

Subsea Compression – Now and the Future

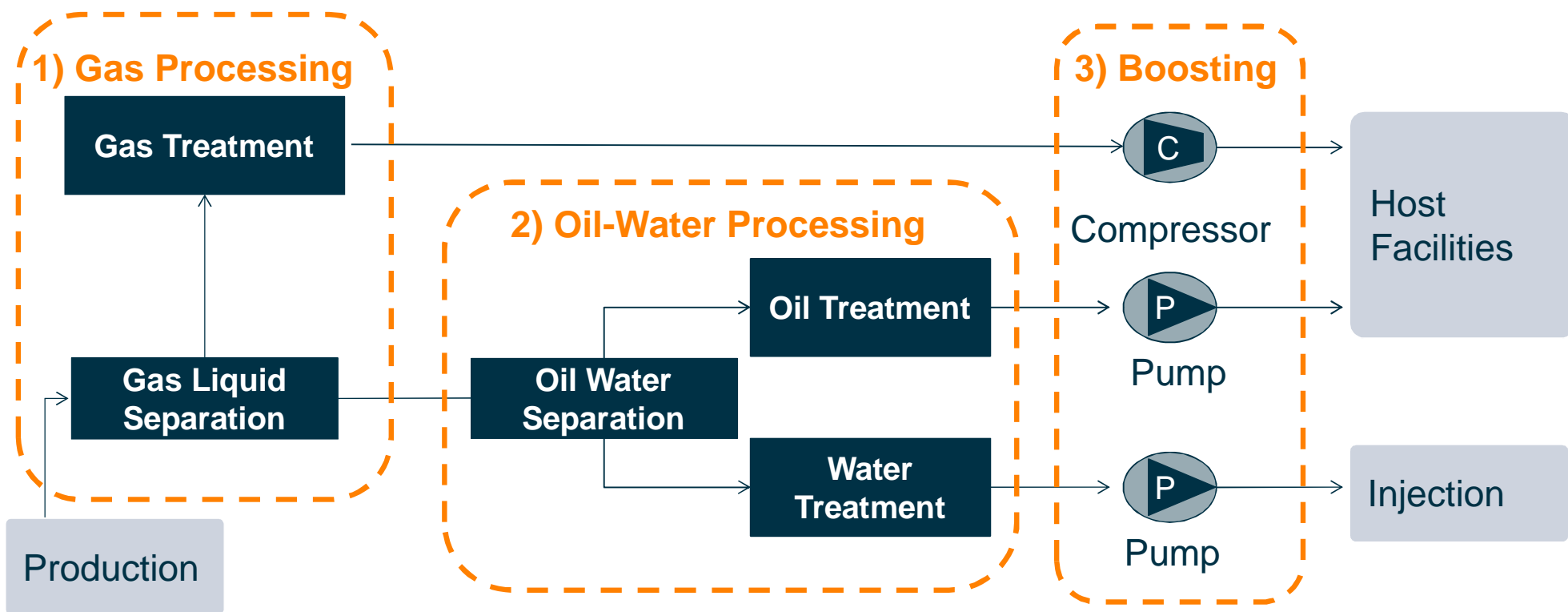
Perth, 12th April 2017

Si Huai Yeaw, Senior Process Engineer



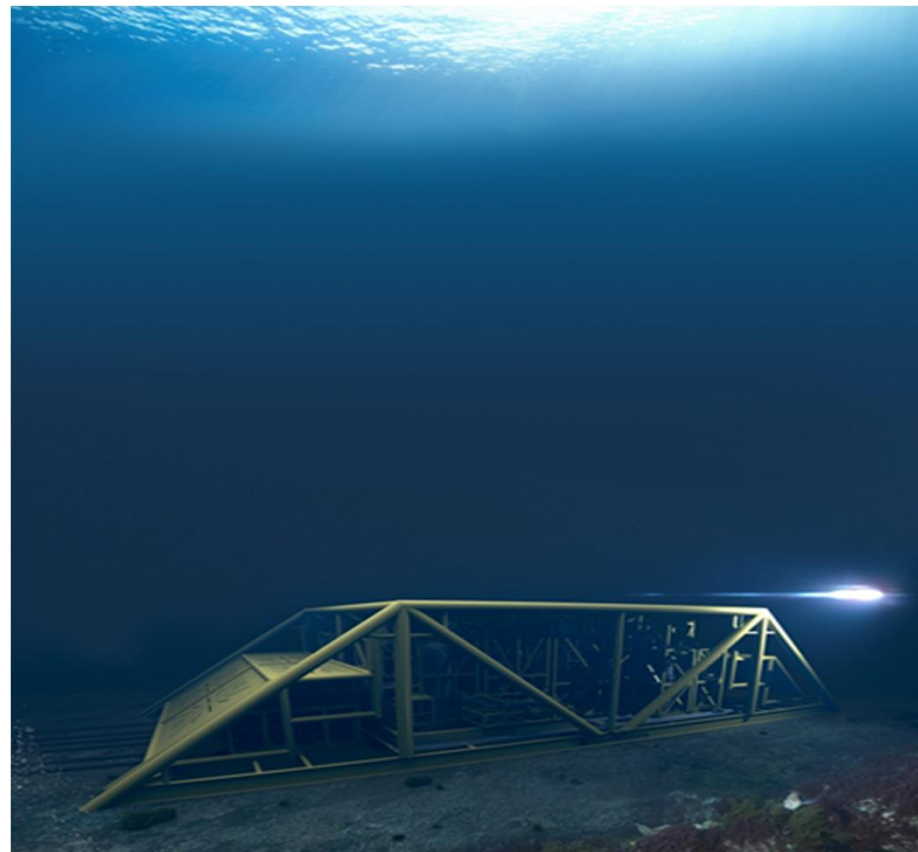
Advanced Subsea Production

Typical Subsea Process Block Diagram - Building Blocks

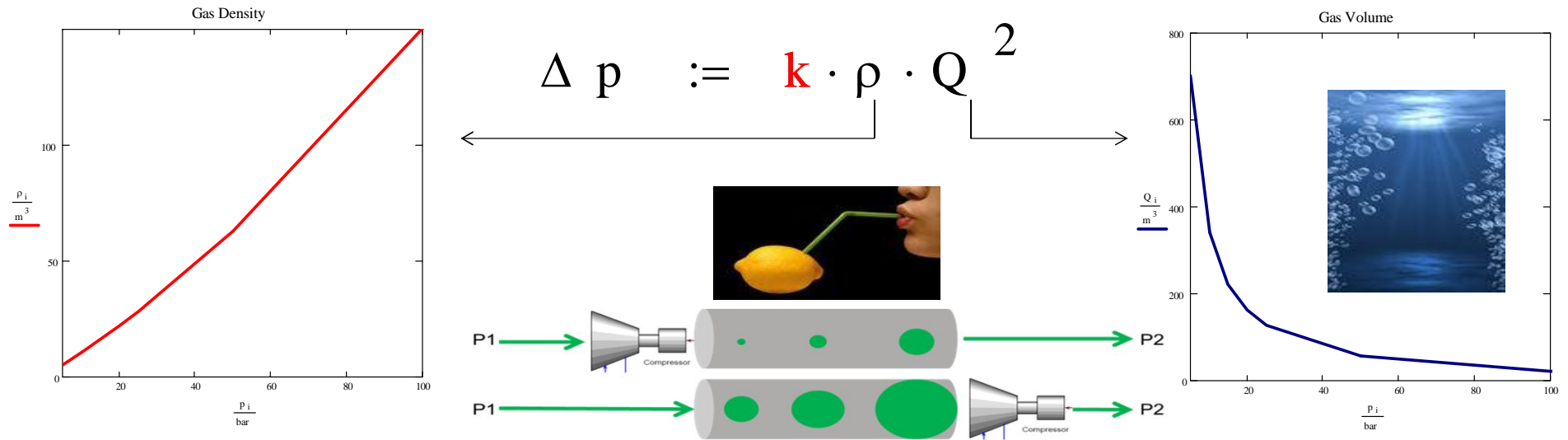


Subsea Gas Compression: Drivers

- Gas fields require boosting of the reservoir flow as reservoir pressure depletes
- Subsea gas compression replaces the need for an offshore platform or onshore compression facility
 - Cost-effective development solution (CAPEX)
 - Reduced operational costs (OPEX)
- HSE advantage due to unmanned operation
- Advantageous to place the compressor close to the well
 - Increased and accelerated production
 - Reducing CO₂ emissions through lower energy consumption
 - No emissions or disposals to sea



Subsea Compression Adds Recovery - Principle

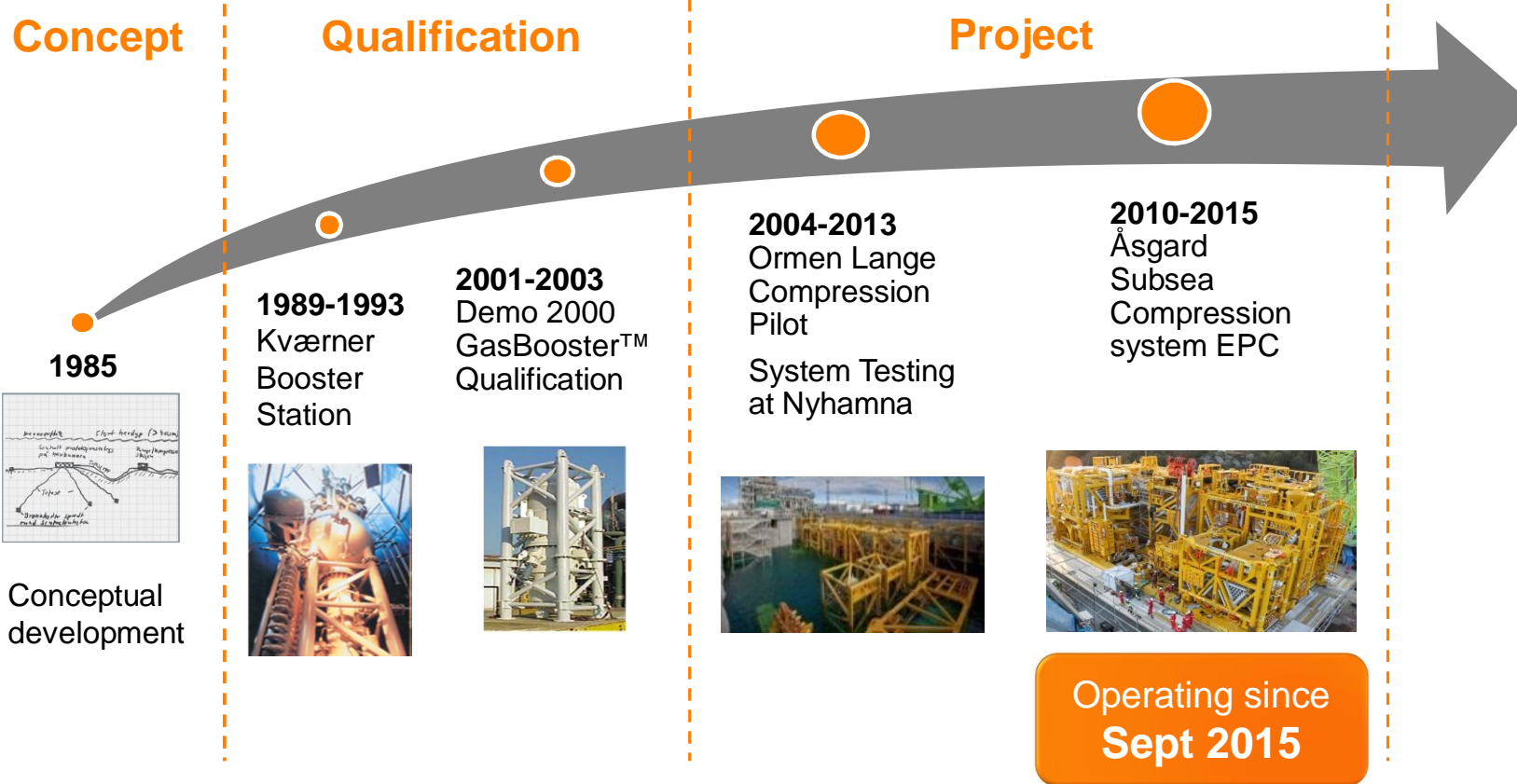


- Pressure drop in the flowline / riser depend on the density and the square of the volume
- Placing the compressor upstream the flowline/riser will give the lowest wellhead pressure

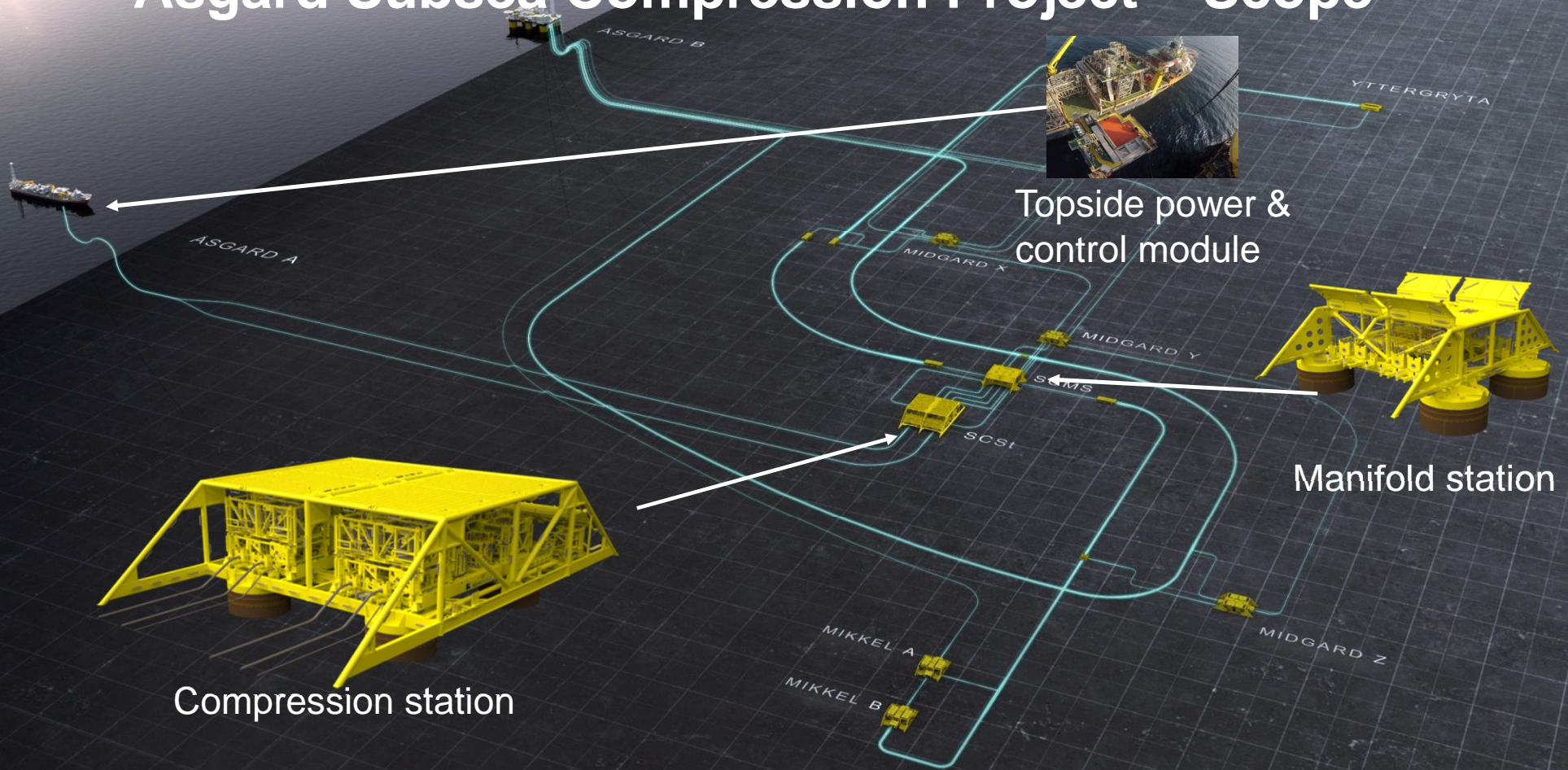


Åsgard Subsea Compression Project

Subsea Compression Development Timeline



Åsgard Subsea Compression Project – Scope



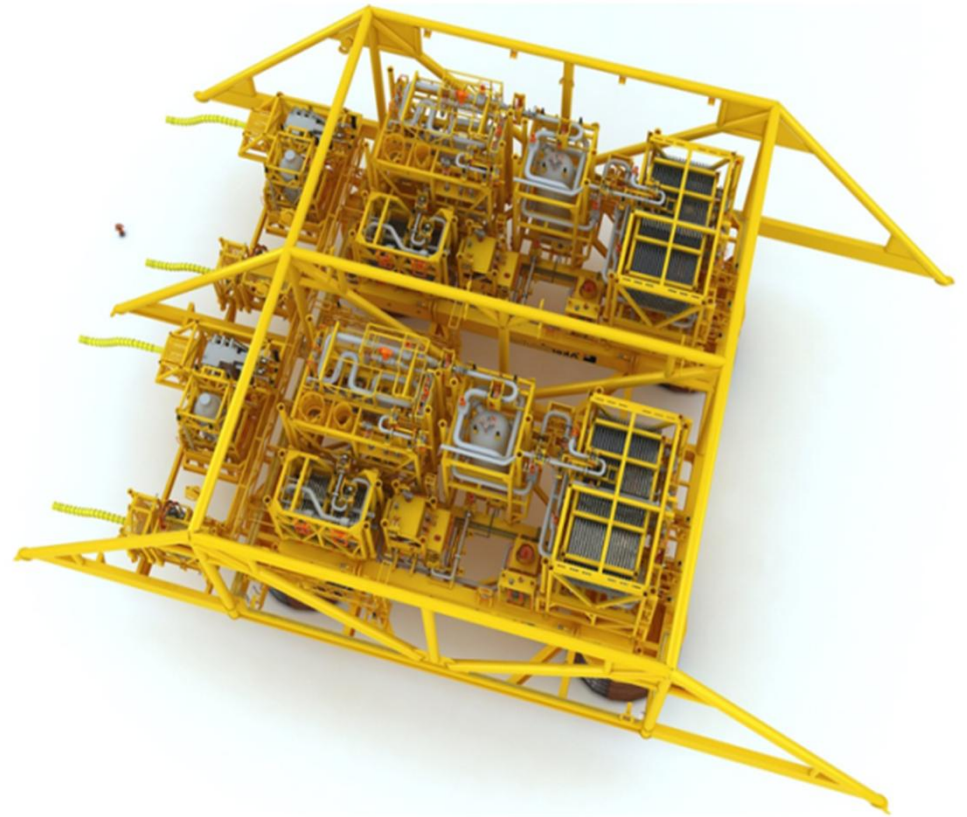
Åsgard Subsea Compression Project – Details

Project details

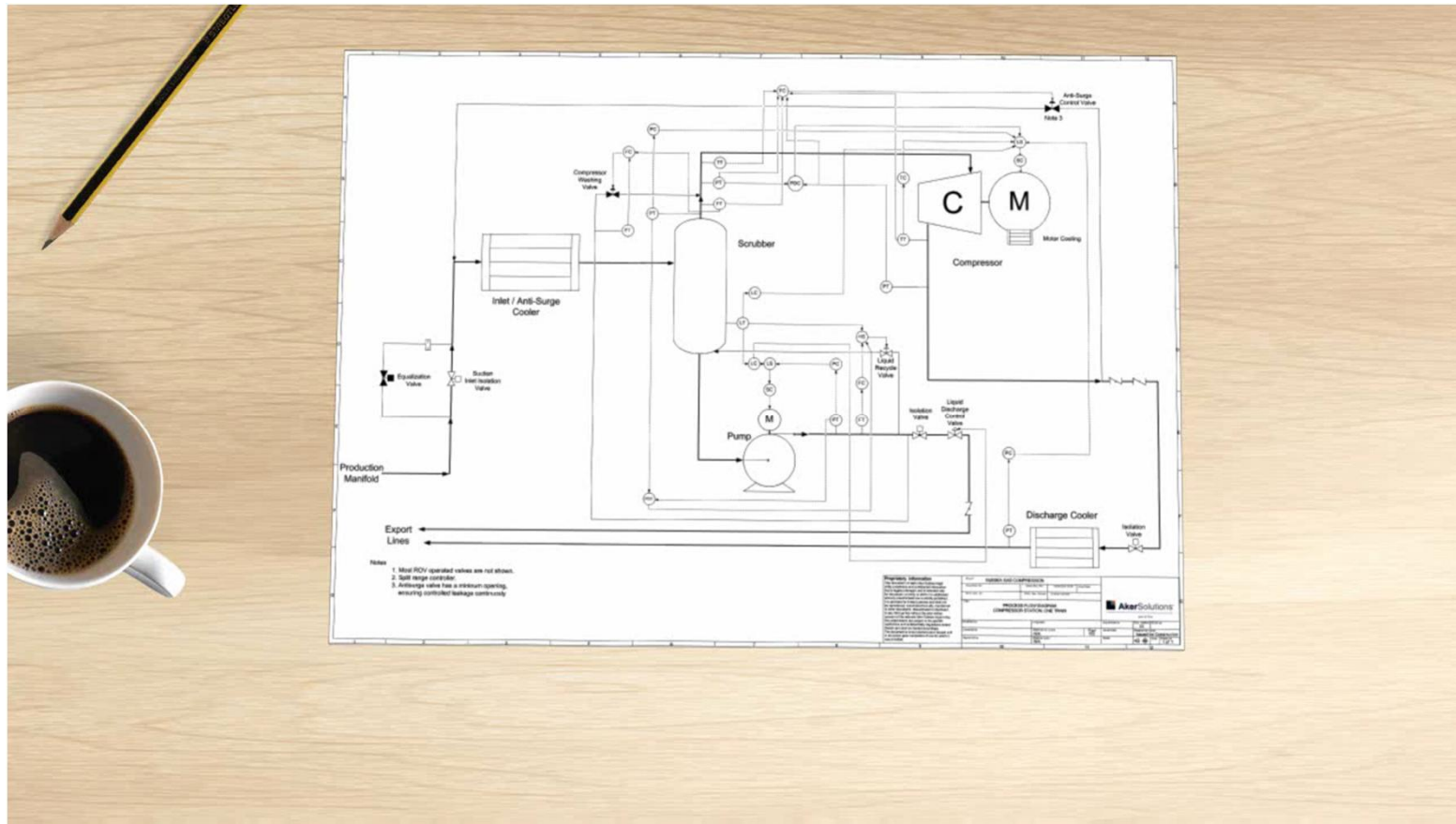
- Water depth: 260 m
- Tie-back distance: 40 km
- Flow rate: 21 MSm³/d
- Power: 2 x 11.5 MW
- Shut in pressure: 220 bar
- IOR: **306 million** barrels of oil equivalent

Project schedule

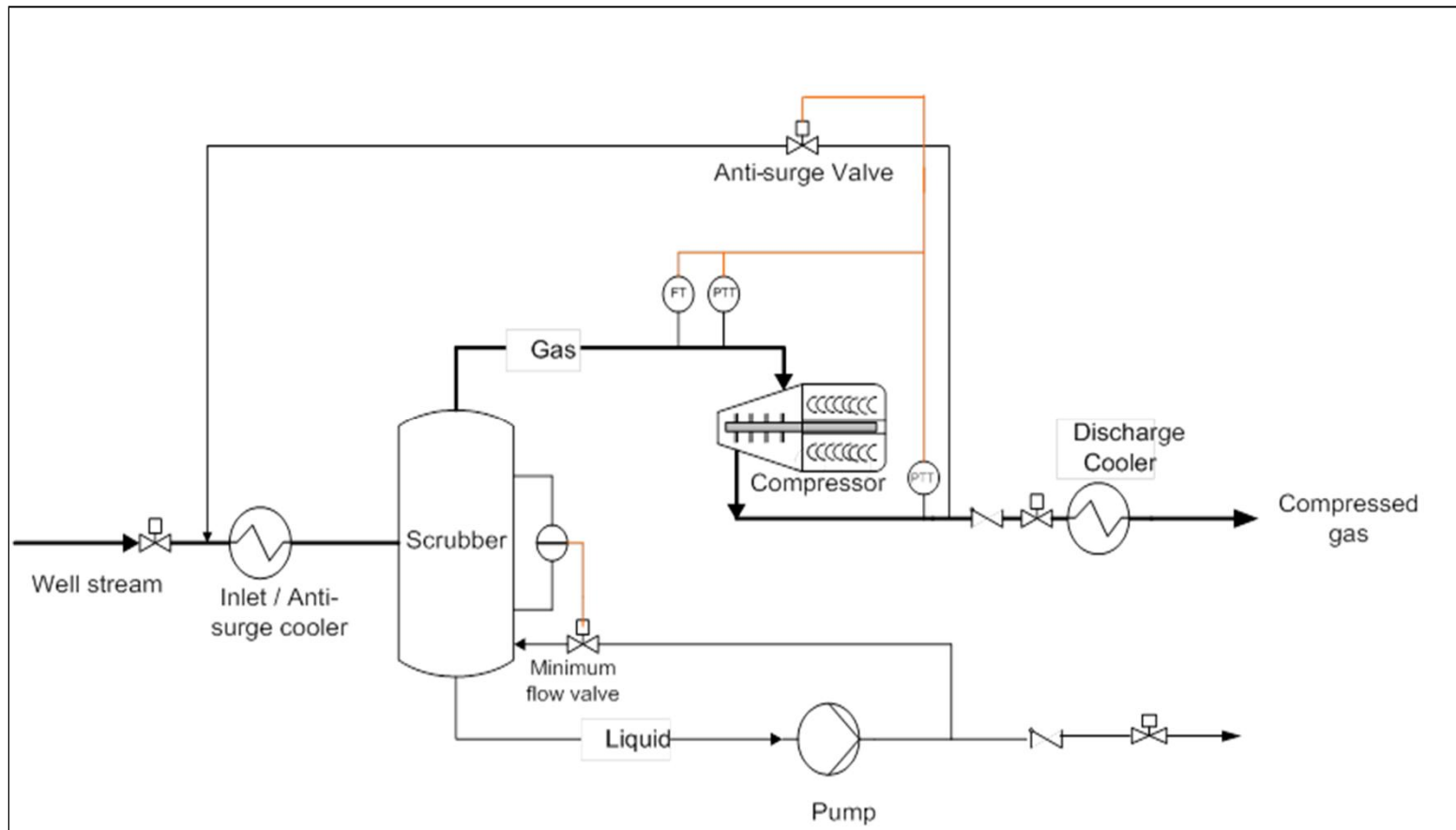
- 2006 - 2010: studies, Pre-FEED, FEED
- 2010: EPC contract (1st December)
- 2013: Fabrication
- 2014: SIT and FUT
- 2015: Delivery and Start-up (17th of September)



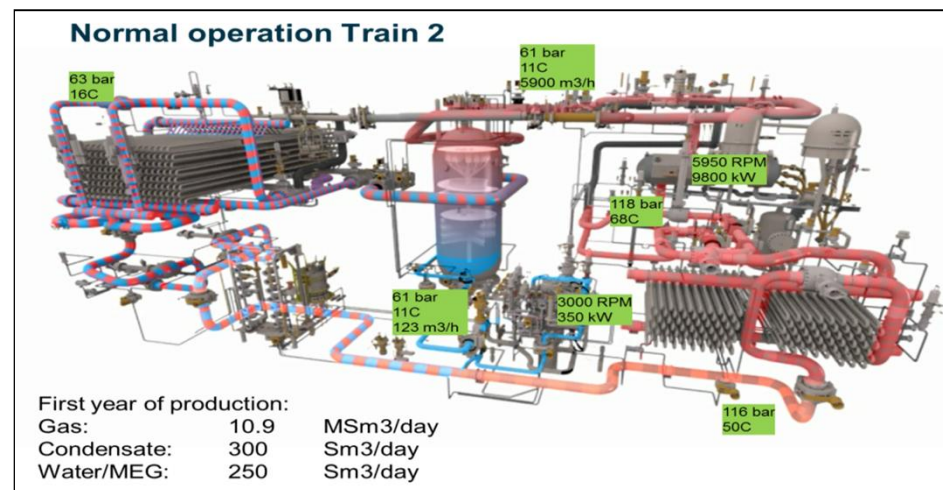
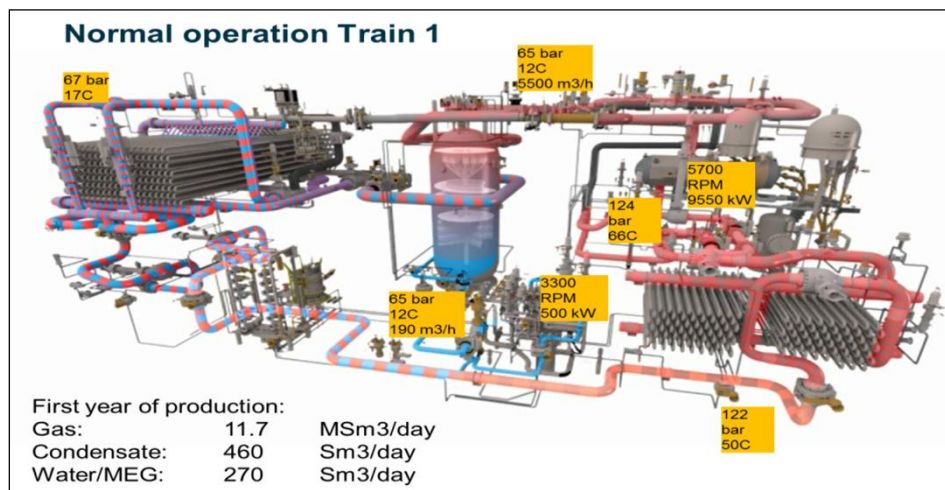
Åsgard Subsea Compression Project – Process System



Åsgard Subsea Compression Project – PFD



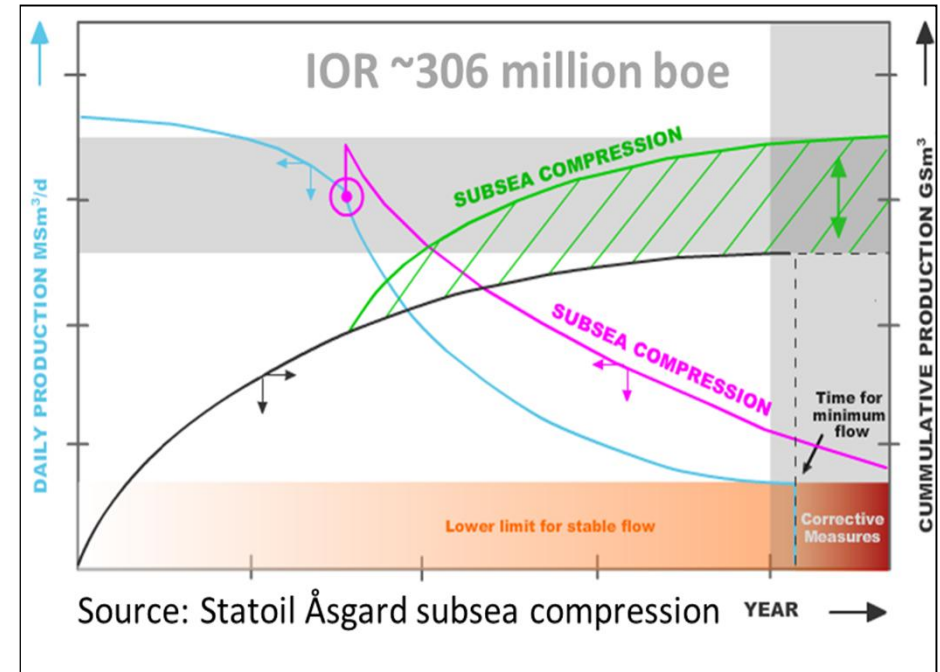
Excellent Operational Performance

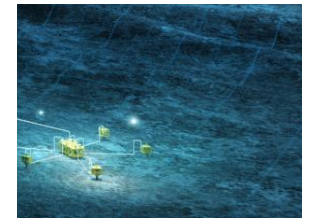
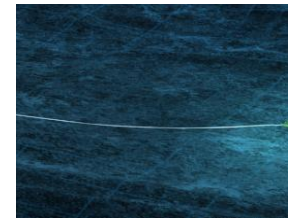
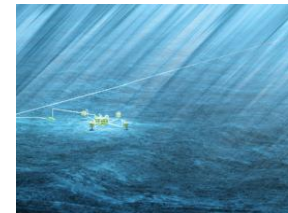
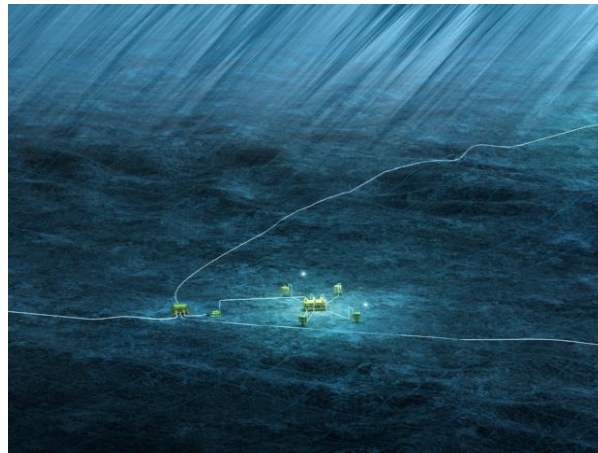
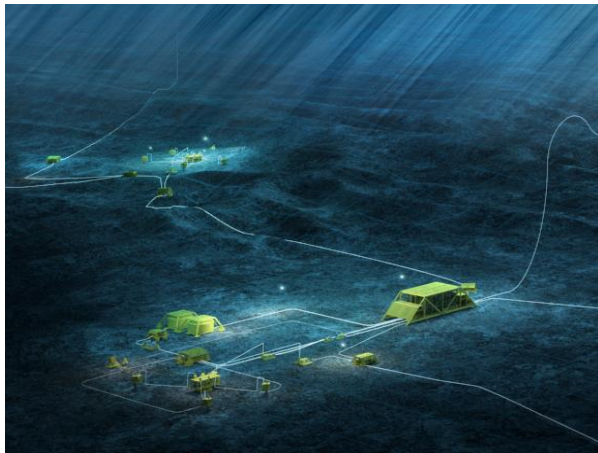


- Accumulated running hours: 12,000 (T1) + 8,800 (T2) = 20,800 in total
- Producing more condensate than expected
- Very low vibrations
- No trips / shutdown caused by the subsea compression system
- 100% availability for the subsea system (Statoil quote "the system has been running like a Swiss clock with practically no stops or interruptions")

Åsgard Subsea Compression Project – Recovery Details

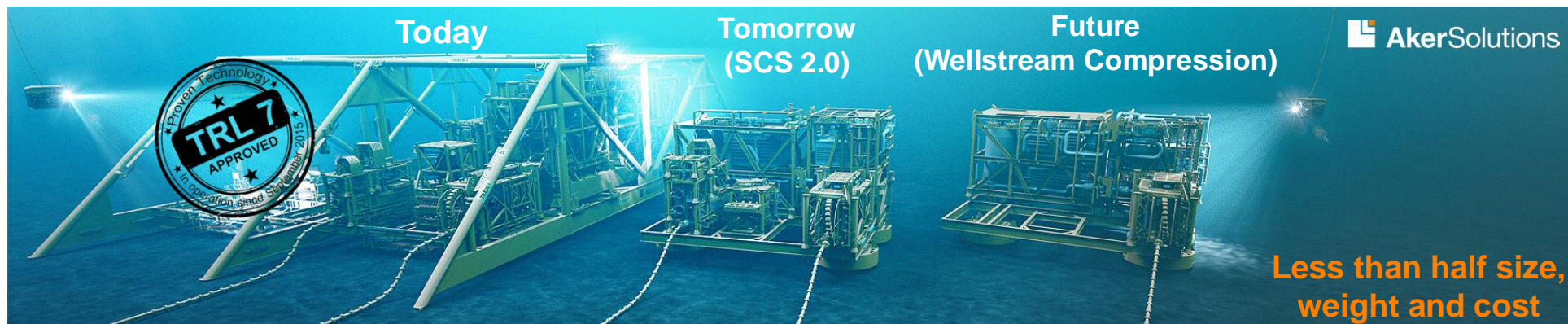
- Increased recovery of 306 Mmboe through the life of field
- Field life extended up to 2032
- Recovery rate from the Midgard and Mikkel reservoirs has been raised from 67% to 87% and from 59% to 84% respectively
- During the first year of operation the production has been raised by an excess of 16 million boe, equivalent to more than 5 billion NOK today's price market (around to 600 MUSD, with a conversion rate of 0.12)





Next Generation – Subsea Compression System

Subsea Compression – Now and the Future



Today (Asgard Copy)

- Asgard-like SSC
- 13 subsea modules
- Similar modularisation and layout philosophy
- Over-trawlable structure
- Proven technology & setup

Tomorrow (SCS 2.0)

- Optimisation with Asgard technology, core components & functionality
- Up to 50% reduction in total size and weight
- 13 → 7 module subsea
- Lighter compressor module
- Able to be fitted in to a 4-slot subsea template

Future (Wellstream Comp.)

- Further optimisation of the SCS 2.0 system
- Utilises liquid tolerance properties of MAN HOFIM compressor
- Eliminate the need of scrubber and pump
- Able to handle up to 30wt% liquid (95% GVF)

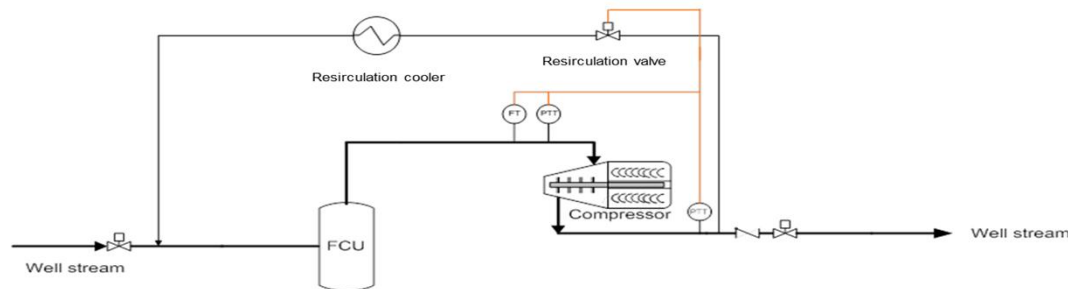
Subsea Well Stream Compression (WSC) System Vision

- A robust, high capacity compression system that can handle wellstream conditions without scrubber and pump
- Design and operation philosophy
 - Liquid tolerant compressor handles normal liquid production
 - System design w/FCU handle upset conditions and transients



Control and automation

- Monitoring and control system designed to handle normal and upset conditions



Flow conditioning unit

- Smoothen GVF variations
- Slug accommodation
- Important to handle upsets

Compressor

- Handle continuous liquid load in wellstream
- Long term tested up to 30% LMF / 5% GVF
- Even distribution of flow at suction



Thank You / Questions



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