

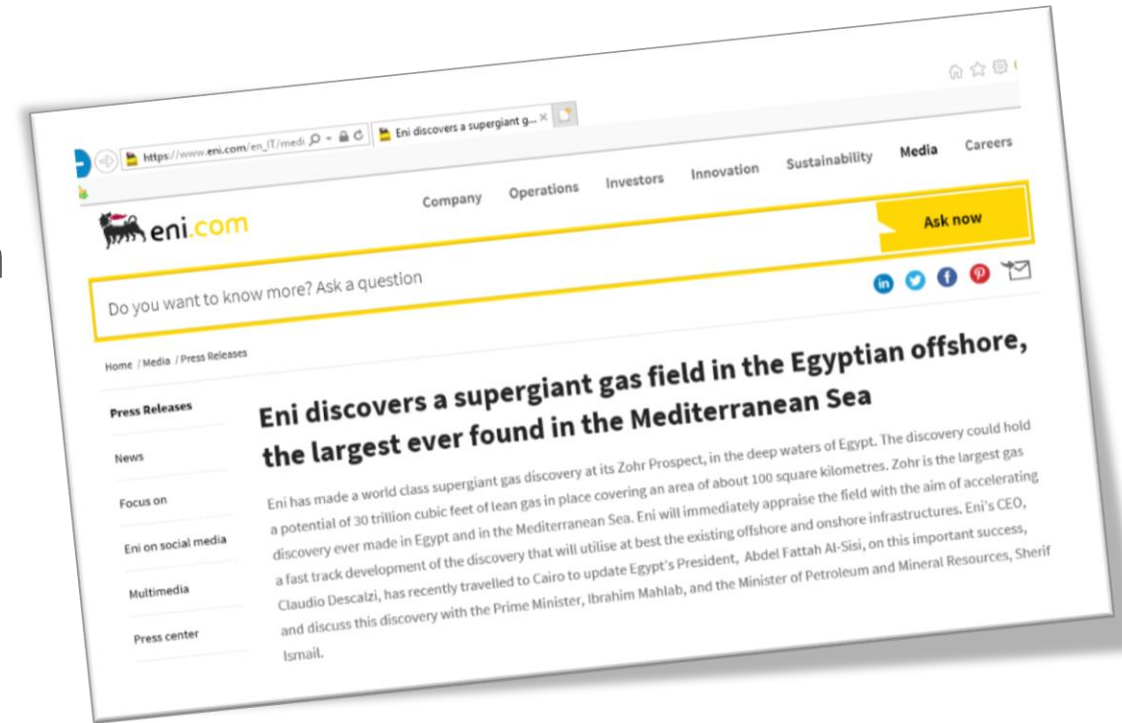
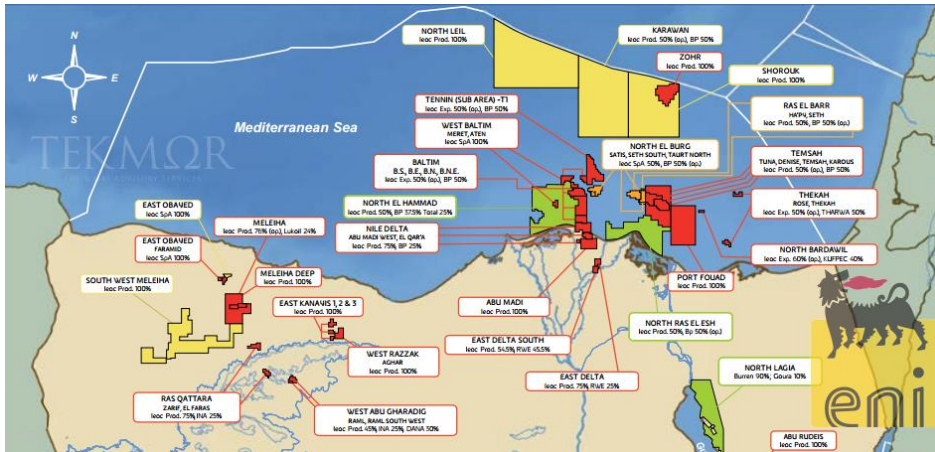
Zohr Gas Field: Successful Demonstration of a Supplier-Led Solution for Fast-Track Subsea Development

Christophe Viellard
OneSubsea – Integrated Solutions



Introduction to the Zohr Field

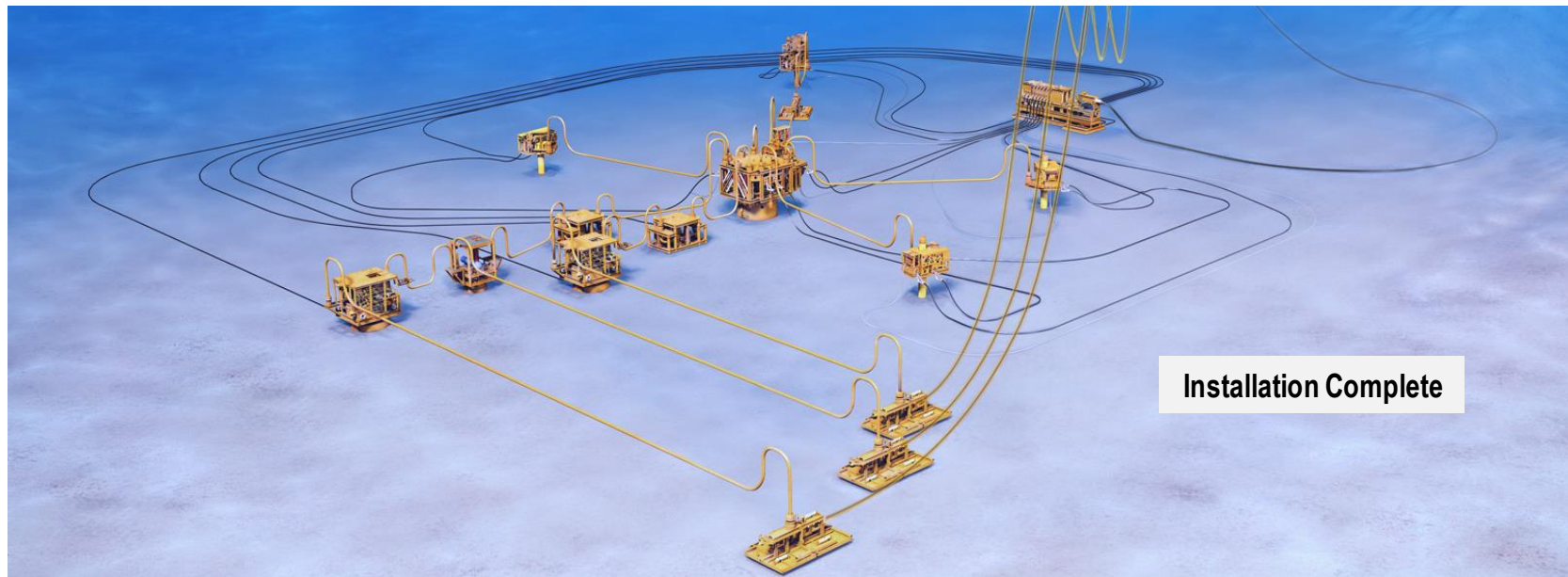
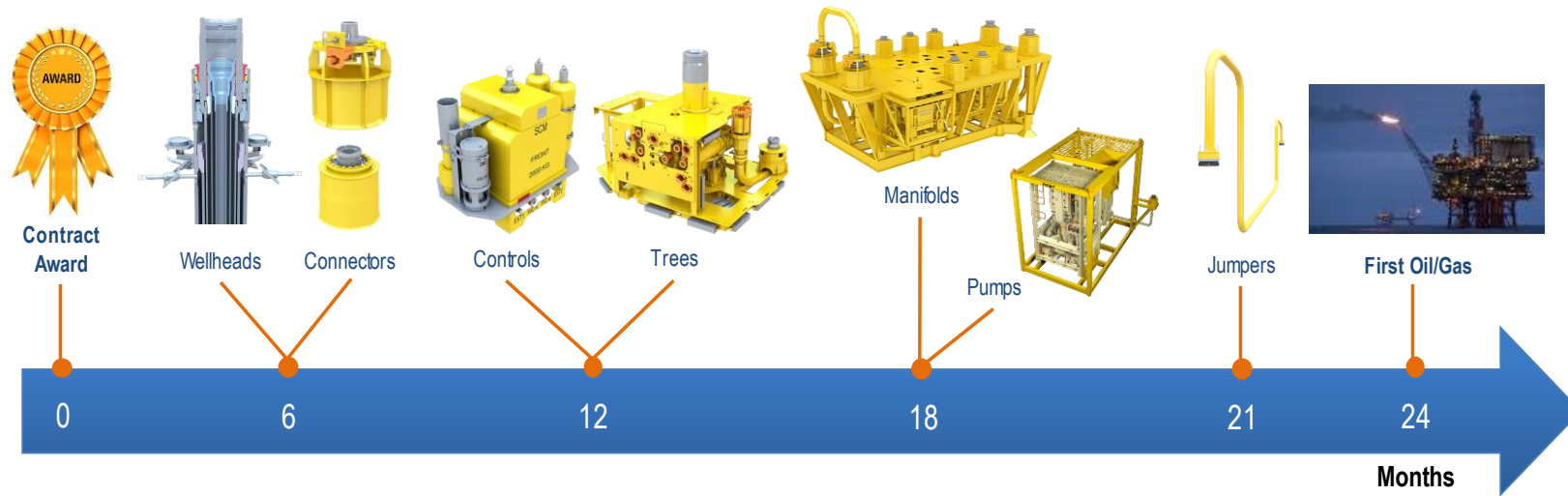
- Biggest gas discovery ever in the Mediterranean
30 TCF
- Longest subsea tie-back ever
220 km
- Deep water
1400 – 1800 m



The field promises to satisfy local demand for gas:

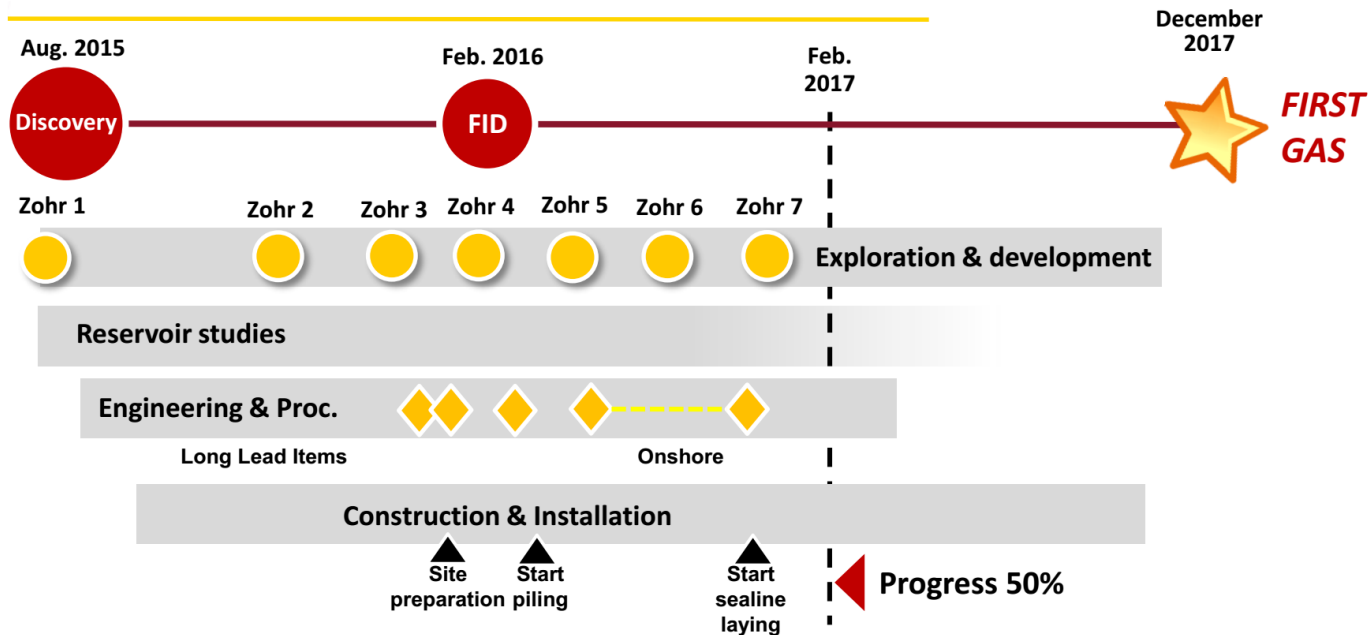
- Halt LNG imports at high cost (2018)
- Transform country back into a gas exporter (2019)
- Third LNG terminal shall be built if needed
- **Fast-track development schedule**

How to achieve 1st oil/gas in 24 months : installation timeline



In practice: Zohr Timeline

Zohr: countdown to first gas



Source: Eni 2016 Annual report

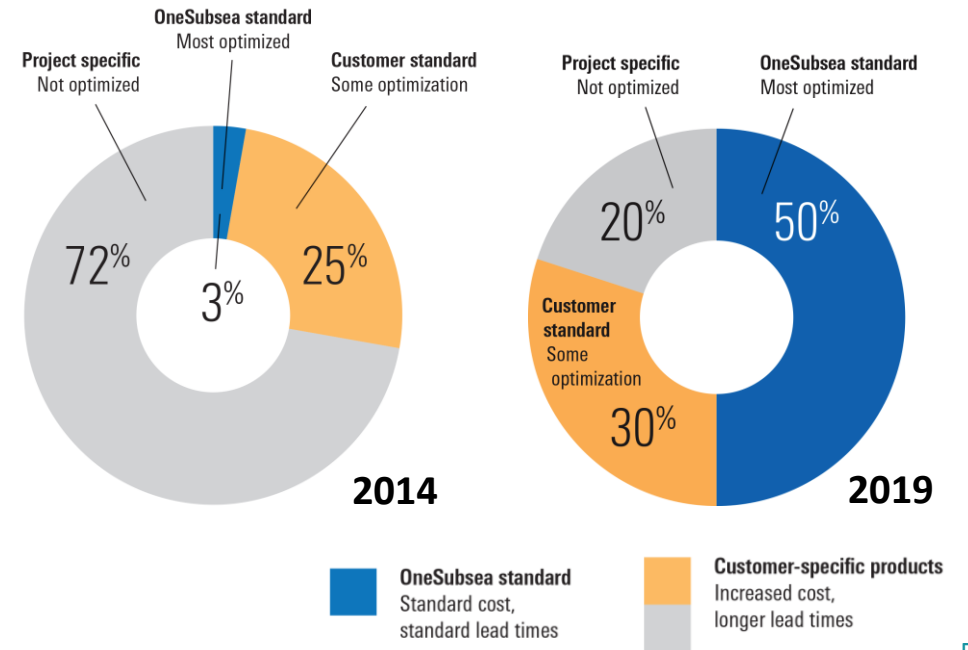
From discovery to 1st gas in
2 years and 4 months:

- Discovery: Aug. 2015
- Early Engagement: Sept. 2015
- FID: Feb 2016
- Contract Award: Mar. 2016
- First UTA batch: Oct. 2016
- First XT: Jan. 2017
- First HIPPS module: Feb. 2017
- First Gas: Dec. 2017

Supplier-Led Solution & Standardization

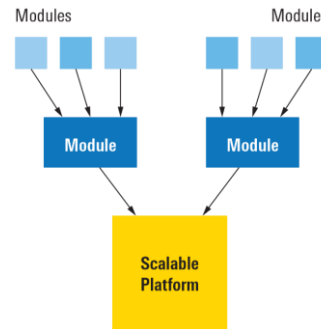
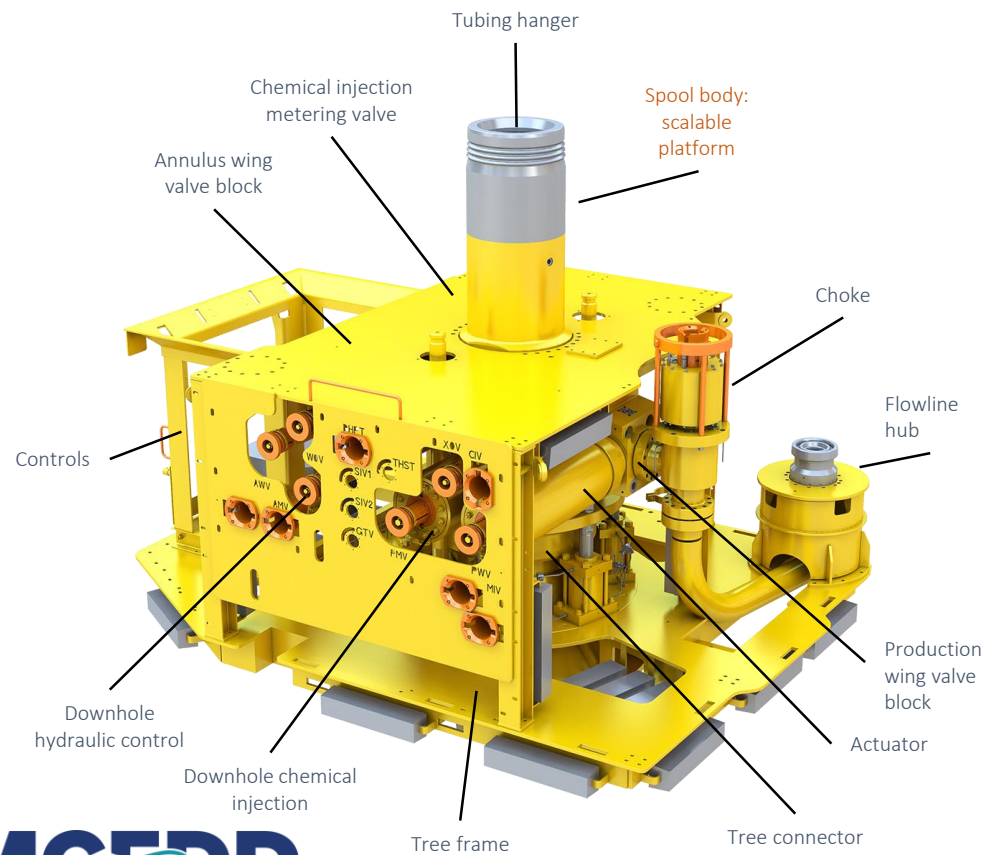
A supplier-led solution consists of standard products and field architecture optimization. The objective of standardization is to help operators balance reliability, performance, and capital efficiency over the life of the field. It enables the optimization of:

- Safety
- Quality
- Schedule
- Cost

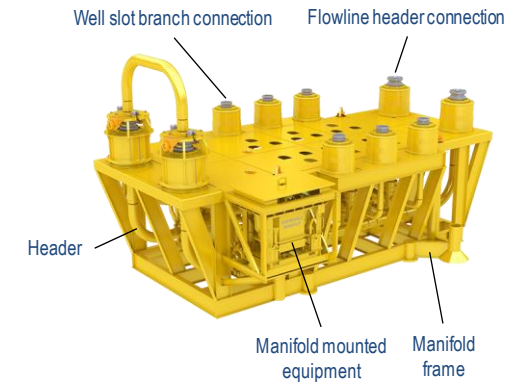
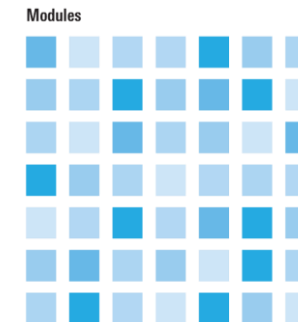
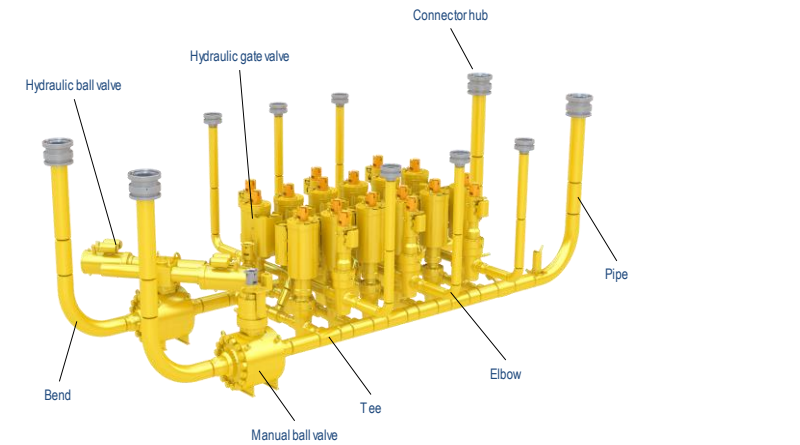


Standardization Strategies

Subsea Christmas Tree available to the project (2015): 5-inch Horizontal 10kpsi
Validation required: bore size, geometry, design temperatures, etc.



Modular strategy



Assembly Kit strategy

Validation of Supplier-Led Approach

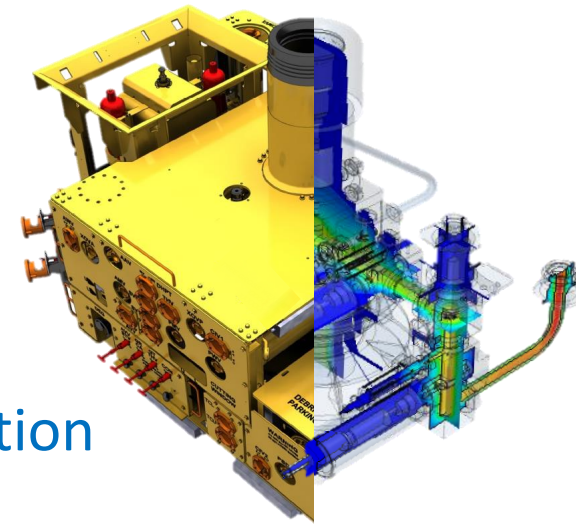
A few design challenges:

- High gas flow rates
- Assumed sand production
- High shut-in pressure
- Limited MEG supply
- Flow metering not possible (schedule)

Flow-induced vibration
Erosion

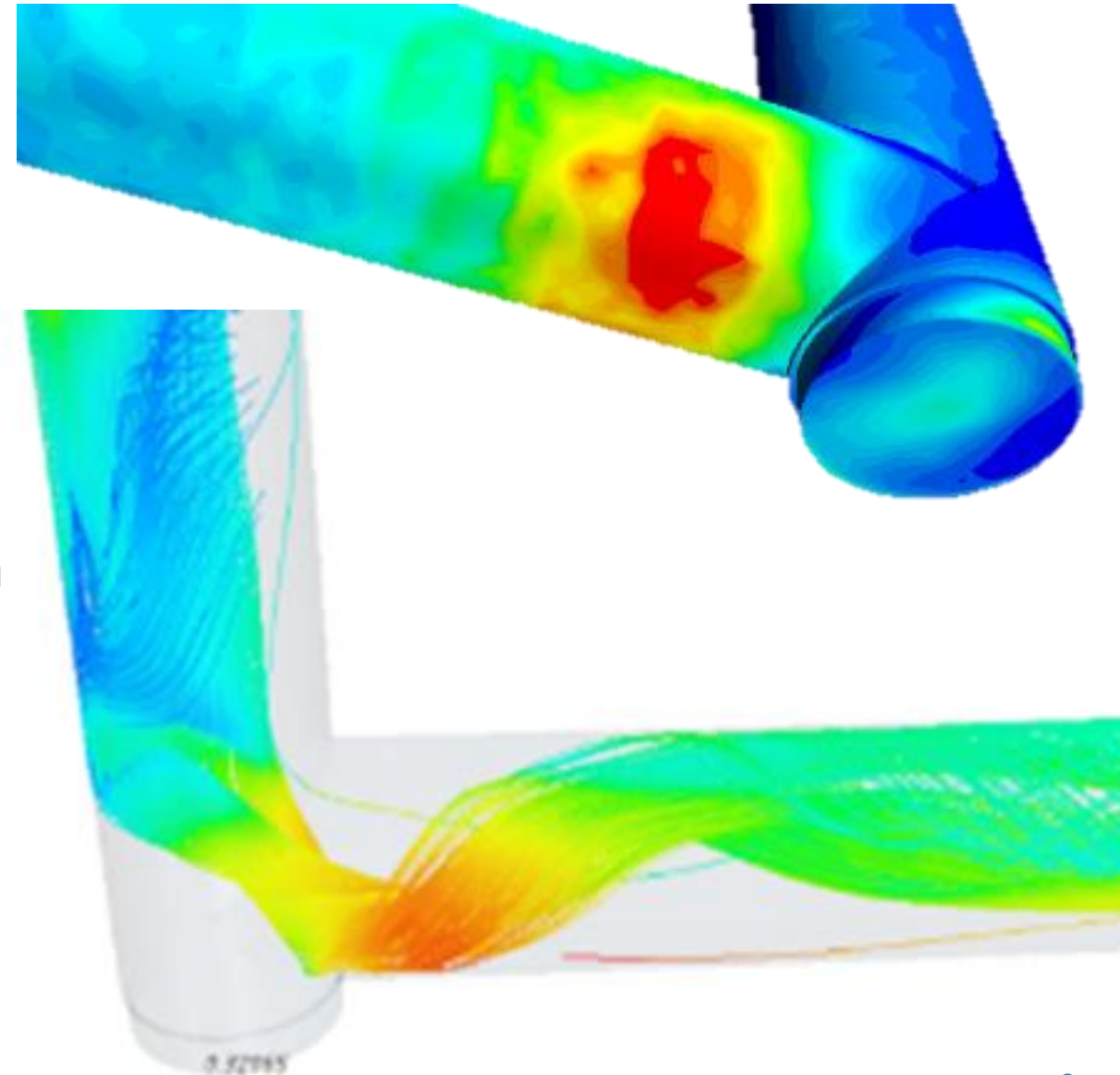
Subsea HIPPS
Well start-up guidelines

Hydrate Management
Measurement workflows



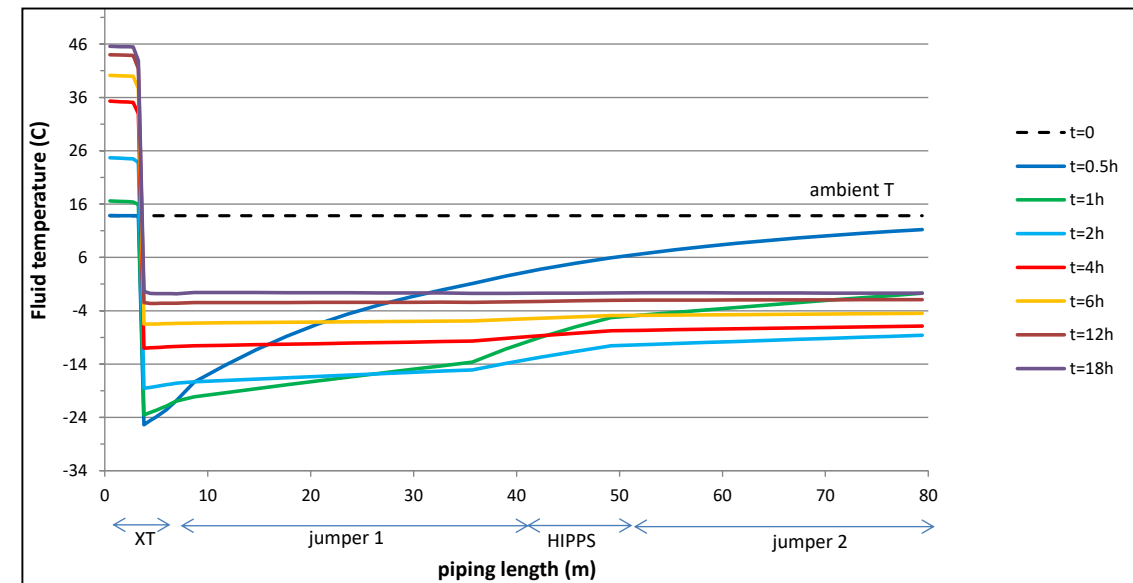
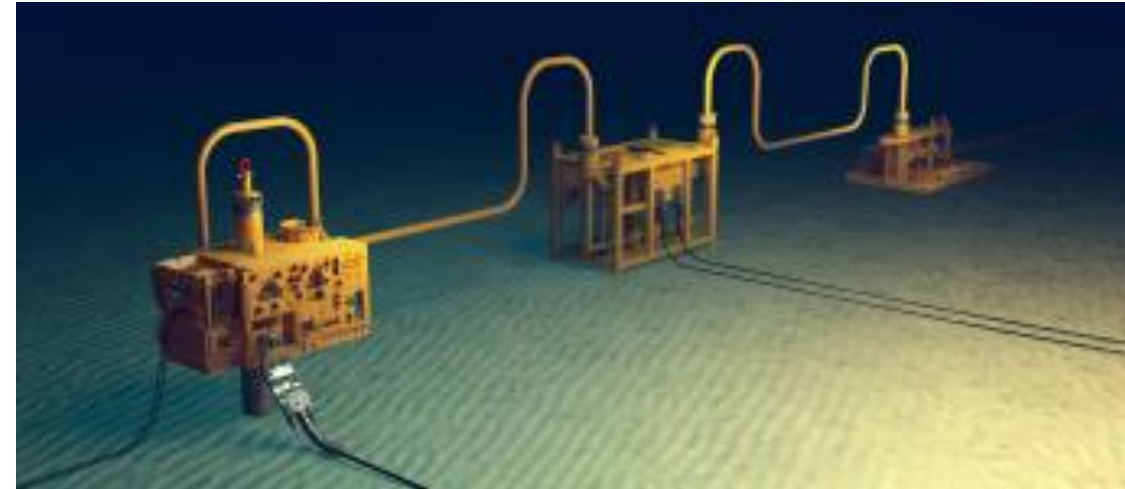
Flow Assurance Validation – Erosion & FIV

- Review of compatibility between subsurface and production system design assumptions
 - Reservoir type, completion design and cladding
- Using exact representation of equipment geometry
- Accounting for compositional data, production profiles and flowline operating conditions
- Benchmarking of results using advanced modelling techniques



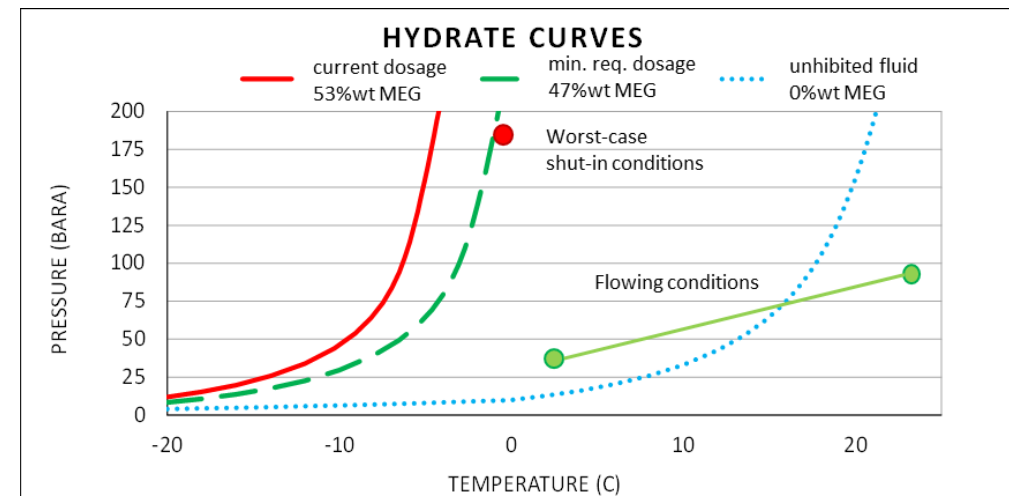
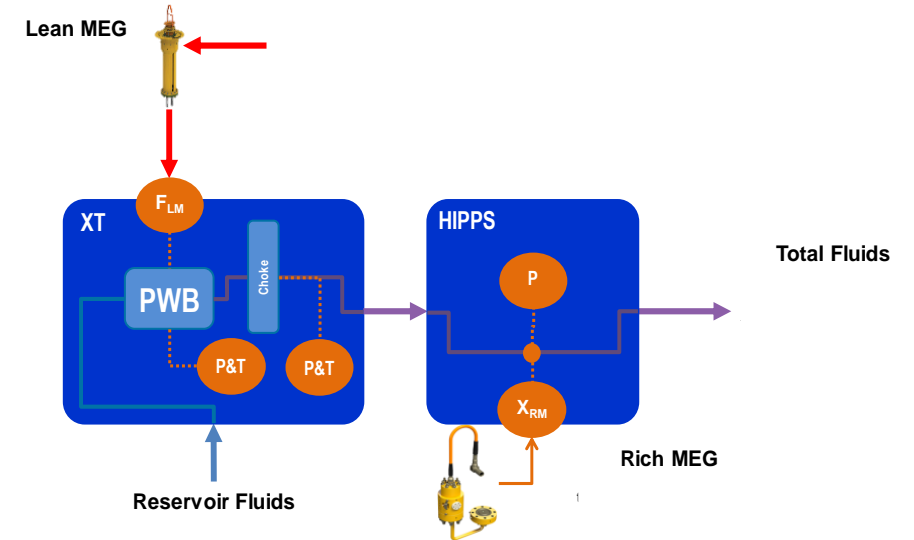
Flow Assurance Validation: Dynamic System Behavior

- Verify subsea HIPPS settings and operability
 - Dynamics of pressure build-up
 - Reset pressure dynamics
- Validate SPS design temperatures
 - Minimum material design temperatures
 - Propagation of cold downstream choke
- Establish well start-up and restart guidelines
 - Methanol & MEG injection capacity
 - Flowline pressure management
- Develop hydrate remediation strategies
 - Depressurization feasibility study



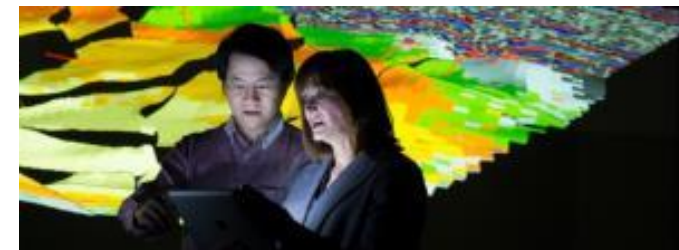
Flow Assurance Validation – Production Management & Optimization

- Using available measurements to manage production
 - Validate/drive minimum requirements
- Innovative application of subsea water-analysis sensor
 - Real-time hydrate inhibition monitoring & optimization
 - Detection and estimation of formation water rates



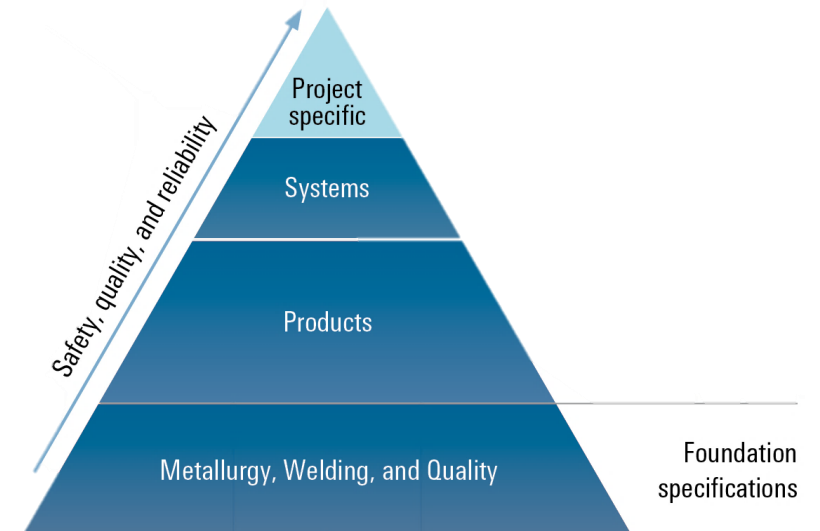
Lessons Learned

- **Flow assurance** provides a critical set of specialist skills and analyses required to validate the application of standard equipment and supplier-led specifications.
- **Early engagement** is highly beneficial to accelerate execution and enhance value.
- **Petro-technical expertise** is very important early-on in a typically hardware execution focused project.
- **Integration** between project disciplines is critical to ensure alignment on assumptions and their impact on design & feasibility for other disciplines.
- **Operational support** ensures most value is extracted from subsea sensors & measurements



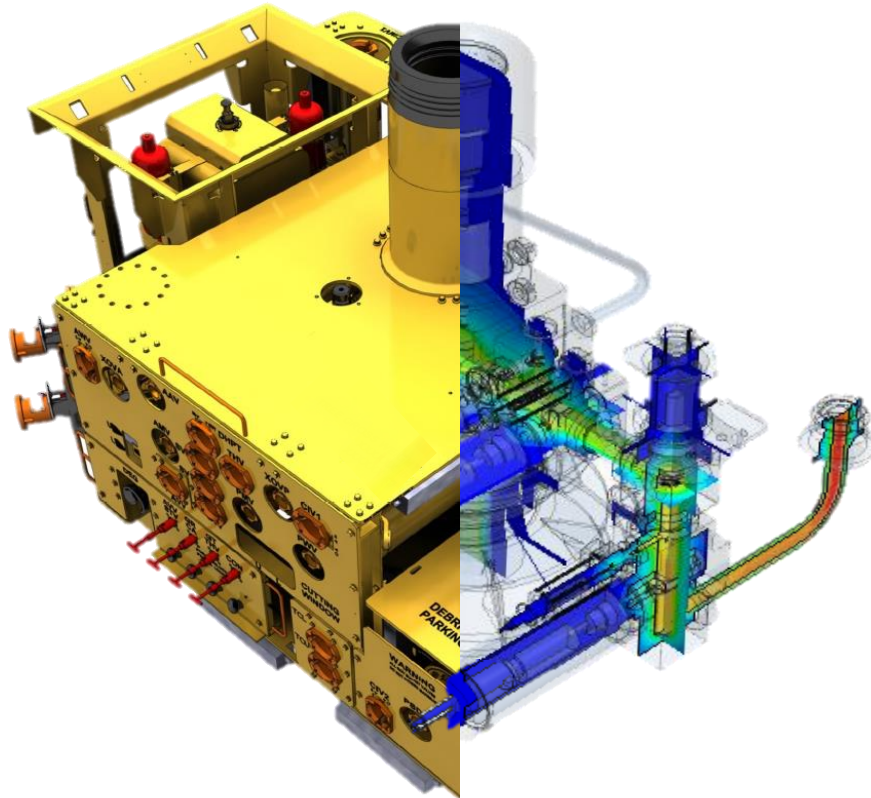
Conclusions

- Zohr changed the game in the application of a supplier-led approach.
- Standard products facilitated optimized delivery timeline and economic viability for the project.
- Early engineering collaboration with customer provided the successful platform for project sanctioning.
- Successful delivery of the equipment and time to first gas has set the expectations for future supplier-led solutions.



Q&A

Thank you.



Christophe Vielliard

Production Assurance Manager
CVielliard@onesubsea.slb.com

Marlos Kiem Medeiros

NSAM Systems Engineering Manager
MMedeiros@onesubsea.slb.com

Brent Gable

Customer Standardization Manager
BGable@onesubsea.slb.com