Technology for Ormen Lange Phase 3

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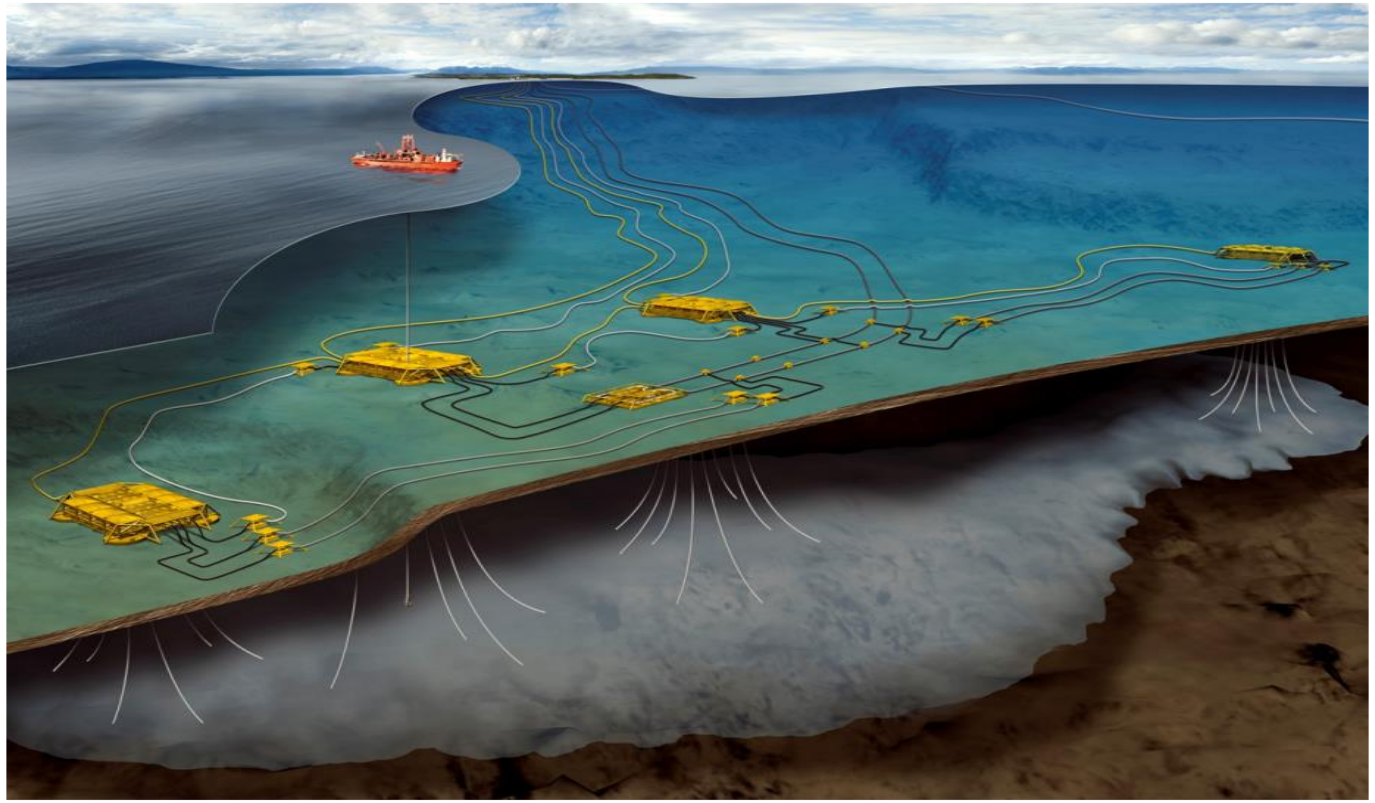
1992: PhD, NTNU, Dept. of Engineering Cybernetics.

1993 - 2014: Oceaneering, Hitec, Poseidon, Siemens

2014 - 2017: Norske Shell - Team Lead for Subsea Controls & Umbilicals.

2017 - now: Norske Shell – Technology Qualification Lead Ormen Lange Phase 3

Presentation Content



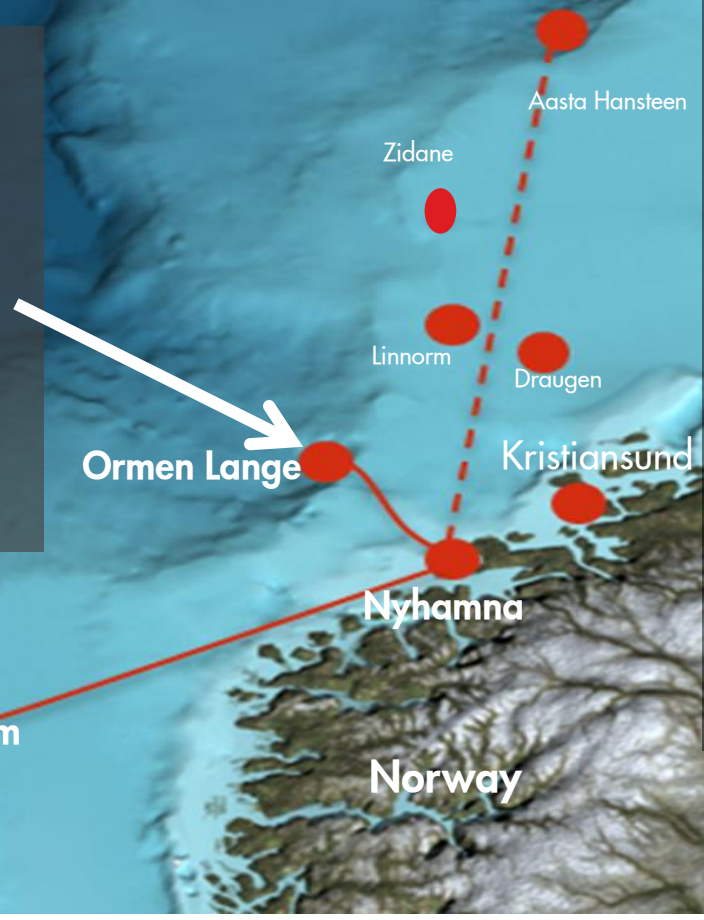
Ormen Lange Phase 3 is a project investigating concepts for increasing total production from the Ormen Lange gas field.

All concepts are based on an offshore compression facility installed along the two 30" pipelines from the Ormen Lange field to Nyhamna, ***either floating or subsea***

This presentation will describe key concepts and technologies evaluated for the project.

What is Ormen Lange Phase 3?

- Ormen Lange is a Mature asset; 19 producing wells w/ declining production
- 120km subsea to beach development, ~1000m water depth, 2*30' flowlines w/ wet gas from 4 templates
- High performing asset, 98.8% reliability



- Ormen Lange Infield Compression (OLIC) stopped in 2014 due to high costs

- **<u>Ormen Lange Phase 3 started to</u>**
  - Make most out of existing infrastructure
  - Reduce/simplify scope
  - Leverage technologies
  - Learn from others

Offshore Compression – Extend Technology in Use and Simplify

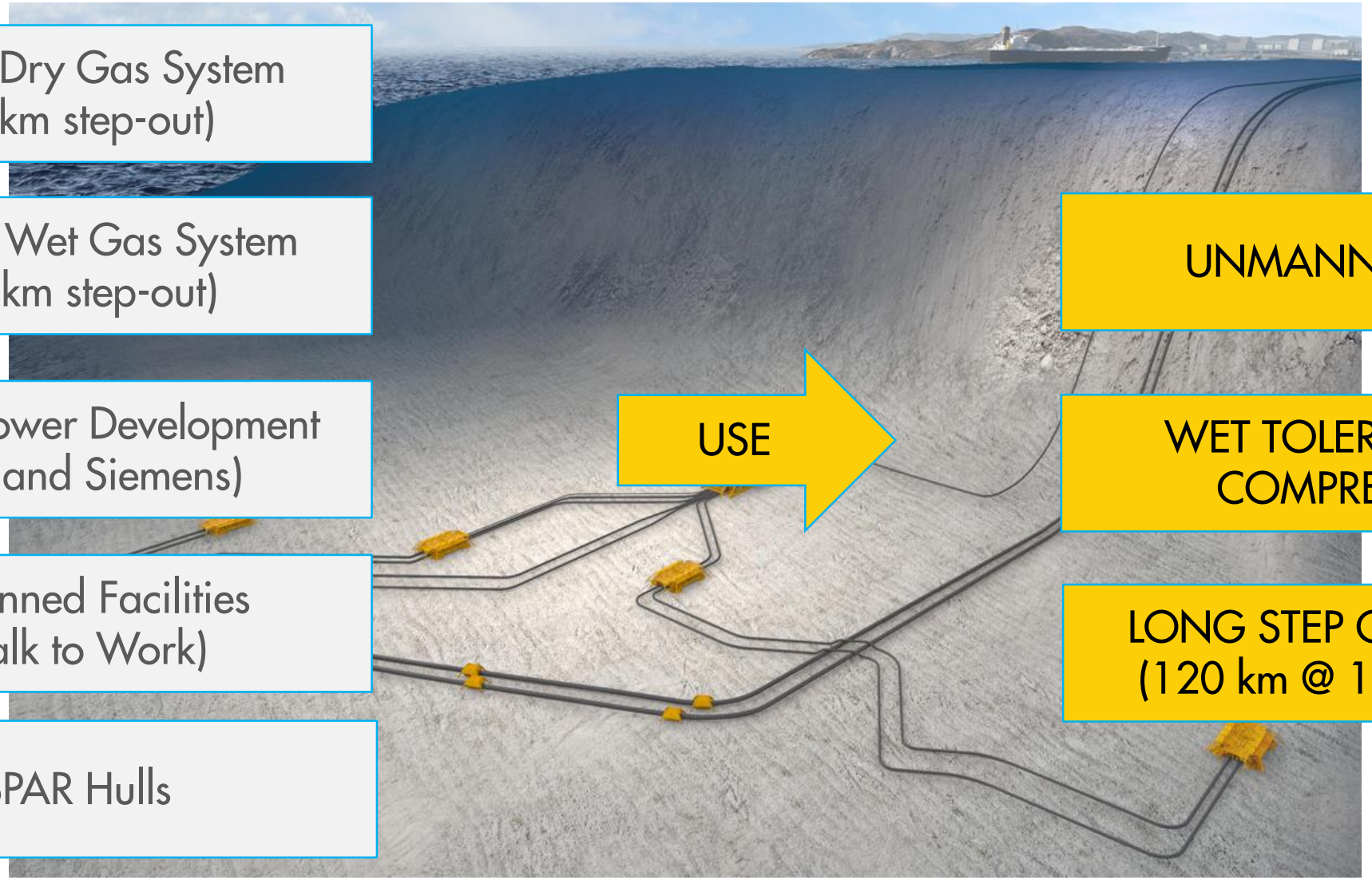
Åsgard Dry Gas System
(40 km step-out)

Gullfaks Wet Gas System
(15 km step-out)

Subsea Power Development
(ABB and Siemens)

Unmanned Facilities
(Walk to Work)

SPAR Hulls



USE

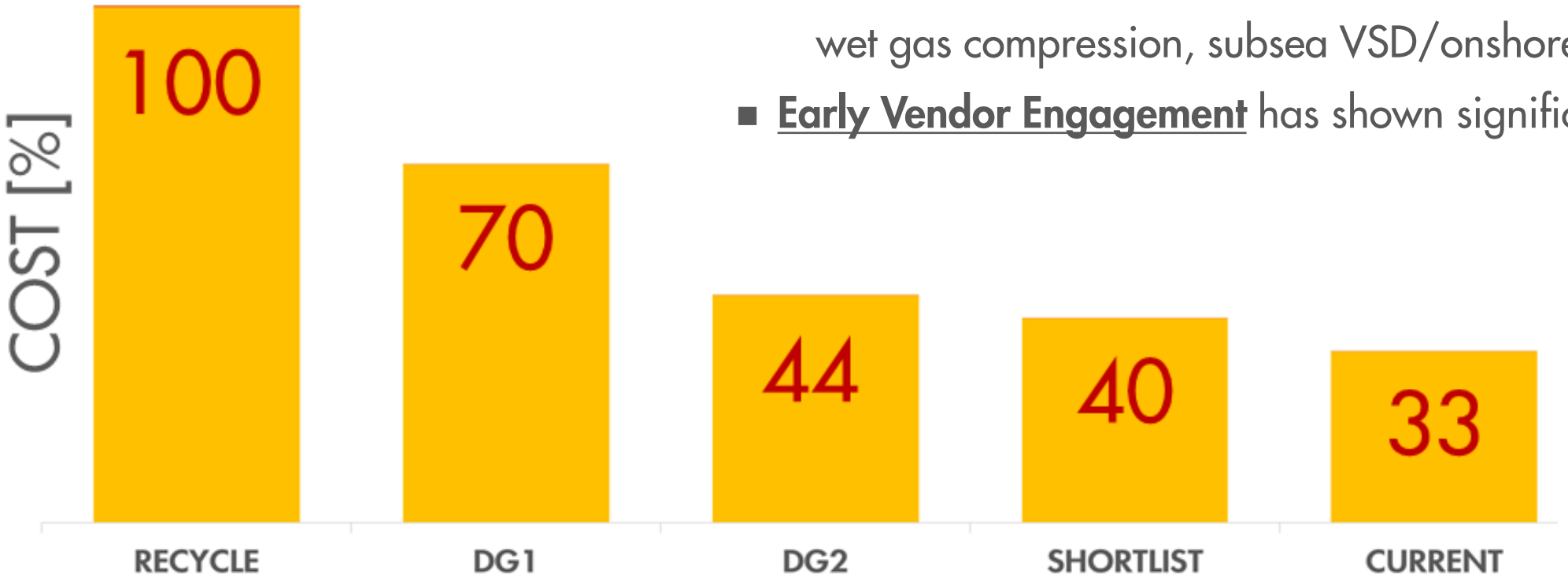
UNMANNED SPAR

WET TOLERANT GAS COMPRESSION

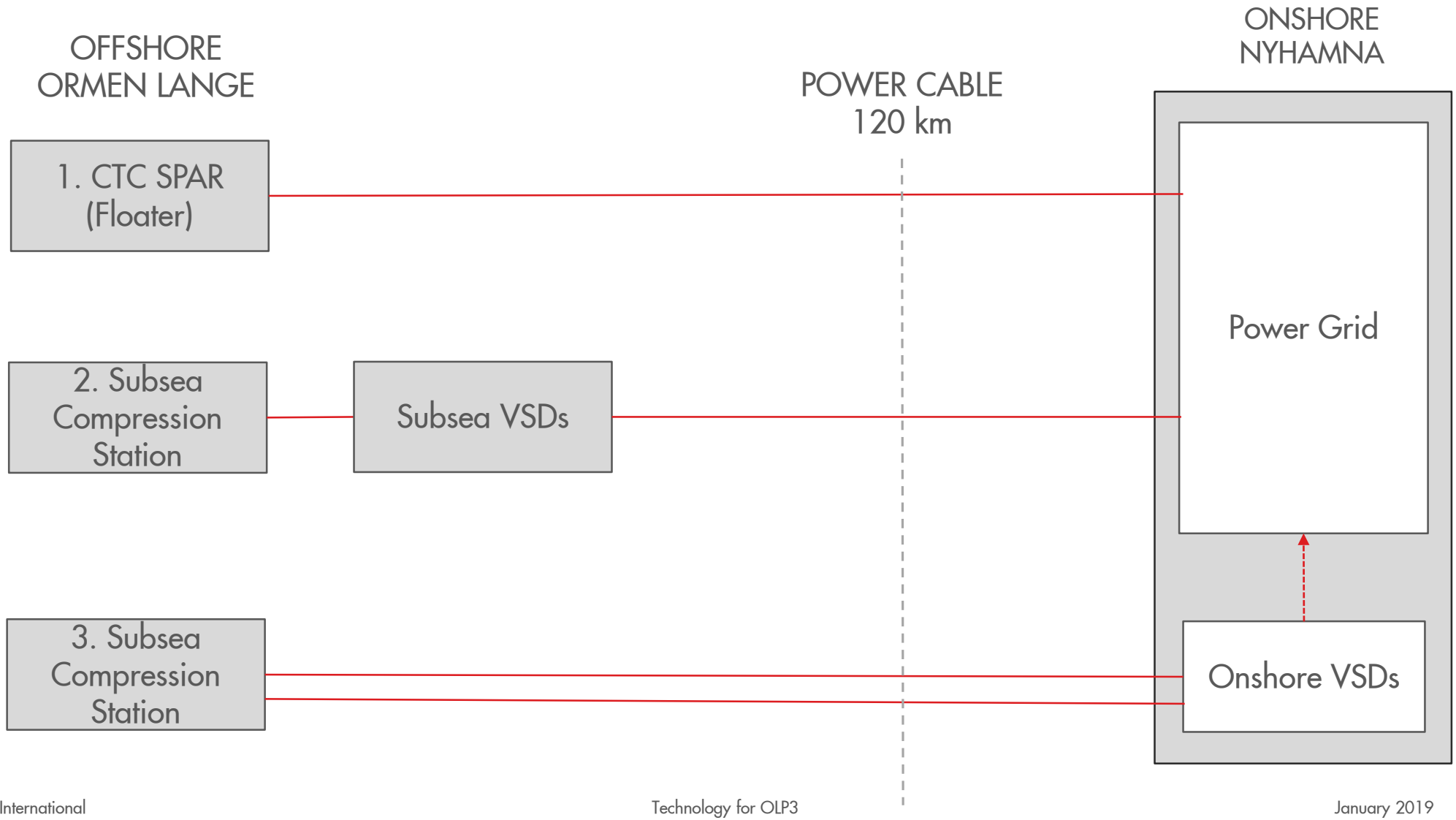
LONG STEP OUT POWER
(120 km @ 1000 meters)

OLIC to OL Phase 3

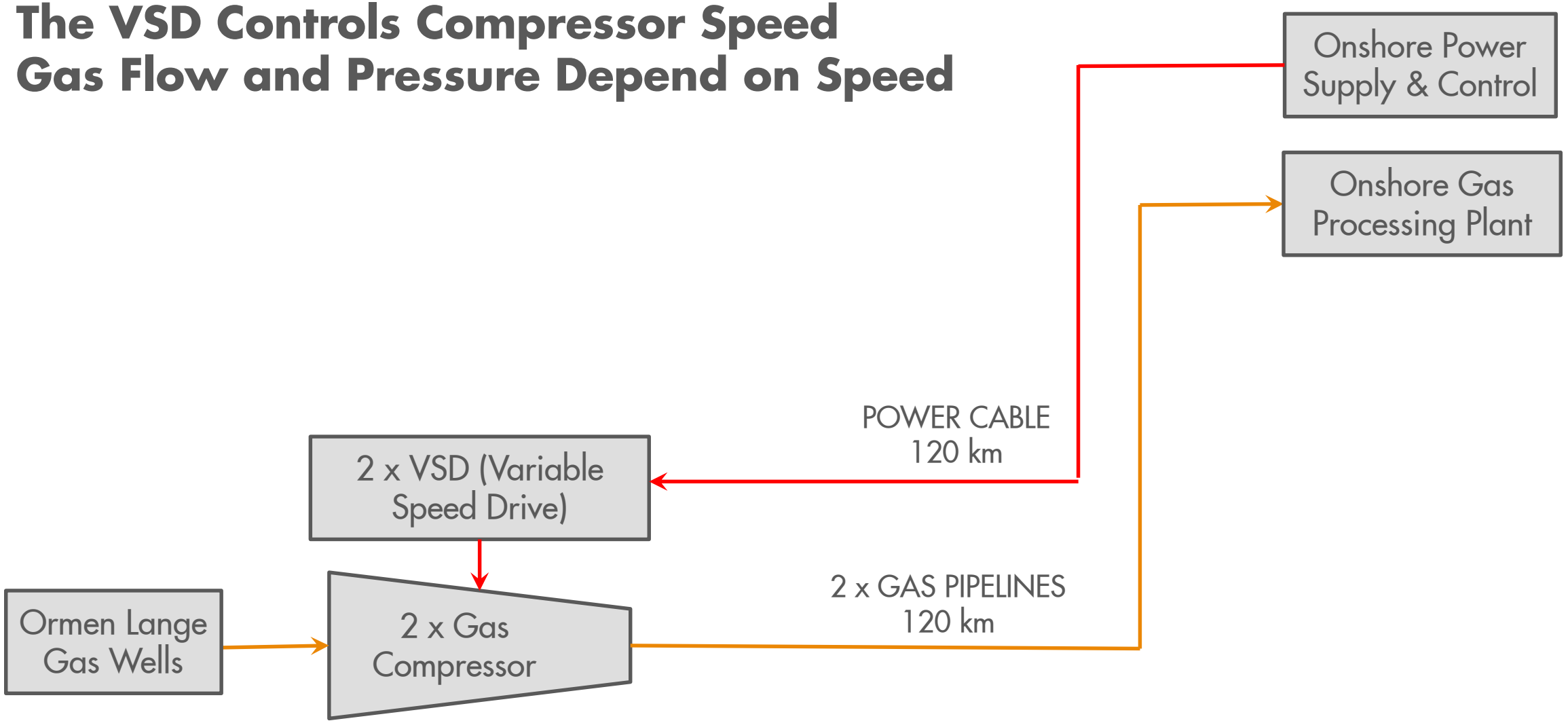
- **Key Developments;**
  - **Cost** reduced by more than 60% since 2014
  - **Volumes** increased due to subsurface and flow assurance
  - **Cost effective solutions** and technologies, such as
    - Eliminate new infield flowline system, unmanned platform, wet gas compression, subsea VSD/onshore VSD,
  - **Early Vendor Engagement** has shown significant value



Offshore Compression – Shortlisted Concepts

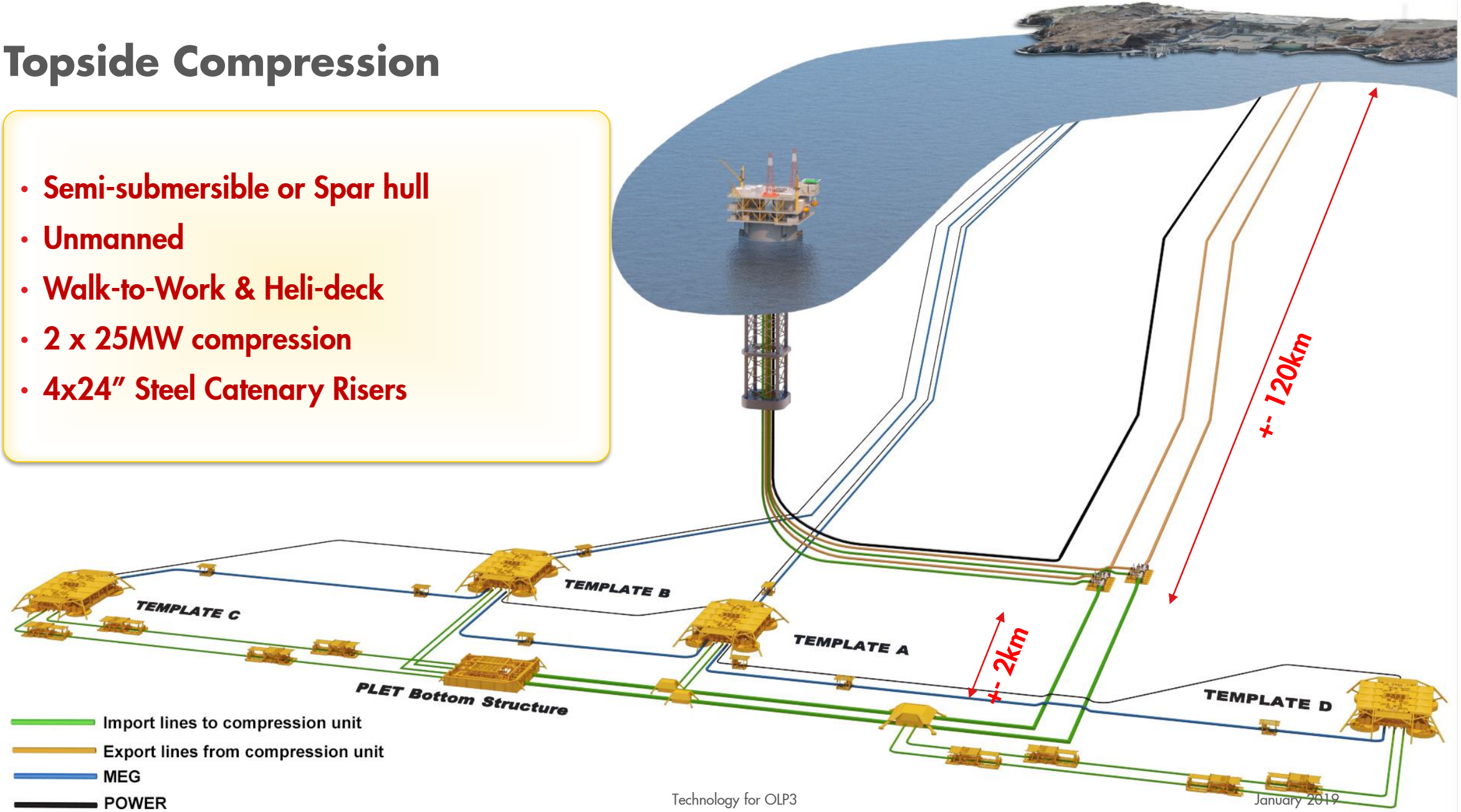


VSD for Dummies:
- The VSD Controls Compressor Speed
- Gas Flow and Pressure Depend on Speed



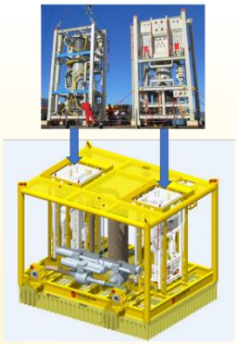
Topside Compression

- Semi-submersible or Spar hull
- Unmanned
- Walk-to-Work & Heli-deck
- 2 x 25MW compression
- 4x24" Steel Catenary Risers



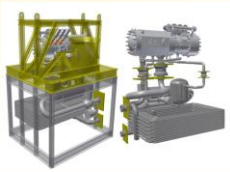
Subsea Compression

- Subsea Wet Gas Compression



- Subsea Dry Gas Compression

- Wet Tolerant Compressor



POWER SYSTEM:

- Power Buoy with Dry VSDs
- 4/6 x Subsea VSDs
- Onshore Dry VSDs

TEMPLATE C
TEMPLATE B
TEMPLATE A
TEMPLATE D
TRAIN 1
TRAIN 2
PLET Bottom Structure

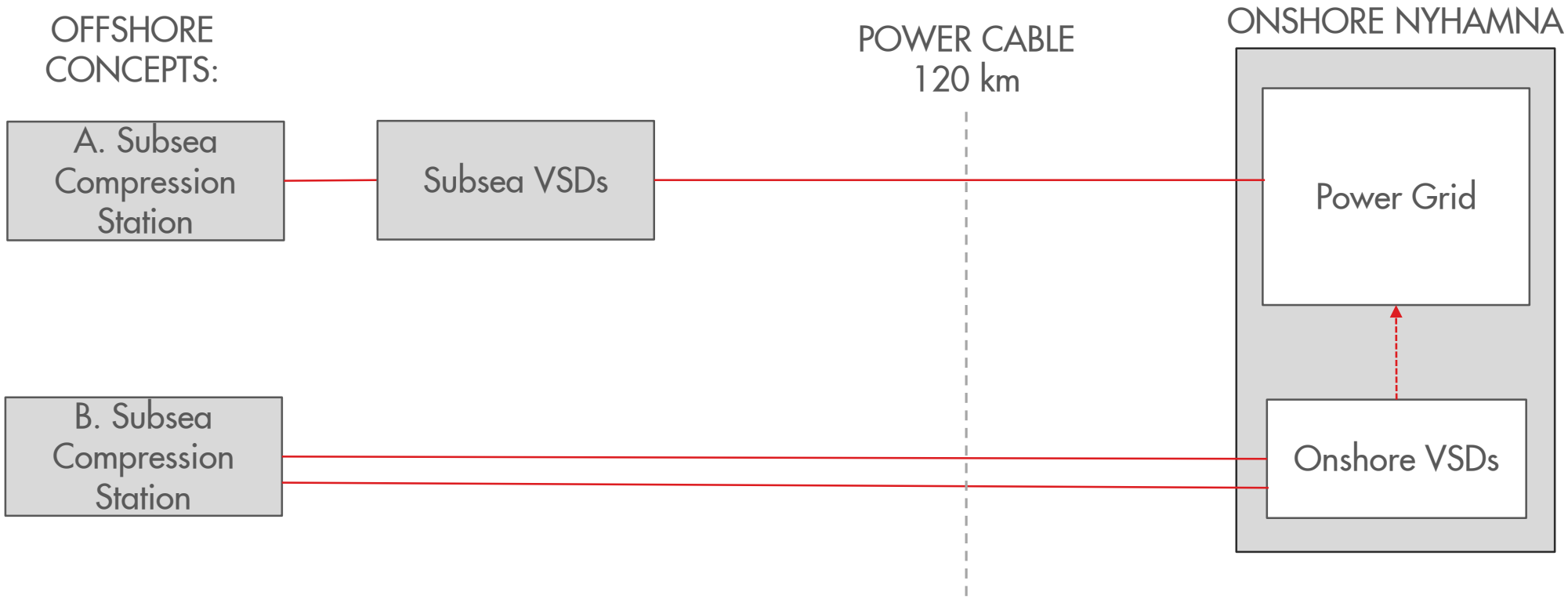
Import lines to compression unit
Export lines from compression unit
MEG
POWER

Subsea Compression Selected – Two Remaining Options

UNMANNED ☺

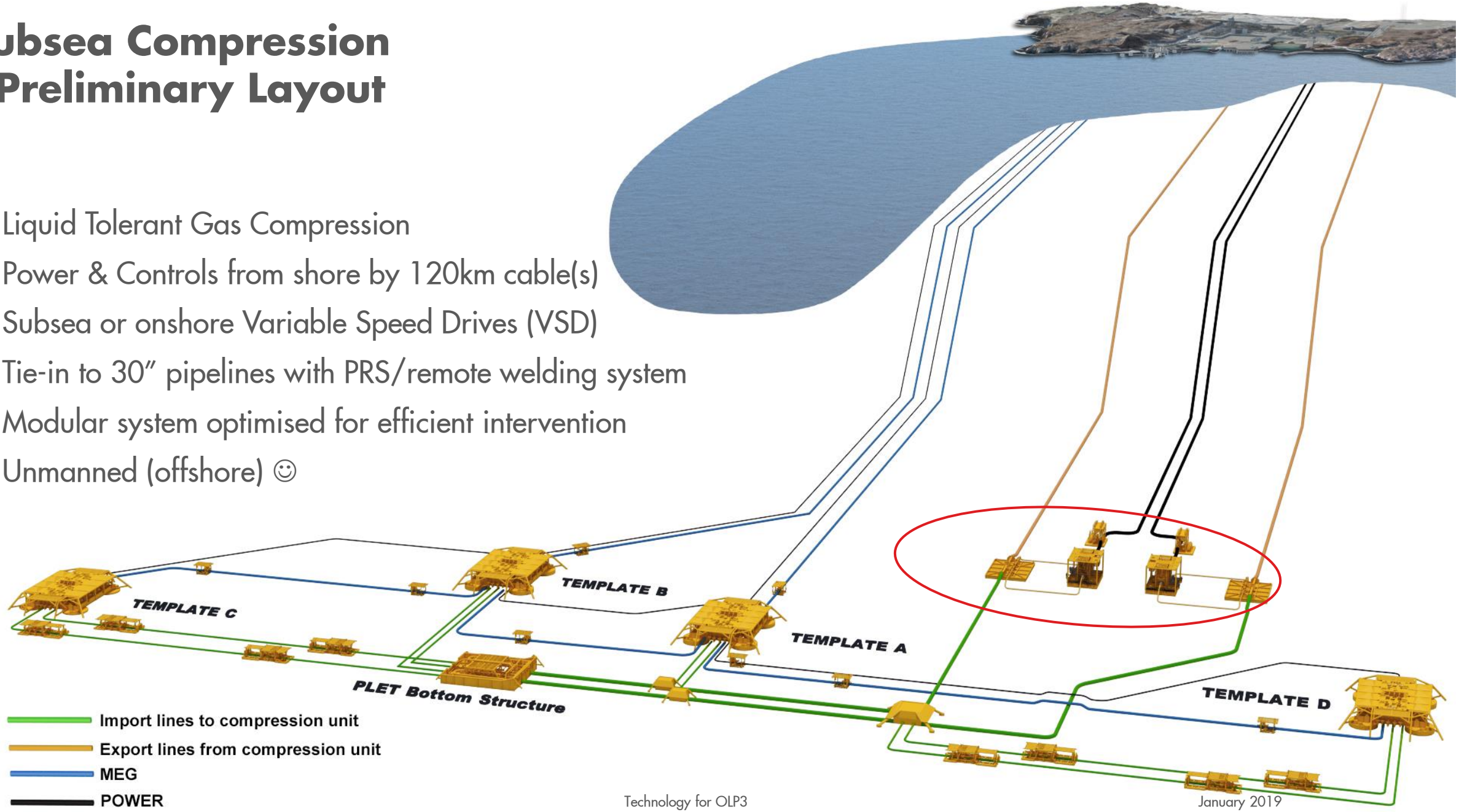
WET TOLERANT GAS COMPRESSION

LONG STEP OUT POWER (120 km @ 1000 meters)



Subsea Compression - Preliminary Layout

- Liquid Tolerant Gas Compression
- Power & Controls from shore by 120km cable(s)
- Subsea or onshore Variable Speed Drives (VSD)
- Tie-in to 30" pipelines with PRS/remote welding system
- Modular system optimised for efficient intervention
- Unmanned (offshore) ☺



Subsea Compression – Going Forward

- The partnership will now further evaluate and then choose between the two remaining options for subsea compression.

- The choice of subsea concept is expected later in 2019, followed by investment decision in the Ormen Lange license with Shell (operator), Petoro, Equinor, ExxonMobil and INEOS.

ORMEN LANGE PARTNERS: