NEXT GENERATION SUBSEA TECHNOLOGY - KEY CHALLENGES AND TECHNOLOGY TREND

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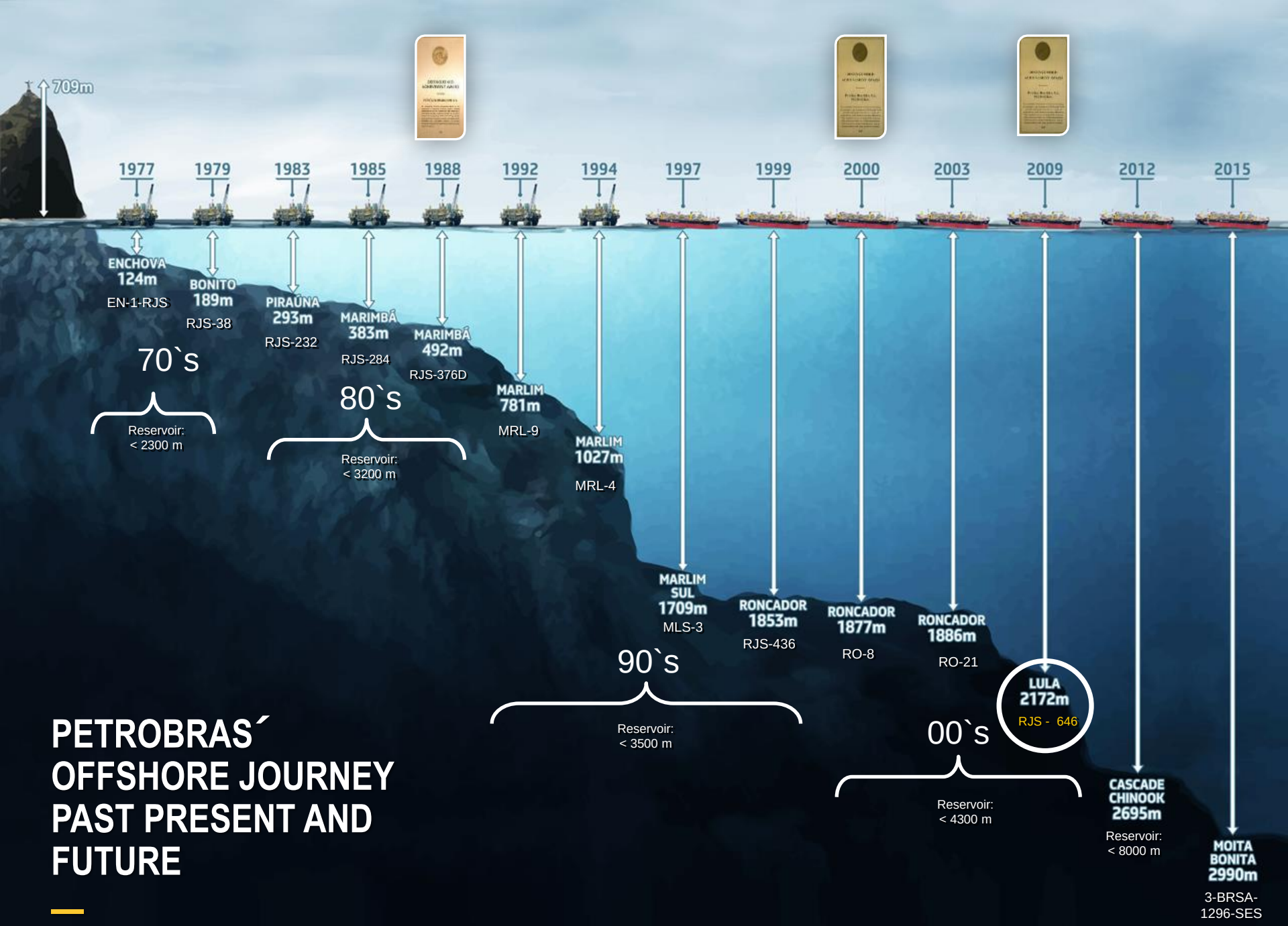
NEXT GENERATION SUBSEA TECHNOLOGY - KEY CHALLENGES AND TECHNOLOGY TREND

Agenda

- Petrobras' subsea oil production – past, present and future
- Mature fields subsea technology challenges
- Pre-salt and green fields subsea technology challenges
- Summary



PETROBRAS´ OFFSHORE JOURNEY PAST PRESENT AND FUTURE

PETROBRAS´ OFFSHORE JOURNEY
PAST PRESENT AND FUTURE

- Subsea numbers

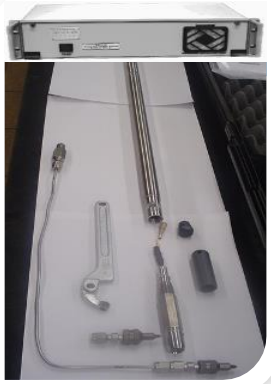
87 Manifolds

4.545 km of E-H Umbilicals

~4.000 tools (TRT, THRT, etc.)

1.002 WCT's

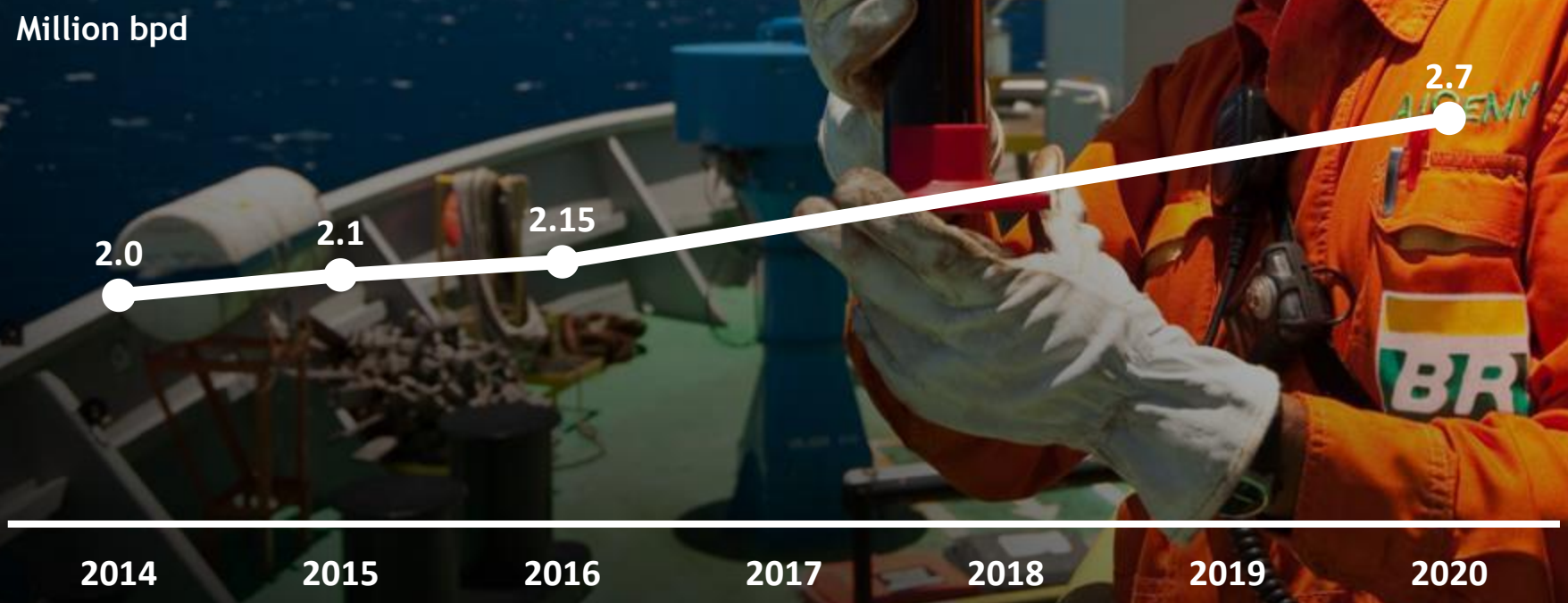
6.836 km of flexible pipe



756 PDG's

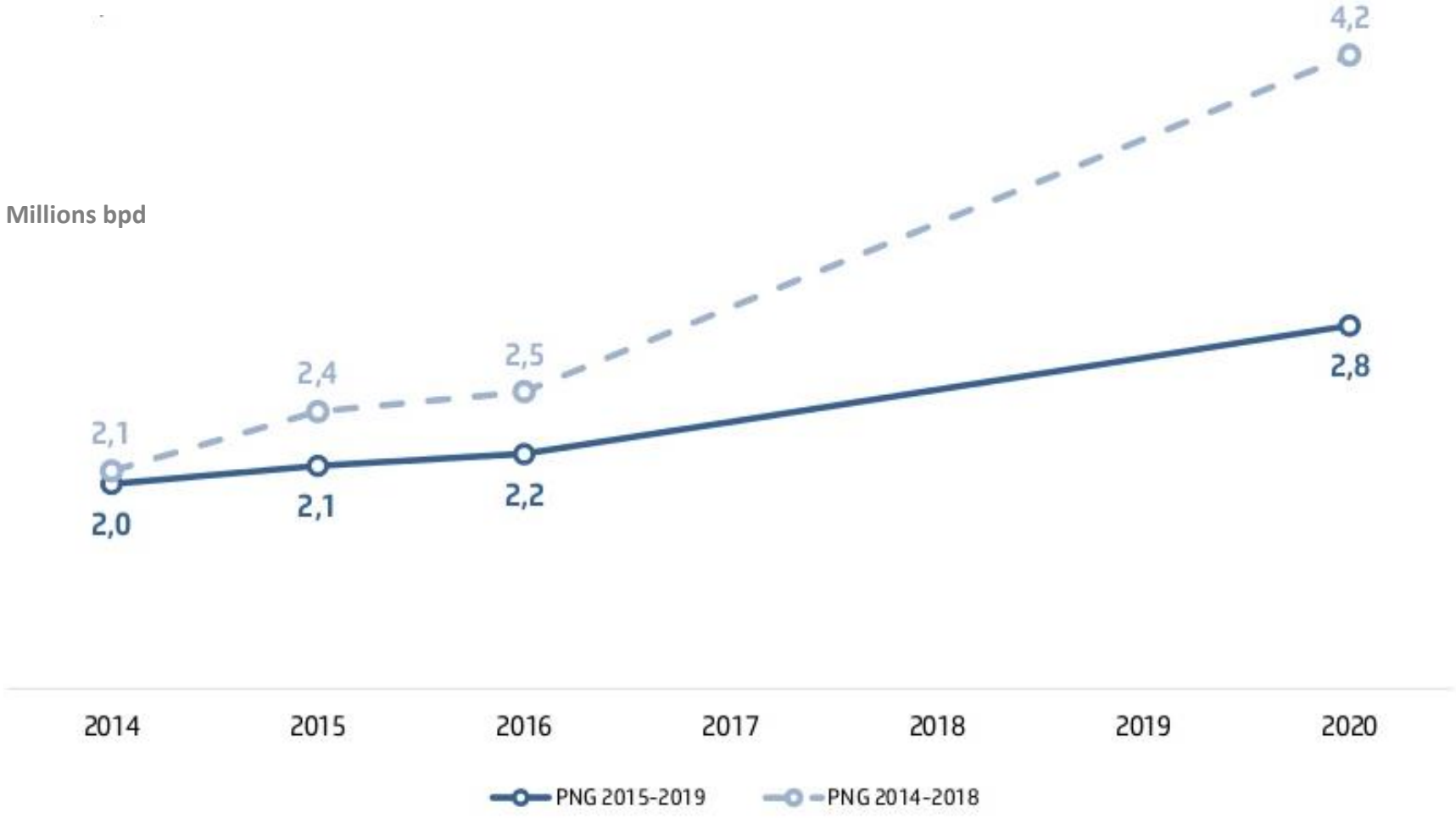
PETROBRAS´ OFFSHORE JOURNEY PAST PRESENT AND FUTURE

WE PRODUCE AROUND 2 MILLION BARRELS OF OIL PER DAY IN BRAZIL

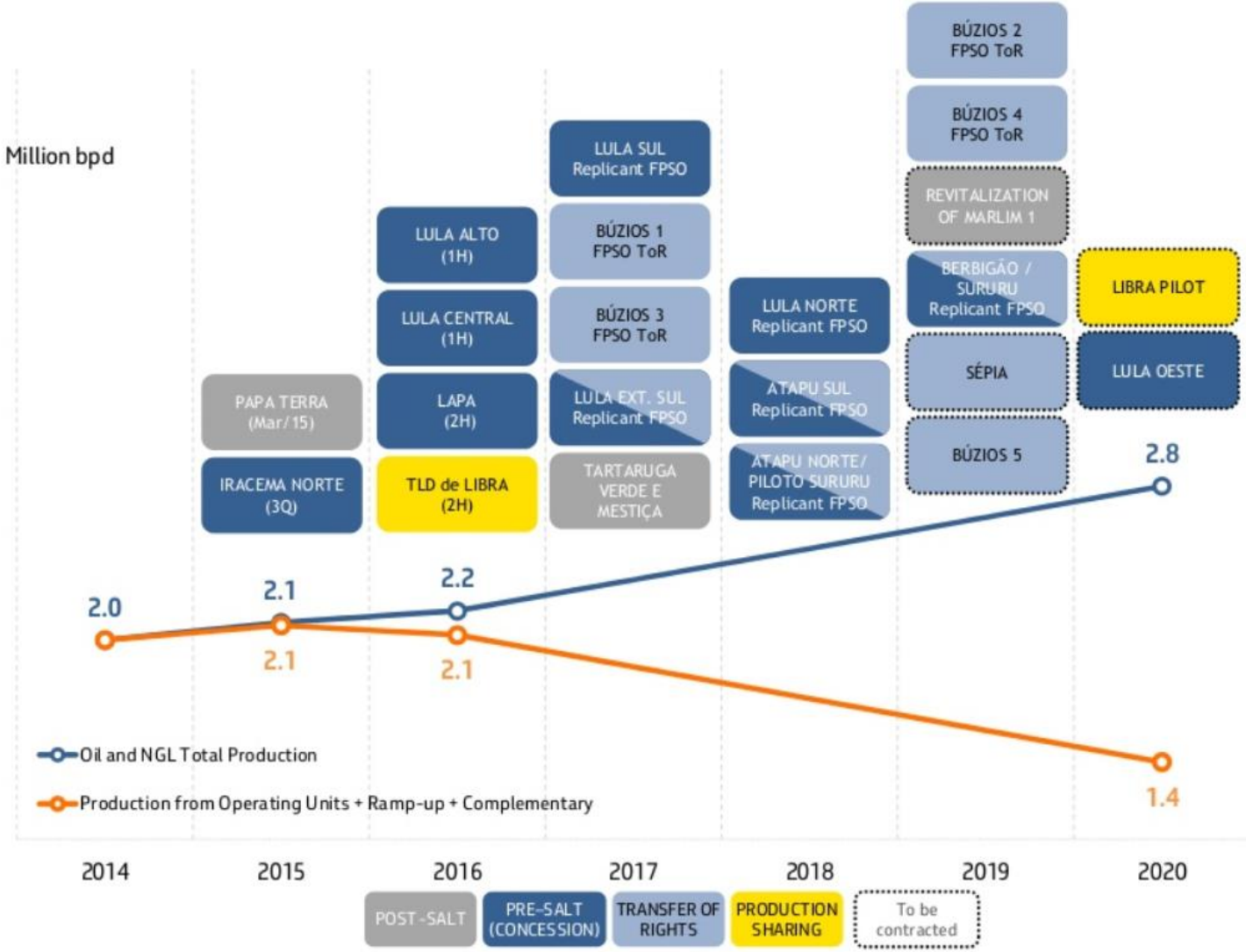


OIL AND NGL PRODUCTION IN BRAZIL

COMPARISON WITH 2014-2018 BMP

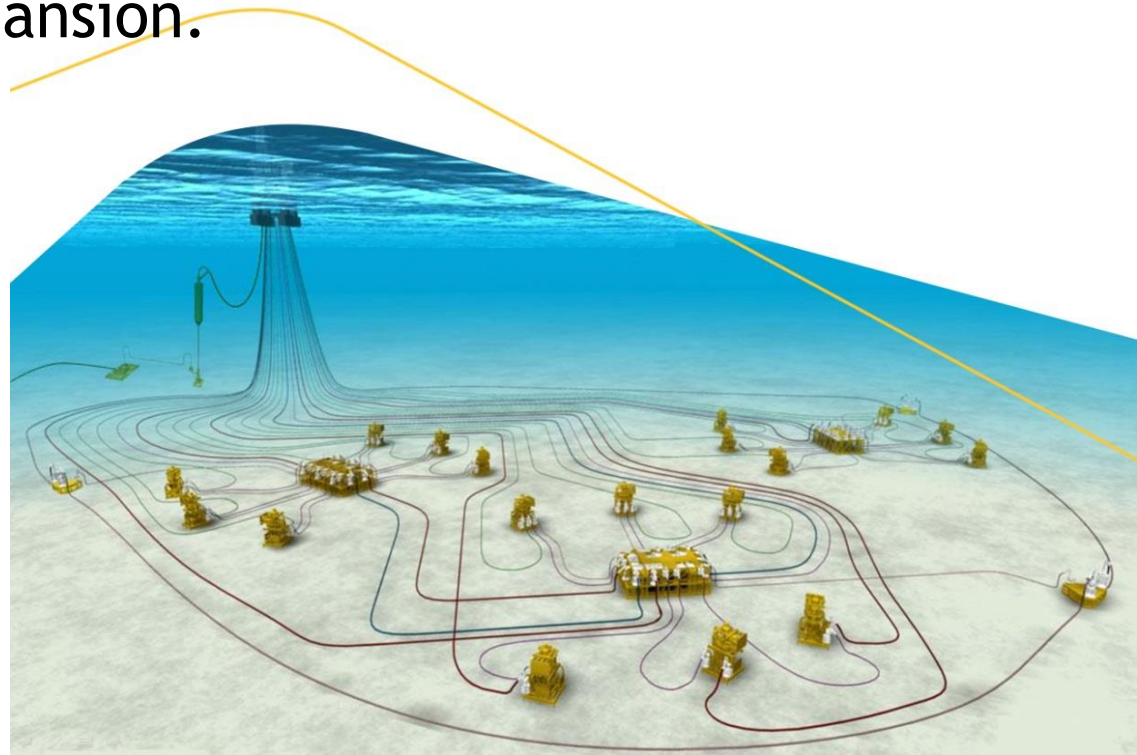


UPCOMING SUBSEA PROJECTS (MOSTELY PRE-SALT BUT NOT JUST PRE-SALT)



- Huge subsea infrastructure installed
- Large variety of age, water-depth, flow rates, technologies, etc.

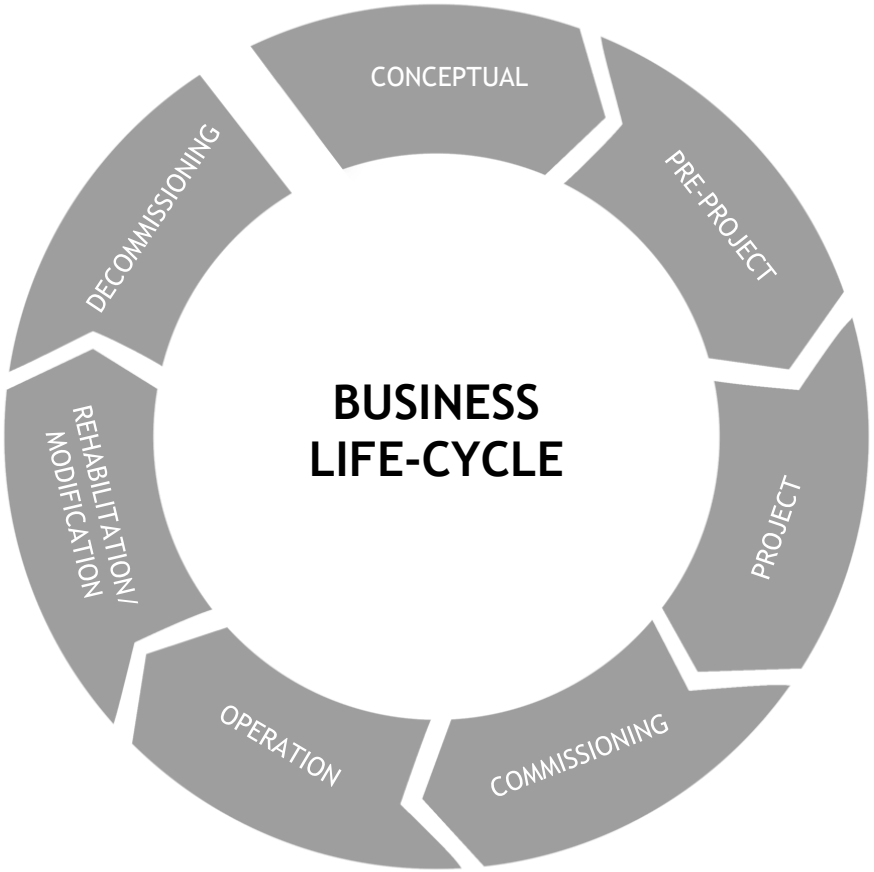
- More subsea equipment will be necessary to support the oil production expansion.



PETROBRAS´ KEY CHALLENGES

The next generation of subsea technology must support this diversity of subsea oil production projects at all their life cycle.

APPRAISAL



GREEN FIELDS

BROWN FIELDS

Technological Focus

Integrated simulation of geological processes

Sea production systems

Mobility and Smart Grid

new materials

renewable energy

Exploration of gas hydrates

Exploration of new frontiers

Reducing total cost of construction, maintenance and abandonment of wells

Production in the Pre-Salt

Increased profitability of mature fields

Subsea production systems

offshore logistics

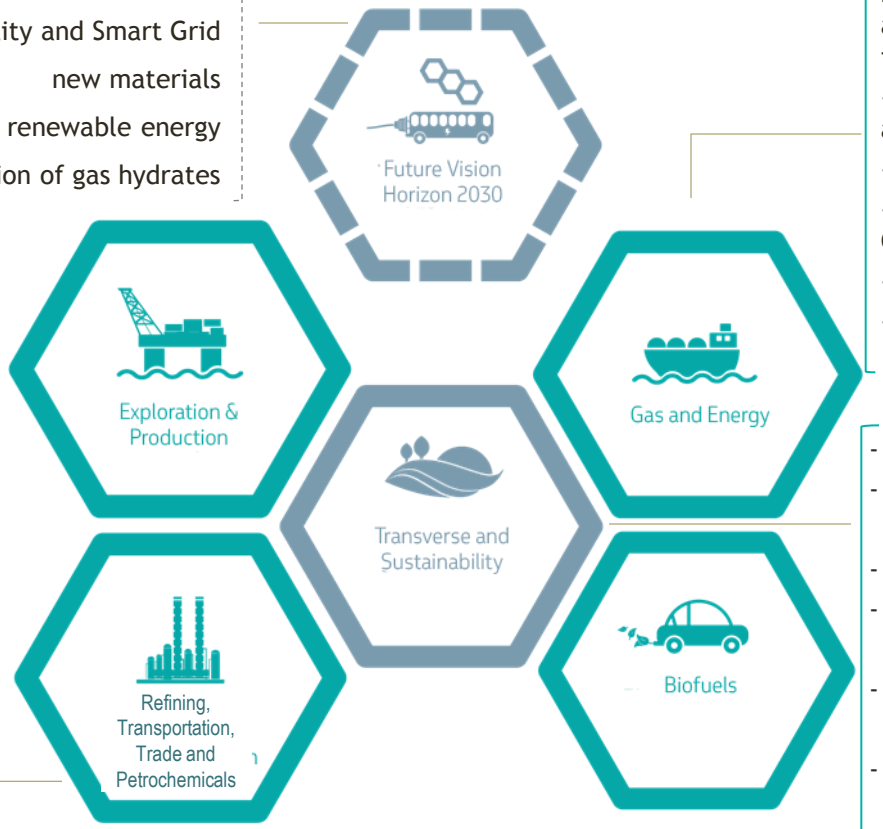
Refining pre-salt oils

Maximizing the production of middle derivatives and gasoline

Optimization, adaptation and integration of logistics and transport

innovative products

Valuation of assets and currents in petrochemical



- New monetization potential of natural gas in onshore conventional and unconventional reservoirs in the inland sedimentary basins in Brazil
- Integration and flexibility in supply and demand of energy and GN
- Natural gas logistics
- Adding value to the GN through the C1 chemistry
- Natural Gas Processing
- Energy and Reliability Integration

- Construction and assembly
- Optimization of production processes and efficient use of energy
- Integrity, safety and reliability
- Environmental characterization and evaluation of environmental impacts
- Recovery of contaminated and degraded areas and support emergency
- CO2 and other air emissions and climate change
- Water, effluents and waste

Bioproducts Production

Reducing raw material costs

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MATURE FIELDS

Campos Basin Overview

- 55 platforms over 100,000 km²
- Operating since 1977
- 15 fixed structures – WD 80 to 170 m
- 40 floating units – WD 80 to 1,800 m

Main challenges

- Life extension
- Field revitalization
- Subsea decommissioning
- Integrity

MATURE FIELD – LIFE EXTENSION

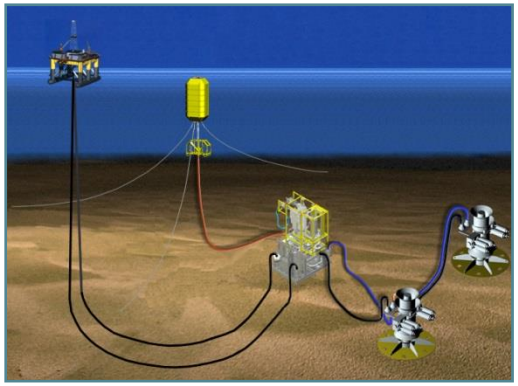
Motivations:

- Extend the life of a field is a business case
- Thinking ahead for pre-salt fields

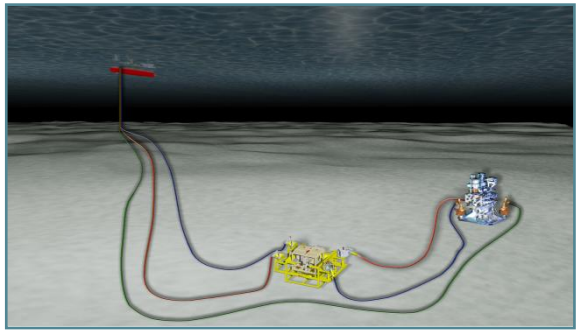
Challenges:

- Recover and validate operational data
- Modelling of degradation mode and calculate remaining life
- To execute in a safe and cost effective way

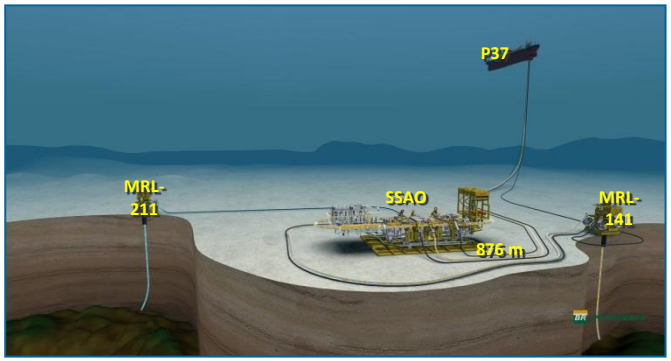
MATURE FIELD – REVITALIZATION – SUBSEA PROCESSING



- Subsea Raw Water Injection



- Subsea Boosting



- Subsea Oil-Water Separation

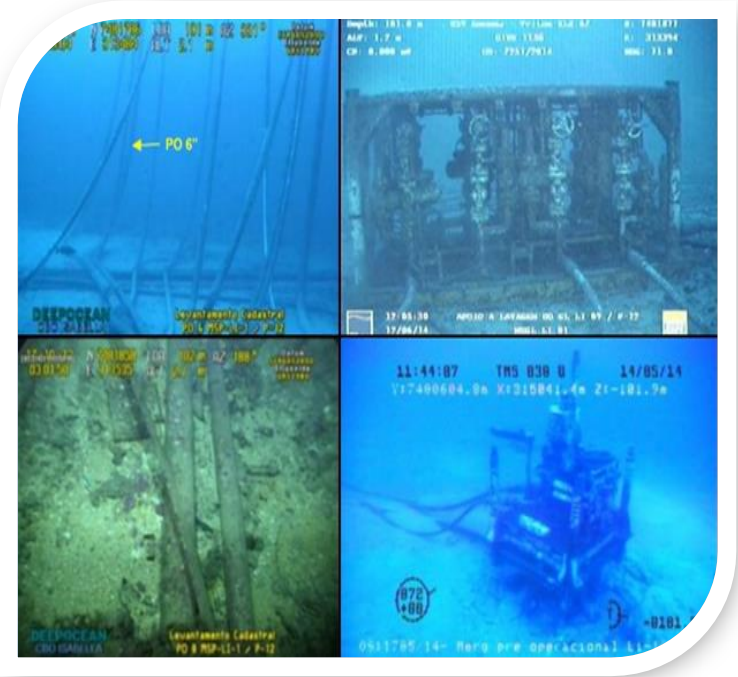
MATURE FIELD - SUBSEA DECOMMISSIONING

Campos Basin Scenario

- Fixed platforms with dry completion and some subsea satellite wells
- Floating production units with subsea wells

Equipment and lines

- Very old equipment, various models
- Lines crossing in several points
- Planning challenging
- More ROV than diving to reduce risk



MATURE FIELD - SUBSEA DECOMMISSIONING

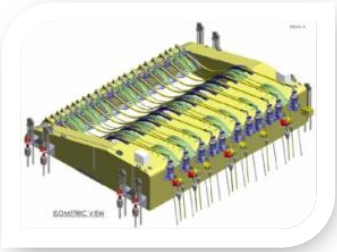
Challenges

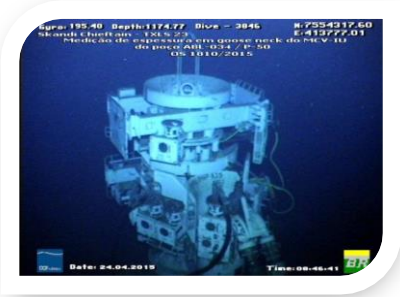
- Recovering vessel must be able to deal with residual oil and several sizes and types of flowlines and umbilicals
- Availability of cutting, plugging and pulling tools ➔ cutting speed and oil leak prevention
- Contingency tools and procedures must be planned in advance to avoid operation discontinuities
- Regulatory frame still in progress ➔ longer interaction with regulatory bodies
- Problems vary from one project to the other ➔ dedicated design for each one
- Previous survey is necessary to allow consistent operation planning
- Final destination of recovered equipment must be defined in advance

SUBSEA INTEGRITY MANAGEMENT- MATURE & GREEN FIELDS

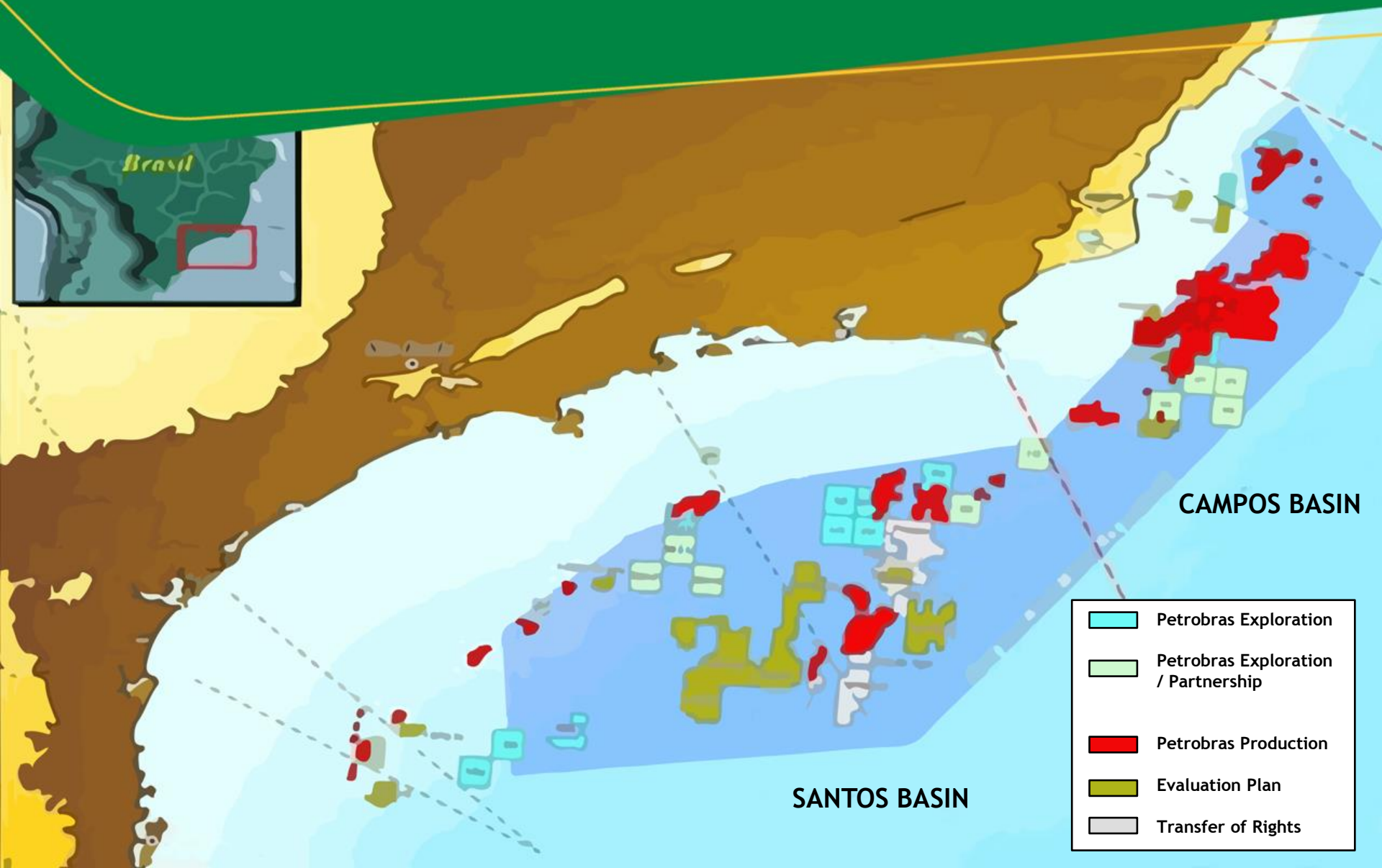
Apply new technics to:

- Detect, monitor and assess damage of subsea hardware more effectively
- Reduce diving for subsea inspection
- Reduce intervention costs
- Predict intervention to reduce downtime due to failure.





PRE-SALT - SUBSEA TECHNOLOGY CHALLENGES



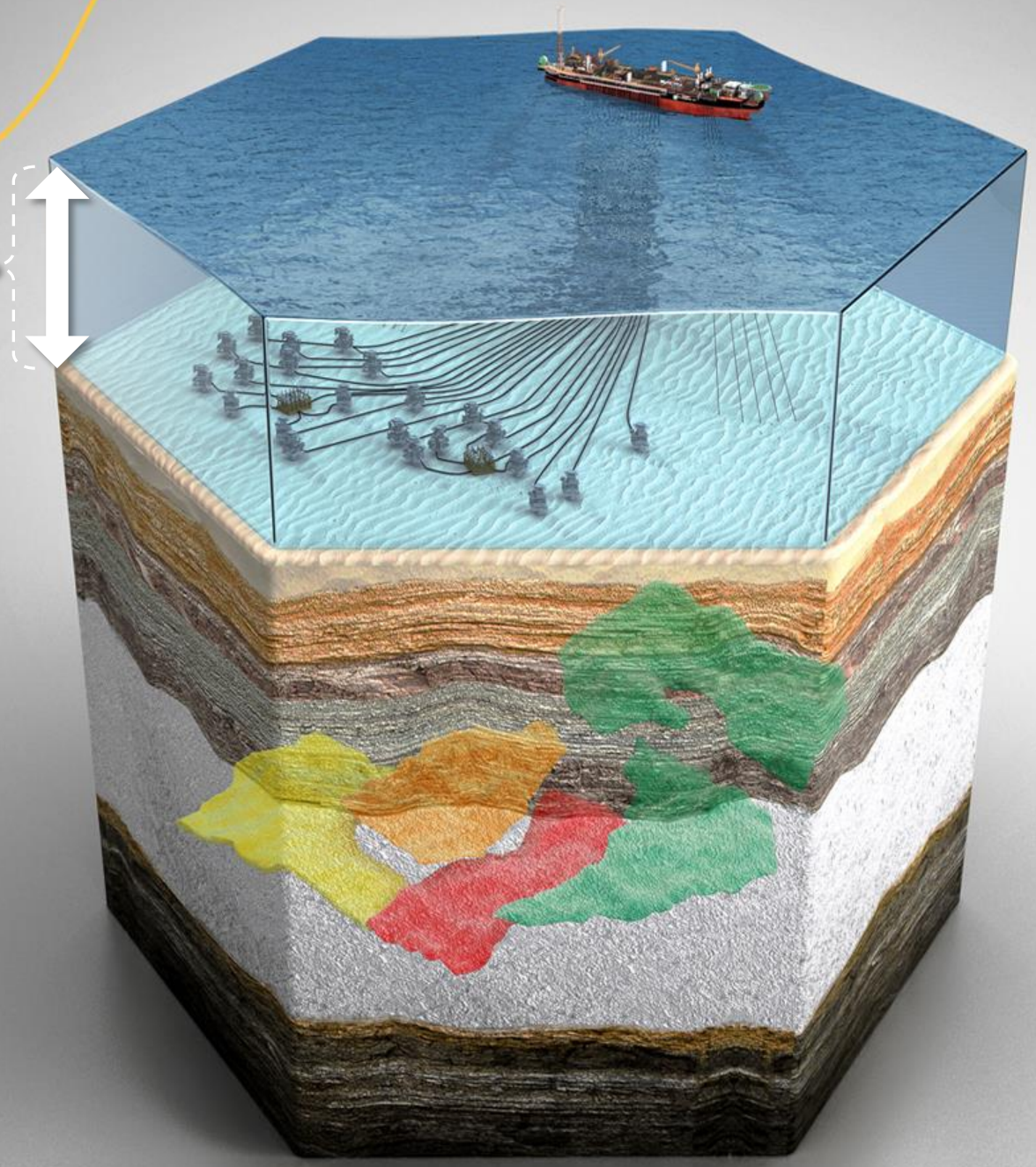
Pre-Salt drivers and challenges

D Ultra-deep waters

C Presence of contaminants (CO_2 and H_2S) in the reservoirs

B Thick salt layer & very deep reservoirs

A Very heterogeneous carbonate reservoirs & seismic imaging complexity



MAIN CHALLENGES TO NEW SUBSEA PROJECTS

- Enabling technologies
  - Harsh environment and fluid characteristics
- Optimizing technologies
- Think ahead integrity, intervention and decommissioning

DEVELOPMENT OF NEW AND RELEVANT TECHNOLOGIES FOR SUBSEA SYSTEMS AT PRE-SALT

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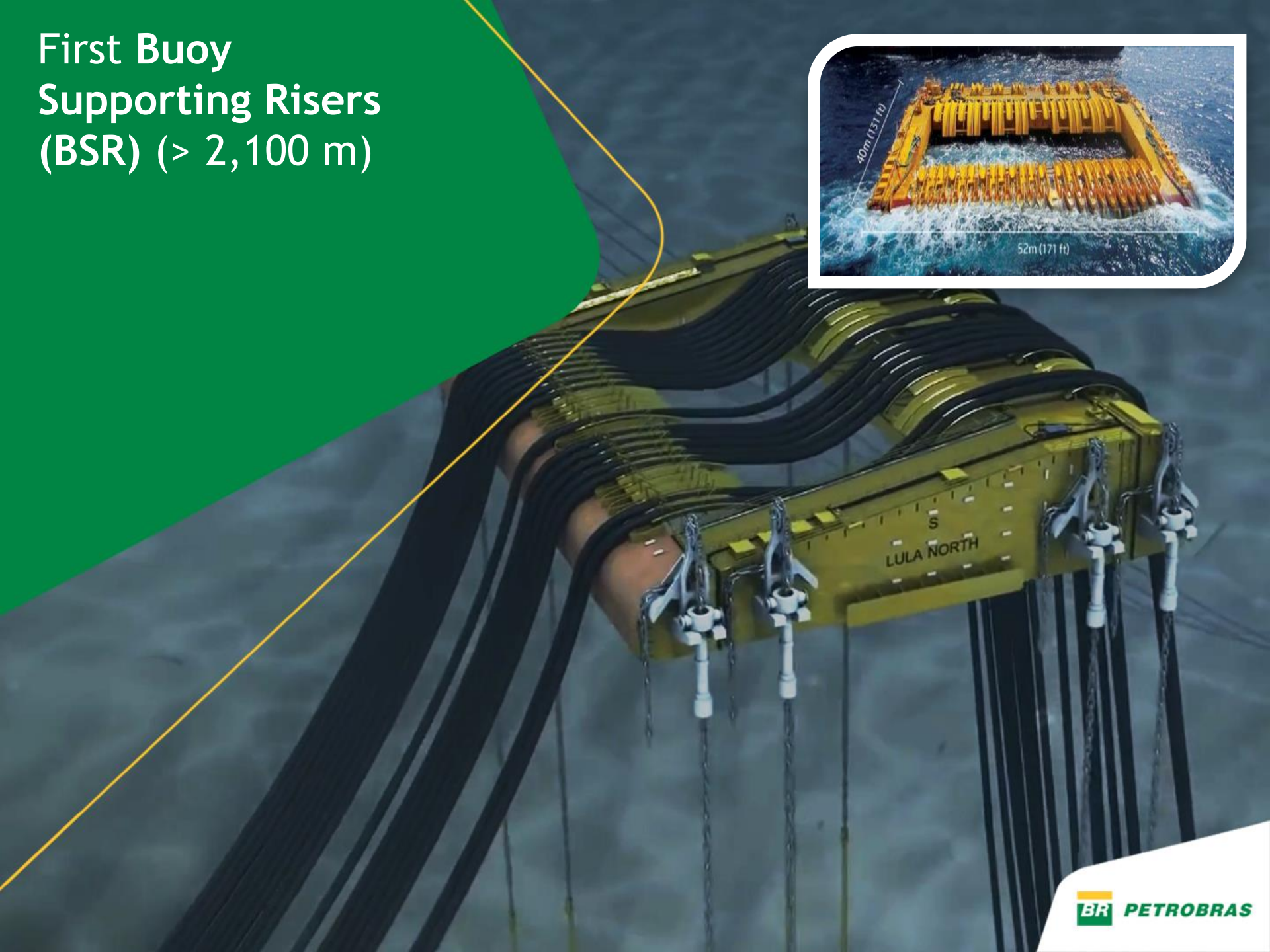
First **Buoy Supporting Risers (BSR)** (> 2,100 m)



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First **Steel Catenary Risers (SCR)** with Lined Pipes installed by reel lay method

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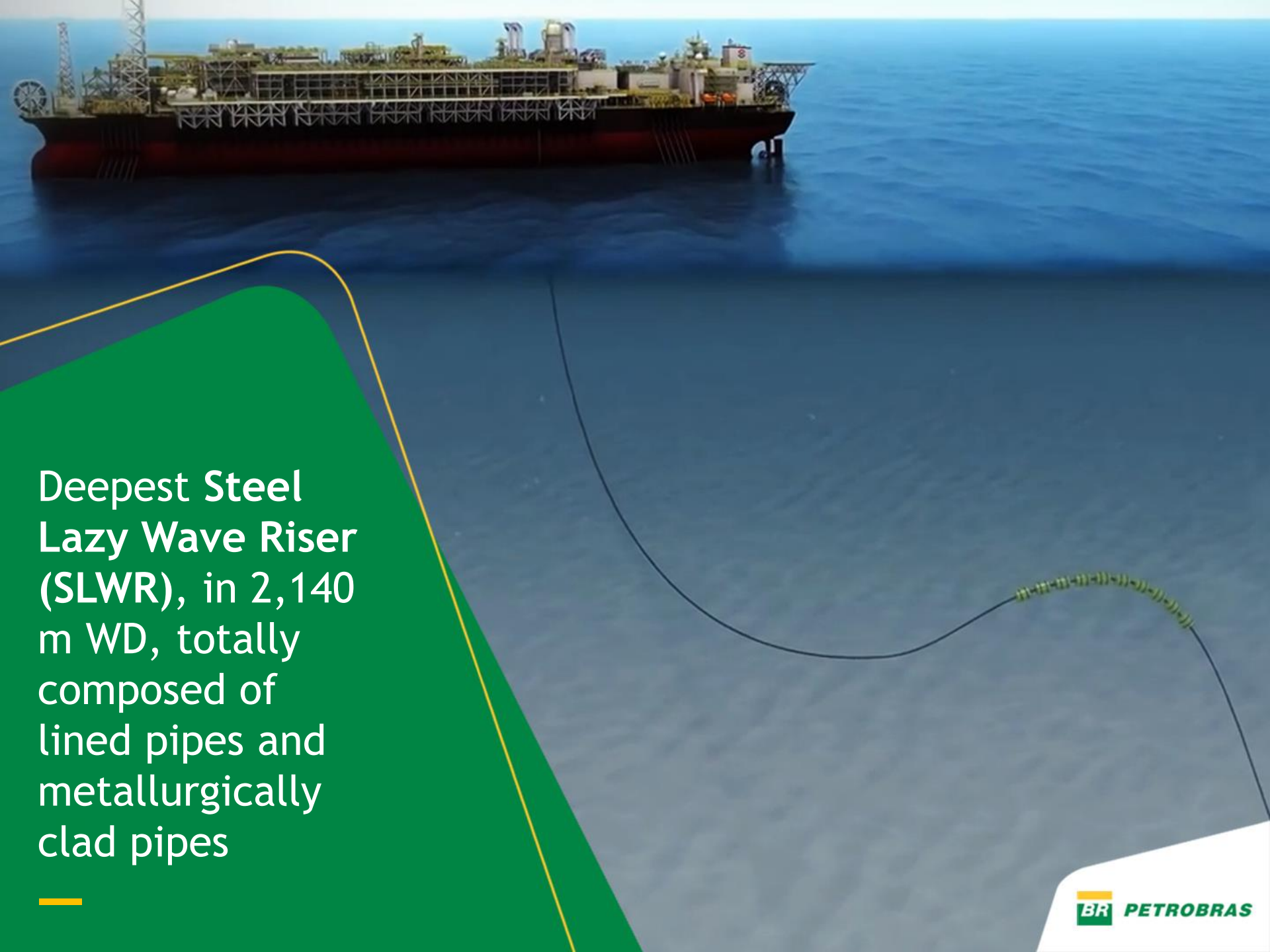

Deepest **Steel Lazy Wave Riser (SLWR)**, in 2,140 m WD, totally composed of lined pipes and metallurgically clad pipes

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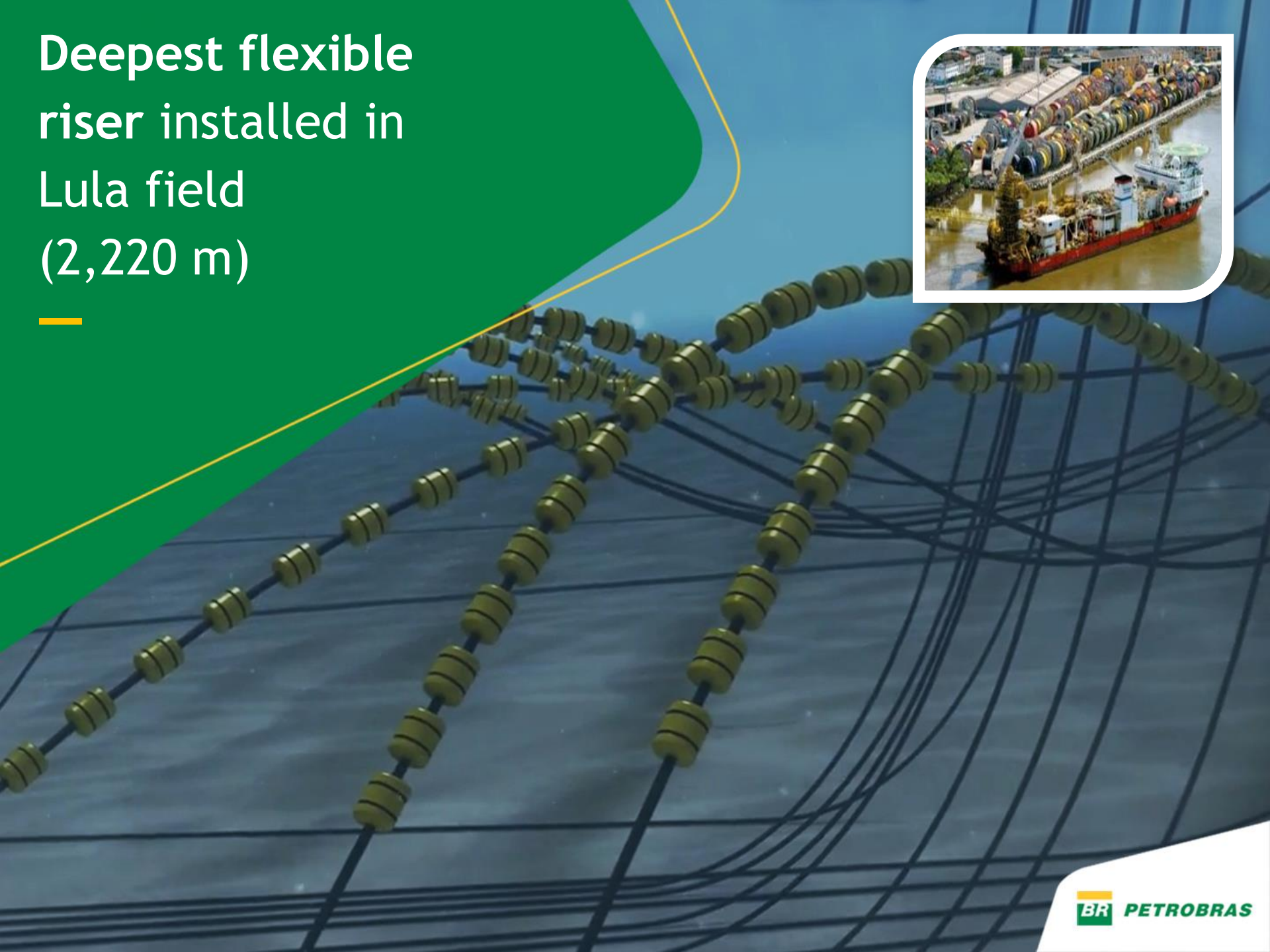
Deepest flexible riser installed in Lula field (2,220 m)



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First application of flexible risers with integrated tensile armor **wire-monitoring system**

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Subsea trees with standard mechanical interfaces

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OPTIMIZATION TECHNOLOGIES FOR SUBSEA GREEN FIELDS

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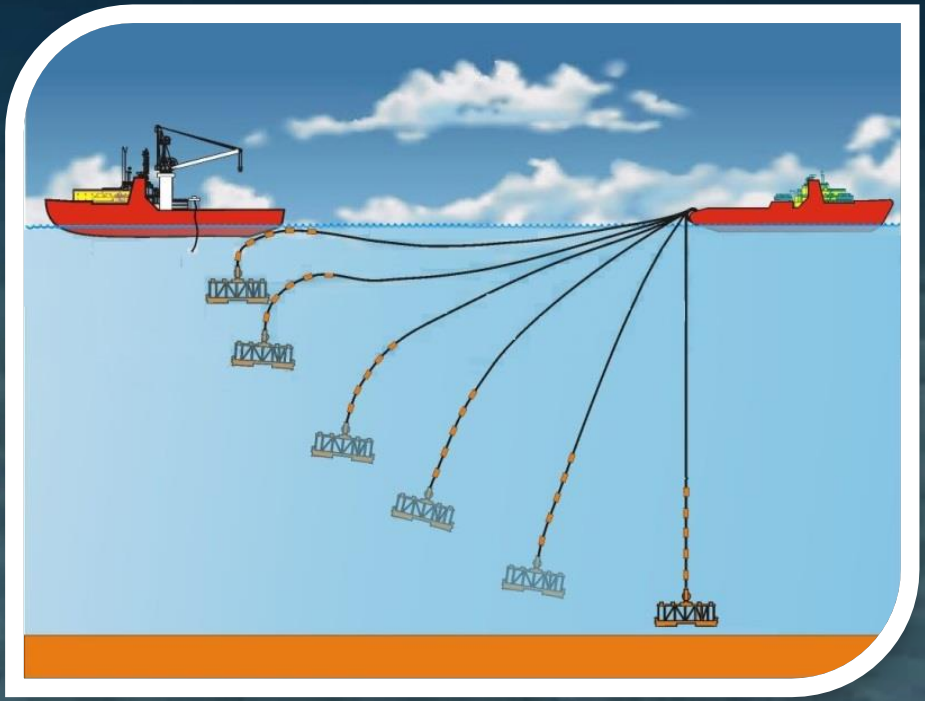

Optimization Installation

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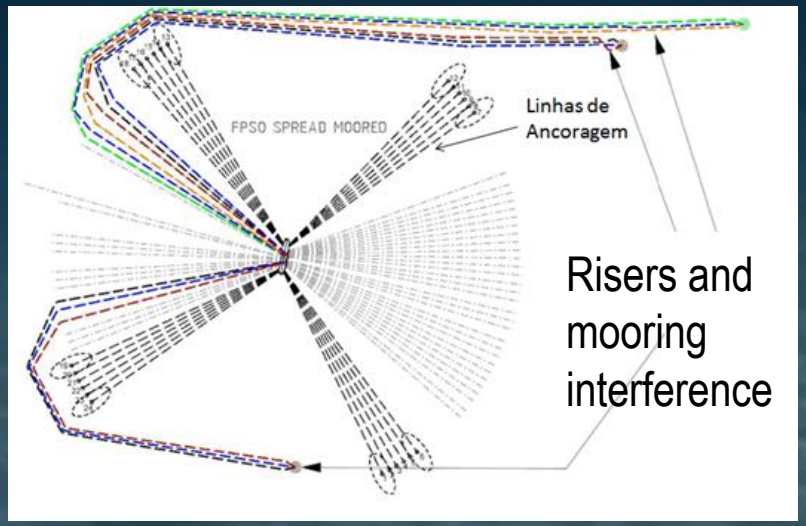
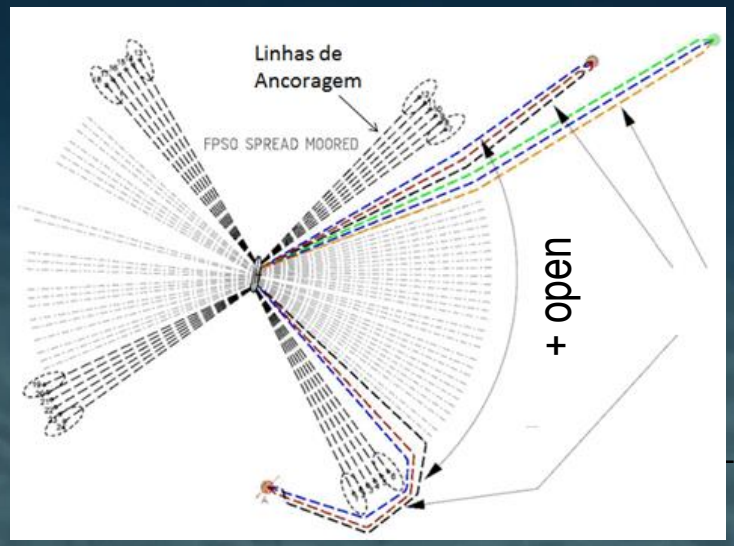
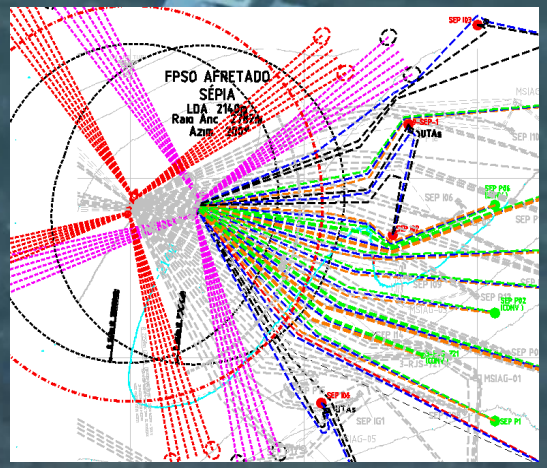




Optimization Layout



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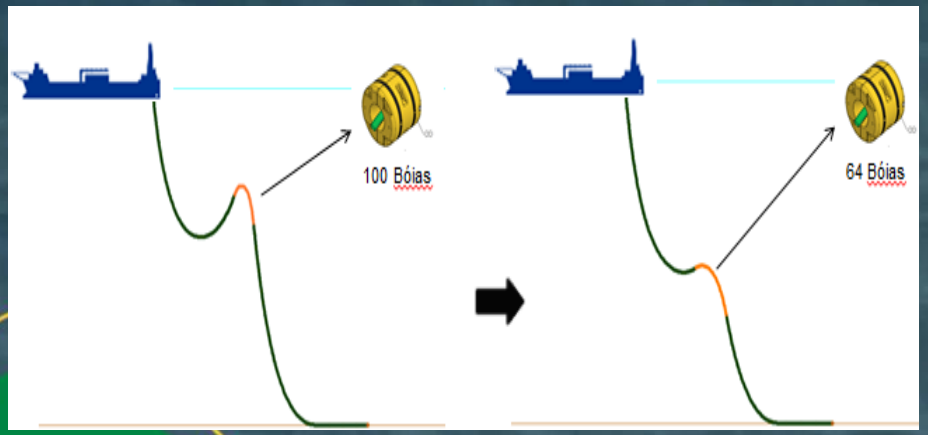

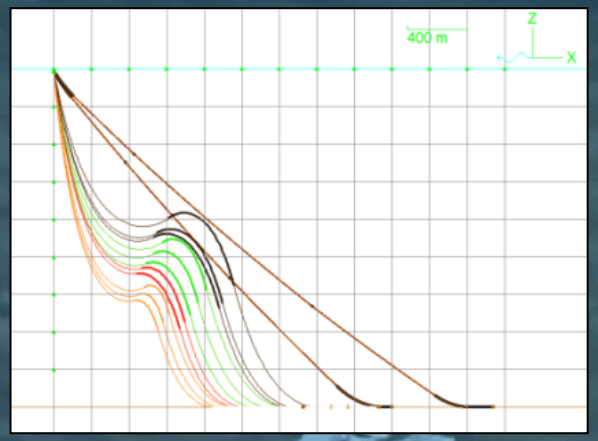

Optimization Equipment

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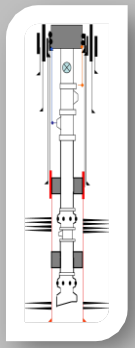
ASSET OPTIMIZATION REQUIRES THE INTEGRATION OF TECHNOLOGIES IN DIFFERENT DISCIPLINES

WELL



- Intelligent completion
- Acid frac/stimulation

SUBSEA

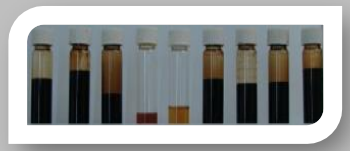
- Flexibility to operate with coupled/decoupled, rigid/flexible risers
- WAG manifold

ASSET OPTIMIZATION

- High-capacity gas plant with CO_2 separation

PROCESSING PLANT

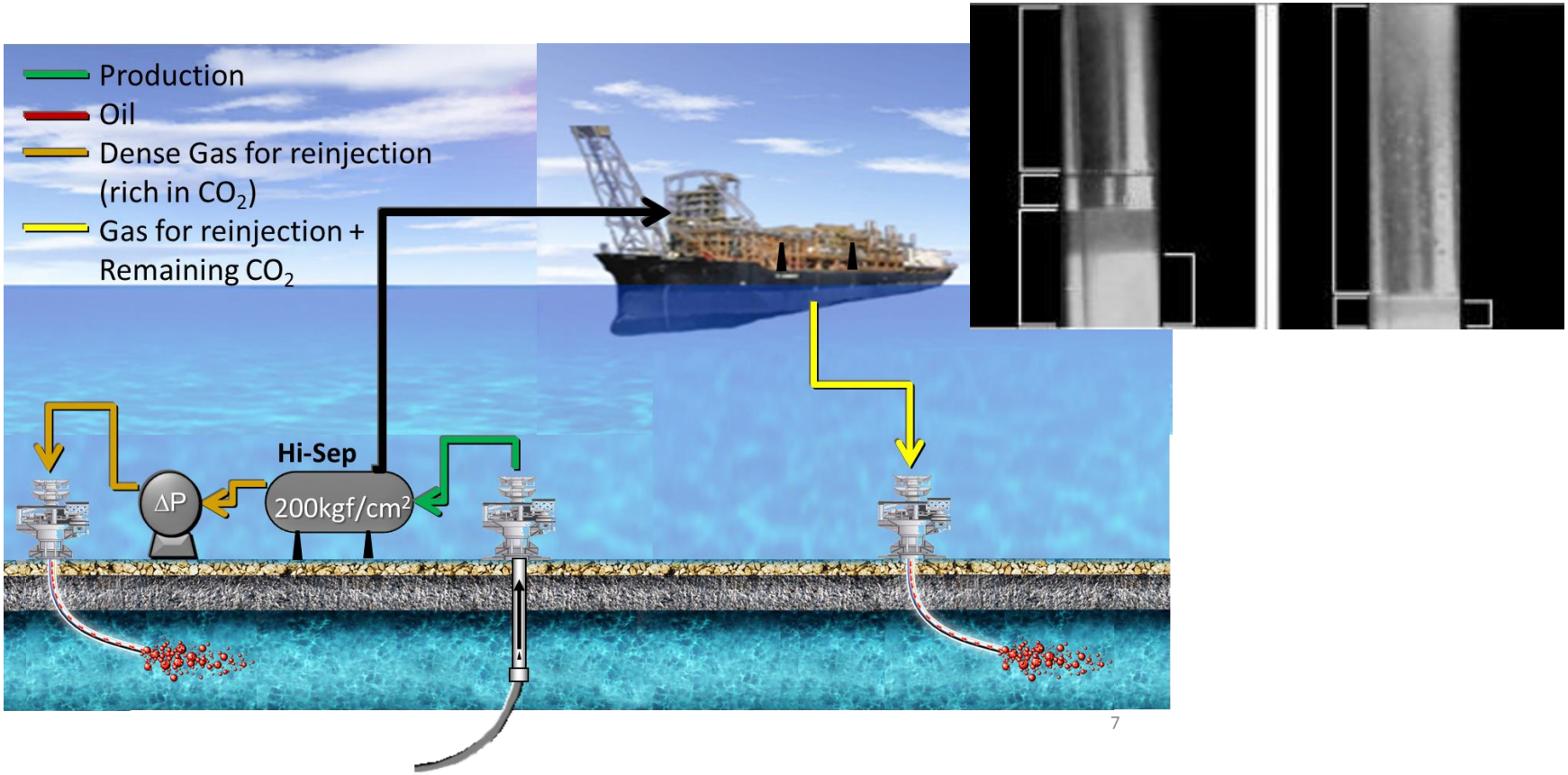
- Hydrate prevention in WAG cycles
- Scale management



FLOW ASSURANCE

ASSET OPTIMIZATION - INTEGRATION OF TECHNOLOGIES

HI-SEP



<u>The mixture of CO_2 and heavy hydrocarbons</u> generates instabilities in the traditional phase equilibrium, creating an unusual envelope, which looks **<u>like Liquid-Liquid equilibrium</u>**

SUMMARY

The next generation of subsea technology must support a diversity of fields at all their life cycle. The future of oil production at PETROBRAS will be Pre-salt plus Mature fields.

The challenges of Mature fields are related to life extension, revitalization, integrity management and decommissioning.

Many enabling technologies have been developed to Pre-salt fields as well as optimizing technologies. The main challenge to the future will be optimizing technologies.
We need to think ahead integrity, intervention and decommissioning to these fields.

Step change technologies to asset optimization would require the integration of different disciplines.