Pre-salt Santos basin
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Overview

Exploration assets

Angola development

Brazil exploration assets

**Pre-salt Santos basin**

Final remarks
Stromatolites are the best pre-salt reservoir

- Stromatolites and other carbonates are the main reservoir in pre-salt
- The process of formation of stromatolites still occurs today
- Due to its formation process stromatolites presents porosity and permeability superior to the remaining carbonates section

Stromatolites in the Lagoa Salgada, Brazil
In early 2000’s, pre-salt play was recognized as having high potential but very high risk related to reservoir depth.

Key success reservoir characteristics: mature source rock, migration paths, trap, seal and synchronism.

A challenge due to the geological unknown, water depth and 2,000 metres evaporitic sequence (salt).
Santos basin is a key area in current portfolio

The total area of the pre-salt province is over 110,000 km², with discoveries along Santos, Campos and Espírito Santo basins.

The pre-salt Santos basin with 50 Bln boe of reserves according to ANP.

Galp Energia was within the first to cream the play, with Tupi discovery in 2006.

19 wells drilled in four blocks with 100% success rate.
First discovery in 2007 with Bem-te-vi well

- Contract for BM-S-8 signed in 2000
- 3D seismic covering all block acquired in 2002
- Bem-te-vi well in 2007 found a reservoir of light oil with API density within the range of 28° - 30°
- 3D seismic reprocessing in 2008 according with the evaluation phase
- Evaluation plan for 2,432 km² from a total initial area of 4,864 km²
Two exploration wells in 2011 in BM-S-8

- Detailed 3D seismic interpretation ongoing
- Two exploration wells to be drilled in 2H11, targeting two new prospects of several identified
- EWT expected in 2012
- Declaration of commerciality to be delivered by December 2012
Appraisal activity underway in BM-S-21

- Presence established in 2001
- 3D seismic covering part of the block acquired in 2003
- Caramba light oil discovery in 2007
- 3D seismic re-processing in 2009 and 2010
- 2nd exploration well will be drilled in 2013 (location still to be decided)
- Expected declaration of commerciality by April 2015
Júpiter in BM-S-24 is a large hydrocarbon bearing structure

- Presence in BM-S-24 established in 2001
- 3D seismic covering all block acquired in 2003
- Significant oil, condensate and gas discovery in 2007 with CO₂ content
- Evaluation plan for 1,394 km² from a total initial area of 2,788 km²
Next appraisal well will decrease uncertainty of reservoir content

- One appraisal well scheduled for 2011 to study CO$_2$ distribution in reservoir
- Special 3D reprocessing to improve reservoir imaging to be executed in 2011
- 3D high resolution seismic acquisition planned for 2012
- Contingent EWT to be performed before February 2016
- Expected declaration of commerciality until February 2016
BM-S-11 is a great success

- Presence in BM-S-11 established in 2000
- 3D seismic covering all the block in 2002
- Tupi well in 2006 found hydrocarbons in cretaceous pre-salt interval
- 16 exploration and appraisal wells drilled so far, with 100% success rate
- 3,180 km² of 3D high resolution seismic acquired for Tupi area in 2009
- EWT in May 2009 and pilot production in October 2010
Iara is another high potential area in BM-S-11

- In evaluation phase since the end of 2008
- Two wells drilled so far, Iara and Iara Horst, increased reservoir knowledge
- Expected recoverable volumes of 3 to 4 Bln boe
- API between 26º and 30º
Formation tests to perform on Iara Horst

3D high resolution seismic acquisition planned for 2011

One appraisal well to be drilled in 4Q11

EWT scheduled for 2013

Expected declaration of commerciality by December 2013
Lula and Cernambi is the largest field development programme of the past 30 years

- Area: Lula 1,172 km$^2$
  Cernambi 348 km$^2$

- Declaration of commerciality and field development programme submitted to ANP in December 2010

- Total recoverable volumes of 8.3 Bln boe, of which, 6.44 Bln boe in Lula and 1.82 Bln boe in Cernambi
FPSO contracting strategy being executed for nine FPSO

- **1st FPSO (charter):** Cidade de Angra dos Reis, already producing
- **2nd FPSO (charter):** Cidade de Parati, being converted
- **3rd FPSO (charter):** tender ongoing
- **4th-9th FPSO (EPC):** Hull EPC contract awarded, LLI tender ongoing

**Key objectives:** adherence to first oil schedule, maximization of local content and cost efficiency via economies of scale
Gross installed oil capacity up to 1,270 kbopd by 2017

Gross FPSO oil production capacity (kbopd)

- Lula pilot
- Lula 2nd FPSO
- Cernambi 1st FPSO
- Lula 3rd and 4th FPSO
- More 4 FPSO for Lula and Cernambi
Lula/Cernambi production of more than 100 kboepd in 2020 net to Galp Energia

Lula/Cernambi production profile¹ (kboepd)

- Galp Energia production forecast assumes current FPSO contracting strategy implemented
- Total of 160 wells (production and injectors) to be executed for the full development
- Average flow rate per well of 20 kboepd

¹ Net to Galp Energia
Several options being studied for oil export from Santos basin

- Oil export solutions/infrastructure to be implemented in parallel with production capacity ramp-up
- Before 2013: oil export via DP shuttle tankers
- After 2013: oil export via shallow water transhipment unit (UOTE)
- Technical alternatives to UOTE are also under study
Gas export solutions being evaluated

- Gas export solutions/infrastructure to be implemented in parallel with production capacity ramp-up
- Already installed: gas export via Mexilhão (10 M³/d capacity) sufficient for three FPSO
- After 2014: gas export via Cabiúnas (13 M³/d capacity)
- Beyond 2016: FLNG or incremental gas pipeline solution (under evaluation)
First commercial project in Lula/Cernambi field of a total of nine FPSO

- **Cidade de Angra dos Reis FPSO** with a 100 kbopd capacity in operation since October 2010
- Three production wells and one injector well connected until the end of 2011, with an expected production at the YE 2011 of 60 kboepd
- Three additional production wells and two injector wells to be connected in 2012
- Possibility of interconnection of more wells to maintain the FPSO production level will be considered in 2013
## Pre-salt projects main optimization triggers

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<tr>
<th>Main optimization triggers</th>
<th>Solutions under evaluation</th>
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<tr>
<td>Maximize hydrocarbon recovery</td>
<td>Enhanced oil recovery (WAG HC, WAG CO₂)</td>
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<tr>
<td>Cost reduction in wells construction and operation</td>
<td>Drilling performance improvements; well number and location optimization; directional and big bore wells implementation</td>
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<tr>
<td>Optimization of fluid elevation and processing</td>
<td>Specification of special materials (CO₂ and H₂S resistant)</td>
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<tr>
<td>Flow assurance (high WAT)</td>
<td>Thermal isolated or electrical-heated pipeline, wax inhibitor specification</td>
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<tr>
<td>Produced CO₂ destination</td>
<td>WAG CO₂; CO₂ separation/sequestration technology</td>
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Acronyms

# Number
$ United States dollar
% Percentage
2D Two dimensional seismic
3D Three dimensional seismic
ANP Brazilian agency for oil, natural gas and biofuels
API gravity American Petroleum Institute gravity
BB Benguela and Belize
BBLT Benguela, Belize, Lobito, and Tomboco
Bcm Billion cubic metres
Bln Billion
Boe Barrel of oil equivalent
c. Circa
CAGR Compound Annual Growth Rate
CSEM Control Source of Electromagnetic Method
CO₂ Carbone Dioxide
CPT Compliant Piled Tower
E&P Exploration & Production
EPC Engineering, Procurement and Construction
EWT Extended Well Test
FLNG Floating Liquified Natural Gas
FPSO Floating Production Storage Offloading
G&P Gas & Power
GWh GigaWatt hour
H₂S Hydrogen sulfide
HC Hydrocarbon
HR Human Resources
IOC International Oil Company
IPO Initial Public Offering
Kboepd Thousand barrels of oil equivalent per day
Kbopd Thousand barrels of oil per day
Km Kilometre
Km² Square kilometre
LLI Long Lead Item
LNG Liquified Natural Gas
LT Lobito Tomboco
M³/d Million cubic metre per day
Mln Million
MW MegaWatt
NG Natural Gas
NOC National Oil Company
p.p. Percentage point
R&M Refining & Marketing
RCA Replacement Cost adjusted
TL Tômbua-Lândana
Ton Tonne
TS Tômbua South
UOTE Oil Transhipment Unit
WAG Water-alternating-gas
WAT Wax appearance temperature
WI Working interest
YE Year End
Disclaimer

Financial outlook figures are RCA figures except otherwise noted.

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