Pilot requirements to subsea gas compression

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Pilot requirements

- Ormen Lange and Snøhvit are the fields that have interest in subsea compression on Norwegian Continental Shelf, at least in a long timeframe (more than 15 years) , possibly in a short timeframe (less than 10 years)
- Ideally a pilot of subsea compression should satisfy requirements for both

Field characteristics

	Ormen Lange	Snøhvit
waterdepth at field (m)	890 – 1100	350
step out for power (km)	120	140* 34 km to Askeladd
reservoirs	1	3: Snøhvit Albatross, Askeladd
recoverable reserves**	375.3 Gsm3 gas 22.1 Msm3 condensate	151 GSm3 gas 5.1 Mton NGL 17.9 Msm3 cond
metocean	wind, waves	wind, waves, ice

*shortest distance available for power to pipeline to shore inlet

**Facta 2003, Olje og energi departementet

Development & timing

	Ormen Lange	Snøhvit
development concept	subsea to land, onshore gas processing, gas export pipeline to UK	subsea to land, onshore LNG plant, CO2 reinjection
multiphase pipeline to shore	2x30 inch	1x28 inch
first gas	2007	2006
offshore compression timing	2016**	2013 – phase 1* 2021 – phase 2**
offshore compression alternatives	- floater with topside compression - subsea compression	-floater with topside compression - subsea compression
main value subsea compression	reduced CAPEX, phased CAPEX	delay development of Askeladd 4 years

*compression base case assumption onshore – subsea compression is alternative

**compression base case assumption offshore, topside – subsea is alternative

Subsea compression design basis

	Ormen Lange	Snøhvit
plateau production with max subsea compression	60 Msm3/d at 75 bara onshore arrival pressure	20 Msm3/d at 75 bara onshore arrival pressure
end plateau with compression		
suction, discharge pressure	80, 140 bara	60, 125 bara
differential, pressure ratio	60 bar, 1.75	65 bar, 2.08
design pressure compression system	about 200 bara	about 210 bara
required power	25+ MW (2016) 50+ MW (2020)	some 10 MW (2013)* some 34 MW (2021)
required production availability from total development	about 97.5%	99.9% (LNG plant)

* compression base case assumption onshore – subsea compression is alternative

Subsea compression design basis

	Ormen Lange	Snøhvit
CO2	0.25%	5 – 7 %
H2S	trace	trace
sand	need sandhandling	need sandhandling
Gas condensate ratio Sm3/sm3	appr 65000	appr 6600 – 14000
Gas volume fraction and gas mass fraction at compression suction conditions *	GVF 0.98 GMF 0.93	GVF 0.93, 0.96, 0.97** GMF 0.88, 0.94, 0.95**
slug flowing back on shutdown	significant	moderate
seabed temperature	-1 C	+2 C

*Assuming suction pressure end of plateau and 25C suction temperature – these numbers drop to lower values after end plateau

**For Snøhvit, Albatross and Askeladd, respectively.

Subsea compression considerations

	Ormen Lange***	Snøhvit**
Subsea power system HVAC technically feasible	probably – technology gap	possibly– technology gap
Subsea power system HVDC technically feasible	possibly – major technology gap	possibly – major technology gap
HVAC power system on buoy* technically feasible	possibly – fatigue on cable technology gap	possibly – fatigue on cable technology gap
HVDC power system on buoy* technically feasible	possibly – fatigue on cable technology gap	possibly – fatigue on cable technology gap
Compressor unit size	8-13 MW	5 MW initially (2013) 8-13 MW (2021)

*No hydrocarbons topside, no manning facilities topside

** For buoy concept no subsea power distribution needed, except perhaps for Askeladd

***Preferred power distribution concept for OL is subsea HVAC, for Snøhvit to be determined

Partners

Ormen Lange (not unitized yet)	Snøhvit
Petoro	Petoro – 30.00%
Norsk Hydro**	Statoil* – 22.29%
Norske Shell***	TotalFinaElf – 18.4%
Statoil	Gas de France – 12.00%
BP	Norsk Hydro – 10.00%
Esso Norge	Amarada Hess – 3.26%
	RWE-DEA - 2.81%
	Svenska Petroleum - 1.24%

*Operator

**Operator development phase

***Operator production phase