

Cost efficient subsea tie-back development concept in 1000m water depth and mitigation of hydrate challenges.

Ole Heggdal



Subsea tie-back to existing jacket platform

- Gas & Condensate field at 1000 m
- Distance to host 30 km at 150 m
- Plateau gas production 400 mmscfd
- Peak water production: 300 bpd
- Base case dual production flowlines 2x12"
- Single line 16" opportunity
- Limited host weight and utilities capacity



Hydrate Management Concept Selection

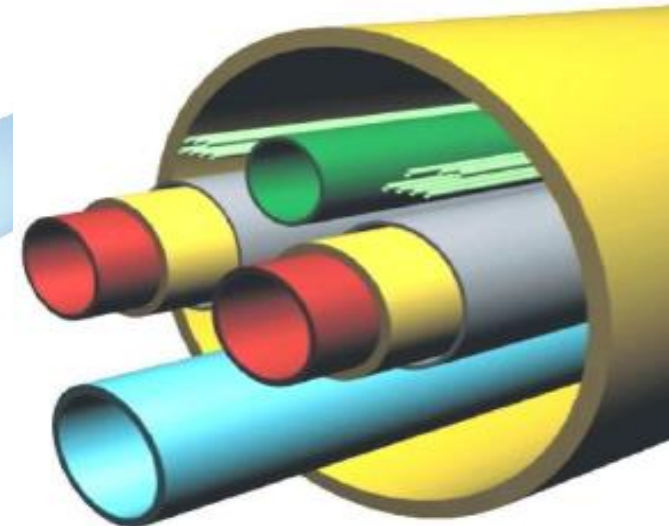
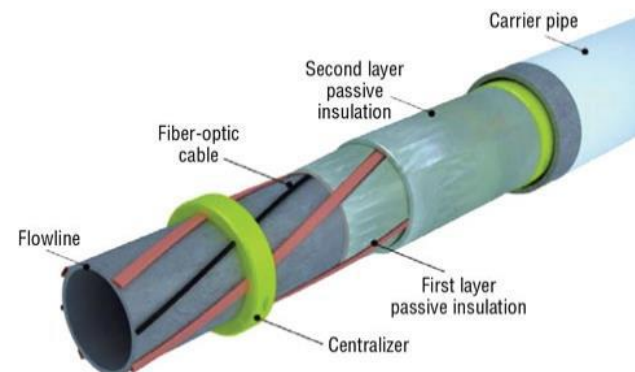
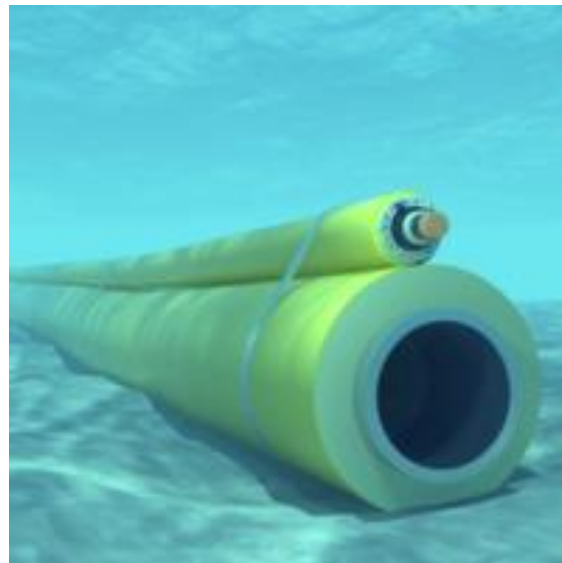
Case 1: Continuous MEG injection and regeneration (MEG)

Case 2: Direct Electrical Heating (DEH)

Case 3: Trace Heated Pipe-in-Pipe (ETH PiP)

Case 4: Production water bundle (PWB)

Case 5: Low dosage hydrate inhibitors (LDHI)



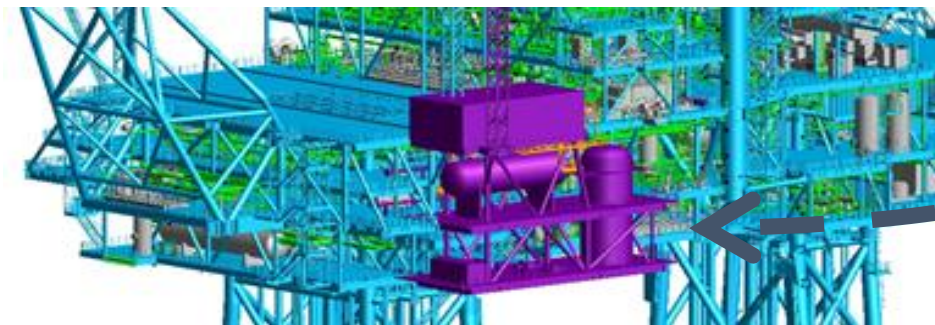
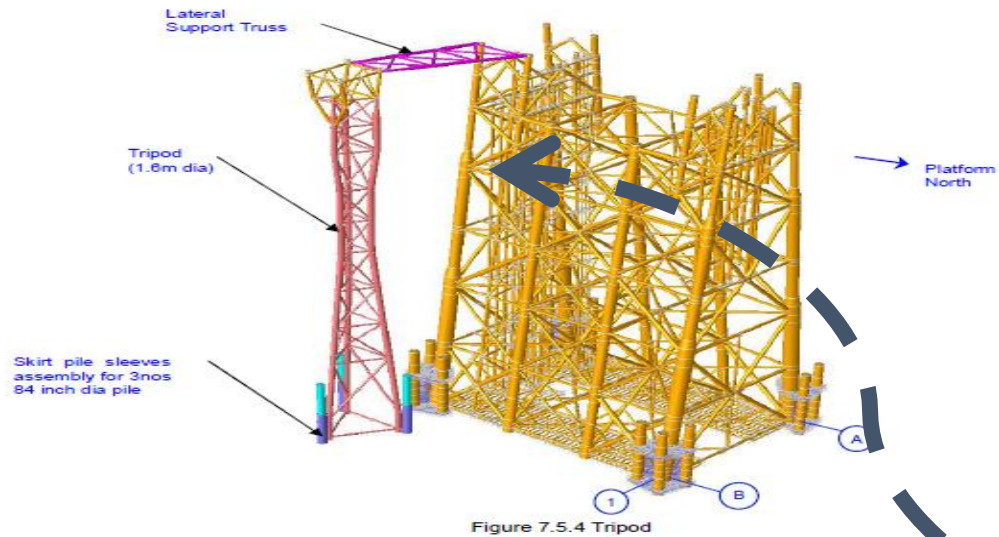
Selection Criteria



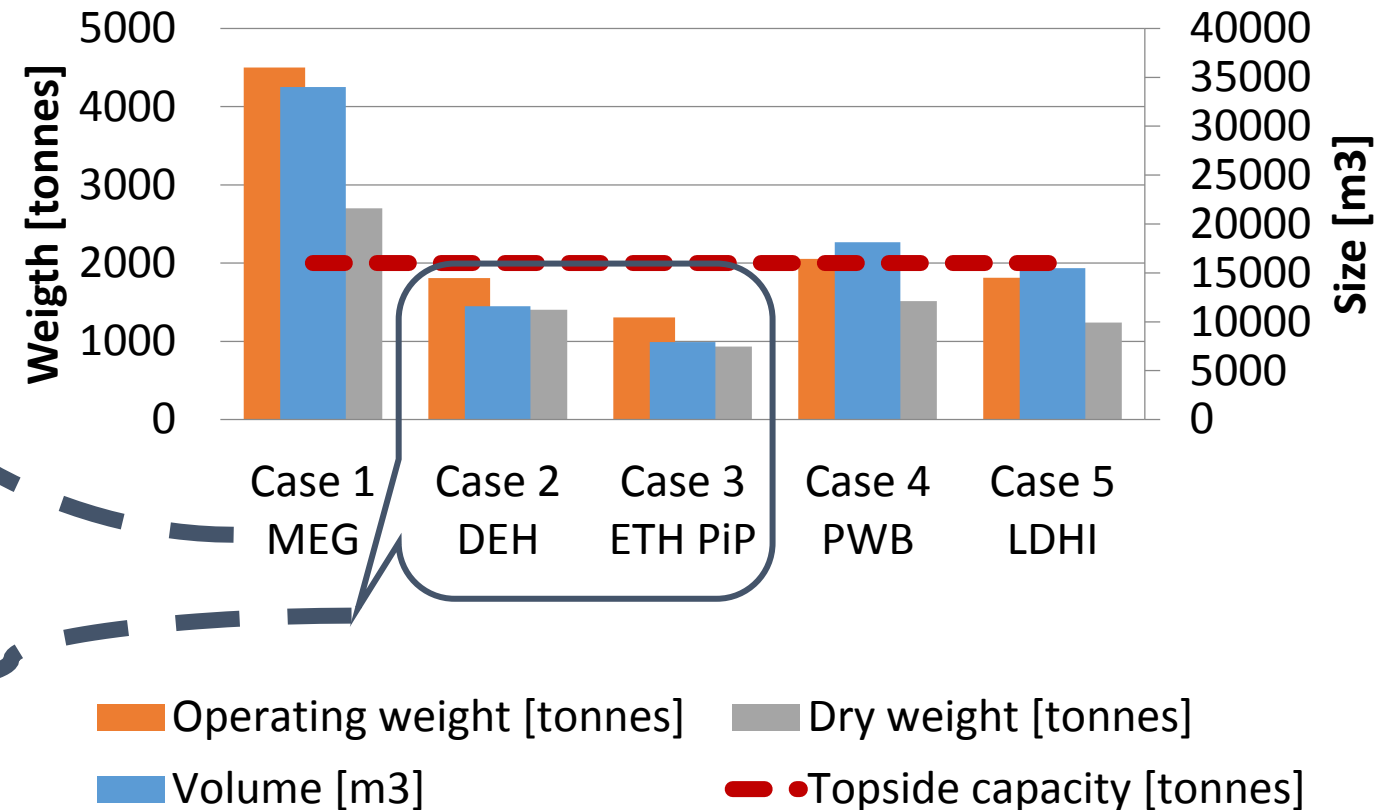
- Topside modifications and constructability
- Operability and Robustness
- Technology feasibility
- HSE
- CAPEX / OPEX

Topside study – Module size / weights

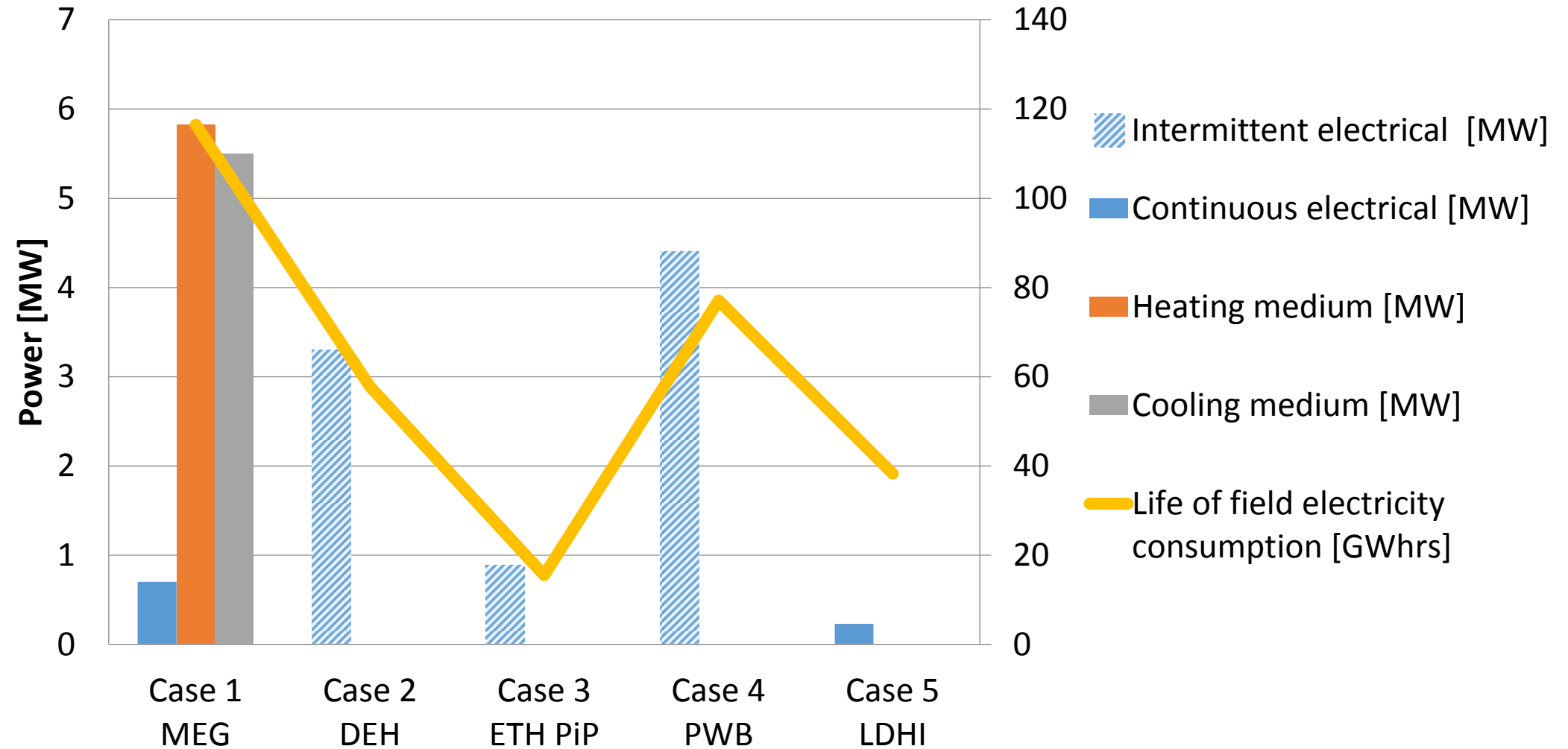
- Weight capacity for new tie-back < 2000 tonnes



Topside size/weight



Hydrate mitigation – Power consumption



Subsea study

	Case 1 - MEG	Case 2 - DEH	Case 3 – ETH PiP	Case 4 - PWB	Case 5 - LDHI
Operability	- Minimum flow restrictions (MEG storage)	- Re-heat one flowline at the time	- Low power consumption	- Cold spots at joints	- Logistics/OPEX - Impact on flow - Sub-cooling limitations - Shut-in/ shutdown
Installability	- 1 off 6" MEG supply line	- Flowline insulation + heating cable	- Availability of reeling vessels	- Distance to manufacturing site - Complex installation scope	- Negligible SURF impact
Technical feasibility	- Field proven	- Field proven	- Lack of track record	- Challenging for deep water > 400m	- Production chemistry specific
HSE	- Power consumption	- No specific challenges	- No specific challenges	- No specific challenges	- Toxicity - Biodegradability

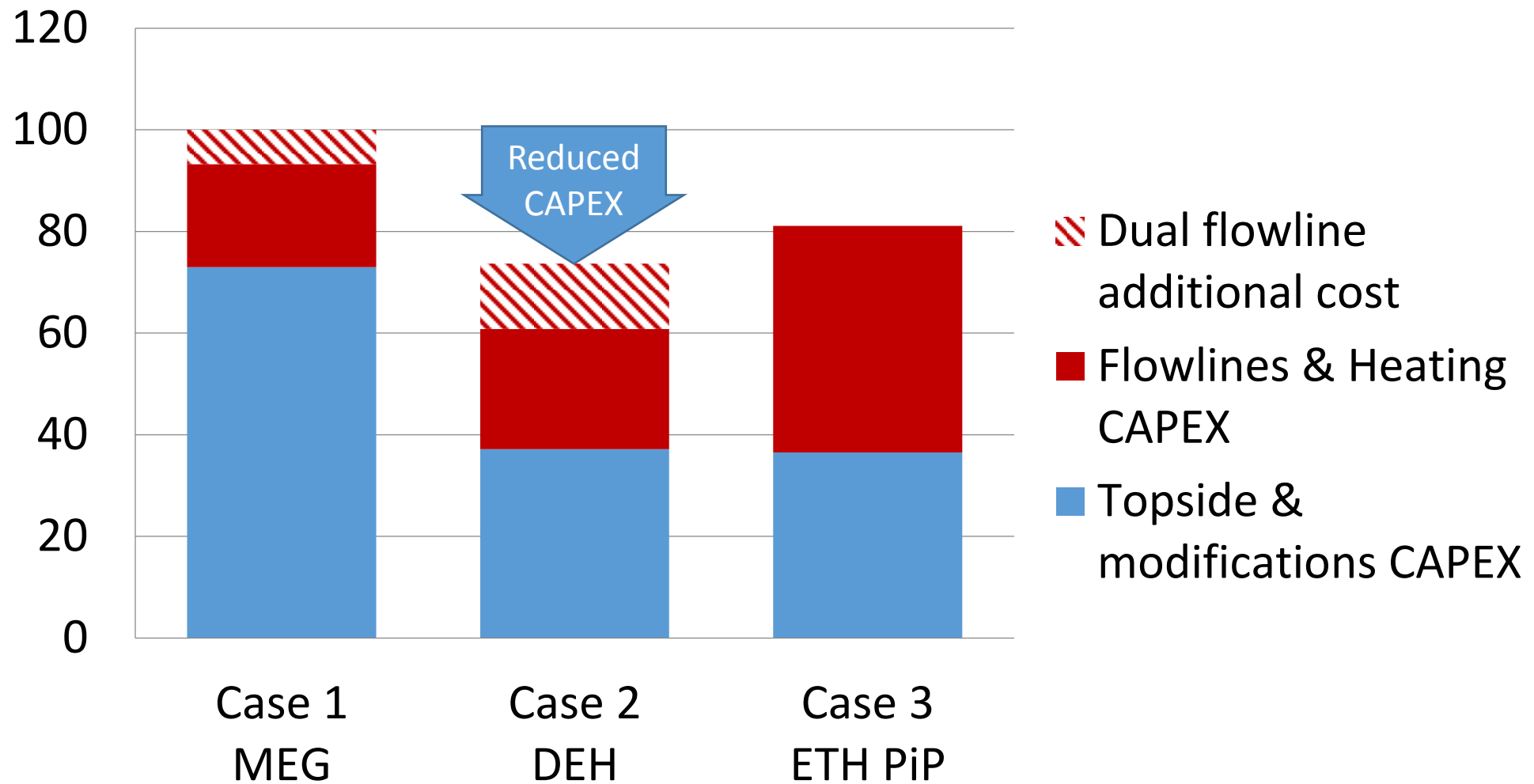
Preferred

Acceptable

Not acceptable

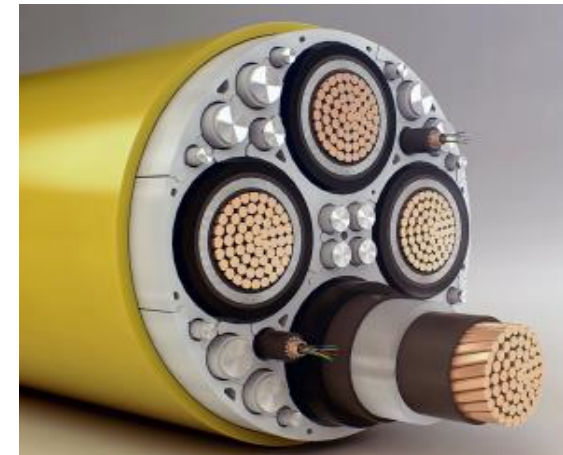
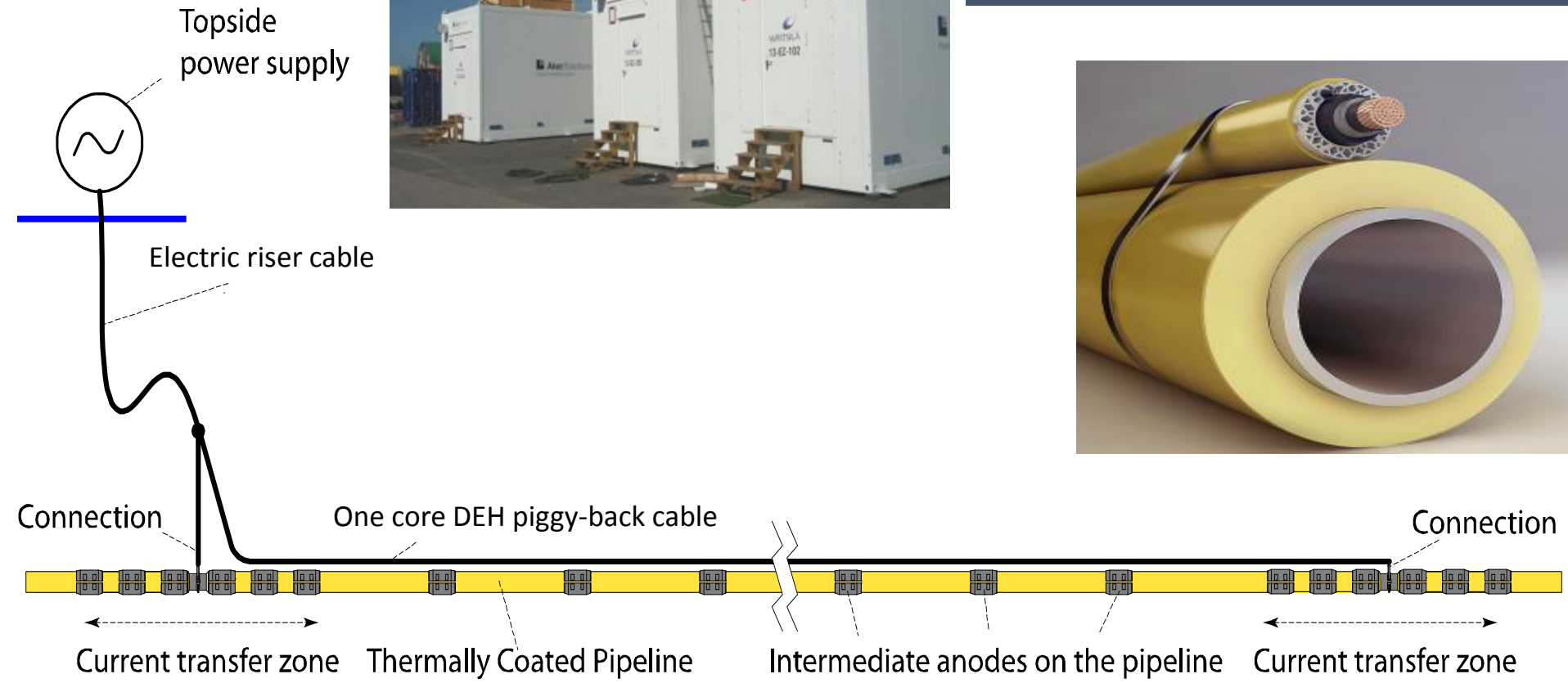


CAPEX Comparison



Direct Electrical Heating: Concept

Purpose: Increase/ maintain temperature in flowline above hydrate, wax or ice appearance temperature, either by intermittent or continuous heating



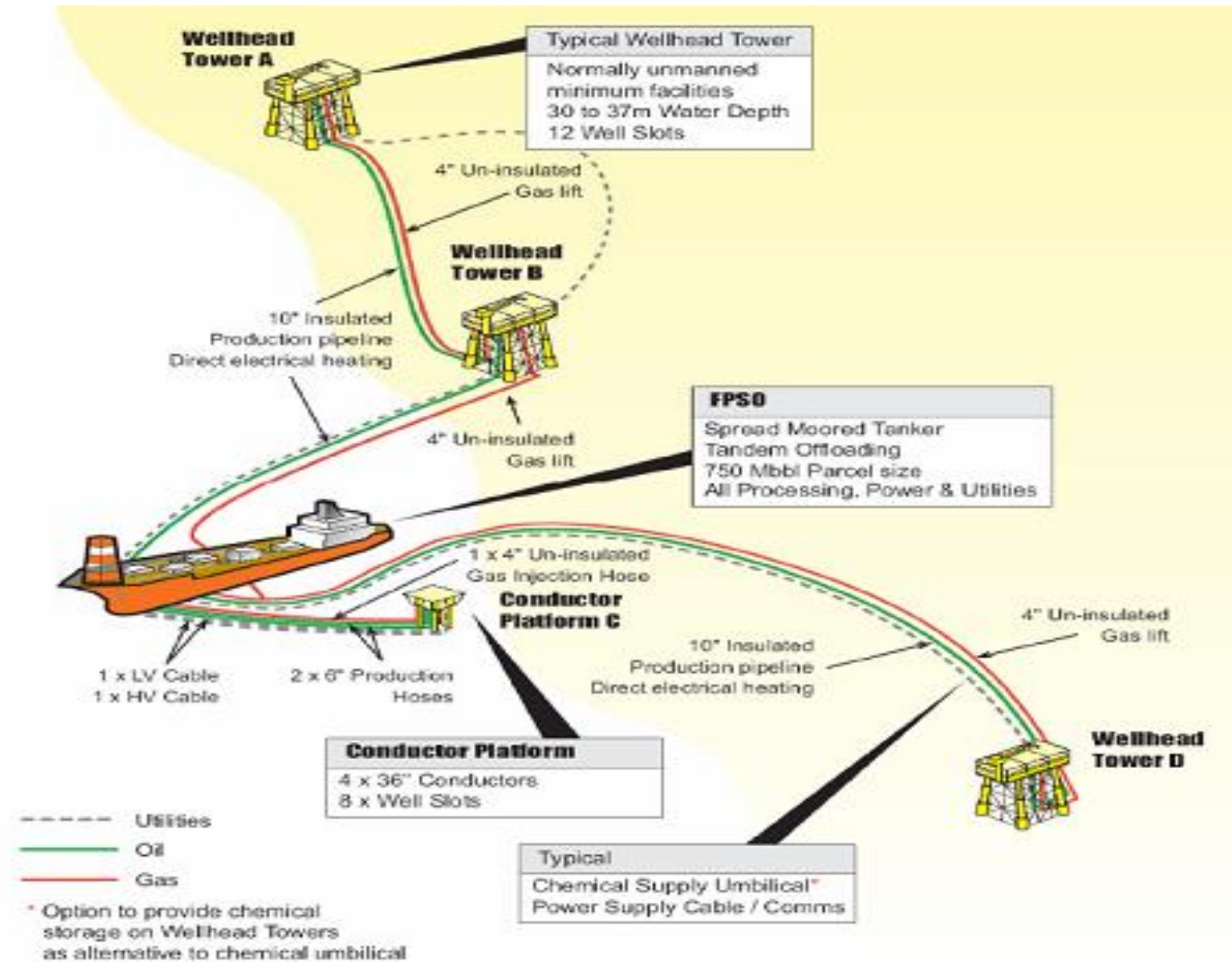
DEH Track Record worldwide



Field	Åsgard Statoil	Huldra Statoil	Kristin Statoil	Urd Statoil	Tyrihans Statoil	Ormen Lange Statoil	Alve Statoil	Morvin Statoil	Skarv BP	Olowi CNR	Skuld Statoil	Lianzi Chevron	Goliat ENI	Gullfaks Statoil	Shah Deniz BP	Maria Wintershall
Pipe dimension (inches)	10	8	10	12 1/2	18	30	12 1/2	10.5	12	8	14	11	12	8	14	14
Flowline length (km)	6-8.5 (6 flowl.)	16	6-7 (6 flowl.)	9	43	20	16	20	13	4 (3 flowl.)	26	43	8 (2 flowl.)	8.5	3 - 18 (12 flowl.)	26
Water depth (m)	300	175	370	390	330	1000	350	300	300	30	370	1000	330	150	500	370
U-value (W/m ² K)	5	3.5	8	4	4	-	3	5	3	4.5	3.5	4	4	4	4	3.5
Cable cross section (mm ²)	1000	650	1200	1200	1200	1200	1200	1200	1200	1000	1200	1400	1200	630	1000	1000
DEH cable rating current/voltage (A/kV)	1500/12	1100/24	1500/12	1400/12	1600/52	3000/52	1300/12	1500/24	1400/12	1300/12	1300/24	1400/52	1300/12	900/12	1300/24	1350/24
Rated power (MW)	1-1.5	2	1.5-1.6	2.3	10	8	2.4	4	2.2	0.9*3	4	9	1.2*2	1.1	0.5 - 2.5	4
Year installed	2000	2001	2004/05	2007	2007	2007 Retrofit	2009	2010	2012	2010	2015	2015	2015	2015	2016 +	2017

Olowi System delivery – a system for continuous operation

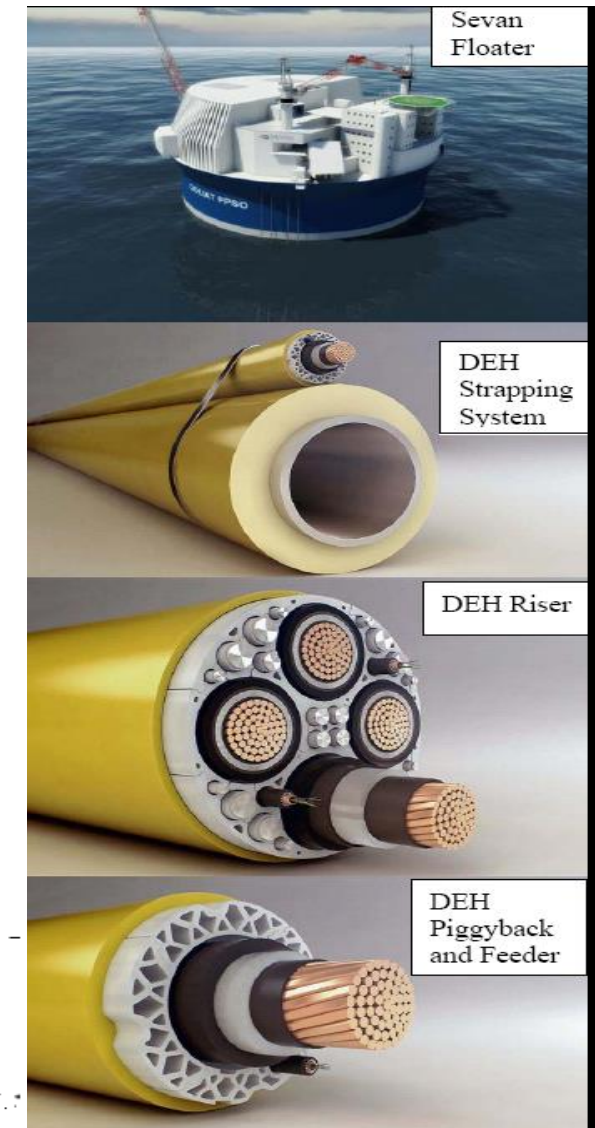
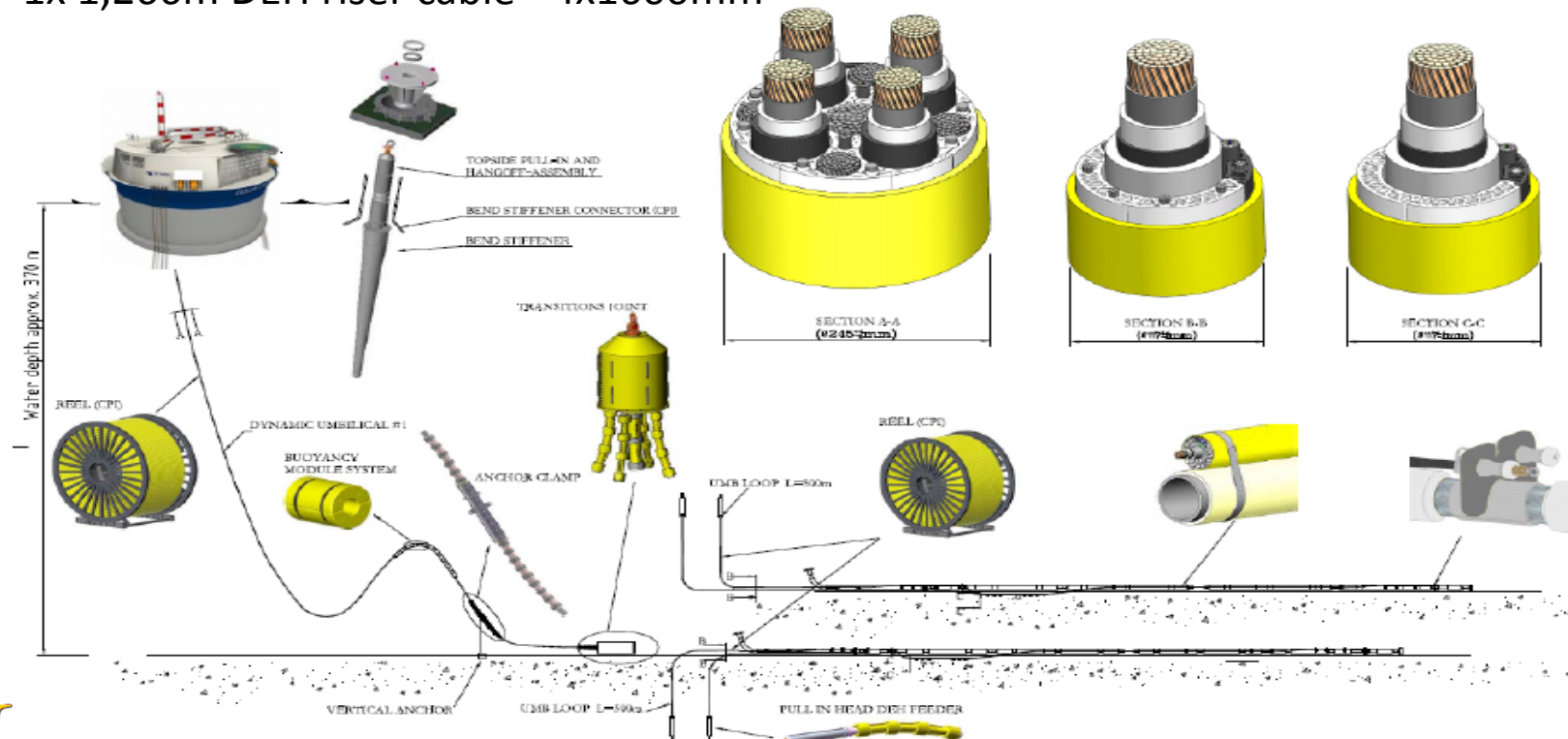
- **Operation:** Continuous
- **Heating temp:** 43 degrees C
- **Service life:** 20 years
- **Flowlines:** 3 off, 4 km
- **Dimension:** 10"
- **Coating:** Concrete and armoring
- **Water depth:** 40m
- **Cable:** 1000mm²
- **Voltage:** 6/12 kV
- **Commissioning:** 2009



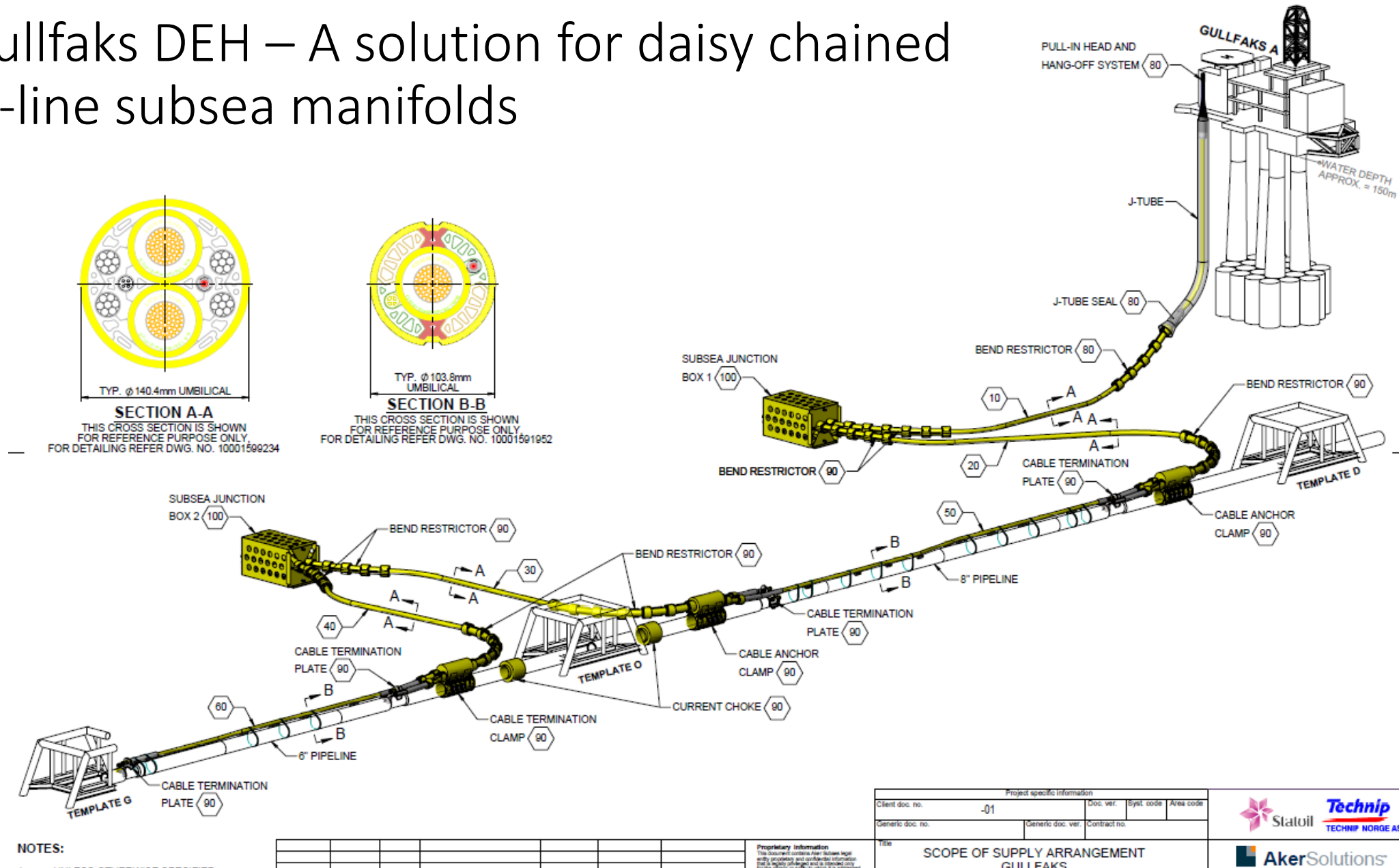
Goliat DEH – A solution for floater with multiple flowlines

Delivery

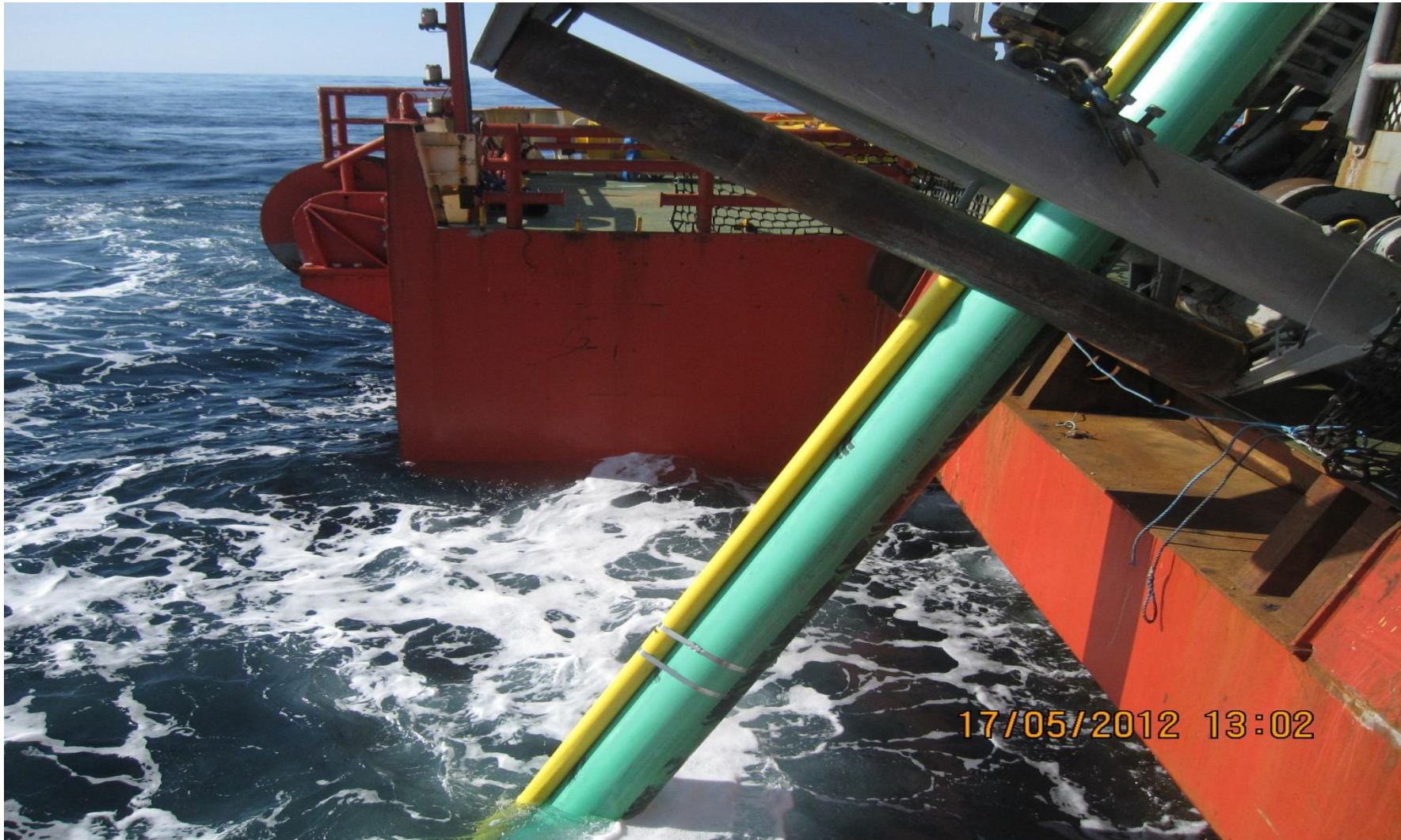
- 4x 500m feeder cables - 1x1200mm²
- 2x 7,487m piggyback cable - 1x1200mm²
- 1x 1,266m DEH riser cable - 4x1600mm²



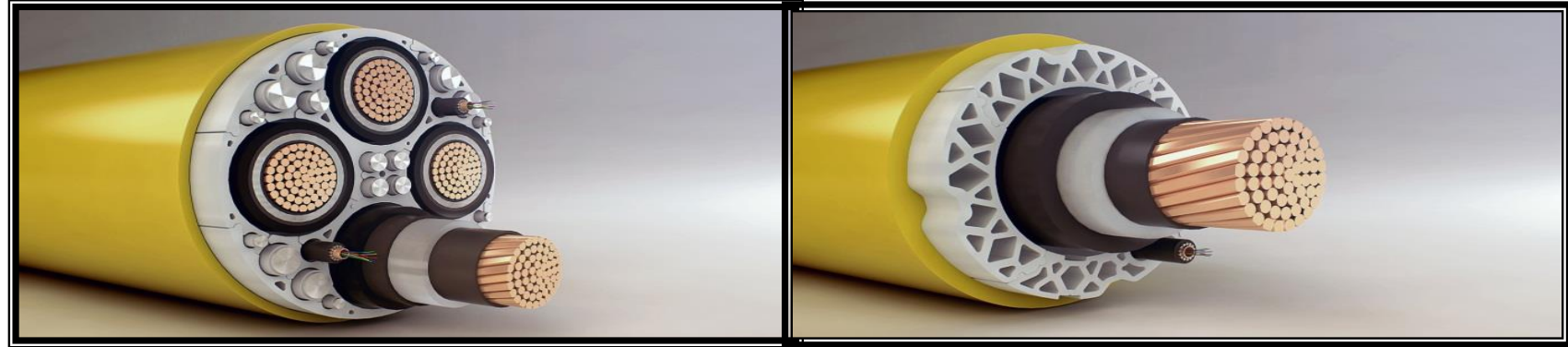
Gullfaks DEH – A solution for daisy chained in-line subsea manifolds



DEH Installation



Summary



- This study concludes that DEH is an attractive technical and commercial solution
- DEH is a field-proven and qualified technology, both for intermittent and continuous use
- Reliable and robust system, 16 years in operation with more than 25 off DEH heated flowlines
- Installation friendly system
- Applicable for long step outs and large flow lines
- Aker Solutions provides feasibility studies, field optimization, cost estimates and support from early conceptual and system definition phase to complete DEH system deliveries



The preferred flowline heating system supplier

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