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Long Distance Subsea Tieback

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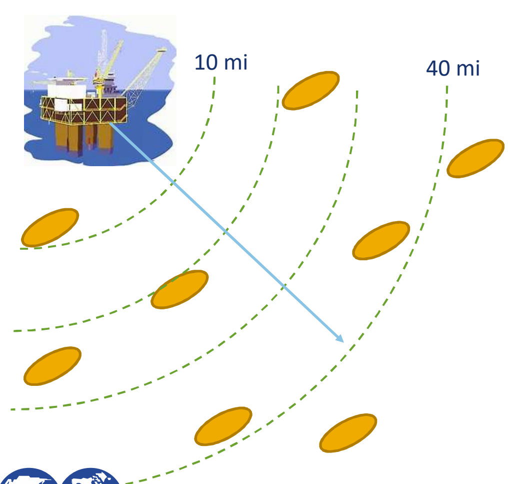
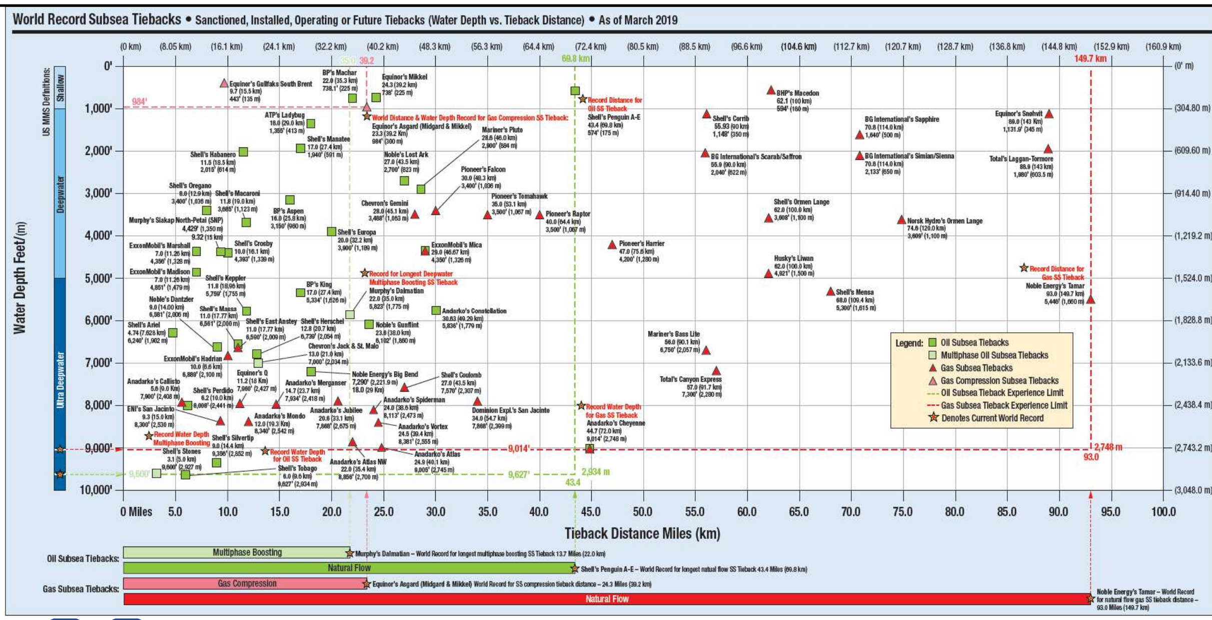
Outline

- Introduction
- Industry Experience
- Key Enablers and Benefits
- Case Study
- Conclusions

Introduction



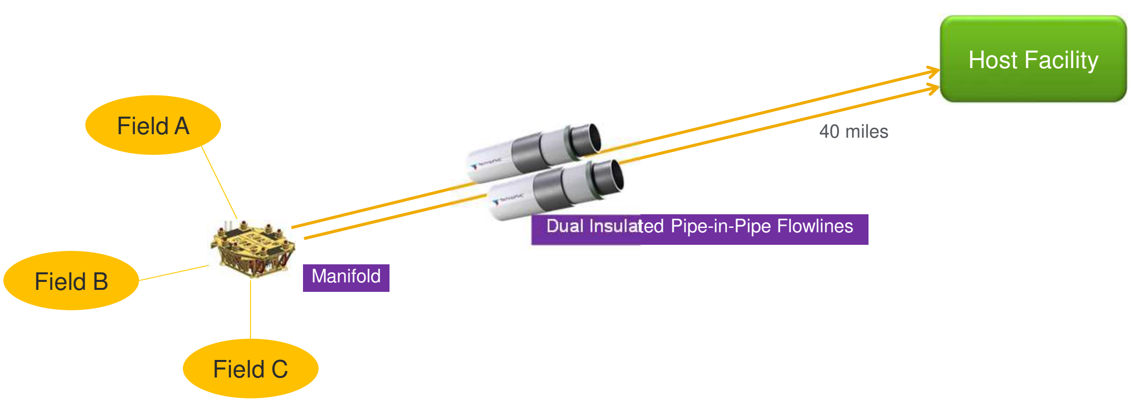
- Marginal and stranded fields
- Most fields cannot afford a dedicated host facility
- Key challenges:
  - Field economics / recoverable reserves
  - Thermal management
  - Long distance transport



Courtesy: Offshore Magazine, 2019 Deepwater Technologies & Solutions for Concept Selection

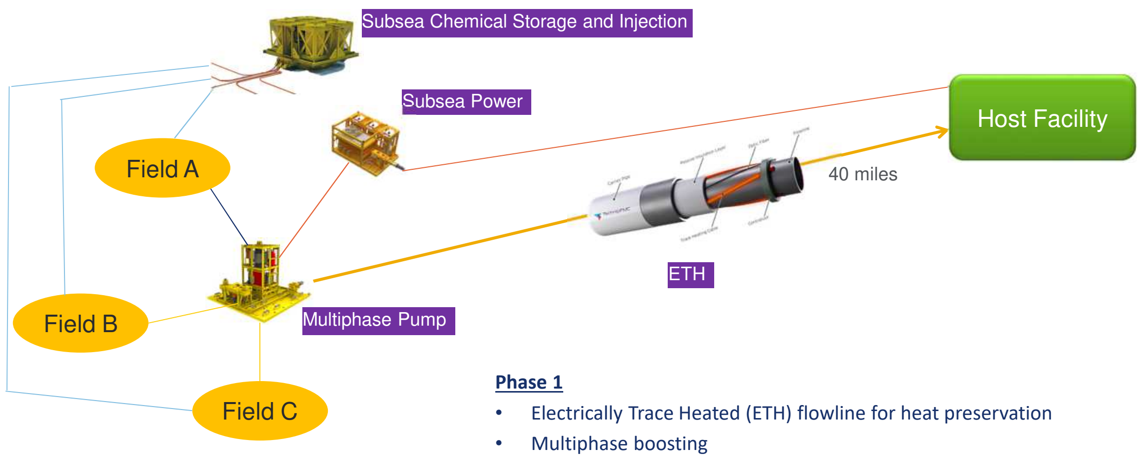
Long Tieback Field Development:

Conventional Approach



Long Tieback Field Development:

Alternate Approach

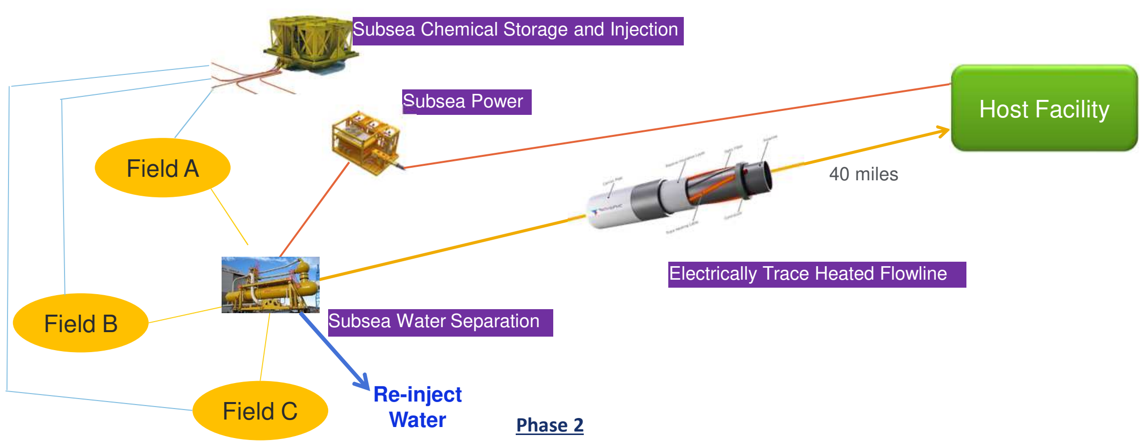


Phase 1

- Electrically Trace Heated (ETH) flowline for heat preservation
- Multiphase boosting
- Subsea power distribution to minimize topside requirements
- All-electric + Subsea Chemical Storage and Injection

Long Tieback Field Development:

Alternate Approach



Phase 2

- **Subsea produced water separation and injection** + Multiphase boosting

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Electrically Trace Heated Flowlines

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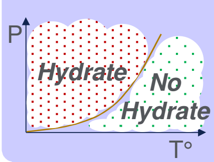
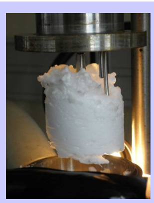
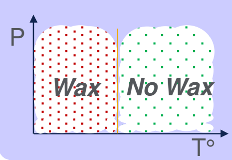
The flow assurance challenge

Hydrate





Wax



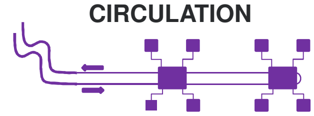
Traditional STRATEGIES

CHEMICALS

Methanol & MEG
Low Dosage Hydrate Inhibitors
Wax Inhibitors

INSULATION

CIRCULATION



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Why use Active Heating?

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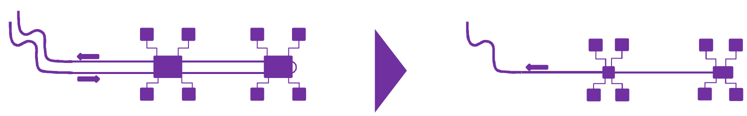
Enabling & Enhancing Technology

- Tie-back distance is too long for circulation
- Required U-value cannot be achieved by traditional strategies
- Flexibility in operation
- Eliminate the need for dual flowlines



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Active Heating Technologies

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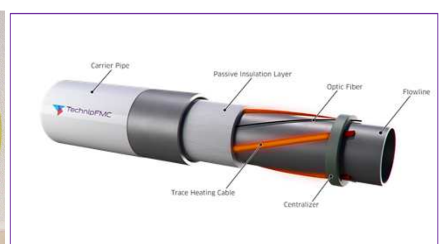
▼ **Hot water heated bundle**	10-off total - 1st by Equinor, Asgard project in 1996
▼ **Direct Electrical Heating (DEH)**	18-off total - 1st by Equinor, Asgard project in 2000
▼ **Heated Integrated Production Bundle (IPB)**	2-off - 1st by Total (IPB), Dalia project in 2004
▼ **Heating Cables Replacing Armour Wires (HCRAW)**	1-off - Lundin, Alta Gotha in 2018
▼ **Electrical Trace Heating – Pipe-In-Pipe (ETH-PIP)**	3-off - 1st by Total, Islay project in 2011

HCRAW

IPB



ETH-PIP

Wet DEH

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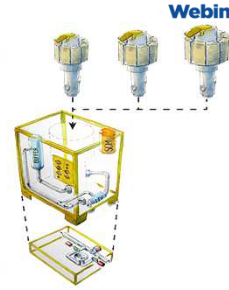
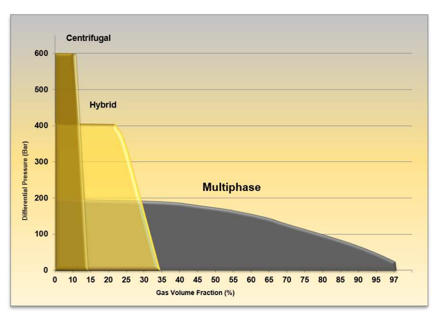
Subsea Boosting and Processing

Subsea Boosting System

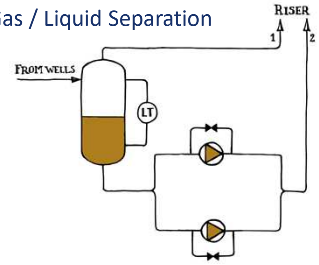
- High-speed multiphase, single phase or hybrid pumping systems using a standard frame
- Efficient pump technology:
  - Shaft power: up to 6 MW
  - Max. Speed: 6,000 rpm
  - Max. Temperature: 350F
  - Water depth: 10,000 feet
- Modular, standard design
- Retrievable components for maintenance / high uptime



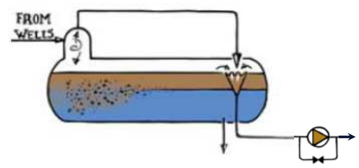


Subsea Separation System

Gas / Liquid Separation



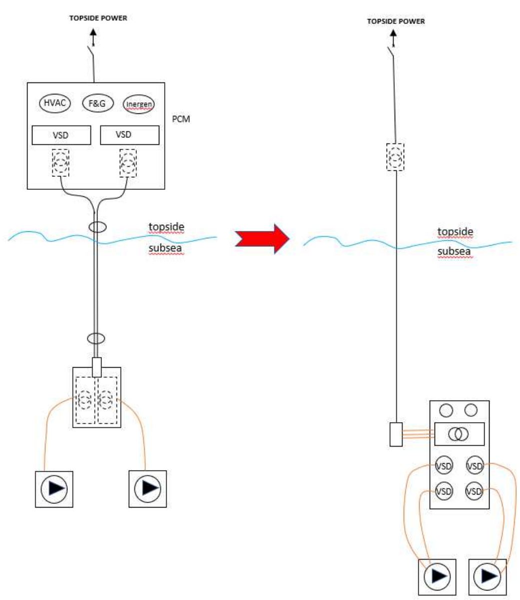
Liquid / Liquid Separation

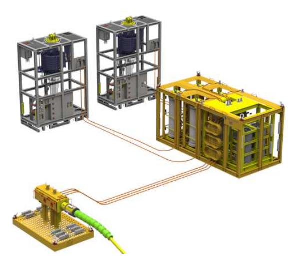


Example: Pazflor - Angola

Example: Tordis – North Sea

Subsea Power Distribution enables long tie-back projects





Spotlight on new TECHNOLOGY

Subsea Power Distribution

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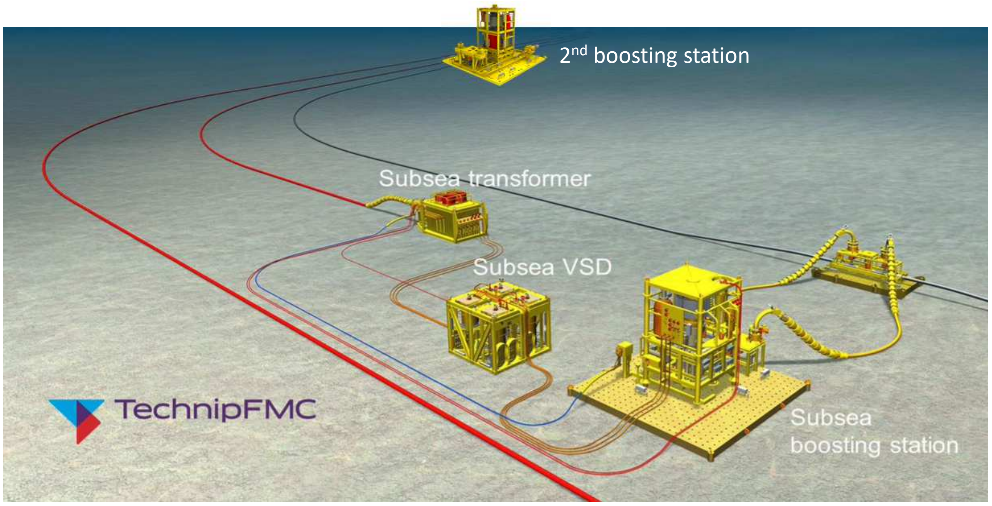

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All Electric Subsea System

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All-Electric Subsea System

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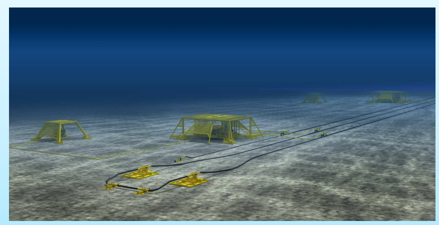
- Replace hydraulic actuators with electric
- > 10 million hours operating experience with subsea electric actuators
- Eliminate hydraulics and topside HPU
- Applicable for all subsea valves and chokes

- Enables long distance subsea tiebacks
- CAPEX savings from lower umbilical hardware cost, topsides and installation
- OPEX savings



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Subsea Chemical Storage and Injection System

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Subsea Chemical Storage and Injection System (SCS&I)

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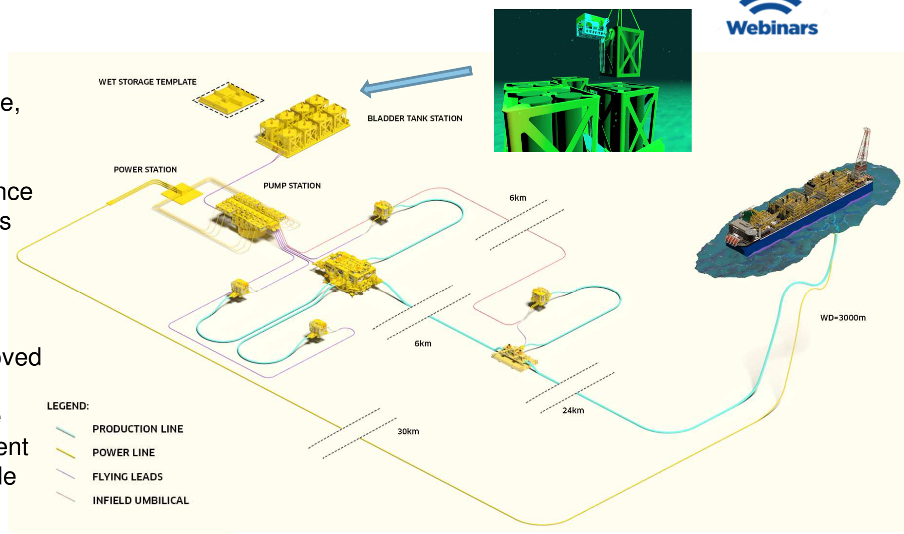
Drivers

- **Long tie-back**, deep water, subsea to shore, HSE (host)
- De-bottlenecking
- Complex flow assurance
- Challenging chemicals
- All-Electric controls

SCS&I

- Tanks and pumps moved subsea
- Tanks filled at service base before deployment
- Modular and adaptable



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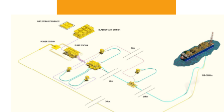
SCS&I for Green field - Case Study



Greenfield Design Case Study:

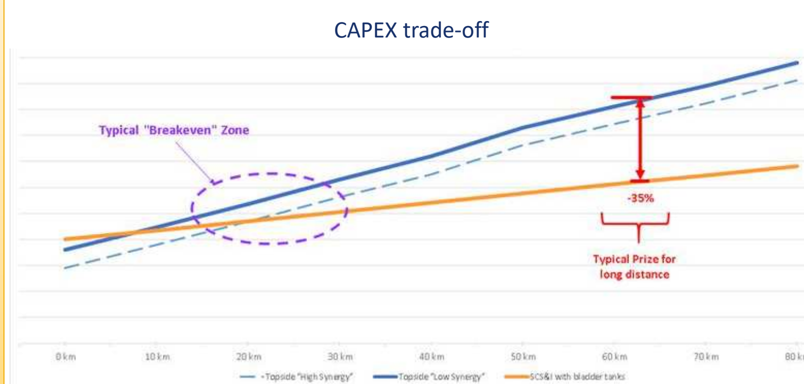
- 3000 meters water depth
- Batch chemicals (Methanol, LDHI, Biocide)
- Continuous injection (Corrosion inhibitor, scale inhibitor)

SCS&I versus conventional

- Substantial CAPEX reduction
- OPEX difference is not significant

Main benefits:

- Umbilical simplification
- Eliminate topside modifications / space
- Improved HSE



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SCS&I for Drag Reducing Agent (DRA)

Oil Field with low pressure and flow line friction challenges

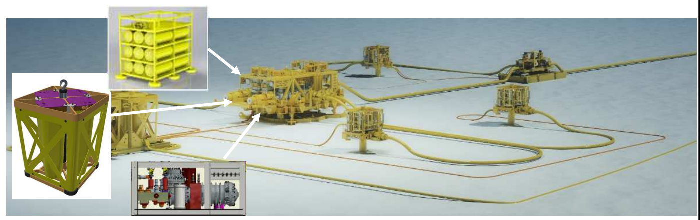
- 1100 meters WD and 13 km to host
- 690 barg design pressure
- 120 bara Flowing pressure

Continuous friction loss mitigation required

- Highly viscous chemical
- One 32 m^3 tank
- Battery trickle charged
- DRA injection pump

Injection of DRA:

- Can increase production by 5 to 20%
- Increase revenue by 30 MUSD/year
- Cost of SCS&I paid for in less than a year.
- *Beneficial for long tie-backs with high friction*

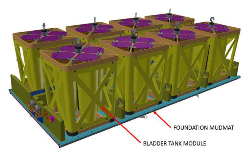


System Simplification

All-Electric Subsea System

+

Subsea Chemical Storage & Injection System



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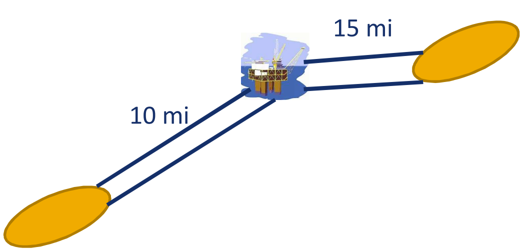
Simplified Marine Power Cable

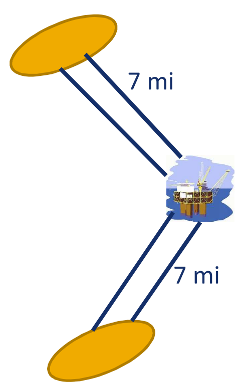
Long Distance Tieback Case Study

Long Distance Tieback Case Study

Conventional Approach:

- Two Hosts
- Dual flowlines

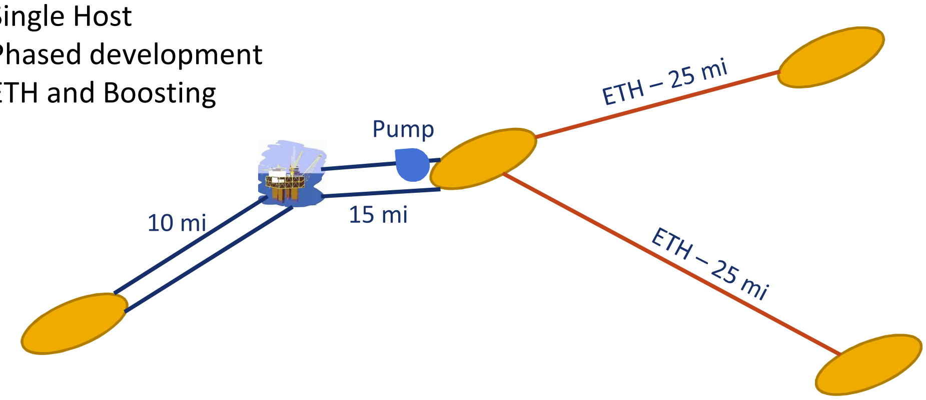




Reference: OTC 29319-MS • Phased Deepwater Developments: Subsea Long-Distance Tie-Backs

Long Distance Tieback Case Study

Alternate:
- Single Host
- Phased development
- ETH and Boosting



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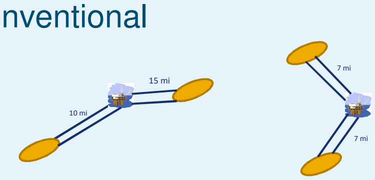
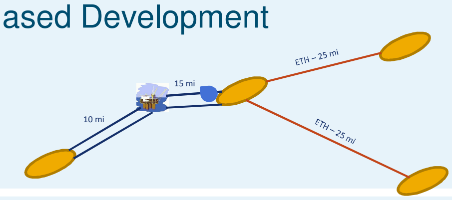
Case Study Comparison

Conventional	Phased Development
	
• Higher CAPEX • More risk • Higher OPEX • Higher carbon footprint	• Substantially lower upfront investment • Early cash flow • Lower risk as early cash flow funds future phases • Lower carbon footprint

Reference: OTC 29319-MS • Phased Deepwater Developments: Subsea Long-Distance Tie-Backs

Summary

- Key technology building blocks to enable long distance tiebacks are available
- Flow assurance considerations are critical for long distance transport
- Economics depend on reserves size, offset distances and field architecture

Q&A