Pre-Salt Super Play: Leading Brazil into the World’s Top 5 Oil Suppliers*

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Abstract

The Brazilian Pre-Salt is the largest worldwide oil discovery in the last decades and it is the most important exploration play in the world, highly coveted by all supermajor oil companies. It is characterized by giant and supergiant fields with excellent quality carbonate reservoirs deposited between the Barremian and the Aptian. These thick and large production zones generally have high porosity and permeability, which is why pre-salt wells have very high productivity, reaching around 60 thousand boe/d. On average, these wells produce 17 thousand bbl/d which is 10 times more than the average production of the post-salt play. Due to these characteristics, in only 7 years, the pre-salt became the main producer play in Brazil, currently producing more than 1.5 million bbl/d, which represents more than 50% of the national oil production. Lula, Sapinhoa and Baleias Cluster are responsible for the vast majority of this production. Over the next five years, Buzios, Mero, Sururu, Berbigao, Itapu and Atapu fields will contribute to dramatically increase Brazilian oil production to 5.0 million bbl/d, leading the country to be among the top 5 oil producers in the world. In addition to the resources already discovered, there are also areas that have been acquired in Brazilian Petroleum Agency (ANP) bidding rounds over the last two years. These areas have geological potential for huge oil discoveries in the Pre-Salt play of both Campos and Santos basins. This potential is corroborated by the strong competition observed in the latest bidding rounds when the largest signature bonuses and profit oil were offered for concession and PSA contracts, respectively. ANP has estimated unrisked in place oil volumes of over 60 billion barrels for these blocks and new discoveries are expected soon. By 2035, considering the potential of these blocks, Brazil could be producing 8.0 to 9.0 million bbl/d, positioning the country in an extremely strategic position as one of the world's largest oil suppliers.
Pre-salt Super Play: Leading Brazil into the World’s Top 5 Oil Suppliers

Eliane Petersohn
Senior Upstream Advisor to the Board of Directors
Brazilian National Agency of Petroleum, Natural Gas and Biofuels
Outline

Brazil Oil Industry Scenario
Pre-Salt Super Play & Oil Production Forecast
Upcoming Licensing Rounds in Brazil
Conclusions
Outline

Brazil Oil Industry Scenario

Pre-Salt Super Play & Oil Production Forecast

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**Upstream**

1953: Union Monopoly, carried out by Petrobras

1975: Risk contracts

1997: End of Petrobras Monopoly (Oil Law) Petrobras retains its dominant position

2010: New Pre-Salt Law (sole Operation of Petrobras) Production sharing Contracts

2017: New E&P Policy

**Downstream**

1953: Union Monopoly, carried out by Petrobras

1997: End of Petrobras Monopoly (Oil Law) Petrobras retains its dominant position

2018-2019: New Reform is needed: leading to a liquid and competitive gas market
Brazil Oil Industry Scenario

- Area under concession: ~ 264,000 km²
- 310 Blocks
- 439 fields

Production (April, 2019)
- Oil: 2.604 million barrels/d
- Natural Gas: 113 million m³/d

Proven Reserves (Dec, 2018)
- Oil: 13.2 billion barrels
- Natural Gas: 368 billion m³

10th largest oil producer in the world and the largest in Latin America
Oil Production

1998

Production (Dec, 1998)

970 thousand bbl/d
30 million m³/d

2018

Production (Dec, 2018)

2.56 million bbl/d
111 million m³/d

Oil Export
(2000)

18.68 bbl/d

Crude Oil Export
(Dec, 2018)

1 million bbl/d
E&P Environments

**Pre-salt Super Play**
- High quality **Carbonate Reservoirs** underneath the salt layer
- High well productivity
- Potential for giant or supergiant oil discoveries

**Conventional Offshore**
- **Eastern and Equatorial Margin**
  - Potential for oil discoveries from the Upper Cretaceous to Paleogene turbidite reservoirs

**Mature Basins** (Remaining Potential)
- **New Frontier Basins**
  - Solimoes Basin: Potential for light oil accumulations
  - Paleozoic and Proterozoic basins: gas prone

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Average oil production per well:
- 17,655 bpd (85 wells)
- 1,650 bpd (628 wells)
- 16 bpd (6,683 wells)

Dec, 2018
Proven Reserves

15 Billion boe

December, 2018

Oil
13.2 Billion bbl

Gas
368 Billion m³

Oil Proven Reserves

- Pre-Salt: 56%
- Conventional Offshore: 39%
- Onshore: 5%

Gas Proven Reserves

- Pre-Salt: 53%
- Conventional Offshore: 29%
- Onshore: 18%

Pre-Salt: 56%
Conventional Offshore: 37%
Onshore: 7%
Outline

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Pre-Salt Super Play
Platforms

Transgressive limestone
Mudstone (mudstone - wakestone)
Micritic limestone (mudstone - wackestone)
Siltstone
Sandstone
Conglomerate
Basement

Intraclast-spherulite (packtone - grainstone)
Wackestone - packstone with spherulites
Argillaceous limestone & marl with spherulites
Lime packestone - grainstone with mollusk shells

Buildup

Shrubby microbial boundstone
Shale (commonly organic-rich)

Depositional Model

Source: Edited of Saller et all, 2016.
Pre-salt Super Play
Petroleum systems

Itapema – Itapema/Barra Velha

Stratigraphic chart: Moreira et al., 2007
Pre-salt Reservoirs
Facies examples – Buzios Field

Spherulite

Schrubs

Calcirudite

Mero Field
Well 2-ANP-2A-RJS
Pre-salt Reservoirs
Thin section petrography

Calcirudite

Spherulitic Calcarenite

Laminated Calculcite
Pre-Salt Super Play comprises huge accumulations underneath the salt layers

Light Oil with excellent quality accumulations and high commercial values:

Great prospectivity, potential for giant and supergiant oil fields

High wells productivity related to high quality carbonate reservoirs and extensive and thick production zones.
Pre-Salt Super Play accounts for 1.5 million barrels of oil/day

Lula (45 wells)
Oil: 909,240 bbl/d
Gas: 38 MM m³/d

Buzios (6 wells)
Oil: 112,870 bbl/d
Gas: 4.21 MM m³/d

Sapinhoa (14 wells)
Oil: 260,590 bbl/d
Gas: 10.96 MM m³/d

Parque das Baleias (14 wells)
Oil: 163,140 bbl/d
Gas: 5.71 MM m³/d
Pre-Salt Super Play Production

![Bar chart showing production in million barrels/day for different fields.]

- Lula: 900 million barrels/day
- Buzios, Mero, Sapinhoa, Parque das Baleias, Sul de Lula, Lapa, Marlim Leste, Atapu, Berigao, Itapu, Sepia, Sururu, Pirambu, Marlim/Voador: To be discovered

The chart highlights the dominance of Lula in Pre-Salt Super Play production.
The Pre-Salt production is derived from 91 wells:

- 69 in Santos Basin
- 22 in Campos Basin

Source: Petrobras
Huge prospectivity for oil discoveries:

The majority of the recoverable resources are yet to be produced.

Pre-salt fields under development phase or in early stages of production:

- Buzios
- Mero
- Sepia
- Berbigao
- Sururu

Libra Discovery is still under evaluation.
Transfer of Rights
Surplus

Atapu
Buzios
Itapu
Sepia

Potential Recoverable resources:

6.0 – 15.0 billion boe

These alone could increase Brazil’s Oil Production in 2.0 million bbl/d
Blocks R14 ~13 billion bbl
Blocks LP2 ~2.5 billion bbl
Peroba LP3 ~5.3 billion bbl
Blocks R15 ~9 billion bbl
Blocks LP4 ~12.1 billion bbl
Blocks LP5 ~17 billion bbl
Blocks LP6 ~42 billion bbl

Unrisked in place volume greater than 100 B bbl*

* It includes estimate for the areas on offer in the 6th Pre-Salt Auction and it do not take in consideration volumes still being forecasted for 16th bidding round
Oil Production Forecast

- Accomplished
- Forecasted (Annual Work Program 2019)

<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>
</tr>
</thead>
<tbody>
<tr>
<td>Million Boe/d</td>
<td>3.31</td>
<td>3.29</td>
<td>3.79</td>
<td>4.27</td>
<td>4.42</td>
<td>4.67</td>
<td>4.82</td>
</tr>
</tbody>
</table>

- Petrojarl Atlanta
- P-74 Buzios
- P-75 Buzios
- P-67 Lula
- P-68 Berigao/Sururu
- FPSO Tartaruga Verde
- P-76 Buzios
- P-77 Buzios
- P-70 Atapu
- Peregrino 3
- Sepia
- Mero 1
- Mero 2
- Marlim Rev 1
- Marlim Rev 2
- Parque das Baleias
- SEAL Deep Water
- Itapu
- Petrojarl Atlantic
- FPSO Tartaruga Verde
- Marlim Rev 1
- Parque das Baleias
- SEAL Deep Water
- Itapu

- Accomplished
- Forecasted (Annual Work Program 2019)
Future Perspectives

Simplified Production Forecasting Exercise

Assumptions

Petrobras Business Plan

Transfer Of Rights Surplus

Very promising potential in the areas awarded in the last ANP Auctions

Diverse of Operators

Top ten global producers of petroleum and other liquids (million barrels per day)

Source: EIA, 2017
A game breaking change in the Oil Industry

2030: progress can be achieved

- **Oil Production**
  - 2018: ~2.6
  - 2030: ~7.5 Million bpd

- **Oil Exporting**
  - 2018: ~1.2
  - 2030: ~4 to 5 Million bpd

- **Platforms in Production**
  - 2018: 106
  - 2030: ~170

- **Tax Revenues**
  - 2018: ~60
    - (Royalties and Special Participation)
  - 2030: peak of over R$ 300
    - (Royalties, Special Participation, income tax and Profit Oil)
Pre-Salt Potential beyond the 200 nm
Outline

Brazil’s Current State

Pre-Salt Super Play & Oil Production Forecast

Upcoming Licensing Rounds in Brazil

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## Bidding Rounds Results 2017-2018

<table>
<thead>
<tr>
<th>Bidding Round</th>
<th>Blocks Awarded</th>
<th>Signature Bonuses (billion R$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14th Bidding Round</td>
<td>37</td>
<td>3.84</td>
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<tr>
<td>15th Bidding Round</td>
<td>22</td>
<td>8.01</td>
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<tr>
<td>2nd Pre-Salt Auction</td>
<td>3</td>
<td>3.30</td>
</tr>
<tr>
<td>3rd Pre-Salt Auction</td>
<td>3</td>
<td>2.85</td>
</tr>
<tr>
<td>4th Pre-Salt Auction</td>
<td>3</td>
<td>3.15</td>
</tr>
<tr>
<td>5th Pre-Salt Auction</td>
<td>4</td>
<td>6.82</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>72</strong></td>
<td><strong>27.97</strong></td>
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</tbody>
</table>
Pre-Salt Exploration Scenario Evolution
TRANSFER OF RIGHTS SURPLUS
16TH BIDDING ROUND
6TH PRE-SALT AUCTION

OPEN ACREAGE

2018

2019

2020

2021

7TH PRE-SALT AUCTION
17TH BIDDING ROUND

8TH PRE-SALT AUCTION
18TH BIDDING ROUND
Open Acreage

Continuous offer of blocks and mature fields.

Companies can bid on blocks not sold in previous auctions.

Applications can be submitted anytime and not just at designated points.

It will promote exploration activity in onshore areas where there are more small and medium size companies.
Open Acreage

600 blocks

New Frontier & Gas Prone Basins:
Parana, Parnaiba and Tucano Sul

Mature Basins:
Reconcavo, Sergipe-Alagoas, Potiguar & Espirito Santo

Offshore Basins:
Sergipe-Alagoas, Campos & Santos

14 marginal fields
Technical and economic parameters are under evaluation

- **1,054 Blocks**
- **Area 441,400 km²**
- **20 Sedimentary Basins**

85 blocks in 7 onshore basins

969 blocks in 3 offshore basins
All blocks from all onshore basins will be included in the Open Acreage Process.
Transfer of Rights Surplus

Atapu Buzios Itapu Sepia

Potential Recoverable Resources:

6.0 - 15.0 billion boe

Nov, 6th
Transfer of Rights Surplus

Economic parameters

<table>
<thead>
<tr>
<th>AREA</th>
<th>BONUS (BILLION REAIS)</th>
<th>PROFIT OIL (% MIN)</th>
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</thead>
<tbody>
<tr>
<td>Atapu</td>
<td>13,742</td>
<td>25.11</td>
</tr>
<tr>
<td>Itapu</td>
<td>1,766</td>
<td>19.82</td>
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<tr>
<td>Buzios</td>
<td>68,194</td>
<td>23.25</td>
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<tr>
<td>Sepia</td>
<td>22,859</td>
<td>27.65</td>
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<tr>
<td>TOTAL</td>
<td>106,561</td>
<td></td>
</tr>
</tbody>
</table>
16th Bidding Round

36 blocks

~29,000 km²

Pernambuco-Paraiba
Jacuipe
Camamu-Almada
Campos & Santos Basins

Auction: Oct, 2019
6th Pre-Salt Licensing Round

5 blocks:
- Aram
- Bumerangue
- Cruzeiro do Sul
- Sudoeste de Sagitario
- Norte de Brava

Unrisked oil in place volume ~ 42 billion bbl
### 6th Pre-Salt Licensing Round

#### Economic parameters

<table>
<thead>
<tr>
<th>AREA</th>
<th>BONUS (BILLION REAIS)</th>
<th>PROFIT OIL (% MIN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aram</td>
<td>5.05</td>
<td>24.53</td>
</tr>
<tr>
<td>Bumerangue</td>
<td>0.55</td>
<td>26.68</td>
</tr>
<tr>
<td>Cruzeiro do Sul</td>
<td>1.15</td>
<td>22.87</td>
</tr>
<tr>
<td>Sudoeste de Sagitário</td>
<td>0.50</td>
<td>26.09</td>
</tr>
<tr>
<td>Norte de Brava</td>
<td>0.60</td>
<td>36.98</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>7.85</strong></td>
<td></td>
</tr>
</tbody>
</table>
6th Pre-salt Bidding Round

Aram Block

Crossline 4802

Depth (m)

Survey: R0014_BS_1_SOUTH_PSDM – Courtesy of PGS

Prominent Basement High
Four-way Closure
Amplitude Anomalies

Area: 1,500 km²
Aram Block

Top of Salt (Aptian/Albian)
Base of Salt (Aptian)
Basement
Fault

Prominent Basement High
Four-way Closure
Amplitude Anomalies

Area: 1,500 km²

Survey: R0014_BS_1_SOUTH_PSDM – Courtesy of PGS
Total Area: ~7,200 km²
2021

Ametista
Tupinamba
Jade
Turmalina

Total Area: ~7,400 km$^2$
Bidding Rounds schedule
concession contracts

2020
Para-Maranhao, Potiguar, Campos, Santos & Pelotas basins

2021
Ceara, Espirito Santo & Pelotas Basins
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Conclusions

The Pre-salt Super Play is the largest oil discovery in the last decade, characterized by giant and supergiant fields with high well productivity.

Currently, Pre-salt super play accounts for 2.0 million barrels of equivalent oil and the majority of the recoverable resources are yet to be produced. Beyond this, several world class leads has been mapped in the blocks awarded in the past bidding rounds. Not to mention areas up for offer in the upcoming ANP Auctions.

The Pre-salt Super Play can lead Brazil to produce 7.5 million barrels of oil per day by 2030, placing it as an extremely strategic position as one of the World’s largest oil suppliers.