LIBRA PROJECT
Production Development Projects: NW Region

Osmond Coelho Jr., Libra Project, Petrobras
Main objective:
- Optimize Libra development by maximizing HSE Best Practices and improving economical results.
Current base case ➔ 4 FPUs (WD = 2,100m);
Objective ➔ anticipation, with an acceptable level of risk;
Sequence based on availability of reservoir information;

## RESERVOIR DATA

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Salt Microbial</td>
<td></td>
</tr>
<tr>
<td>Aptian Carbonates</td>
<td></td>
</tr>
<tr>
<td>27 API Oil</td>
<td></td>
</tr>
<tr>
<td>Reservoir Depth 5,300 m</td>
<td></td>
</tr>
<tr>
<td>GOR 415 scm/scm</td>
<td></td>
</tr>
<tr>
<td>CO₂ content ~ 40%</td>
<td></td>
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</tbody>
</table>
# Libra EWT De-Risking Campaign (NW Area)

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
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<tbody>
<tr>
<td><strong>EWT / FPS Program</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Libra 1</strong></td>
<td>FPSO LOI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Libra 2</strong></td>
<td>FPSO ITT</td>
<td>FPSO LOI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Libra 3</strong></td>
<td>FPSO ITT</td>
<td>FPSO LOI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Libra 4</strong></td>
<td>FPSO ITT</td>
<td>FPSO LOI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Operation**
- 1st Oil Jul/17
- DP Wells Campaign
- 1st Oil
- FP SO ITT
- FPSO LOI
- DP Wells Campaign
- 1st Oil

**Production Line**
- EWT
- SPA 1
- SPA 2
- NW1
- NW2
- NW3
- NW5

**Ref:** Forecast Apr/17, Petrobras Business Plan 17-21 and Libra Business Plan 2017
## MILESTONES

<table>
<thead>
<tr>
<th>MILESTONE</th>
<th>OBJECTIVES</th>
</tr>
</thead>
</table>
| Conceptual Definition | Jul, 2015  
- Schedule driven project,  
- Early production to anticipate cost recovery (NPV), |
| Project Sanction  | Set, 2017  
- 1st test for water injection and WAG on the field,  
- Information to optimize development of NW area, |
| 1st Oil | 2020  
- Information to accelerate the incorporation of reserves. |

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### LIBRA-1 ➔ ACCELERATING PRODUCTION AND GATHERING INFORMATION

**Ref:** Forecast Apr/17 and Petrobras Business Plan 17-21
LIBRA 1 - PILOT PROJECT: TECHNICAL ASPECTS
(STANDARD PRE-SALT PROJECTS SOLUTION)

**SUBSEA & FLOW ASSURANCE**
- 2nd generation of std. pre-salt X-Trees
- Full Gas reinjection
- Water Alternating Gas injection wells (WAG)
- Rigid or Flexible lines

**WELLS**
- 8 production and 9 injectors.
- Incorporation of 4 appraisal wells
- Intelligent Completion (2/3 zones)

**FPU**
- Oil Capacity: 180 k bbl/d
- Gas Comp.: 12 MM m3/d
- Water Injection: 225 k bpd
- Water Depth: 2,100 m
- Chartered Unit
### MILESTONES

<table>
<thead>
<tr>
<th>MILESTONE</th>
<th>DATE</th>
<th>OBJECTIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptual Definition</td>
<td>Jun, 2017</td>
<td>Production development for NW region optimizing Libra 1:</td>
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<tr>
<td></td>
<td></td>
<td>• FPU separation pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• CO₂ separation technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reduced FPU weight</td>
</tr>
<tr>
<td>Project Sanction</td>
<td>Feb, 2018</td>
<td></td>
</tr>
<tr>
<td>1st Oil</td>
<td>2021</td>
<td></td>
</tr>
</tbody>
</table>

Ref: Forecast Apr/17 and Petrobras Business Plan 17-21

#### Libra 2

- **Appraisal (not drilled)**
- **Drilled Wells**
- **Completed Wells**

Libra 2 map showing wells NW1 to NW13.
# LIBRA 2: ALTERNATIVES STUDIES

<table>
<thead>
<tr>
<th>RESERVOIR</th>
<th>FPU</th>
<th>SURF</th>
<th>WELL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimization</td>
<td>Gas Mgmt</td>
<td>FPU Capacity</td>
<td>Sep. Pressure</td>
</tr>
<tr>
<td># of wells (spacing); Wells schedule; EOR; Completion strategy.</td>
<td>Full gas Re injection</td>
<td>180 kbdp 12MM m³/d</td>
<td>25 bar</td>
</tr>
<tr>
<td></td>
<td>Gas export</td>
<td>120 kbdp 8MM m³/d</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>225 kbdp 15MMm³/d</td>
<td>65 bar</td>
</tr>
</tbody>
</table>

SELECTION BASED ON HIGHER IMPACT ON NPV

ALTERNATIVES TO BE ANALYZED ONLY FOR SELECTED CASE

## Generation of alternatives

1. **1st approach selection**
2. Probab. approach
3. Petrobras technical Workshop
4. Partners technical Workshop

## OPTIMIZATIONS

1. Gas Technical Studies
2. Gas Exportation
3. Re injection

## Diagram

[Diagram showingWorkflow and alternative options]

**OTC2017**

OFFSHORE TECHNOLOGY CONFERENCE
1-4 May 2017  
Houston, Texas, USA

2017.otcnet.org
LIBRA 2: TECHNICAL ASPECTS
(Pilot Concept with Optimizations)

**Subsea and Flow Assurance**
- 2nd generation of std. pre-salt X-Trees
- Full Gas reinjection
- Water Alternating Gas injection wells (WAG)
- Rigid or Flexible lines

**FPU**
- Oil Capacity: 180 k bbl/d
- Gas Comp.: 12 MM m³/d
- Water Injection: 225 k bpd
- Water Depth: 2.100 m
- Chartered Unit

**Optimization**
- Psep: 65 bar (25 in Pilot)
- CO₂ separation: TEG (Molecular Sieve in Pilot)
- Reduced FPSO weigh

**Wells**
- 8 production and 9 injectors
- Incorporation of 3 wells from EWT
- Intelligent Completion (2/3 zones)
LIBRA-3 AND LIBRA-4 ➔ REDUCING BREAK EVEN AND INCREASING NPV

<table>
<thead>
<tr>
<th>MILESTONES</th>
<th>OBJECTIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LIBRA 3</strong></td>
<td></td>
</tr>
<tr>
<td>Conceptual</td>
<td>Production development for NW region including new concepts:</td>
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<tr>
<td>Definition</td>
<td>• Subsea technologies;</td>
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<tr>
<td>May, 2018</td>
<td>• O&amp;G transport;</td>
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<tr>
<td>Project Sanction</td>
<td>• Accelerated ramp up;</td>
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<tr>
<td>May, 2019</td>
<td>• LC solutions;</td>
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<tr>
<td>1st oil</td>
<td>• Production Optimization;</td>
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<tr>
<td>2022</td>
<td>• Well design;</td>
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<tr>
<td></td>
<td>• Gas destination.</td>
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<tr>
<td><strong>LIBRA 4</strong></td>
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<tr>
<td>Conceptual</td>
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<tr>
<td>Definition</td>
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<tr>
<td>Mar, 2019</td>
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<td>Project Sanction</td>
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<tr>
<td>Mar, 2020</td>
<td></td>
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<tr>
<td>1st oil</td>
<td></td>
</tr>
<tr>
<td>2023</td>
<td></td>
</tr>
</tbody>
</table>

Ref: Libra Business Plan 2017
PROJECTS RISKS AND OPPORTUNITIES

- **Reservoir Uncertainties:**
  - Volume of Oil in Place
  - Gas Breakthrough
  - Recovery Factor

- **Local Content:**
  - Level required not always feasible
  - Local Content waiver negotiation is a key issue to allow projects implementation.

- **Gas Use and Destination:**
  - Increase in the number of production systems
  - Economic feasibility for gas exportation
  - Technology improvement for gas management
LIBRA NW GAS HUB MAY BE AN OPTION FOR GAS EXPORT, MAINTAINING FLEXIBILITY FOR EACH PROJECT

Main objectives:
- Be a potential option for feasible gas export;
- Maintain flexibility for project implementation.

Value Proposition
- Field gas management
- Gas export or end-of-life reservoir blowdown

Costs and Constraints
- Local build with minimum functional specifications
- CO₂ disposal: aquifer/selling/ EOR in other fields

Key Uncertainties
- Aquifer gas injectivity and storage capacity
- Gas market and regulatory rules
“The farther backward you can look, the farther forward you can see.”

**Sir. Winston Churchill**
Thank You