Deep Offshore Developments – Subsea / Topsides Integrated Approach

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SUMMARY

1. Subsea Processing - Integrated Methodology

2. Case Study Description

a. Conventional Architecture

b. Advanced Architecture

3. Subsea Processing Selection

4. Impact on other packages

Flowlines Design

Subsea Layout

Electrical and Umbilical

Floating Facilities and Topsides Layout

5. Availability, Schedule and Cost elements

Conclusion

SUBSEA PROCESSING - INTEGRATED METHODOLOGY

IMPACTS ⟷ IMPACTS

Subsea

- Flow Assurance
- Pipeline Design
- Riser Design
- Umbilicals
- Structure

Subsea Processing

- Process,
- Flow Assurance,
- Rotating, Electrical,

Topsides

- Process,
- Rotating, Electrical
- Layout
- Naval
- Instrumentation

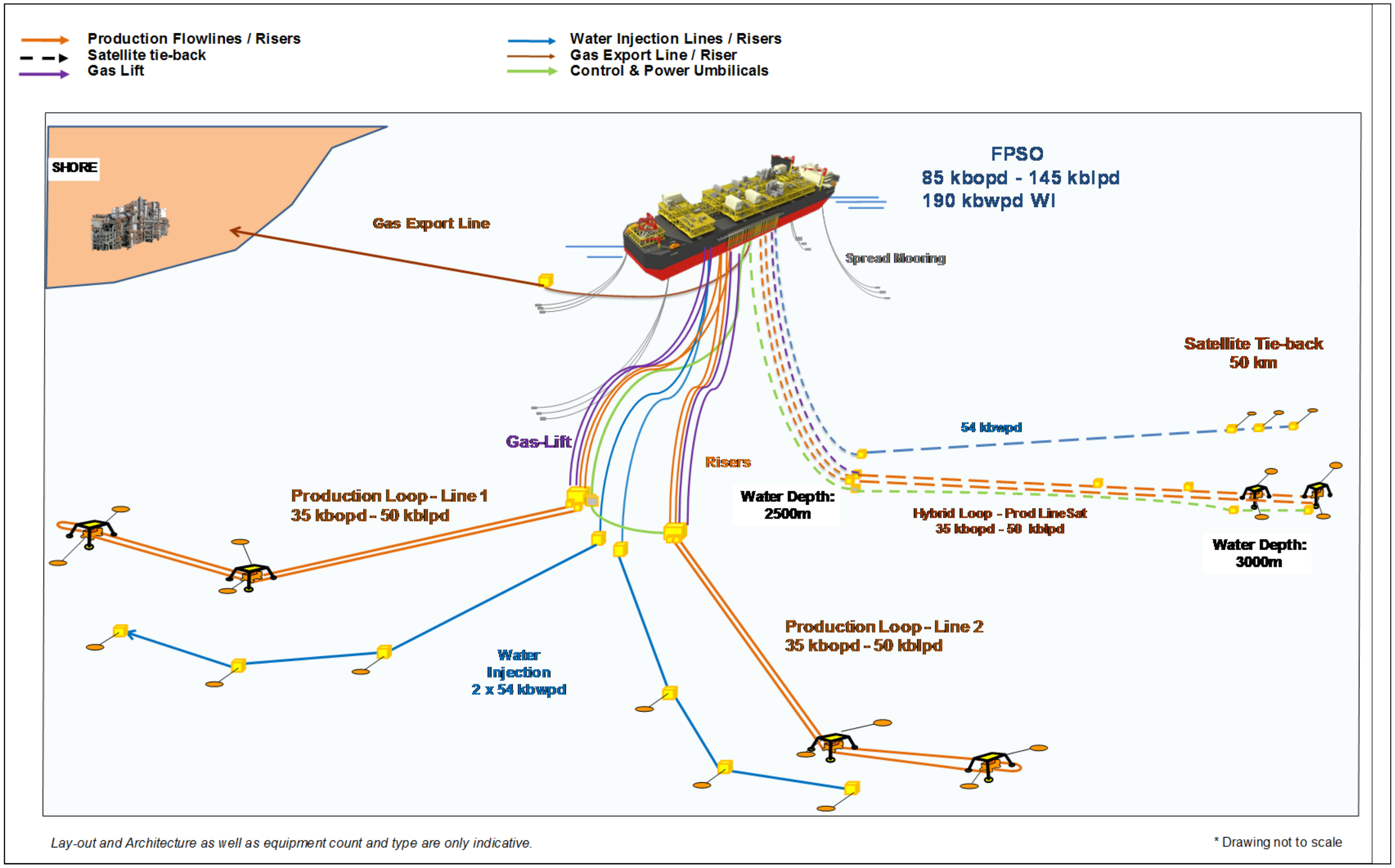
INTERFACE MANAGEMENT

INTEGRATION

- OPERABILITY
- MAINTAINABILITY
- HEALTH, SAFETY, ENVIRONMENT
- PROJECT
- BUSINESS DRIVER

CONVENTIONAL ARCHITECTURE (W/O SUBSEA PROCESSING)

proven and approved technologies for FPSO, subsea flowlines and risers

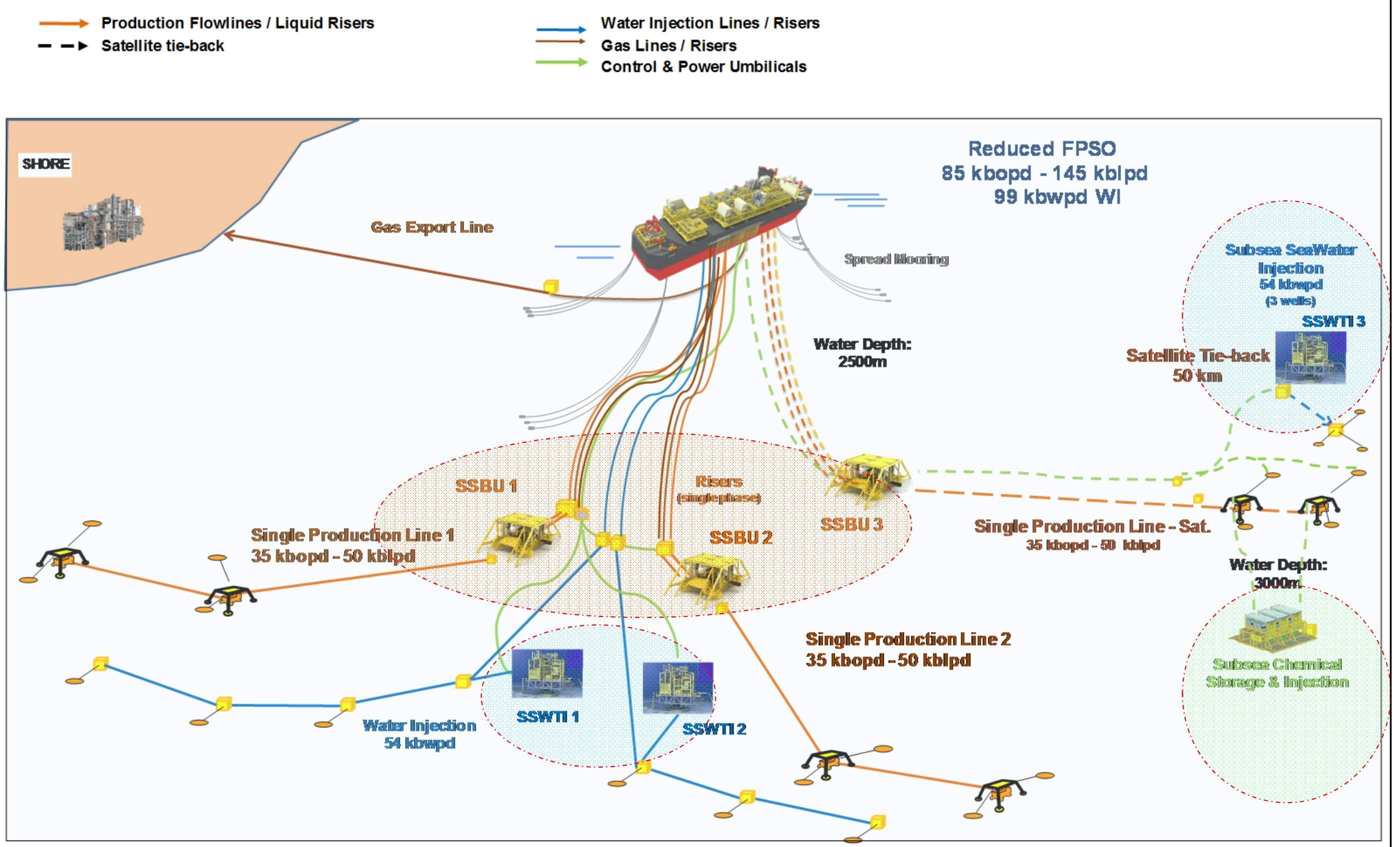


Lay-out and Architecture as well as equipment count and type are only indicative.

* Drawing not to scale

ADVANCED ARCHITECTURE (WITH SUBSEA PROCESSING)

cutting edge approach encompassing advanced industry approved components and technologies



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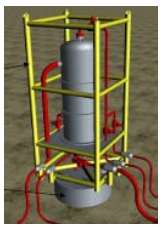
SUBSEA PROCESSING SELECTION

❑ Choice based on following Criteria

- ***Technologies mature in 2020, modules weight limited to 400t***
- ***Selection criteria: HSE, Cost, Performance, Operation, Project execution***

❑ Main Selection drivers and impacts

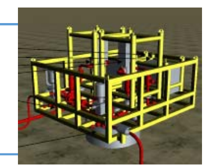


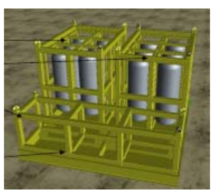
Separator

- Located at riser base with gas free flowing to the Topsides
- Pressure selected to minimise Topsides Compression and Subsea Boosting
- More flexible operations

Pump

- Selection of an Hybrid pump for all operations
- Removal of Gas Lift requirement
- Impact on the Umbilical (control, fluids, electrical)



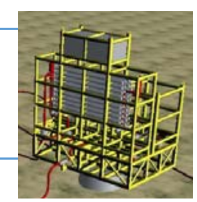


Chemical Storage and Injection

- Located close to the Satellite Wells
- Impact on Umbilicals, Electrical and Topsides facilities designs

Seawater treatment and injection

- Located close to the Water Injection Wells
- Impact on Riser, Flowlines and Topsides facilities design



FLOWLINES DESIGN

	CONVENTIONAL	ADVANCED
Main Field	Loop Lines 2 x 2 x 8” ID Wet insulated	Single Line 2 x 1 x 8” ID Wet insulated & active heating
Satellite Field	Hybrid Loop Lines 1 x 12” ID PiP 1 x 12” ID service line	Single Line 1 x 9” ID Wet insulated & active heating

ADVANCED ARCHITECTURE :

OPERATION Philosophy

- **Intermittent heating (Main Field)**
- **Continuous heating (Satellite)**

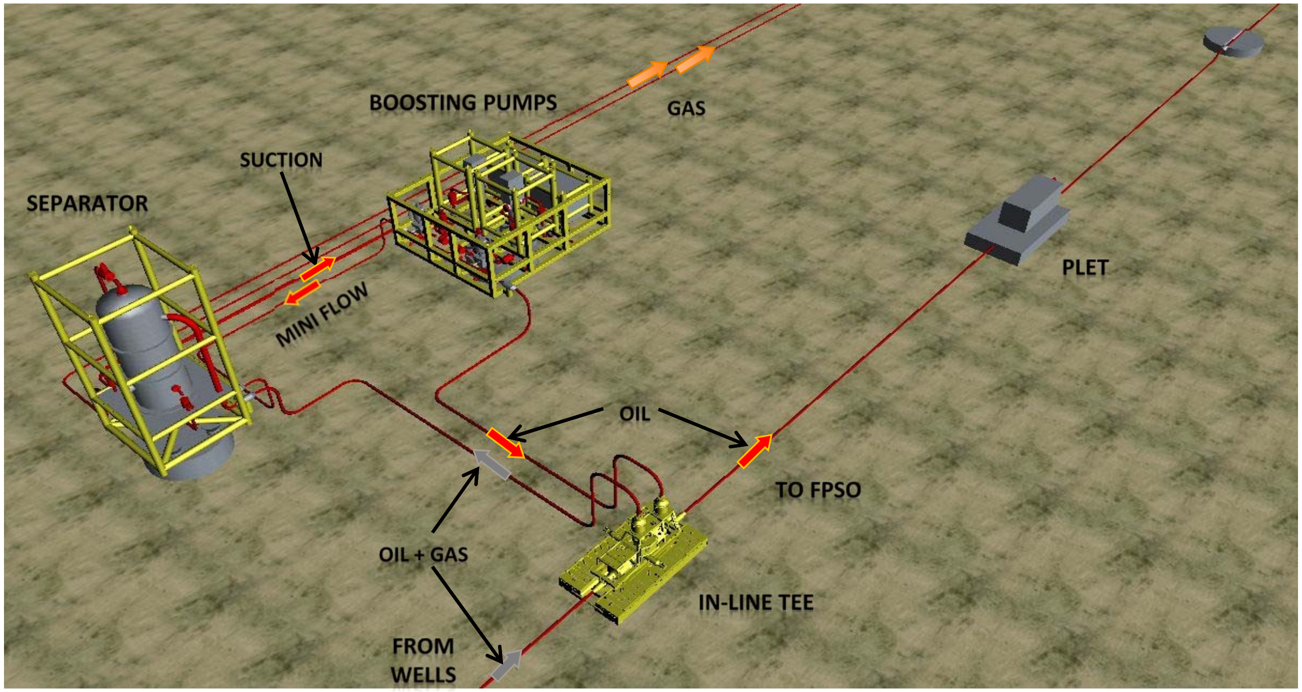
TECHNOLOGY - Active Heating

- **DEH wet insulated single pipe**
- **Trace Heated Single Pipe**

Best Thermal management
Easier Operation: shutdown, restart, preservation
Reduction of Subsea Lines and Sizes

SUBSEA LAYOUT – RISER BASE

ADVANCED ARCHITECTURE :



Module Arrangement Design with Process and Installation constraints

ELECTRICAL and UMBILICAL SYSTEMS

	CONVENTIONAL	ADVANCED
Subsea Power Requirement	Only control	SSP Equipment, Active Heating, Control 15 MW Main Field 7 MW Satellite
Umbilical Main Field	1 x 5'' OD – Wellhead	1 x 5'' OD – Wellhead 1 x 7'' OD – Active Heating 2 x 6'' OD – SSP Equipment
Umbilical Satellite	1 x 9'' OD – Wellhead	1 x 6'' OD – Power Cable to Tie-back + Wellhead 1 x 8'' OD – SSP Equipment + Active Heating

ADVANCED ARCHITECTURE :

Main Field

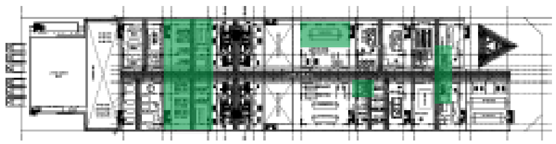
- **No Electrical showstopper**
- **Power through Umbilicals**

Satellite

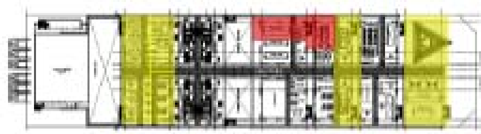
- **Long Distance Transport**
- **Flowline Active Heating**
- **Simplified Umbilical**

FLOATING FACILITY AND LAYOUT

❑ **Conventional Architecture**



❑ **Advanced Architecture**



REMOVED

- SW treatment
- 1st stage separator
- Oil circulation
- Gas Lift

REDUCED

- Utilities
- Water Injection
- HP Compression
- Flare

INCREASED

- 2nd stage separator
- MP Compression

ADVANCED ARCHITECTURE :

Reduction in Hull size (up to 30m)
Reduction in Topsides weights (-12%)

AVAILABILITY, SCHEDULE AND COST ELEMENTS

ADVANCED ARCHITECTURE :

❑ Availability

Subsea Processing equipment failure has minimal impact on the global production availability (RAM study)

❑ Project Schedule

FPSO construction time can be reduced due to less Topside

❑ Cost elements

i. Equivalent global CAPEX compared to the conventional Architecture but SSP costs could be optimised
ii. Cost savings with :

SURF Main Field:	-13%
SURF Satellite Field:	-30%
FPSO:	-10%

iii. Potentially increased reserves thanks to lower subsea tie-in pressure

CONCLUSION

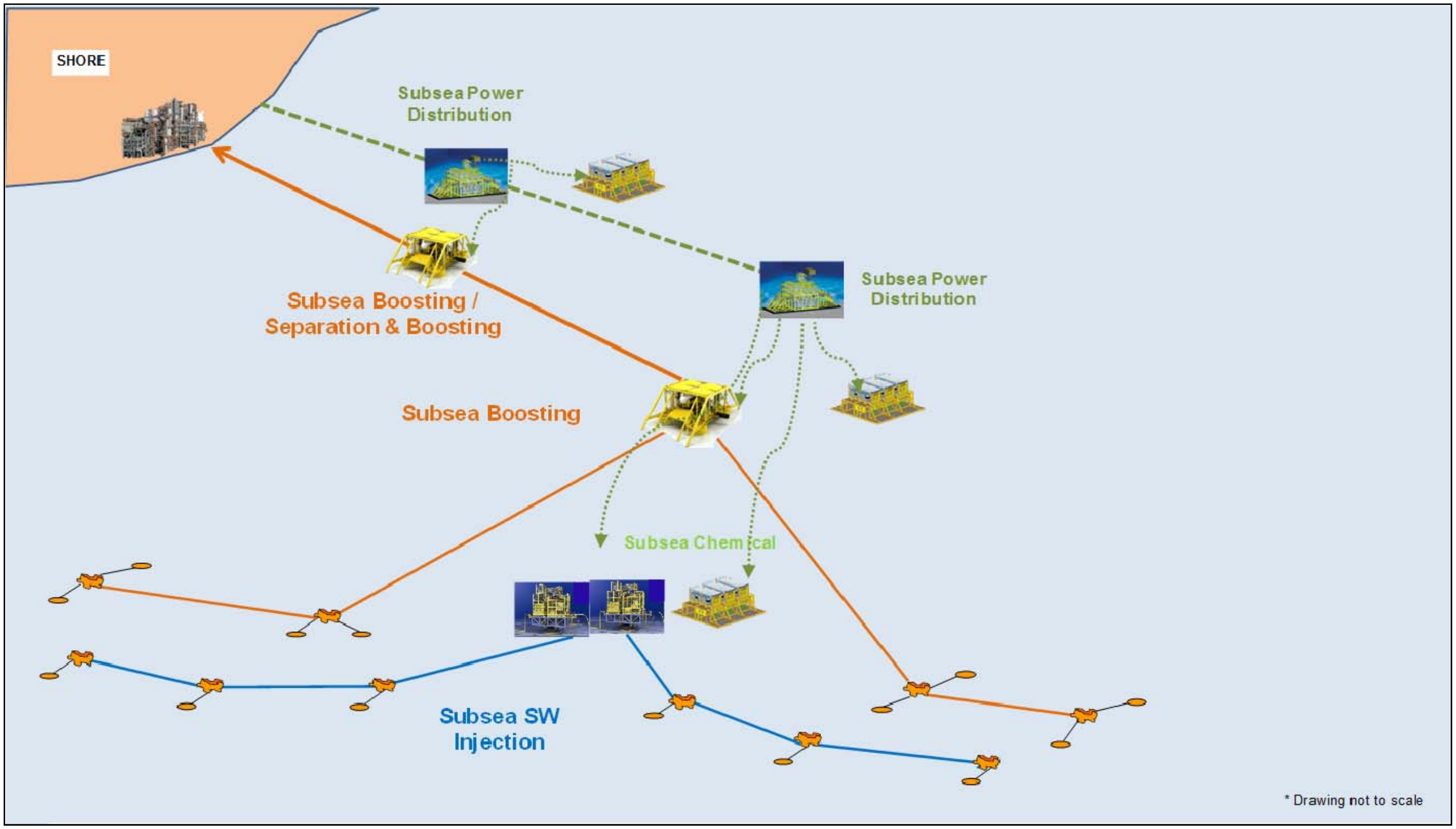
- **Advanced subsea architectures including Subsea Processing and Active Heating are economic enablers for developing deepwater fields and very long tie-backs.**

- **Integration of Subsea Processing equipment brings the following benefits compared to a conventional approach:**
  - ***Simplified SURF system combined with active heating***
  - ***Smaller and lighter FPSO***
  - ***More flexible operations***
  - ***Increase of Reserves with the Subsea Separation & Boosting***

- **Subsea / Topside integrated approach is paramount for a project's success**

- **Opportunities for a « full subsea to shore » project are currently investigated**

SUBSEA TO SHORE PERSPECTIVE



Subsea to Shore Concept without floater support is being studied

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Questions ?