Hydrate and Wax Plug: Prevention and remediation using active heating technology

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Agenda

1. Overview & challenges
2. ETH flexible pipe technologies
3. ETH rigid pipe technologies
4. Performance summary
5. Key takeaways
6. Q&A

Overview & challenges

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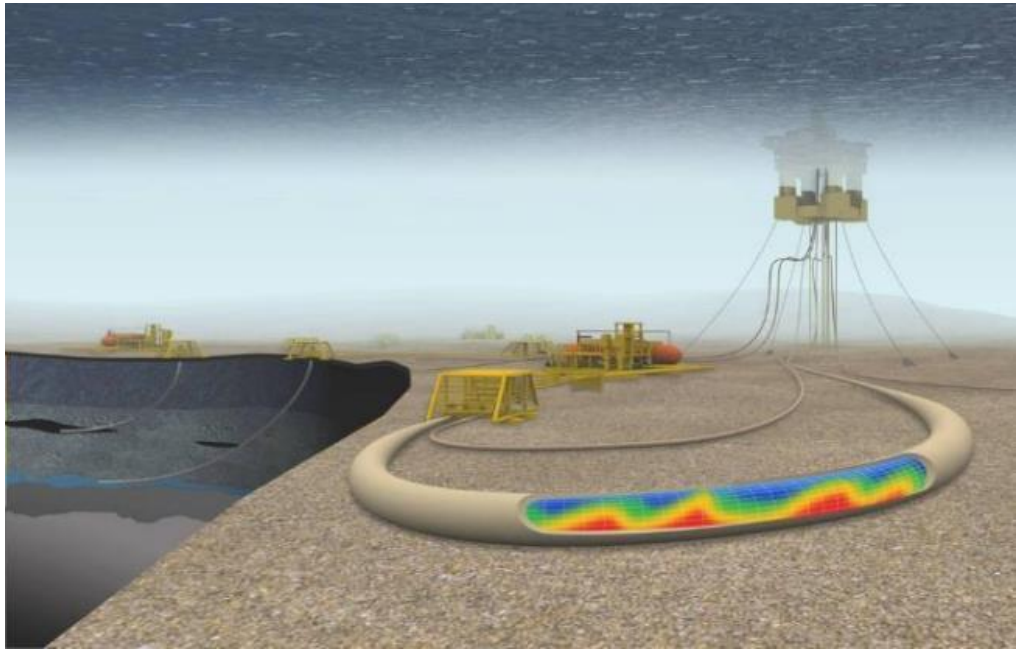
Overview & challenges

Deepwater / long tie back challenges:



Flow assurance challenges:

Viscous oil

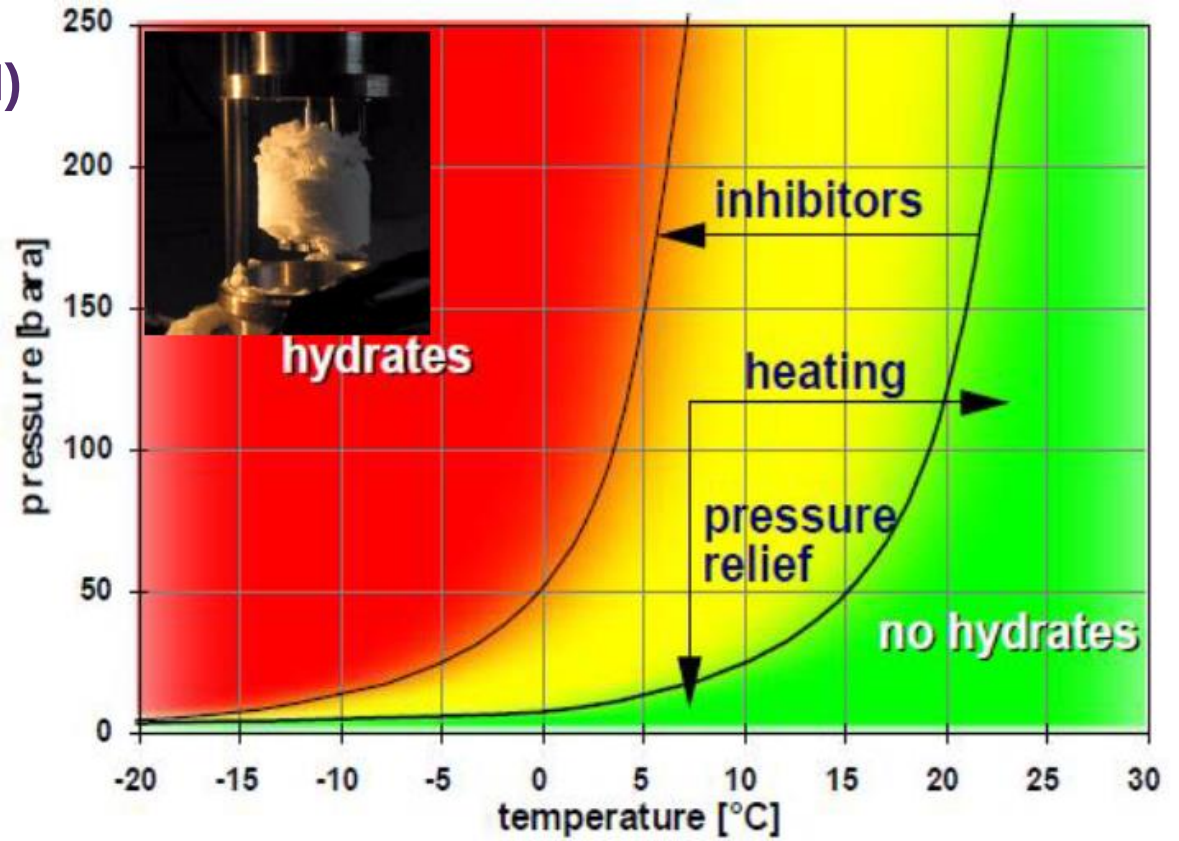
Wax

Hydrate

Active heating technologies – Benefits

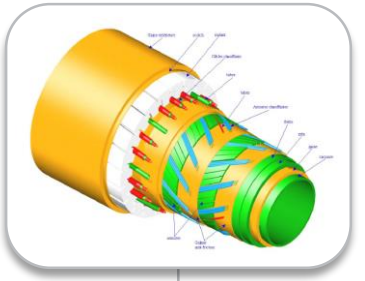
Main benefits of Electrically Trace Heated (ETH) by Joule effect:

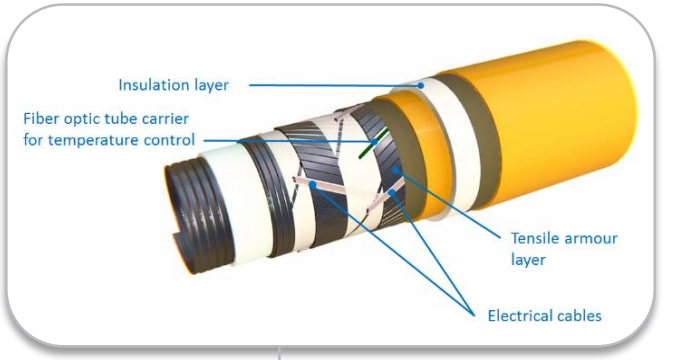
- Cost effective alternative to chemical injection (hydrate mitigation)
- Wax and Hydrate prevention & remediation (control of heating power and live monitoring)
- Accelerate start-up operations after a shutdown
- To enhance flow rates by increasing fluid temperature for viscous oil, long tie-back or deep water development (continuous heating)



Active heating by ETH technologies provides the most adapted solution for demanding applications

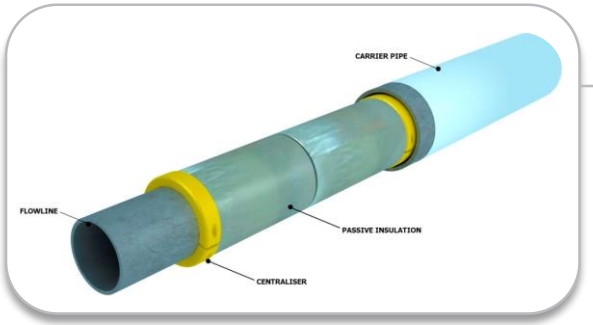
ETH track records

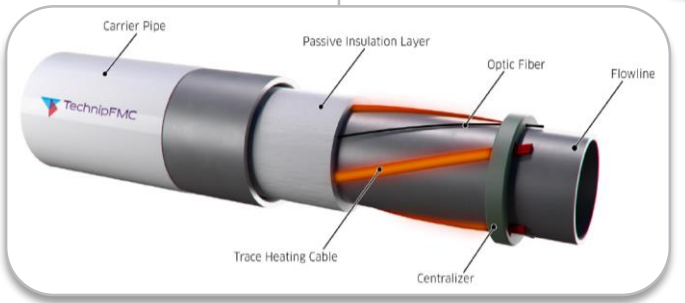




1970 — 1980 — 1990 — 2000 — 2010 — 2020

- 1970: 1ST FLEXIBLE PIPE
- 1980: ETH-HCRAW Conoco UDANG
- 2000: Demo 2000 JIP
- 2010: 1st ETH-IPB Dalia
- 2010: ETH-IPB Papa Terra
- 2020: ETH-HCRAW Alta Gohta
- 1990: 1ST PiP
- 2000: ETH-PiP Early Qualification Work
- 2010: 1st ETH-PiP Islay Project
- 2020: ETH-PiP Neptune Energy Fenja
- 2020: 1st ETH-SP





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ETH flexible pipe technologies

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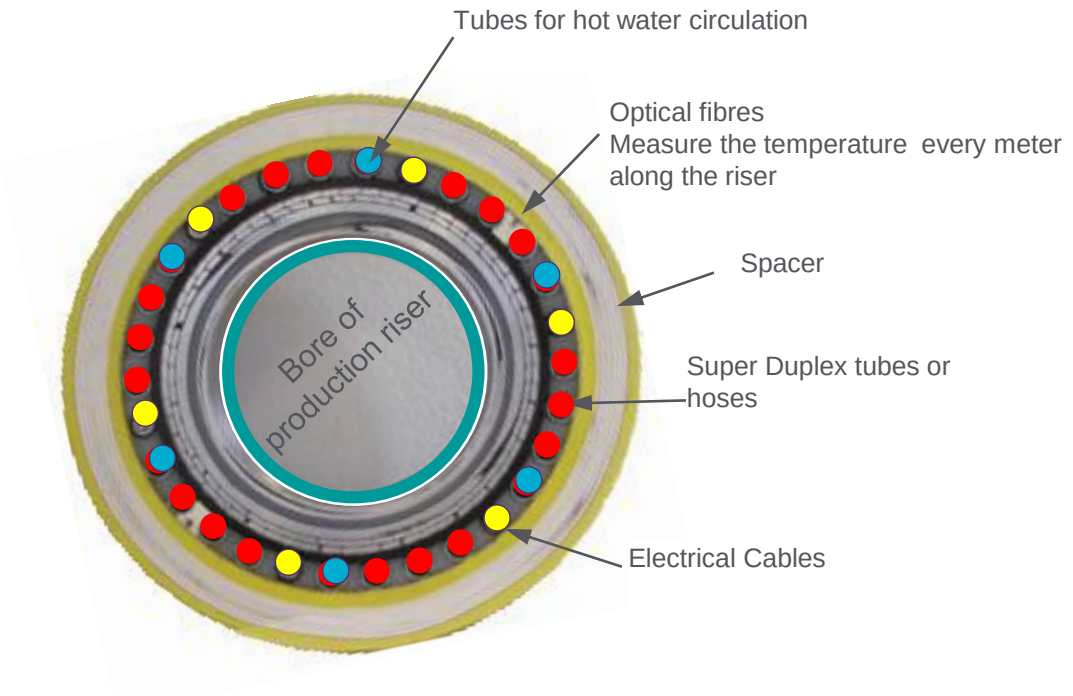
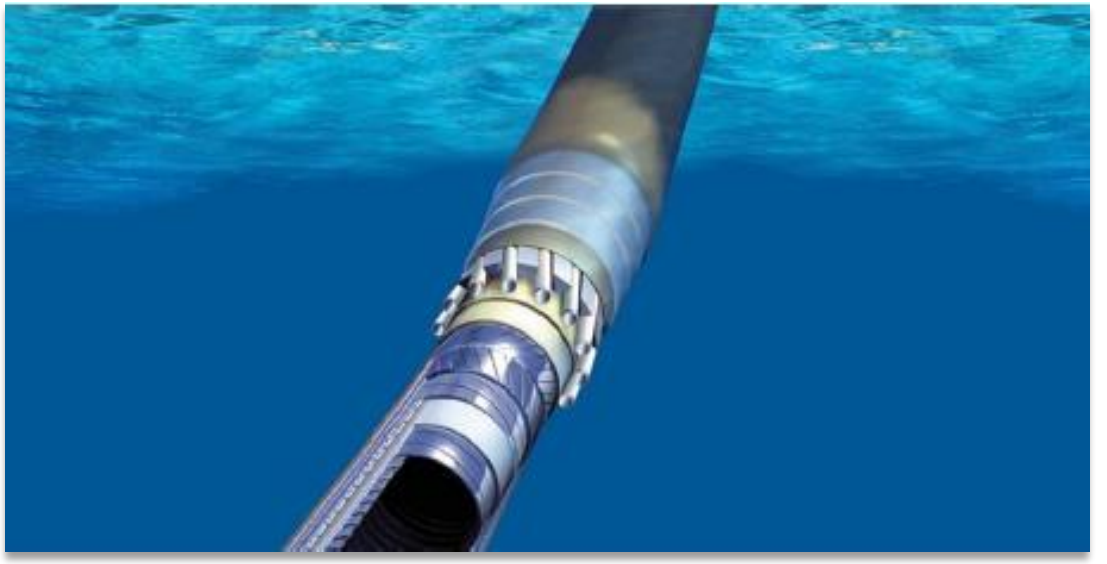
Integrated Production Bundle – System description



IPB: Integrated Production Bundle

- Flexible pipe production core structure
- Bundle assembly
- Thermal insulation



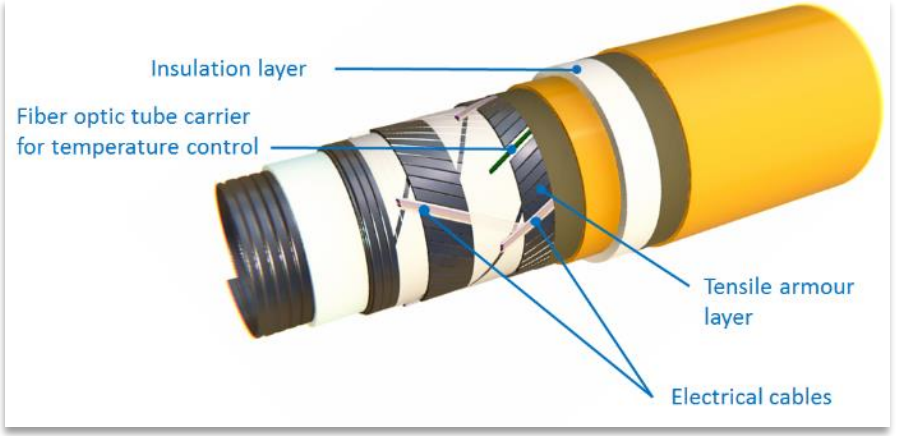
IPB key capabilities

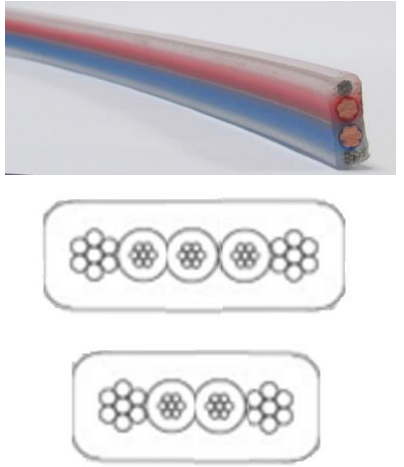
- Multiple functions available combined within single bundle design (ETH, GI, GL, WI, OF etc.)
- Temperature monitoring
- High electrical efficiency
- Wet insulation (~U value = 3–6W/m2K)
- Internal diameter capabilities: 2–12’’

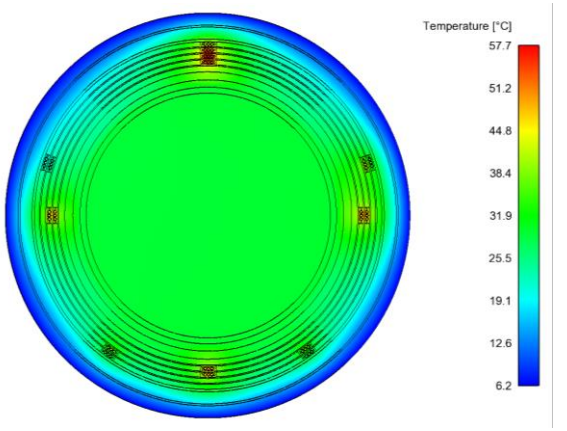
ETH-HCRAW technology – System overview

HCRAW = Heating Cables Replacing Armour Wires

- Cost effective, simple design
- No bundle (weight and OD reduction compared to ETH-IPB)
- Embedded electrical cables, high heating efficiency
- Tailor made design: design number of cables selected for each application



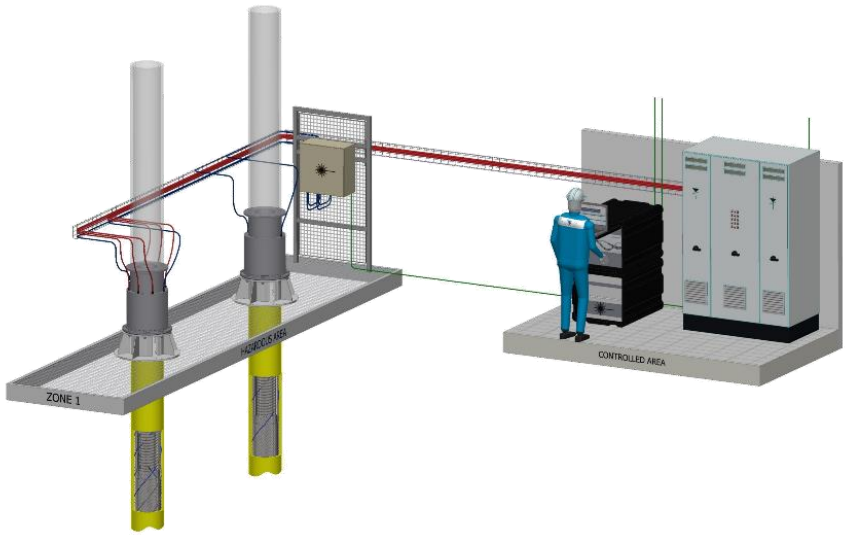


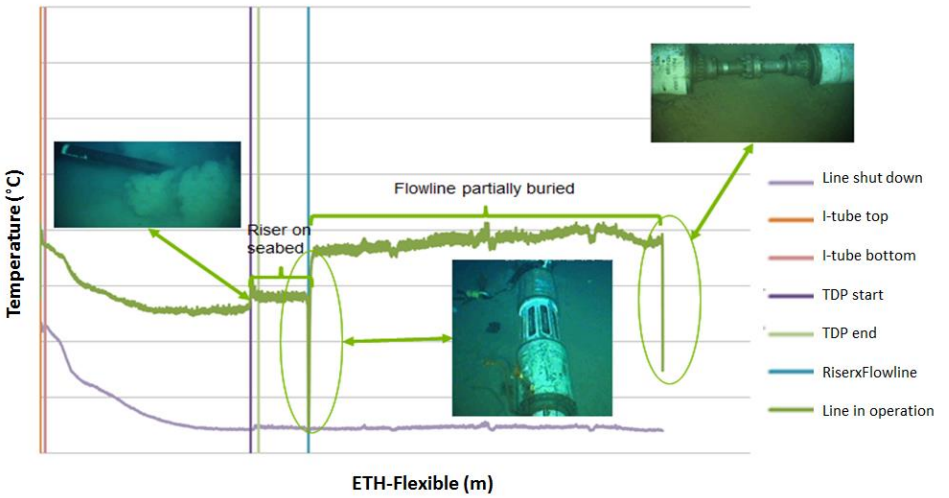


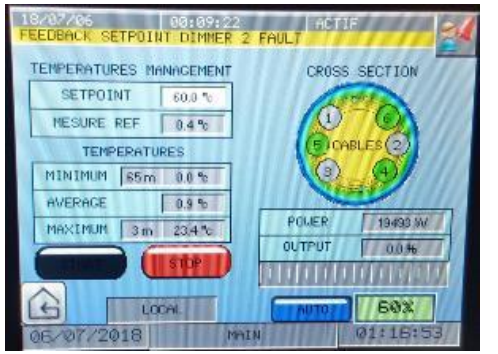
Design & number of cables adapted to each specific project requirements

ETH-HCRAW technology – Temperature monitoring

Distributed Optical Fibre Temperature System (DTS)







Typical ETH - Flexible temperature profile

- ✓ **Deep understanding of the temperature variations along and within the flexible pipe & detection of any water presence in annulus**
- ✓ **Can be combined with topside interface system (warm up / maintain modes)**
- ✓ **Field proven technology**

ETH rigid pipe technologies

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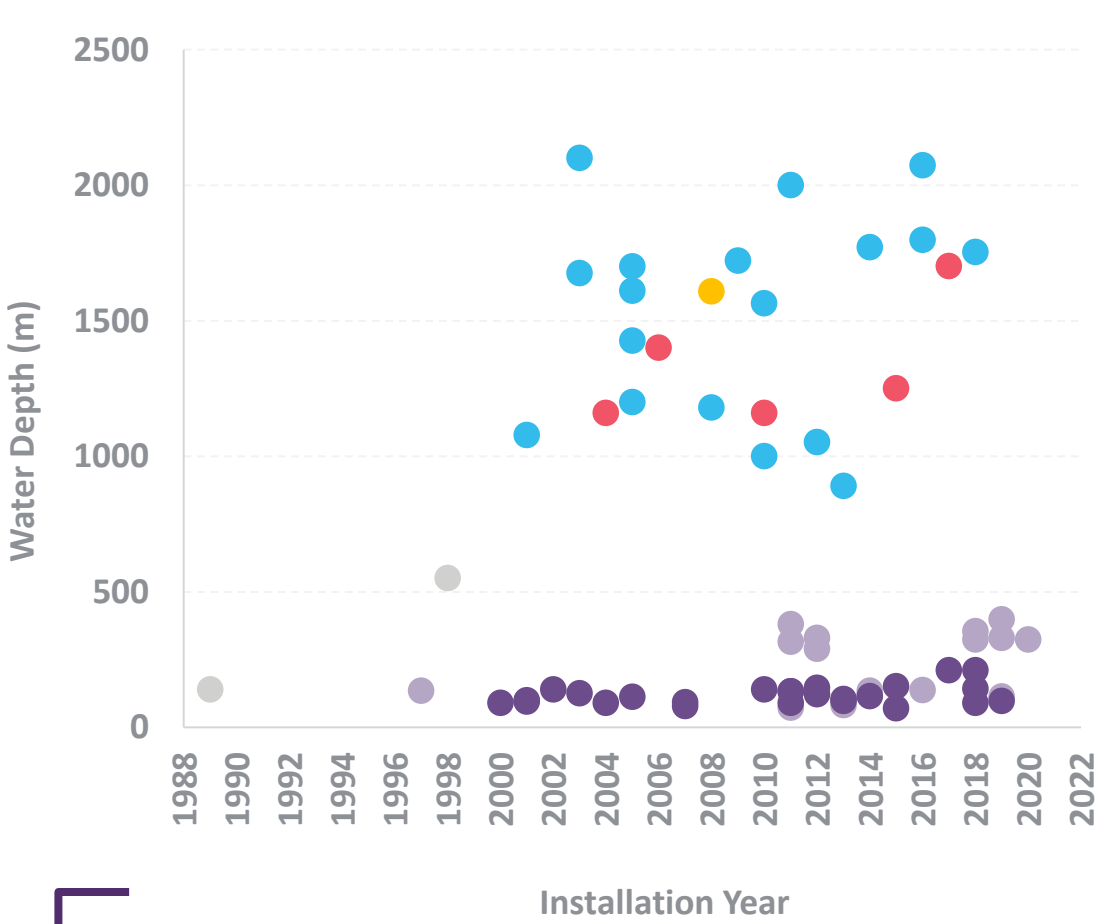
Pipe-in-pipe – Extensive track record

Track record, per water depth

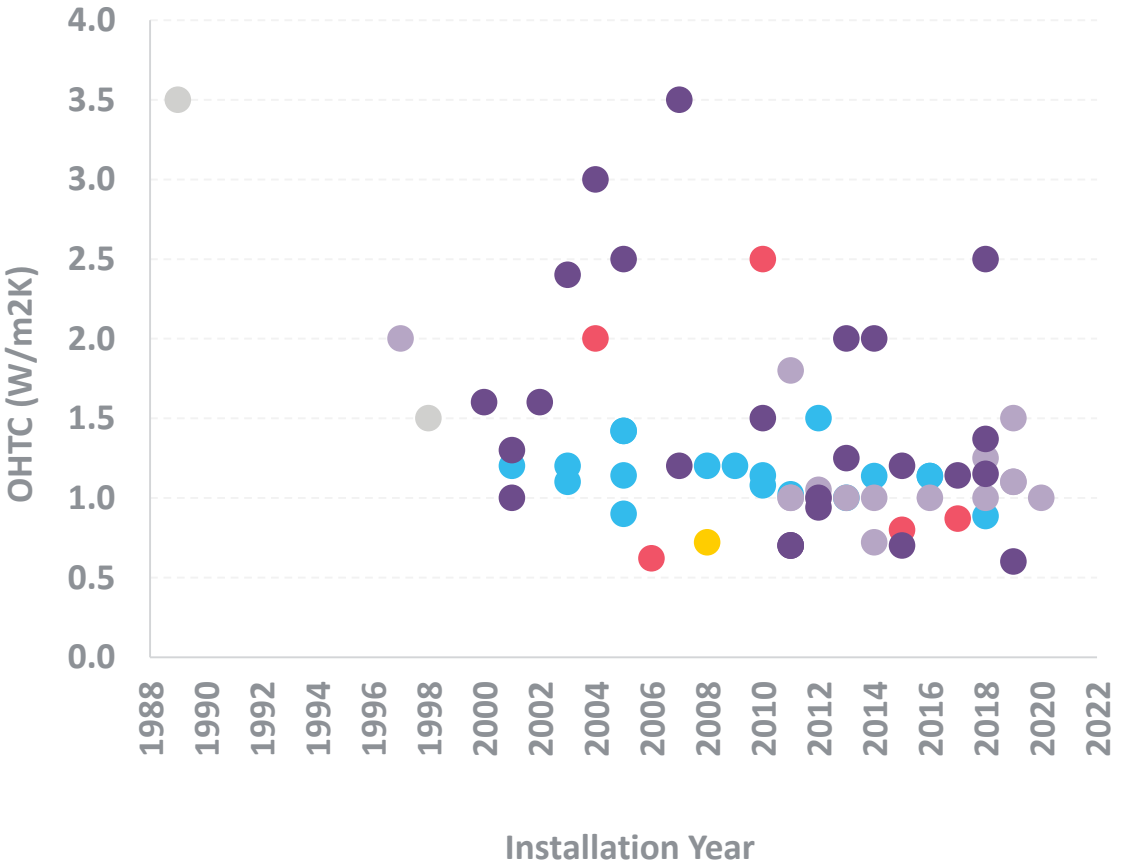


Africa

Apac

Brazil

Track record, per OHTC



ETH-PiP = Using reeled PiP track record to develop a new technical solution

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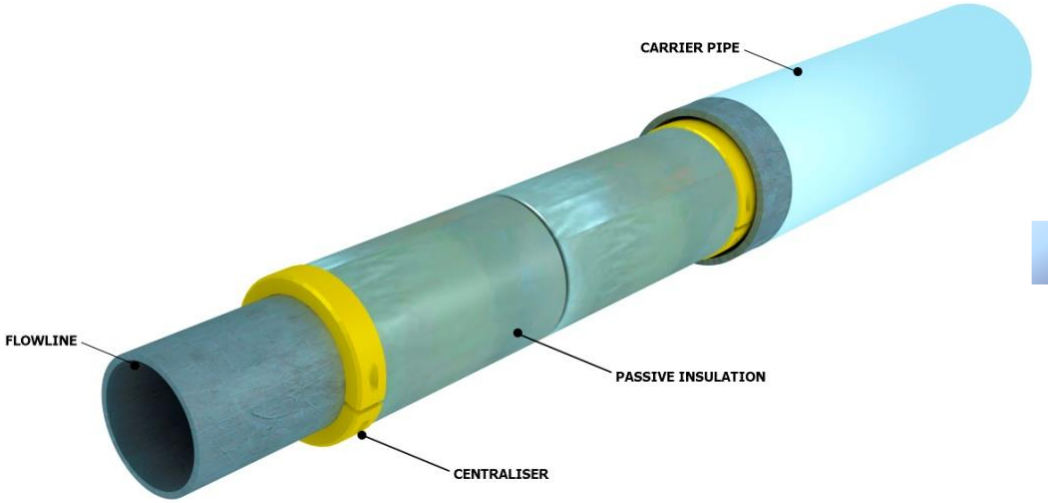
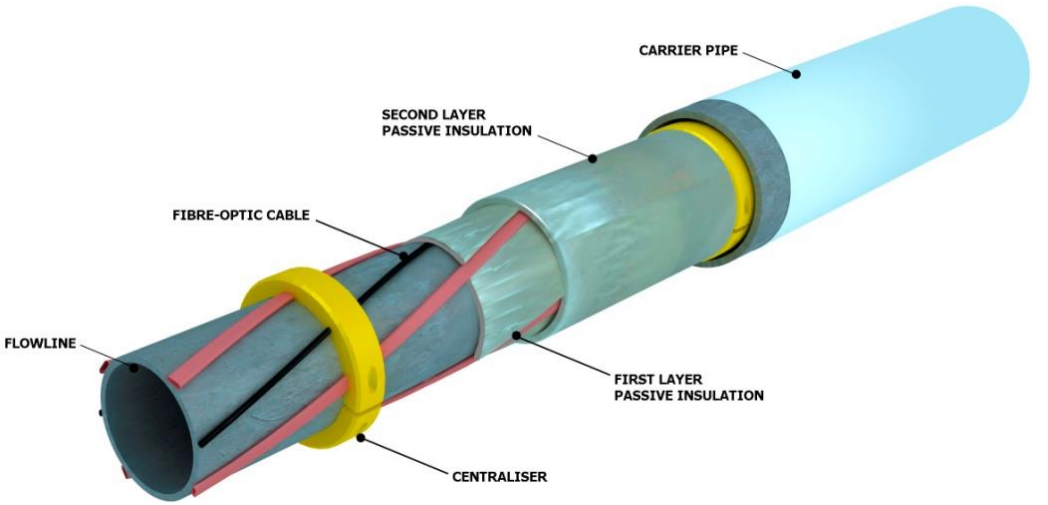
ETH-PiP – System description and functions

Standard Pipe-in-Pipe (PiP)



Electrically Trace Heated PIP (ETH-PiP)



- Trace heating used in other industrial applications
- Exposed to harsher conditions
- Reeled Pipe-in-Pipe Offshore track record
- Manufacturing in standard adapted spoolbase

The ETH-PiP is the combination of qualified components for dry environment

ETH-PiP – Active heating rigid pipe technologies

- Low U-Value (0.6 to 2 W/m^2.K)
  - Reducing power requirement during keep warm mode
  - Allows longer cool down and no touch duration
- Simplify operating procedure and subsea architecture
- Reduce chemical injection volumes (MEG)
- High redundancy,
- Temperature monitoring (DTS) allowing
  - Wax / plug management via continuous monitoring
  - Hydrate plug melting operations
- Field proven technology

ETH-PiP provide the full range of functionalities for hydrate management

ETH-PiP – Qualification and track record

Early qualification work (1999 to 2004, extended to 2010)

- Full scale tests on 12m joints, including all electrical circuits and mechanical parts
  - Confirmation of the high level of heating efficiency (heating curves)
  - CFD model calibration
  - Confirmation of reel-ability

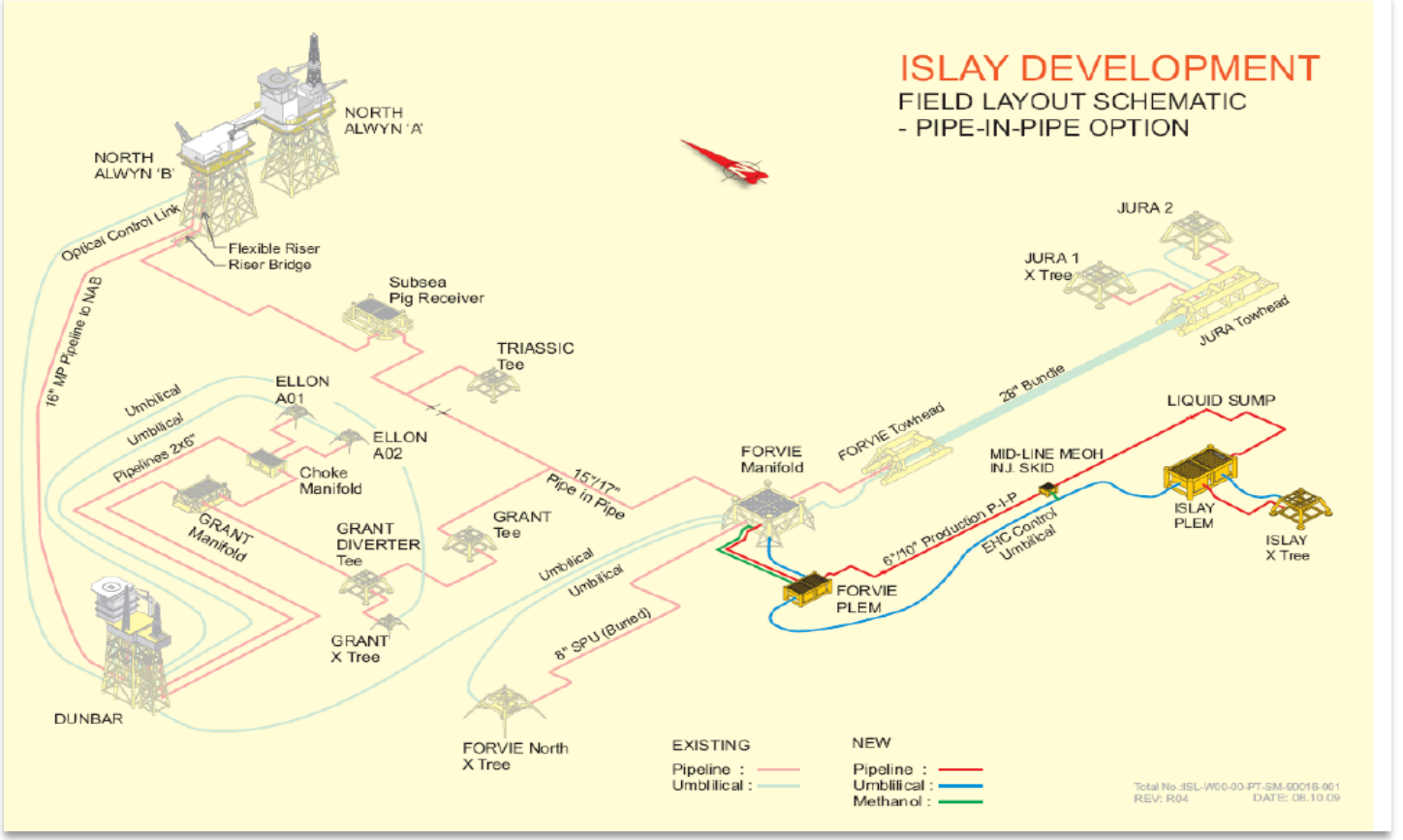
Extended qualification (2009-10)

- Re-assessment of technical readiness with a project study case with TOTAL TEQP programme (Technology Evaluation & Qualification Process)
  - Confirmation of the high redundancy and operation under degraded mode
  - Ageing long term at 120ºC, higher specification on trace heating cable
  - CFD, lab test and mechanical testing

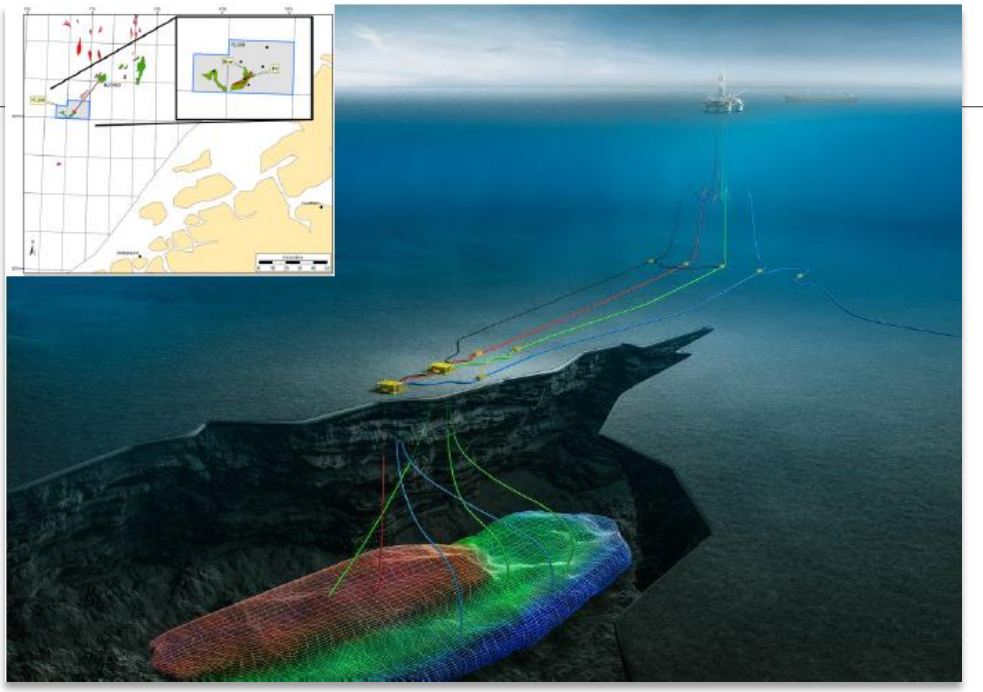
ETH-PiP – Track record

ETH-PiP – First project application Total Islay, 2011

- 122m WD with challenging bathymetry
- 6 km single well tie-back
- 6.625” x 12.75” ETH-PiP line
- U value (20ºC) = 0.9 W/m2.K
- High Temperature (120 °C)



ETH-PiP – Track record

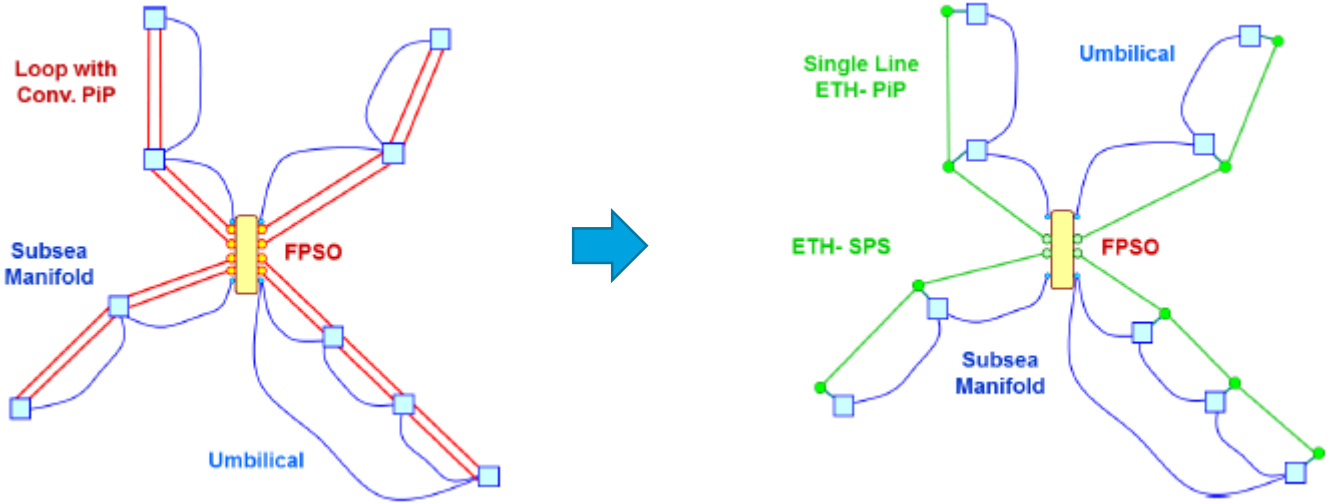


ETH-PiP – Neptune Energy Fenja

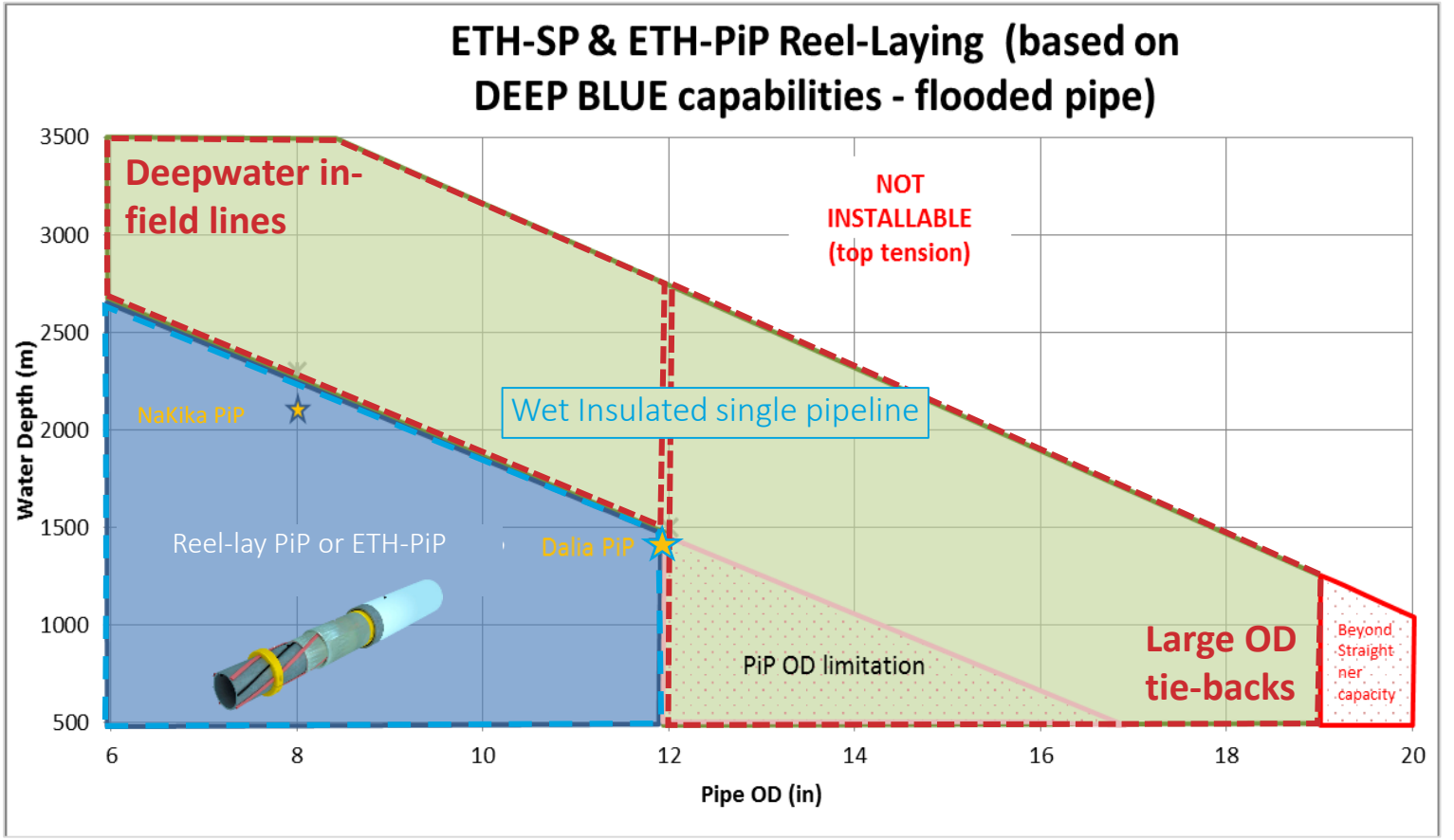
- Ongoing pipe manufacturing
- 324m WD
- Longest and largest ETH-PiP
- 36 km single well tie-back
- 12” x 18” Production ETH-PiP
- Continuous heating

- ETH-PiP selected vs
  - chemical injection option
  - heated dual flowline and riser

Significant CAPEX reduction

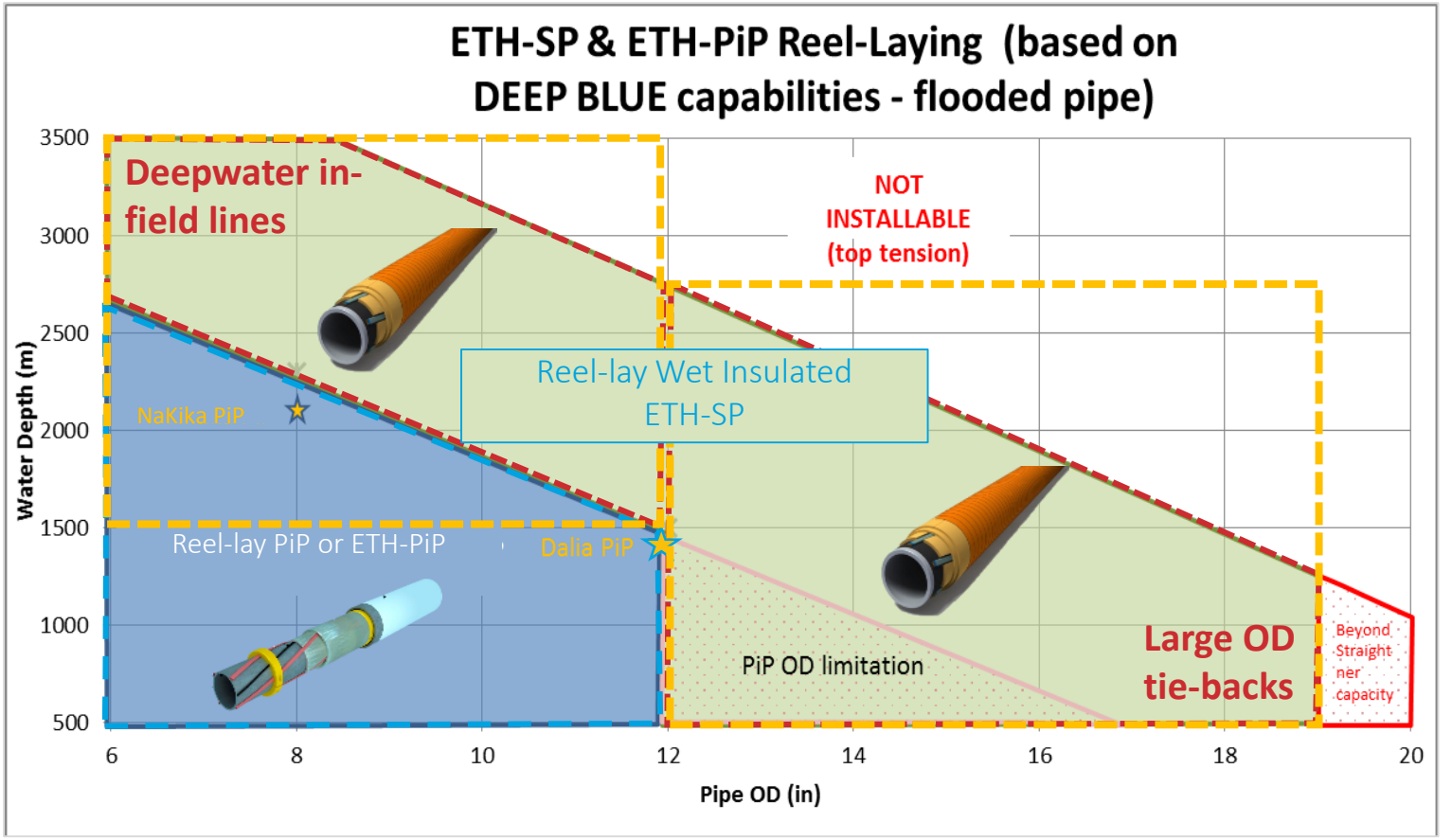


TechnipFMC active heating rigid pipe technologies



Missing efficient product for deepwater and large OD tie-back field development

TechnipFMC active heating rigid pipe technologies

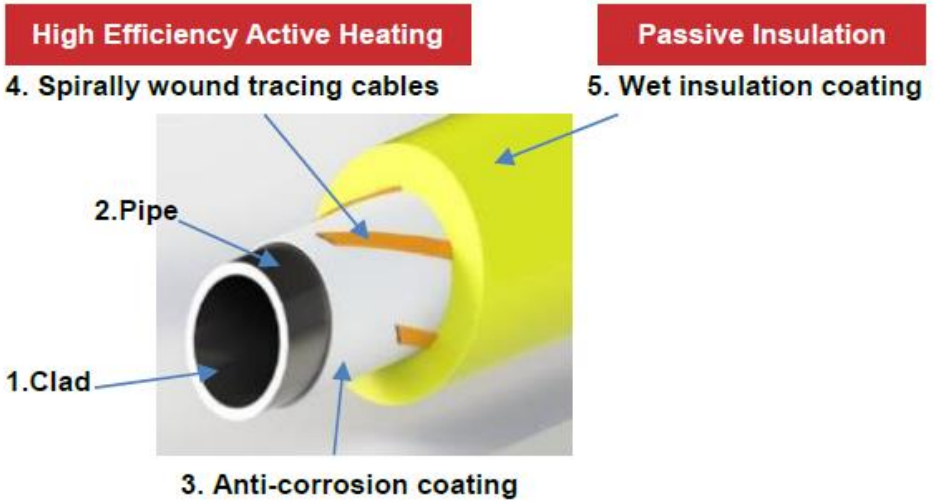


Development of Wet Insulated ETH Single Pipe

TechnipFMC active heating rigid pipe technologies

ETH-SP (Single Pipe)

- Solution in development
- Designed for both continuous and intermittent heating
- Wet insulated pipeline, for project where U-value is not driving
- Unlock deeper water installation with moderate top tensions
- Compact solution giving access to longer tie-back
- High redundancy
- Temperature Monitoring (DTS) with similar benefits than the ETH-PiP



ETH-SP complementary of the ETH-PiP

Performance summary

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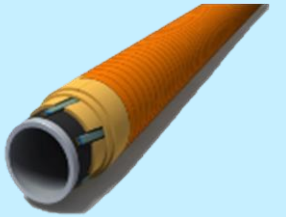
Active heating pipe technologies – Performances

	ETH-HCRAW	ETH-IPB	ETH-PiP	ETH-SP
				
Construction	Flexible Pipe	Flexible Pipe	Pipe-in-Pipe	Wet Insulated
U-Value / OHTC (W/m^2.K)	3 to 6	3 to 6	0.6 to 2	3 to 6
Power requirement (base ETH-PiP)	x 2	x 3	x 1 (reference)	x 5/6 (estimation)
Maximum diameter (inner pipe)	2" to 20" ID	2" to 12" ID	Up to 12" ID (dependent on vessel capabilities)	Up to 16" OD (dependent on vessel capabilities)
Heated length (in one go, size dependant)	up to 12km	up to 12km	up to 50km	Up to 75km (estimation)
Maturity	3 projects	2 projects	1 project + 1 on-going	Under development

Key takeaways

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Key takeaways

- ETH-Technology is a versatile, and cost effective solution for hydrate and wax plug management
- Field proven technology with more than 45km of ETH Pipes successfully delivered to date (80km by end 2020)
- Integrated solution part of a Subsea 2.0 technologies portfolio
- Early engagement
- DTS part of iLoF products for complete field condition performance monitoring solution

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Questions

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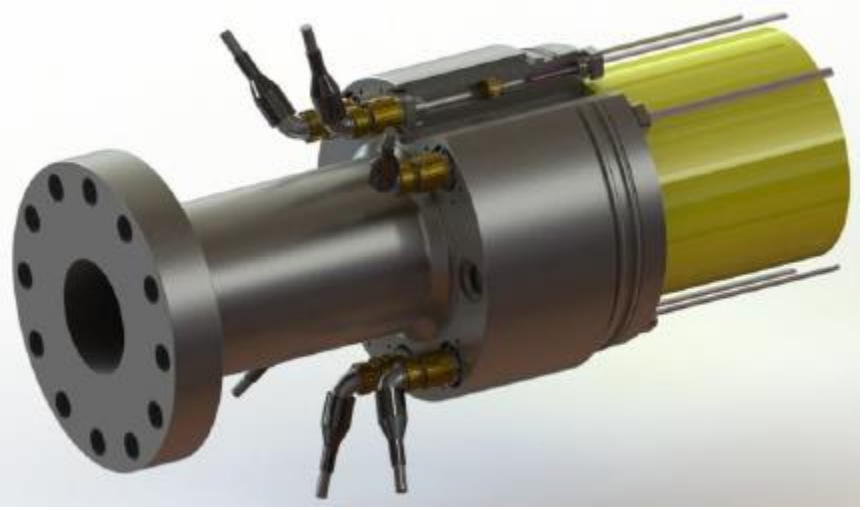
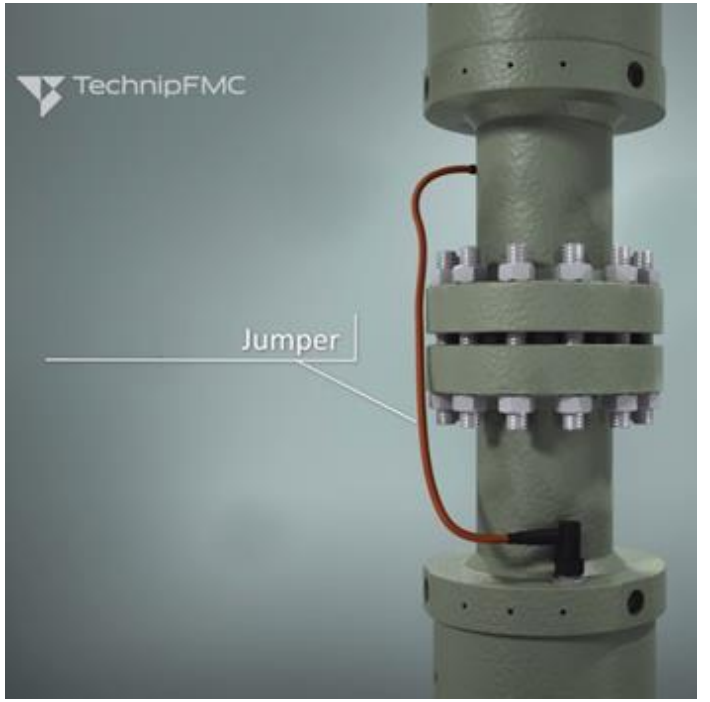
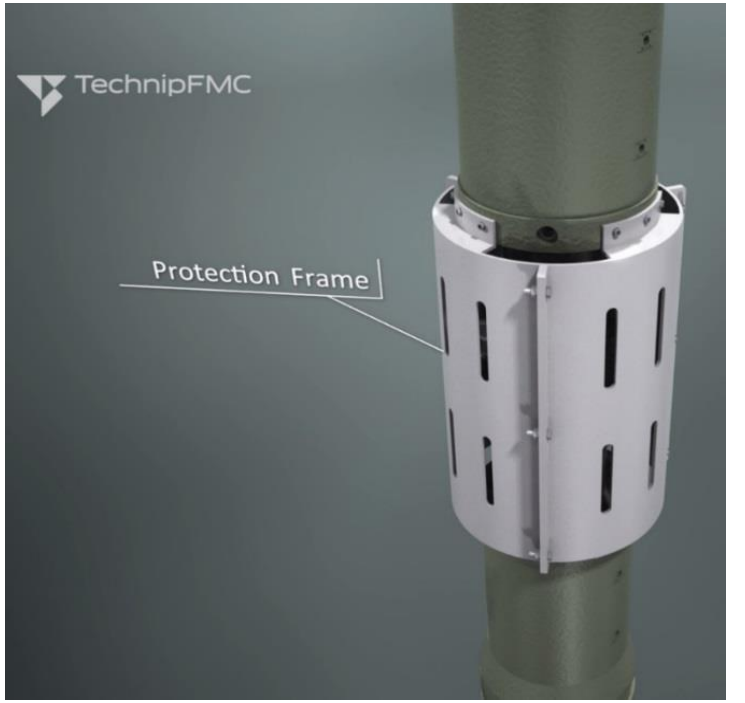
ETH-HCRAW technology – End fitting

- **End Fitting**

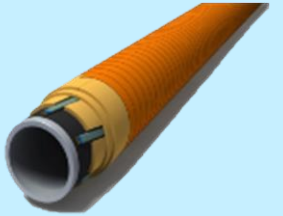






Integration of connector will slightly increase external size of EF

Active heating pipe technologies – Performances

	ETH-HCRAW	ETH-IPB	ETH-PiP	ETH-SP	WET-DEH
					
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U-Value / OHTC (W/m^2.K)	3 to 6	3 to 6	0.6 to 2	3 to 6	3 to 6
Power requirement (base ETH-PiP)	x 2	x 3	x 1 (reference)	x 3	x 10
Maximum diameter (inner pipe)	2" to 20" ID	2" to 12" ID	Up to 12" ID (dependent on vessel capabilities)	Up to 16" OD (dependent on vessel capabilities)	Up to 18" OD (dependent on vessel capabilities)
Heated length (in one go, size dependant)	up to 12km	up to 12km	up to 75km	Up to 75km	Up to 43km
Maturity	3 projects	2 projects	1 project + 1 on-going	Under development	Under development