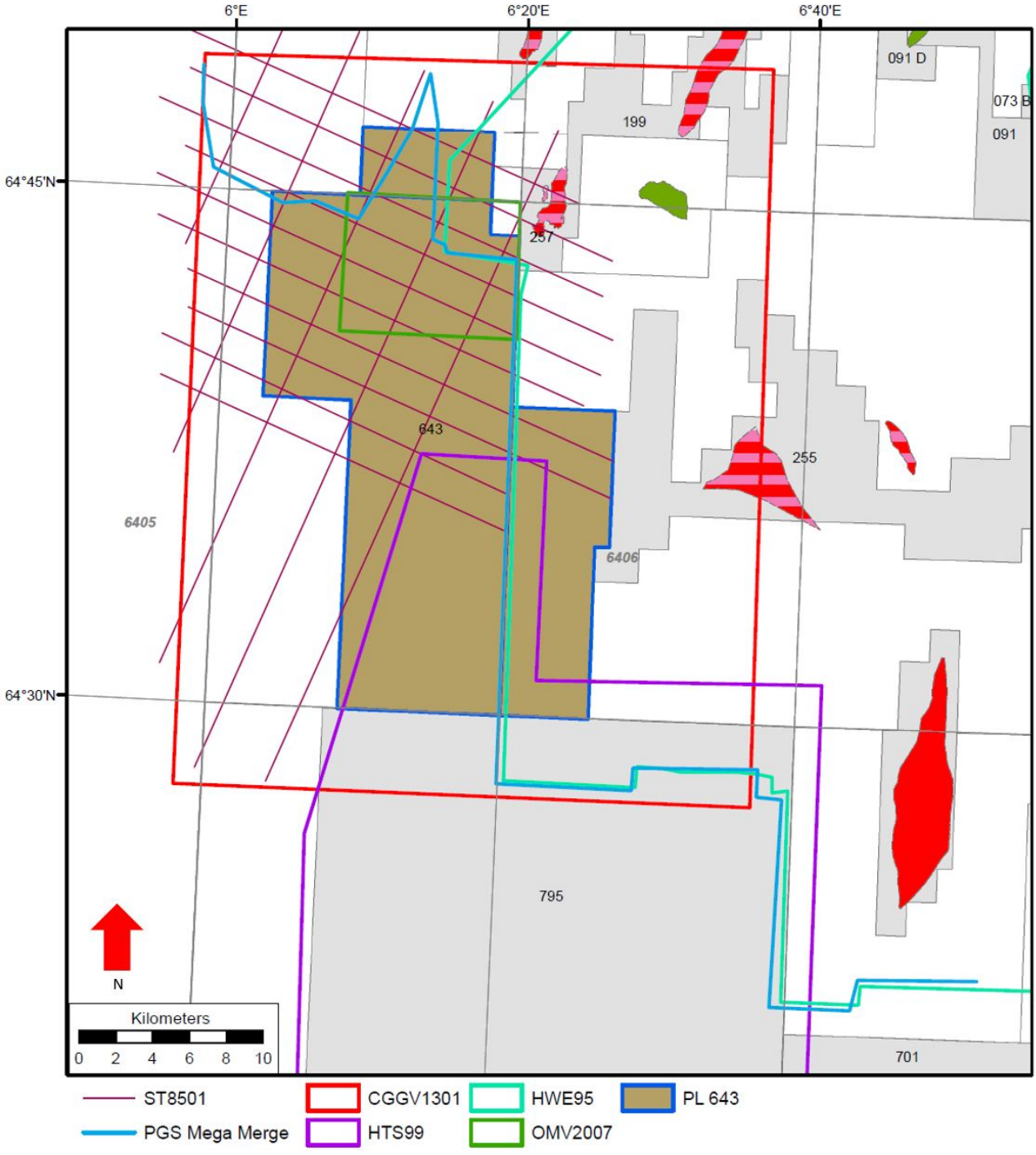

Fig. 2.1 Seismic database

An overview of the seismic database for PL643.

Well database

All relevant regional wells were evaluated for the prospectivity analysis. Reference is made to Table 2.1 listing the released 32 background wells which were also used in the APA 2011 application (VNG Norge AS et al., 2011). In addition, the 6406/2-8 Imsa Sør well was added to the common database in 2015 and was used to see if there was need to change the resources and risk for the prospect. The wells were used for studying depositional environment, reservoir properties and hydrocarbon/source rock distribution.

Table 2.1 Common well database

Listing of wells used in the PL 643 license.

Well	Year	TD mMD	TD Fm	Well result and discovery name
6406/1-1	2001	5057	Åre Fm	G/C Tofte Fm Erlend N
6406/1-2	2003	4500	Red Beds	G/C Lange Fm
6406/1-3	2004	4276	Lange Fm	Dry
6406/1-4	2005	4596	Red beds	Shows Lange Fm
6406/2-1	1995	5292	Åre Fm	G/C Ile,Tofte,Tilje,Åre Fms
6406/2-2	1996	5361	Åre Fm	G/C Ile Tofte Fms
6406/2-4S	1999	5080	Åre Fm	G/C Garn Fm + Båt Gp
6406/2-5	1997	5439	Åre Fm	Dry Kristin
6406/2-5 A	1998	5600	Ror Fm	G/C Garn, Ile Fms Kristin
6406/2-6	1998	5263	Åre Fm	G/C Ile, Tofte Fms Ragnfrid
6406/2-6 A	2000	5251	Tofte Fm	G/C Tofte Fm Ragnfrid
6406/2-7	1999	4981	Tilje Fm	G/C Garn, Ile Fms Erlend
6406/3-1	1984	4902	Red beds	G shows Jurassic
6406/3-2	1986	4523	Åre Fm	Oil, Garn Fm Trestakk
6406/3-4	1989	4414	Tilje Fm	No shows Cret + Jurassic Trestakk
6406/3-5	1988	4283	Tilje Fm	Shows Jurassic
6406/3-6	2002	4175	Tilje Fm	O/G Garn,Ile Fms Tyrihans S
6406/3-7	2006	4520	Åre Fm	Dry
6406/5-1	2002	4692	Tilje Fm	G/C Garn Fm Tott prospect
6406/6-1	1985	4715	Tilje Fm	Shows. Cret + Jur
6406/6-2	2007	4670	Tilje Fm	Dry
6406/8-1	1988	4910	Åre Fm	G shows Jurassic
6406/8-2	2007	4700	Tilje Fm	Dry
6406/9-1	2005	5080	Åre Fm	Gas, Ile,Tofte,Tilje Fms Linnorm
6406/9-2	2007	5348	Åre Fm	Gas, Garn,Ile,Tofte Fms Linnorm
6407/1-2	1983	4560	Grey Beds	G/C Garn Fm
6407/1-3	1984	4469	Grey Beds	O/G in Fangst Gp. Tyrihans
6407/1-4	1996	3805	Not Fm	O/G in Garn Fm. Tyrihans
6407/4-1	1985	4835	Åre Fm	G/C in Garn Fm.
6407/4-2	2011	4230	M Jur	Dry
6407/7-8	2008	5138	Åre Fm	G/C in Fangst + Båt Gp. Noatun
6407/7-8A	2008	5227	Åre Fm	G/C in Fangst + Båt Gp. Noatun

Studies database

Fault sealing was one of the main challenges for the Nebbiolo prospect. The operator proposed to include a fault seal study performed for the area and integrated with the failure analysis. This study focused on the vertical leakage risk since many discoveries locally appear to have leaked after filling. The report was prepared by Badley Geoscience Limited in 2014 and 2015.

The licencees also agreed to a reservoir quality gross depositional environment analysis, a basin modelling study and Seismic Data Analysis which were all completed ahead of the DoD decision.

3 Review of geological framework

For the APA application, the Hans Nord prospect and the Hans Nordøst lead were identified by the AMI group consisting of VNG Norge and Lotos, whilst the Nebbiolo and Malvasia prospects together with the Sangiovese lead were recognized by Edison Norge. All of the prospects and leads were based on a Lower - Middle Jurassic play concept with potential stacked reservoirs in the Garn-, Ile-, Tilje- and Tofte Formations (Fig. 3.1). The technical work after the award was focussed towards maturing either Nebbiolo or Hans Nord to a drilling candidate. The main risk identified for the two prospects was related to closure definition and timing and migration and several studies were initiated to address these risks.

Trap definition, basin modelling and trap retention

Reprocessing of existing seismic, and the purchase and processing of a new PSTM dataset (CGGV1301) (Fig. 3.2), improved the trap definition of the prospects in the South and led to a better definition of northern prospectivity (Nebbiolo and Malvasia). The interpretation incorporated a new geological model of both gravity driven tectonics (forming landslides) and thick-skinned extension. The landslides created petroleum system carrier beds during fault block degradation and resulted in local fault block thinning (Welbon et al., 2007). The seismic mapping helped define a framework of source rocks, fetch areas and fault blocks that contain reservoirs. A full 3D basin modelling study was done which included pressure analysis and concluded gas condensate was the most likely phase in the prospects, matching nearby wells (Exploro Geoservices 2014). This work was iterated with the results of a fluid inclusion study on several wells (Fluid Inclusion Technologies, 2012, 2014).

An analysis of hydrocarboncolumn heights in the area concluded that many structures were under-filled or had leaked. Since top seal capacity was robust based on LOT's, this pointed to a vertical leakage of the fault systems. Across-fault seal was predicted to be robust from a Shale Gouge Ratio Study. A major study was completed to look at vertical leakage along faults due to critically stressed faults as a function of present day stresses and pressure acting on the fault planes (Badleys Geoscience Limited, 2014, 2015) (Fig. 3.3). The model results matched well data in the area, where only small columns can be retained, or the segment leaks, including the recently drilled Imsa Sør well 6406/2-8 S (see below). The bounding fault between the small Ragnfrid discovery and the Nebbiolo prospect was predicted to leak (vertically) in the footwall (Ragnfrid side) and have a better chance to retain hydrocarbons on the hanging wall side (with a new retention risk 0.6). Malvasia was dropped due to the high risk.

Reservoir presence and quality was addressed with a reservoir quality study of wells based on cored intervals (Robertson Limited 2014) combined with a sedimentological and petrophysical analysis.

New wells

Towards the end of the licence period two more wells were drilled in the area, 6406/2-8 Imsa Sør (PL 589) and well 6406/6-4 S Tvillingen Sør (in PL 510). The PL 643 licence successfully applied for a second extension to the DoD deadline to evaluate the Imsa Sør results since it was close to the PL 643 licence. Post well analysis of 6406/2-8 (Wintershall 2015), shows the well entered older reservoir than expected and two small oil columns were encountered in different pressure regimes. The water leg beneath these accumulations is a separate, higher pressure compartment and contained multiple shows. Modelling of the segment bounding faults using a critically stressed fault model was consistent with the well results of lower pressure compartments higher up the well and that the shallowest part of the trap had leaking faults. A gas chimney is seen above the structure and a small oil accumulation is present in the Lange Formation, again consistent with vertical leakage. Since the Imsa Sør well (6406/2-8) encountered older stratigraphy than prognosed, the Nebbiolo area interpretation was re-checked and still found to have a good match with the nearby Ragnfrid well. The 6406/6-4 S well encountered a 25 m column of gas in Garn with only 1.5-3.0 x $10^6 Sm^3$ o.e. Although the PL 643 licence does not have access to the data, this result is consistent with the fault leakage model.

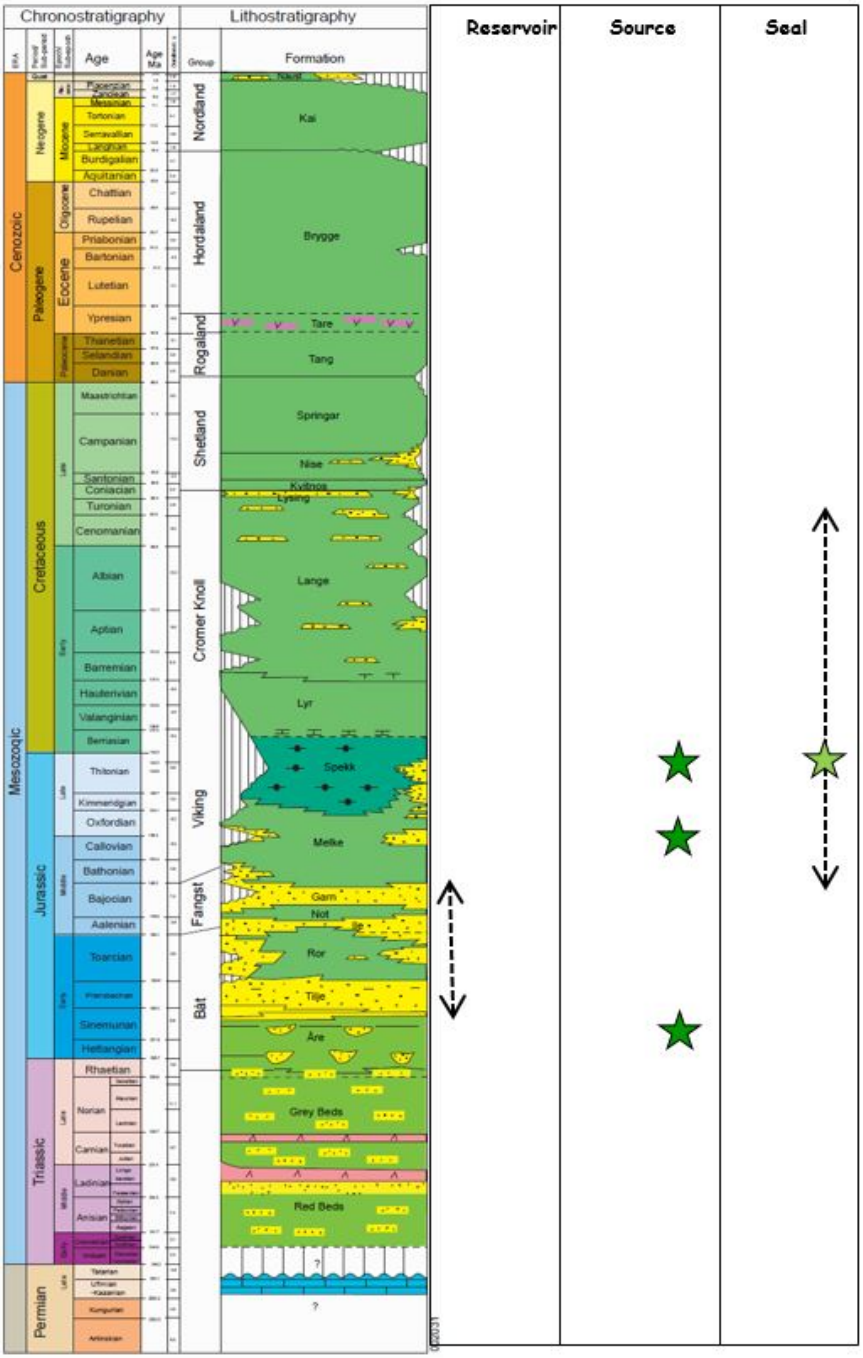

Fig. 3.1 Stratigraphic chart
Stratigraphic position of the Nebbiolo and Hans Nord prospects.

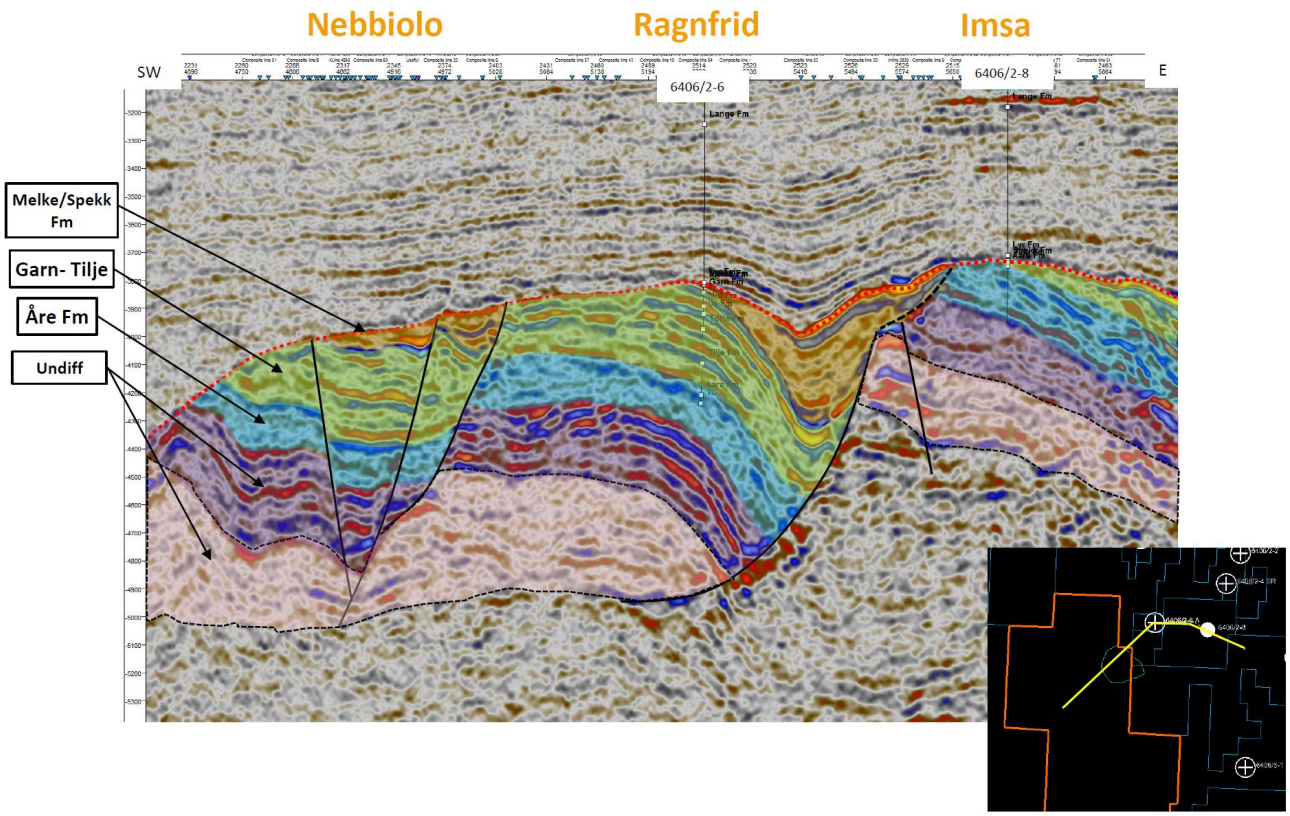

Fig. 3.2 A seismic line through the Nebbiolo prospect through to Ragnfrid and Imsa

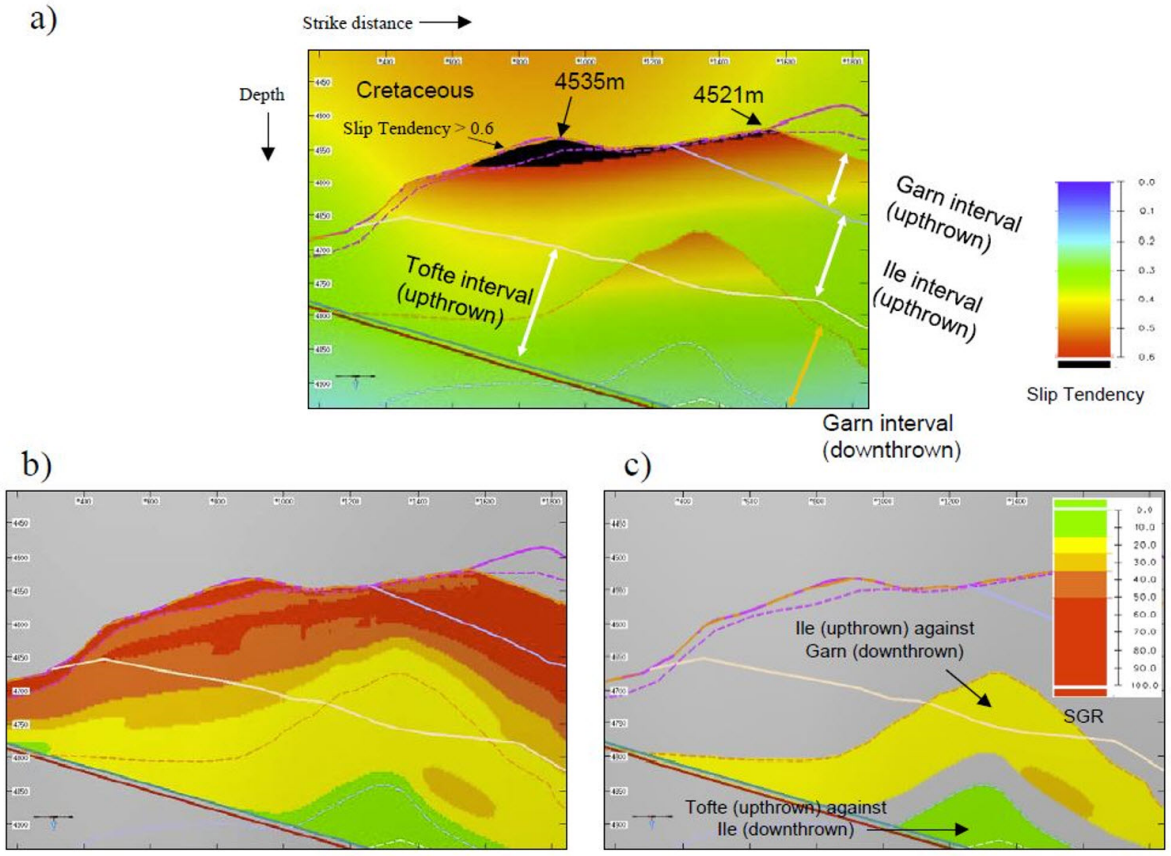

Fig. 3.3 Fault plane diagrams of the Intra Nebbiolo Fault

a) slip tendency, note the Garn (downthrown) has values <0.6 b) Shale Gouge Ratio (SGR) in the upthown Jurassic intervals c) SGR at the Jurassic interval

4 Prospect update

The original prospect map from the VNG APA Application is in Fig. 4.1 and the summary of volumes and risk are summarised Table 4.1. Through the licence work programme, with new seismic data and wells drilled in the neighbouring licences, Hans Nord and the Edison prospect (Nebbiolo) were matured (Fig. 4.2).

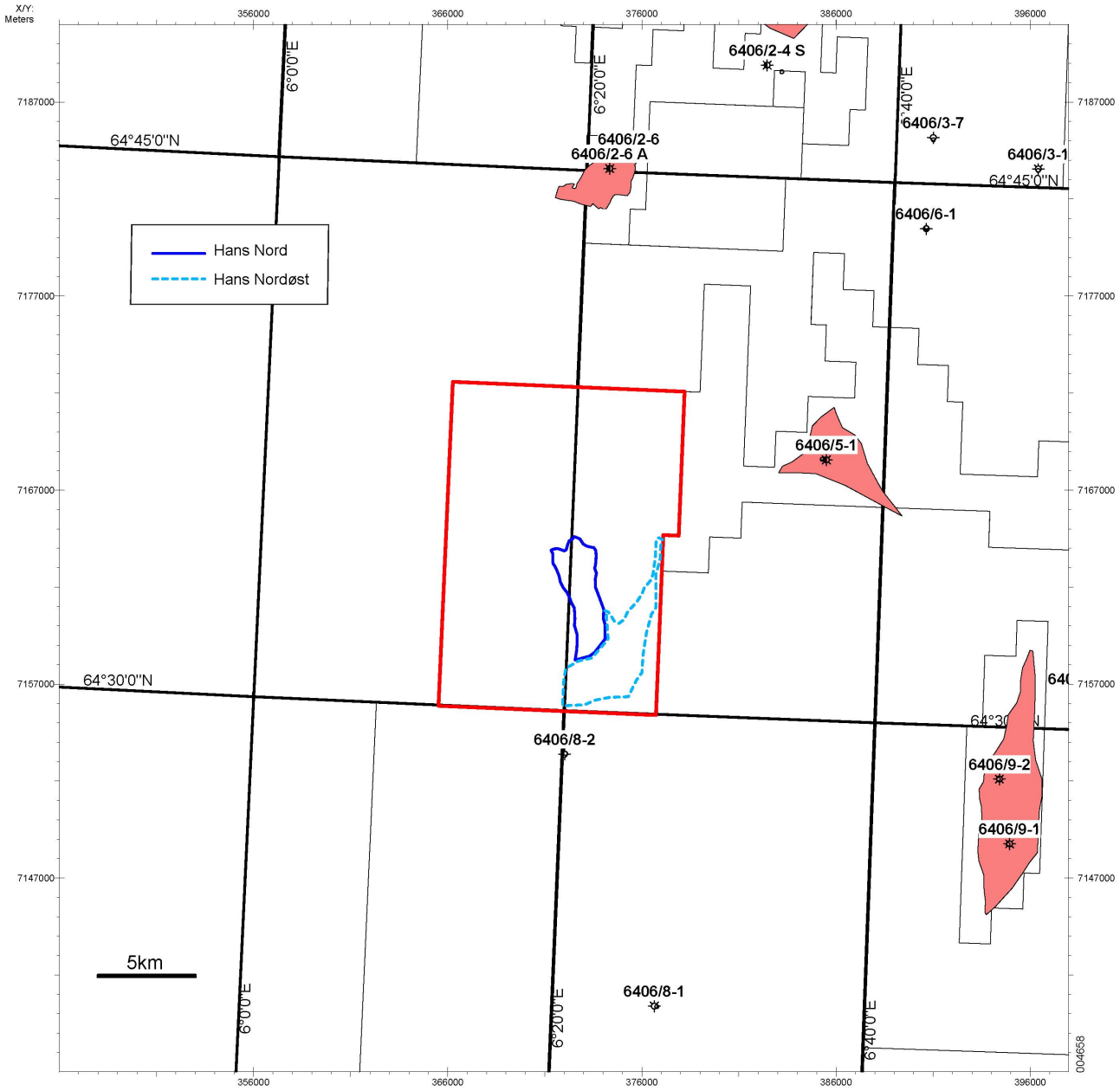

Fig. 4.1 The APA prospect and lead map from the VNG AMI

Table 4.1 Summary table of the original Prospect and Lead in the APA application

Discovery/ Prospect/ Lead name	D/ P/ L	Unrisked recoverable resources						Probability of discovery	Part in acreage applied for %	Reservoir		Distance to infra-structure (km)
		Oil 10^6Sm^3			Gas 10^9Sm^3					Litho-/ Chrono-stratigraphic level	Reservoir depth (m MSL)	
		Low	Base	High	Low	Base	High					
Hans Nord	P	3.28	13.20	25.80	2.76	12.30	24.90	0.288	100	Ile,Tofte and Tilje Fms/Mid - Early Jurassic	4350	40
Hans NordØst	L								100	Ile,Tofte and Tilje Fms/Mid - Early Jurassic		

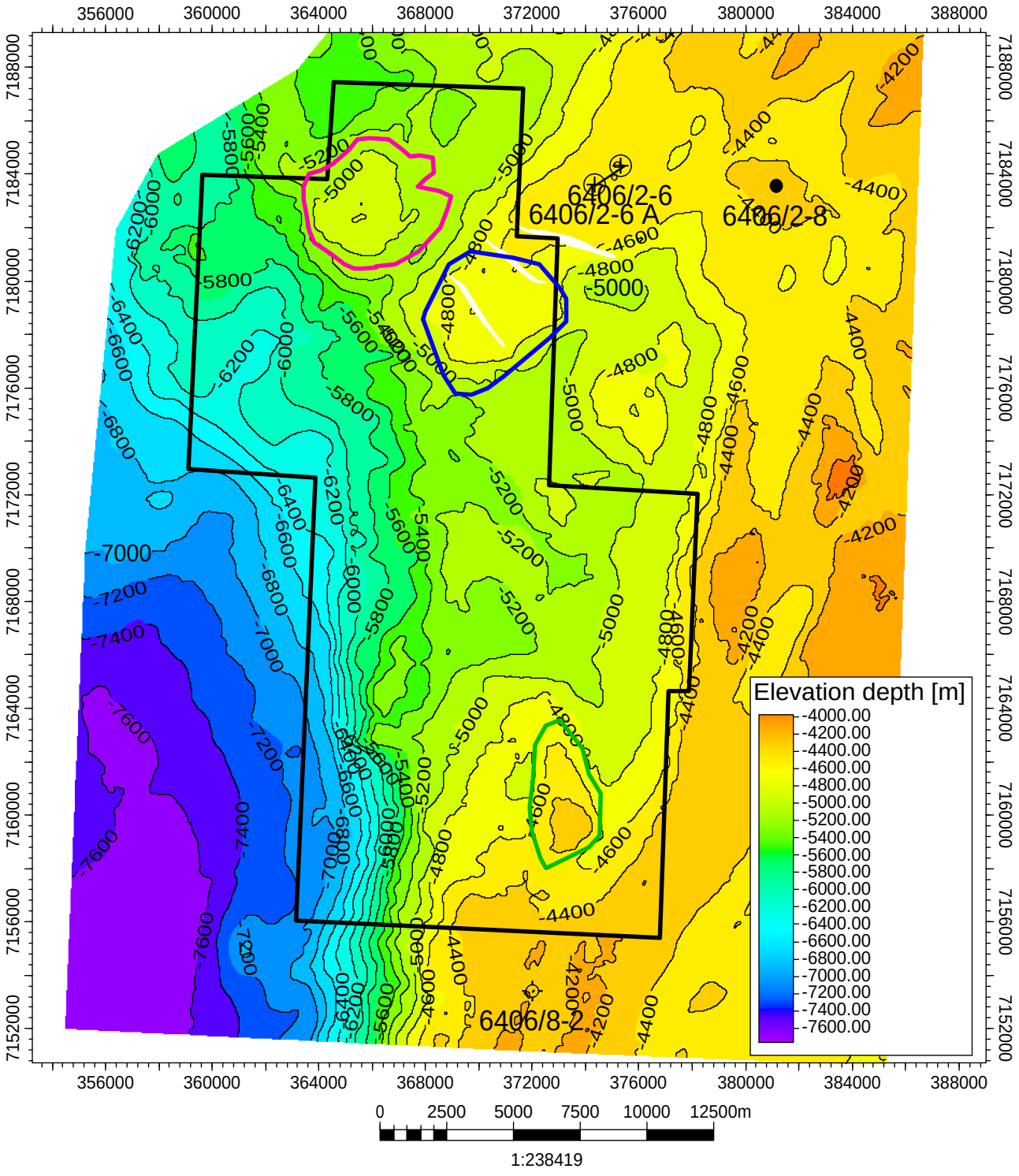

Fig. 4.2 Top reservoir map PL643

BCU depth map with PL643 boundary in black. The two prospects Hans Nord and Nebbiolo are marked on in green and blue respectively, while the Malvasia lead is in pink.

One of the main risks for the prospects was related to seal retention recognised through the presence of under-filled structures in the area. As described in Chapter 3 Review of geological framework, several studies were performed in order to de-risk the prospects such as a pressure prediction study as well as a fault seal and fault reactivation analysis. These studies had implications for the expected column heights in the Nebbiolo and Hans Nord prospects. Although the top seal capacity trend indicates that the Nebbiolo prospect could hold columns up to about 600 m, the basin modelling and fault seal and fault reactivation

analysis showed that smaller columns should be expected due to indications of leakage along faults in the nearby under-filled discoveries. The fault seal and fault reactivation analysis performed by Badley Geoscience indicated that the Nebbiolo prospect maximum could hold a 300 m column with a overpressure of 435 bar.

Initially reservoir quality was a concern and hence a comprehensive sedimentology and diagenesis study of nearby wells was performed. The results reduced the risk on reservoir quality. The new available seismic data was conditioned to improve the data quality (sharpreflections 2014) and was used for SDA to produce other attribute cubes such as lithology cubes. The lithology cube was particularly useful when it came to recognize dips and bodies where reflection data were ambiguous. The new conditioned data as well as the lithology cube led to re-interpretation of the Tofte, Tilje and Åre Formations in the Nebbiolo prospect. Due to the depth of the prospects, no fluid effects were expected to be seen on seismic. The Tofte Formation was interpreted as thinner than in previous analysis which indicated that the Tilje Formation could be above the contact. The aggregated resource was unchanged as a result of the remapping but the associated probability of discovery increased from 0.51 to 0.56 due to the Tilje Fm segment that was added.

Also source and migration has been a risk for the Nebbiolo and Hans Nord prospects. As mentioned in Chapter 3 Review of geological framework several studies such as basin modelling, fluid inclusion and pressure studies have been performed in order to de-risk the prospect in terms of charge. The studies show that Nebbiolo, Malvasia and Hans Nord prospects are situated in a working petroleum system with Spekk, Melke and Åre Formationsource rocks that could fill the structures. However, regional discoveries show clear trend of leakage and this has been taken into account when risking.

The resources from the APA application in 2011 for the Hans Nord prospect are shown in Table 4.2 for the Ile Fm, in Table 4.3 for the Tilje Fm and in Table 4.4 for the Tofte Fm. After an extensive work programme and incorporation of new seismic and new well data, the resource and risk changed significantly for Hans Nord and the new numbers are shown in Table 4.5 for the Ile Fm, in Table 4.6 for the Tofte Fm and in Table 4.7 for the Tilje Formation. The licence studies resulted in a reduction of the reservoir, trap and charge risk and an increase in the retention risk. The economical evaluation performed in 2014 for the initial drill or drop decision, showed a negative EMV for the Hans Nord prospect and it was decided to switch the main focus to the Nebbiolo prospect.

Table 4.2 Input parameters and resource estimates Hans Nord - Ile Formation (APA 2011)

Block	Prospect name		Discovery/Prosp/Lead		Prosp ID (or New!)	NPD approved?
6406/4,6406/5	Hans Nord		Prospect		*NPD will insert data*	*NPD will insert data*
Play (name / new)	Structural element		Company/ reported by / Ref. doc.			Year
NPD will insert data	Halten terrace		VNG Norge			2011
Oil/Gas case	**Resources IN PLACE**					
Gas 109 Sm3	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3						
Gas 10^9 Sm^3	13.7	34.8	59.8			
	Resources RECOVERABLE					
	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3				3.35	9.65	17.4
Gas 10^9 Sm^3	3.69	10.7	19.4			
	Which fractiles are used as:		Low:	P90	High:	P10
Type of trap	Water depth (m)		Reservoir Chrono (from - to)		Reservoir Litho (from - to)	
Structural	365		Middle Jurassic		Ile Fm.	
Source Rock, Chrono	Source Rock, Litho		Seal, Chrono		Seal, Litho	
Upper-Lower Jurassic	Shale		Upper Jurassic-Lower Cretaceous		Shale	
Seismic database (2D/3D):	3D					
Probability of discovery:						
Technical (oil+gas case)	0.15		Prob for oil/gas case			
Probability (fraction):	Reservoir (P1)	Trap (P2)	Charge (P3)	Retention (P4)		
	0.7	0.6	0.55	0.65		
Parametres:	Low	Base	High	Comments		
Depth to top of prospect (m)		4350				
Area of closure (km^2)	3.7	6.7	9.7			
Reservoir thickness (m)	64	100	136			
HC column in prospect (m)	100	200	300			
Gross rock vol. (10^9 m^3)	0.269	0.608	0.973			
Net / Gross (fraction)	0.68	0.8	0.91			
Porosity (fraction)	0.12	0.155	0.18			
Water Saturation (fraction)	0.4	0.35	0.29			
Bg. (<1)	0.003101737	0.00285714	0.002648305			
Bo. (>1)						
GOR, free gas (Sm^3 /Sm^3)	825	750	675			
GOR, oil (Sm^3 /Sm^3)	1212	1333	1480			
Recovery factor, main phase	0.49	0.6	0.71			
Recovery factor, ass. phase	0.45	0.54	0.63			
Temperature, top res (deg C) :	161	Pressure, top res (bar) :		769		

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Table 4.3 Input parameters and resource estimates Hans Nord - Tilje Formation (APA 2011)

Block	Prospect name		Discovery/Prosp/Lead		Prosp ID (or New!)	NPD approved?
6406/4,6406/5	Hans Nord		Prospect		*NPD will insert data*	*NPD will insert data*
Play (name / new)	Structural element		Company/ reported by / Ref. doc.			Year
NPD will insert data	Halten terrace		VNG Norge			2011
Oil/Gas case	**Resources IN PLACE**					
Gas 109 Sm3	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3						
Gas 10^9 Sm^3	8.9	31.3	59.6			
	Resources RECOVERABLE					
	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3				2.6	9.9	20.1
Gas 10^9 Sm^3	2.1	8.3	16.7			
	Which fractiles are used as:		Low:	P90	High:	P10
Type of trap	Water depth (m)		Reservoir Chrono (from - to)		Reservoir Litho (from - to)	
Structural	365		Early Jurassic		Tilje Fm.	
Source Rock, Chrono	Source Rock, Litho		Seal, Chrono		Seal, Litho	
Upper-Lower Jurassic	Shale		Upper Jurassic-Lower Cretaceous		Shale	
Seismic database (2D/3D):	3D					
Probability of discovery:						
Technical (oil+gas case)	0.139		Prob for oil/gas case			
Probability (fraction):	Reservoir (P1)	Trap (P2)	Charge (P3)	Retention (P4)		
	0.55	0.65	0.6	0.65		
Parametres:	Low	Base	High	Comments		
Depth to top of prospect (m)		4650				
Area of closure (km^2)	3.7	6.8	9.7			
Reservoir thickness (m)	94	140	203			
HC column in prospect (m)	100	200	300			
Gross rock vol. (10^9 m^3)	0.389	0.854	1.341			
Net / Gross (fraction)	0.25	0.5	0.75			
Porosity (fraction)	0.1	0.14	0.19			
Water Saturation (fraction)	0.44	0.3	0.37			
Bg. (<1)	0.003101737	0.002264831	0.002857143			
Bo. (>1)						
GOR, free gas (Sm^3 /Sm^3)	825	750	675			
GOR, oil (Sm^3 /Sm^3)	1212	1333	1480			
Recovery factor, main phase	0.49	0.6	0.71			
Recovery factor, ass. phase	0.45	0.54	0.63			
Temperature, top res (deg C) :	200	Pressure, top res (bar) :		799		

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Table 4.4 Input parameters and resource estimates Hans Nord - Tofte Formation (APA 2011)

Block	Prospect name		Discovery/Prosp/Lead		Prosp ID (or New!)	NPD approved?
6406/4,6406/5	Hans Nord		Prospect		*NPD will insert data*	*NPD will insert data*
Play (name / new)	Structural element		Company/ reported by / Ref. doc.			Year
NPD will insert data	Halten terrace		VNG Norge			2011
Oil/Gas case	**Resources IN PLACE**					
Gas 109 Sm3	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3						
Gas 10^9 Sm^3	4.23	16.1	31.1			
	Resources RECOVERABLE					
	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3				1.23	5.11	10.5
Gas 10^9 Sm^3	1.01	4.26	8.74			
	Which fractiles are used as:		Low:	P90	High:	P10
Type of trap	Water depth (m)		Reservoir Chrono (from - to)		Reservoir Litho (from - to)	
Structural	365		Early Jurassic		Tofte Fm.	
Source Rock, Chrono	Source Rock, Litho		Seal, Chrono		Seal, Litho	
Upper-Lower Jurassic	Shale		Upper Jurassic-Lower Cretaceous		Shale	
Seismic database (2D/3D):	3D					
Probability of discovery:						
Technical (oil+gas case)	0.164			Prob for oil/gas case		
Probability (fraction):	Reservoir (P1)	Trap (P2)	Charge (P3)	Retention (P4)		
	0.7	0.6	0.6	0.65		
Parametres:	Low	Base	High	Comments		
Depth to top of prospect (m)		4450				
Area of closure (km^2)	3.7	6.8	9.7			
Reservoir thickness (m)	43	67	89			
HC column in prospect (m)	100	200	300			
Gross rock vol. (10^9 m^3)	0.177	0.409	0.651			
Net / Gross (fraction)	0.25	0.63	0.75			
Porosity (fraction)	0.1	0.15	0.2			
Water Saturation (fraction)	0.44	0.3	0.37			
Bg. (<1)	0.003101737	0.002264831	0.002857143			
Bo. (>1)						
GOR, free gas (Sm^3 /Sm^3)	825	750	675			
GOR, oil (Sm^3 /Sm^3)	1212	1333	1480			
Recovery factor, main phase	0.49	0.6	0.71			
Recovery factor, ass. phase	0.45	0.54	0.63			
Temperature, top res (deg C) :	180	Pressure, top res (bar) :		779		

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Table 4.5 Input parameters and resource estimates Hans Nord - Ile Formation

Table 4: Prospect data

Block	Prospect name		Discovery/Prosp/Lead		Prosp ID (or New!)	NPD approved?
6406/1,4 &5	Hans Nord		Prospect		*NPD will insert data*	*NPD will insert data*
Play (name / new)	Structural element		Company/ reported by / Ref. doc.			Year
NPD will insert data	Halten terrace		VNG Norge			2014
Oil/Gas case	**Resources IN PLACE**					
Gas	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3						
Gas 10^9 Sm^3	1.29	5.54	9.27			
	Resources RECOVERABLE					
	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3				0.579	2.45	4.91
Gas 10^9 Sm^3	0.785	3.38	6.52			
	Which fractiles are used as:		Low:	P90	High:	P10
Type of trap	Water depth (m)		Reservoir Chrono (from - to)		Reservoir Litho (from - to)	
Structural	365		Middle Jurassic		Ile Fm.	
Source Rock, Chrono	Source Rock, Litho		Seal, Chrono		Seal, Litho	
Upper-Lower Jurassic	Shale		Upper Jurassic-Lower Cretaceous		Shale	
Seismic database (2D/3D):	3D					
Probability of discovery:						
Technical (oil+gas case)	0.3		Prob for oil/gas case			
Probability (fraction):	Reservoir (P1)	Trap (P2)	Charge (P3)	Retention (P4)		
	0.8	0.9	0.7	0.6		
Parametres:	Low	Base	High	Comments		
Depth to top of prospect (m)		4310				
Area of closure (km^2)	1.62	3.24	5.35			
Reservoir thickness (m)		75				
HC column in prospect (m)	65	145	260			
Gross rock vol. (10^9 m^3)	242	286	330			
Net / Gross (fraction)	0.77	0.84	0.88			
Porosity (fraction)	0.17	0.19	0.21			
Water Saturation (fraction)	0.4	0.3	0.2			
Bg. (<1)	0.0040	0.0036	0.0033			
Bo. (>1)						
GOR, free gas (Sm^3 /Sm^3)	825	750	675			
GOR, oil (Sm^3 /Sm^3)	1212	1333	1480			
Recovery factor, main phase	0.4	0.53	0.7			
Recovery factor, ass. phase	0.5	0.63	0.8			
Temperature, top res (deg C) :	161	Pressure, top res (bar) :		769		

For NPD use:

Innrapp. av geolog:		Registrert:		Map OK:		Nr:
Dato:		Dato:		Dato:		

Table 4.6 Input parameters and resource estimates Hans Nord - Tofte Formation

Table 4: Prospect data

Block	Prospect name		Discovery/Prosp/Lead		Prosp ID (or New!)	NPD approved?
6406/1,4 &5	Hans Nord		Prospect		*NPD will insert data*	*NPD will insert data*
Play (name / new)	Structural element		Company/ reported by / Ref. doc.			Year
NPD will insert data	Halten terrace		VNG Norge			2014
Oil/Gas case	**Resources IN PLACE**					
Gas	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3						
Gas 10^9 Sm^3	1.93	6.15	11.3			
	Resources RECOVERABLE					
	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3				0.6	1.92	4.03
Gas 10^9 Sm^3	1.1	3.56	6.93			
	Which fractiles are used as:		Low:	P90	High:	P10
Type of trap	Water depth (m)		Reservoir Chrono (from - to)		Reservoir Litho (from - to)	
Structural	365		Middle Jurassic		Tofte	
Source Rock, Chrono	Source Rock, Litho		Seal, Chrono		Seal, Litho	
Upper-Lower Jurassic	Shale		Upper Jurassic-Lower Cretaceous		Shale	
Seismic database (2D/3D):	3D					
Probability of discovery:						
Technical (oil+gas case)	0.23		Prob for oil/gas case			
Probability (fraction):	Reservoir (P1)	Trap (P2)	Charge (P3)	Retention (P4)		
	0.8	0.9	0.7	0.45		
Parametres:	Low	Base	High	Comments		
Depth to top of prospect (m)		4390				
Area of closure (km^2)	3.49	6.23	9.01			
Reservoir thickness (m)		75				
HC column in prospect (m)	130	220	340			
Gross rock vol. (10^9 m^3)	618	731	847			
Net / Gross (fraction)	0.35	0.45	0.55			
Porosity (fraction)	0.13	0.15	0.17			
Water Saturation (fraction)	0.4	0.3	0.2			
Bg. (<1)	0.0038	0.0036	0.0031			
Bo. (>1)						
GOR, free gas (Sm^3 /Sm^3)	825	750	675			
GOR, oil (Sm^3 /Sm^3)	1212	1333	1480			
Recovery factor, main phase	0.45	0.581	0.75			
Recovery factor, ass. phase	0.35	0.477	0.65			
Temperature, top res (deg C) :	161	Pressure, top res (bar) :		769		

For NPD use:

Innrapp. av geolog:		Registrert:		Map OK:		Nr:
Dato:		Dato:		Dato:		

Table 4.7 Input parameters and resource estimates Hans Nord - Tilje Formation

Table 4: Prospect data

Block	Prospect name		Discovery/Prosp/Lead		Prosp ID (or New!)	NPD approved?
6406/1,4 &5	Hans Nord		Prospect		*NPD will insert data*	*NPD will insert data*
Play (name / new)	Structural element		Company/ reported by / Ref. doc.			Year
NPD will insert data	Halten terrace		VNG Norge			2014
Oil/Gas case	**Resources IN PLACE**					
Gas	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3						
Gas 10^9 Sm^3	0.656	2.78	14.7			
	Resources RECOVERABLE					
	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3				0.272	1.19	6.54
Gas 10^9 Sm^3	0.359	1.65	8.92			
	Which fractiles are used as:		Low:	P90	High:	P10
Type of trap	Water depth (m)		Reservoir Chrono (from - to)		Reservoir Litho (from - to)	
Structural	365		Middle Jurassic		Tilje	
Source Rock, Chrono	Source Rock, Litho		Seal, Chrono		Seal, Litho	
Upper-Lower Jurassic	Shale		Upper Jurassic-Lower Cretaceous		Shale	
Seismic database (2D/3D):	3D					
Probability of discovery:						
Technical (oil+gas case)	0.2		Prob for oil/gas case			
Probability (fraction):	Reservoir (P1)	Trap (P2)	Charge (P3)	Retention (P4)		
	0.8	0.9	0.7	0.4		
Parametres:	Low	Base	High	Comments		
Depth to top of prospect (m)		4470				
Area of closure (km^2)	1.42	4.73	10.1			
Reservoir thickness (m)		75				
HC column in prospect (m)	130	200	335			
Gross rock vol. (10^9 m^3)	1.8	2	2.6			
Net / Gross (fraction)	0.35	0.45	0.55			
Porosity (fraction)	0.13	0.14	0.16			
Water Saturation (fraction)	0.4	0.3	0.2			
Bg. (<1)	0.0040	0.0036	0.0033			
Bo. (>1)						
GOR, free gas (Sm^3 /Sm^3)	825	750	675			
GOR, oil (Sm^3 /Sm^3)	1212	1333	1480			
Recovery factor, main phase	0.45	0.581	0.75			
Recovery factor, ass. phase	0.35	0.477	0.65			
Temperature, top res (deg C) :	161	Pressure, top res (bar) :		769		

For NPD use:

Innrapp. av geolog:		Registrert:		Map OK:		Nr:
Dato:		Dato:		Dato:		

The Nebbiolo prospect has also been significantly de-risked (partly because of aggregating segments in GEOX) and has a risk of 0.56 in the final evaluation. Input parameters and resource estimates for Nebbiolo are shown in Table 4.8 for the Garn Fm, in Table 4.9 for the Ile Fm, in Table 4.10 for the Tilje Fm and in Table 4.11 for the Tofte Fm.Table 4.12 shows the aggregated volumes in the Nebbiolo prospect.

Table 4.8 Input parameters and resource estimates Nebbiolo - Garn Formation

Table 4: Prospect data

Block	Prospect name		Discovery/Prosp/Lead		Prosp ID (or New!)	NPD approved?
6406/1,4 &5	Hans Nord		Prospect		*NPD will insert data*	*NPD will insert data*
Play (name / new)	Structural element		Company/ reported by / Ref. doc.			Year
NPD will insert data	Halten terrace		VNG Norge			2011
Oil/Gas case	**Resources IN PLACE**					
Gas 109 Sm3	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3						
Gas 10^9 Sm^3	13.7	34.8	59.8			
	Resources RECOVERABLE					
	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3				3.35	9.65	17.4
Gas 10^9 Sm^3	3.69	10.7	19.4			
	Which fractiles are used as:		Low:	P90	High:	P10
Type of trap	Water depth (m)		Reservoir Chrono (from - to)		Reservoir Litho (from - to)	
Structural	365		Middle Jurassic		Ile Fm.	
Source Rock, Chrono	Source Rock, Litho		Seal, Chrono		Seal, Litho	
Upper-Lower Jurassic	Shale		Upper Jurassic-Lower Cretaceous		Shale	
Seismic database (2D/3D):	3D					
Probability of discovery:						
Technical (oil+gas case)	0.15			Prob for oil/gas case		
Probability (fraction):	Reservoir (P1)	Trap (P2)	Charge (P3)	Retention (P4)		
	0.7	0.6	0.55	0.65		
Parametres:	Low	Base	High	Comments		
Depth to top of prospect (m)		4350				
Area of closure (km^2)	3.7	6.7	9.7			
Reservoir thickness (m)	64	100	136			
HC column in prospect (m)	100	200	300			
Gross rock vol. (10^9 m^3)	0.269	0.608	0.973			
Net / Gross (fraction)	0.68	0.8	0.91			
Porosity (fraction)	0.12	0.155	0.18			
Water Saturation (fraction)	0.4	0.35	0.29			
Bg. (<1)	0.003101737	0.00285714	0.002648305			
Bo. (>1)						
GOR, free gas (Sm^3 /Sm^3)	825	750	675			
GOR, oil (Sm^3 /Sm^3)	1212	1333	1480			
Recovery factor, main phase	0.49	0.6	0.71			
Recovery factor, ass. phase	0.45	0.54	0.63			
Temperature, top res (deg C) :	161	Pressure, top res (bar) :		769		

For NPD use:

Innrapp. av geolog:		Registrert:		Map OK:		Nr:
Dato:		Dato:		Dato:		

Table 4.9 Input parameters and resource estimates Nebbiolo - Ile Formation

Table 4: Prospect data

Block	Prospect name		Discovery/Prosp/Lead		Prosp ID (or New!)	NPD approved?
6406/1,4 &5	Nebbiolo		Prospect		*NPD will insert data*	*NPD will insert data*
Play (name / new)	Structural element		Company/ reported by / Ref. doc.			Year
NPD will insert data	Halten terrace		VNG Norge			2016
Oil/Gas case	**Resources IN PLACE**					
Gas	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3						
Gas 10^9 Sm^3	1.22	7.96	20			
	Resources RECOVERABLE					
	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3				0.56	3.64	10.4
Gas 10^9 Sm^3	0.816	5.14	14.5			
	Which fractiles are used as:		Low:	P90	High:	P10
Type of trap	Water depth (m)		Reservoir Chrono (from - to)		Reservoir Litho (from - to)	
Structural			Middle Jurassic		Ile Fm.	
Source Rock, Chrono	Source Rock, Litho		Seal, Chrono		Seal, Litho	
Upper-Lower Jurassic	Shale		Upper Jurassic-Lower Cretaceous		Shale	
Seismic database (2D/3D):	3D					
Probability of discovery:						
Technical (oil+gas case)	0.269		Prob for oil/gas case			
Probability (fraction):	Reservoir (P1)	Trap (P2)	Charge (P3)	Retention (P4)		
	0.7	0.8	0.8	0.6		
Parametres:	Low	Base	High	Comments		
Depth to top of prospect (m)		4660				
Area of closure (km^2)	1.48	5.97	9.98			
Reservoir thickness (m)		75				
HC column in prospect (m)	110	195	328			
Gross rock vol. (10^9 m^3)	836	987	1140			
Net / Gross (fraction)	0.7	0.787	0.854			
Porosity (fraction)	0.16	0.179	0.196			
Water Saturation (fraction)	0.4	0.31	0.2			
Bg. (<1)	0.0039	0.0035	0.0032			
Bo. (>1)						
GOR, free gas (Sm^3 /Sm^3)	825	750	675			
GOR, oil (Sm^3 /Sm^3)	1212	1333	1480			
Recovery factor, main phase	0.5	0.632	0.798			
Recovery factor, ass. phase	0.4	0.529	0.7			
Temperature, top res (deg C) :	175	Pressure, top res (bar) :		864		

For NPD use:

Innrapp. av geolog:		Registrert:		Map OK:		Nr:
Dato:		Dato:		Dato:		

Table 4.10 Input parameters and resource estimates Nebbiolo - Tilje Formation

Table 4: Prospect data

Block	Prospect name		Discovery/Prosp/Lead		Prosp ID (or New!)	NPD approved?
6406/1,4 &5	Nebbiolo		Prospect		*NPD will insert data*	*NPD will insert data*
Play (name / new)	Structural element		Company/ reported by / Ref. doc.			Year
NPD will insert data	Halten terrace		VNG Norge			2016
Oil/Gas case	**Resources IN PLACE**					
Gas	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3						
Gas 10^9 Sm^3	0.142	2.04	10.2			
	Resources RECOVERABLE					
	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3				0.0449	0.637	3.28
Gas 10^9 Sm^3	0.0819	1.13	6.11			
	Which fractiles are used as:		Low:	P90	High:	P10
Type of trap	Water depth (m)		Reservoir Chrono (from - to)		Reservoir Litho (from - to)	
Structural	300		Lower Jurassic		Tilje Fm	
Source Rock, Chrono	Source Rock, Litho		Seal, Chrono		Seal, Litho	
Upper-Lower Jurassic	Shale		Middle - Lower Jurassic		Shale	
Seismic database (2D/3D):	3D					
Probability of discovery:						
Technical (oil+gas case)	0.235		Prob for oil/gas case			
Probability (fraction):	Reservoir (P1)	Trap (P2)	Charge (P3)	Retention (P4)		
	0.7	0.8	0.7	0.6		
Parametres:	Low	Base	High	Comments		
Depth to top of prospect (m)		4350				
Area of closure (km^2)	0.74	4	8.31			
Reservoir thickness (m)	100	100	100			
HC column in prospect (m)	77	162	279			
Gross rock vol. (10^9 m^3)	1877	2223.4	2563.8			
Net / Gross (fraction)	0.272	0.4	0.528			
Porosity (fraction)	0.114	0.131	0.15			
Water Saturation (fraction)	0.4	0.31	0.2			
Bg. (<1)	0.0037	0.00337	0.00305			
Bo. (>1)						
GOR, free gas (Sm^3 /Sm^3)	825	750	675			
GOR, oil (Sm^3 /Sm^3)	1212	1333	1480			
Recovery factor, main phase	0.449	0.577	0.732			
Recovery factor, ass. phase	0.35	0.476	0.647			
Temperature, top res (deg C) :	185	Pressure, top res (bar) :		864		

For NPD use:

Innrapp. av geolog:		Registrert:		Map OK:		Nr:
Dato:		Dato:		Dato:		

Table 4.11 Input parameters and resource estimates Nebbiolo - Tofte Formation

Table 4: Prospect data

Block	Prospect name		Discovery/Prosp/Lead		Prosp ID (or New!)	NPD approved?
6406/1,4 &5	Nebbiolo		Prospect		*NPD will insert data*	*NPD will insert data*
Play (name / new)	Structural element		Company/ reported by / Ref. doc.			Year
NPD will insert data	Halten terrace		VNG Norge			2016
Oil/Gas case	**Resources IN PLACE**					
Gas 109 Sm3	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3						
Gas 10^9 Sm^3	3.21	10.4	26.6			
	Resources RECOVERABLE					
	Main phase			Ass. phase		
	Low	Base	High	Low	Base	High
Oil 10^6 Sm^3				3.2	9.24	22.6
Gas 10^9 Sm^3	5.9	16.4	45.1			
	Which fractiles are used as:		Low:	P90	High:	P10
Type of trap	Water depth (m)		Reservoir Chrono (from - to)		Reservoir Litho (from - to)	
Structural	360		Lower Jurassic		Tofte Fm	
Source Rock, Chrono	Source Rock, Litho		Seal, Chrono		Seal, Litho	
Upper-Lower Jurassic	Shale		Middle Jurassic		Shale	
Seismic database (2D/3D):	3D					
Probability of discovery:						
Technical (oil+gas case)	0.235		Prob for oil/gas case			
Probability (fraction):	Reservoir (P1)	Trap (P2)	Charge (P3)	Retention (P4)		
	0.7	0.8	0.7	0.6		
Parametres:	Low	Base	High	Comments		
Depth to top of prospect (m)		4670				
Area of closure (km^2)	,	7.25	13.8			
Reservoir thickness (m)	150	150	150			
HC column in prospect (m)	78	160	263			
Gross rock vol. (10^9 m^3)	1489.3	1764.1	2034.3			
Net / Gross (fraction)	0.757	0.865	0.926			
Porosity (fraction)	0.165	0.187	0.206			
Water Saturation (fraction)	0.4	0.31	0.2			
Bg. (<1)	0.00373	0.00337	0.00305			
Bo. (>1)						
GOR, free gas (Sm^3 /Sm^3)	825	750	675			
GOR, oil (Sm^3 /Sm^3)	1212	1333	1480			
Recovery factor, main phase	0.449	0.579	0.742			
Recovery factor, ass. phase	0.35	0.477	0.65			
Temperature, top res (deg C) :	180	Pressure, top res (bar) :		864		

For NPD use:

Innrapp. av geolog:		Registrert:		Map OK:		Nr:
Dato:		Dato:		Dato:		

Table 4.12 Volume summary of the Nebbiolo prospect

These are the aggregated resources and risks at the time of the drop decision

Discovery/ Prospect/ Lead name	D/ P/ L	Unrisked recoverable resources						Probability of discovery	Part in acreage applied for %	Reservoir		Distance to infra-structure (km)
		Oil 10^6Sm^3			Gas 10^9Sm^3					Litho-/ Chrono-stratigraphic level	Reservoir depth (m MSL)	
		Low	Base	High	Low	Base	High					
Nebbiolo	P	1.00	4.21	12.10	1.32	5.88	18.00	0.56	100	Garn, Ile, Tofte and Tilje Fms/Mid-Early Jurassic	4640	33

5 Technical evaluations

A full project review was performed to assess the technical and economical aspects of the Nebbiolo prospect. The exploration plan consisted of one exploration well where in case of success, it will be performed a DST and than an appraisal well the year after. Since it is a HPHT, a 2 year planning phase is required.

Production forecast assumptions

The Nebbiolo prospect is a HPHT with > 400 bar overpressure expected and a temperature around 163° C. The drainage strategy will be natural depletion, with an estimated mean recovery factor of around 60%. With four formations stacked, it is assumed a commingled production although the majority of columns are allocated in the Tofte Formation. The production wells are highly deviated to ensure sufficient productivity. This is similar to the wells on Kristin. The analogue field is considered to be the HPHT Kristin field.

Field development solutions

A 4 slot subsea template (Fig. 5.1) would be installed with 6 production wells and a subsea tie-back to Kristin (approximately 33 km). Medium topside modifications at Kristin are assumed (500 MNOK). The condensate will than be offloaded to Åsgard C, while the gas will be transported via the Åsgard transport to Kårstø.

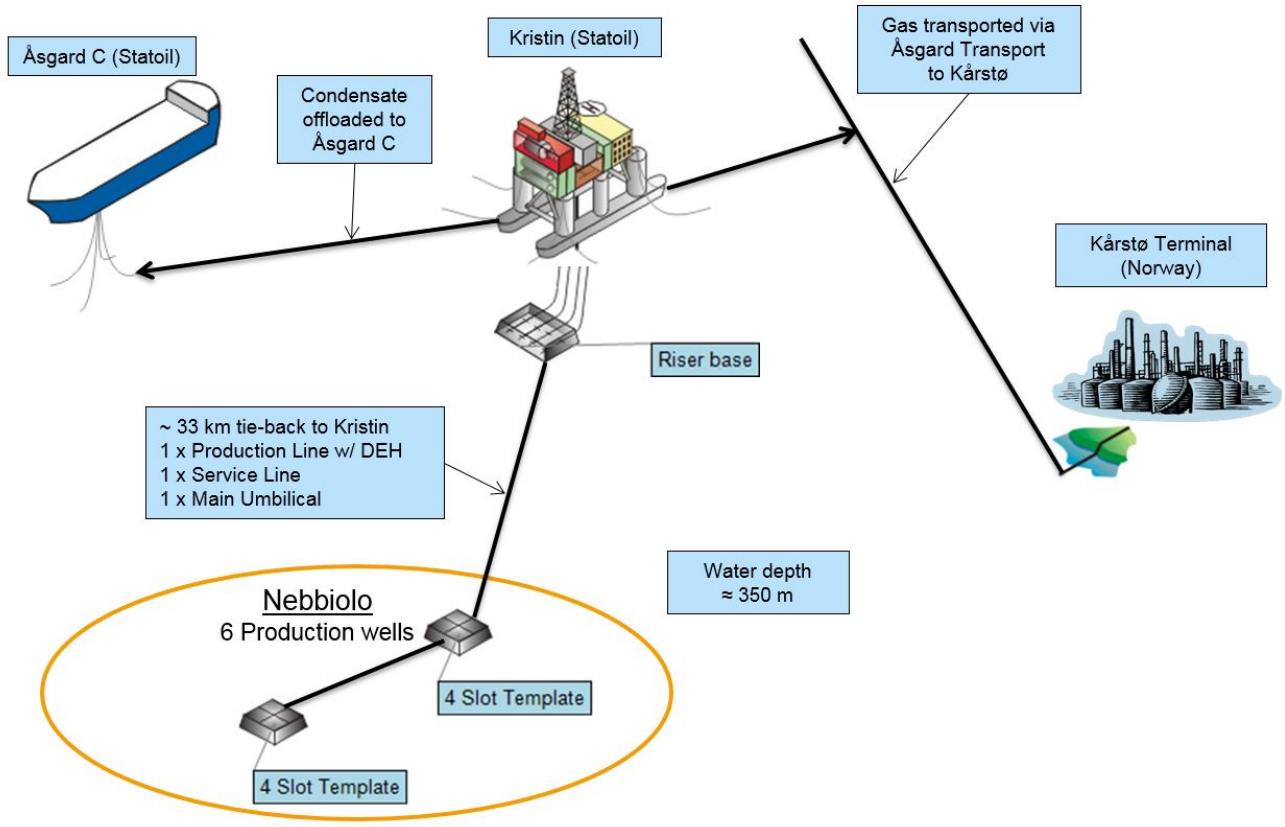


Fig. 5.1 Field development solution

The Nebbiolo will have 6 production wells and a subsea tie-back to Kristin

Estimated production start-up would have been in 2026, with a production life time of 13 years. At this stage in the technical review there were still many outstanding uncertainties, among those the most important being:

- Other potential tie-ins in the area may occupy the spare capacity of the Kristin field
- Capacity issues related to the Åsgard Transport area B is well known and is a risk for the project
- In the calculations, Kristin is assumed available for the entire economical field life of the Nebbiolo prospect, despite the design life for Kristin is 20 years (until 2025). This means there is a risk of increased CAPEX due to life extension of Kristin.
- There is also a risk of exceeding maximum CO_2 contents in Åsgard Transport
- In the calculations, it is assumed sufficient capacity in pipeline from Nebbiolo to Kristin (and in riser) to produce without any hold back.
- The tariffs are assumed for processing at Kristin (no Opex sharing)

Potential upsides to current technical evaluation

- Potential upside volumes in Hans Nord and Malvasia (currently not included)
- Tie-in Kristin subsea infrastructure (shorter flowline, no separate risers)
- Possible synergies with Ragnfrid, Lavrans, Erlend

There are many offset wells in the area of the Nebbiolo prospect. A HPHT classified well is required due to the expected pressure of 690 bar at wellhead and/or BHT > 150°C. As a base case there will be a vertical main bore with a conductor and three casing string design. An additional side track is assumed to establish GWC/resource volume(s). The sidetrack will have a maximum inclination of approximately 40° and will be used for coring of all hydrocarbon bearing sands (NPD requirement). An alternative case is to place the rig between the two targets and have a S-shaped well to both mainbore and sidetrack targets. For a dry hole case, 106 days are assumed in a base case scenario.

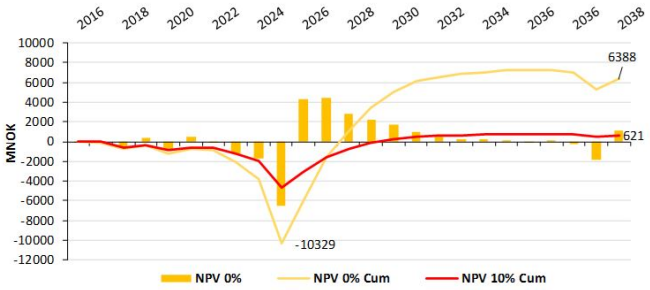
Health, safety and environment (HSE)

The HPHT conditions impose an additional risk to the drilling and development solution. There is also a high occurrence of corals in the area and a high probability of finding corals in PL 643. Aspects that have been identified that may cause increased costs and/or delays are limitations on available rigs for HPHT drilling, as well as prolonged duration of drilling operations as HPHT procedures must be imposed.

Economy

Premises for hydrocarbon prices and currency exchange rate were taken from WoodMackenzie for the untruncated mean oil volumes economics (Fig. 5.2). The economy summary table shows a positive net present value (NPV) with an internal rate of return (IRR) of 17 %. The oil (gas) break even price is estimated to $67,7 ($36,4 gas breakeven price).

PL 643 (100%) NPV date January 2016	Unconsolidated economics		Economic Illustrations
Basis for economic evaluation	**Gas**	**Oil (Condensate)**	**Cash-Flow, Base Case**
Price in USD / boe (real)	43,9	81,6	
NOK/USD	6,50		
Inflation p.a.	2,0 %		
Recoverable mean resources, MSm3 OE	8,64	5,80	
Key Cost figures / KPI's			
Total EPEX, MNOK (real 2016)	2669		
Total CAPEX, MNOK (real 2016)	8950		
Total OPEX, MNOK (real 2016)	9658		
Total D&A, MNOK (real 2016)	1858		
CAPEX/boe, USD	13,4		
OPEX (incl. Tariffs)/boe, USD	14,4		
D&A/boe, USD	2,8		
Key Performance Indicators			**Sensitivities on NPV (MNOK)**
Internal Rate of Return (IRR)	13,5 %		
NPV MNOK (10% nominal)	621		
EMV MNOK (10% nominal)	81		
Break-Even-Price oil (gas) (USD/boe)	67,7 (36,4)		
Profitability - Index (P/I)	0,14		
Maximum exposure, MNOK (nom)	-10329		
Payback year of investments and expenditures	2028		



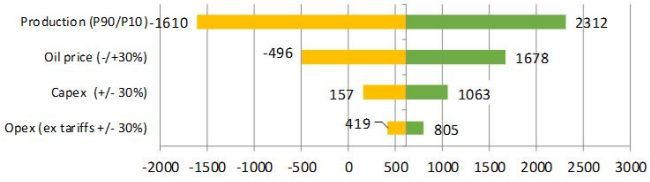


Fig. 5.2 Economic summary

Economic evaluation of the Nebbiolo prospect using mean untruncated oil volumes.

6 Conclusions

The PL 643 licence is located in a favourable position within proven plays and close to existing infrastructure. The Nebbiolo prospect consists of stacked reservoir of the Garn-, Ile-, Tilje- and the Tofte Formations. The license work program has significantly improved the understanding of the leads and prospects thorough internal and external studies. One way of succeeding in the area would be to look at combined development solutions of similar prospect/discoveries, but many of the surrounding discoveries are too small to be a tie-in candidate to Nebbiolo. Any new wells in the area in a similar setting would be helpful to further de-risk the Nebbiolo prospect, but the main risk of vertical leakage along faults remains.

Nebbiolo is a relatively large gas-condensate prospect located only 33 km from the Kristin Field. However, the high cost and long planning time to drill and develop the high pressure and high temperature prospect, with only marginal positive economics, is not a priority for the partnership in today's challenging market. A unanimous decision was taken in the partnership to relinquish the licence.

7 References

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