INTERNATIONAL GAS UNION
UNION INTERNATIONALE DU GAZ

IGU COMMITTEE MEETING (WOC1 and PGC A)

18-21 February 2013

Rio de Janeiro, Brazil
The Windsor Atlantica Hotel

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COMPACT AND OTHER ADVANCED GTL TECHNOLOGIES

Offshore Gas-to-Liquids

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Coordinator - CENPES

February, 2013

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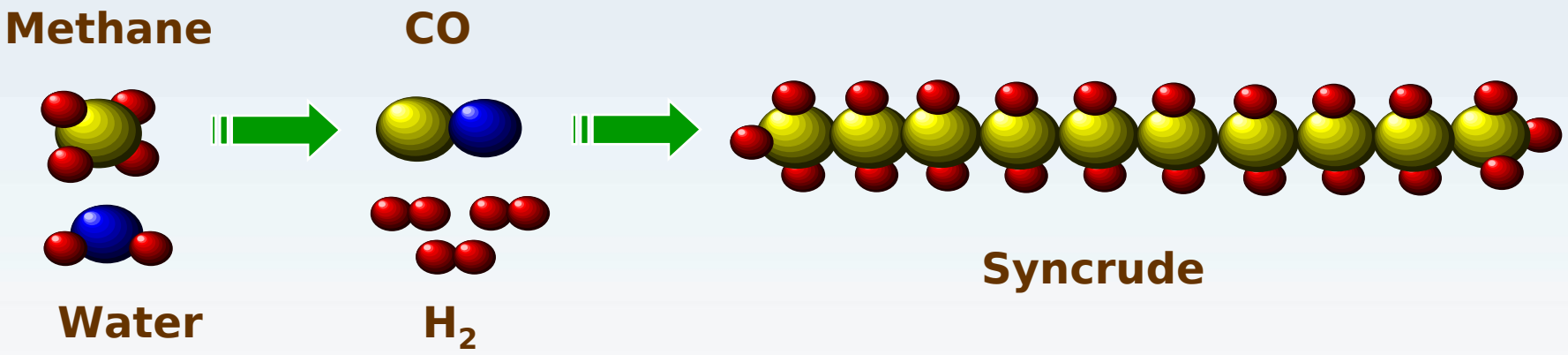
SUMMARY

- Gas-to-Liquids Technology
- Modular GTL
- Roadmap of Modular GTL in PETROBRAS
- Modular GTL Demonstration Plants
- Offshore GTL Process

Gas-to-Liquids



Hydrogen Carbon Oxygen

Main Reactions

- **Steam Methane Reforming**

$CH_4 + H_2O \leftrightarrow CO + 3H_2$ (Steam Methane Reforming)

$CO + H_2O \leftrightarrow CO_2 + H_2$ (Water Gas Shift Reaction)

CO_2 content makes the “dry reforming” reaction compete with the SMR reaction.

$CO_2 + CH_4 \leftrightarrow 2CO + 2H_2$ (Dry Reforming)

- **Fischer-Tropsch Synthesis**

$nCO + (2n+1)H_2 \leftrightarrow H – (CH_2)n – H + nH_2O$

  - Polymerization of H_2 and CO into alkanes
  - Exothermic (ΔH–)
  - Requires efficient temperature control

AGENDA

- Gas-to-Liquids Technology
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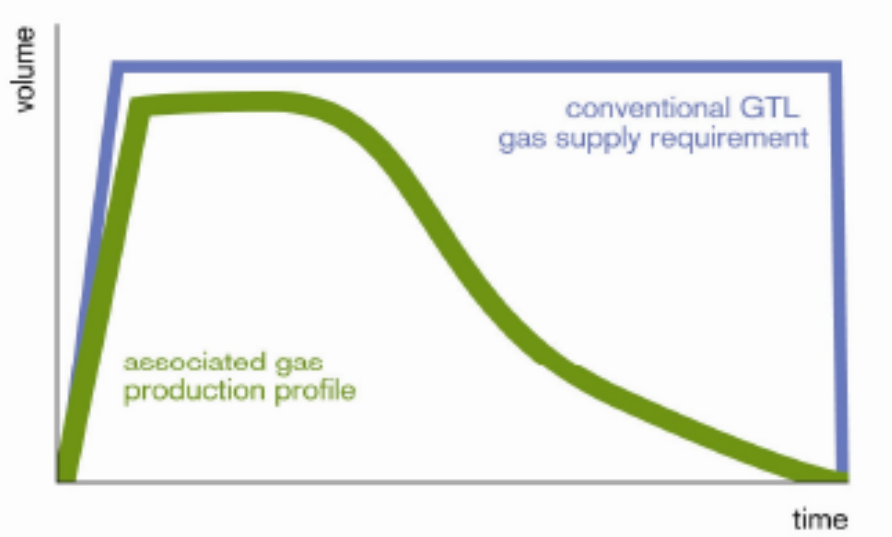
Why Use Compact and Modular GTL Reactors Use?

- Limitation of space and weight in an offshore production facility
- Needing of intensified processes of mass and heat transfer
- Production of natural gas falls along the time
- Modules can be removed as production falls
- Modules can go on-line and off-line to accommodate production variability (turndowns flexibility)



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Modular Offshore Gas-to-Liquids

- Technological solution for transporting and monetizing associated and stranded gas reserves.
- The compact reactors applied in GTL process represent a breakthrough in GTL technology, because of their small footprint, lower weight, modular design and high efficiency per unit of reactor volume which meet the requirements for offshore applications.

Gas-to-Flare

Gas-to-Liquid

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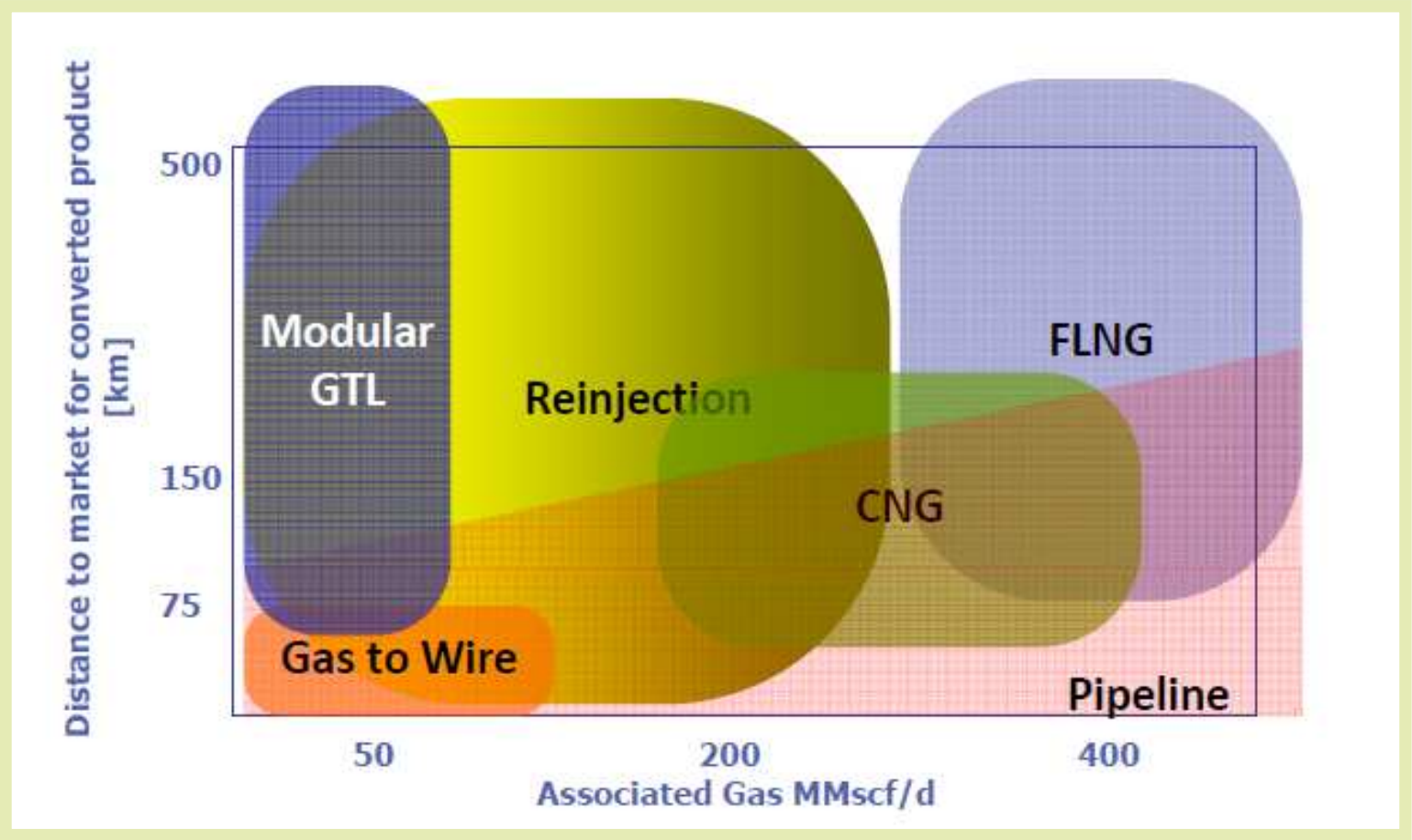
Distinct Market for Modular GTL



Source: Compact GTL, Zeus 2011 Modular GTL Seminar

SUMMARY

- Gas-to-Liquids Technology
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- **Roadmap of Modular GTL in PETROBRAS**
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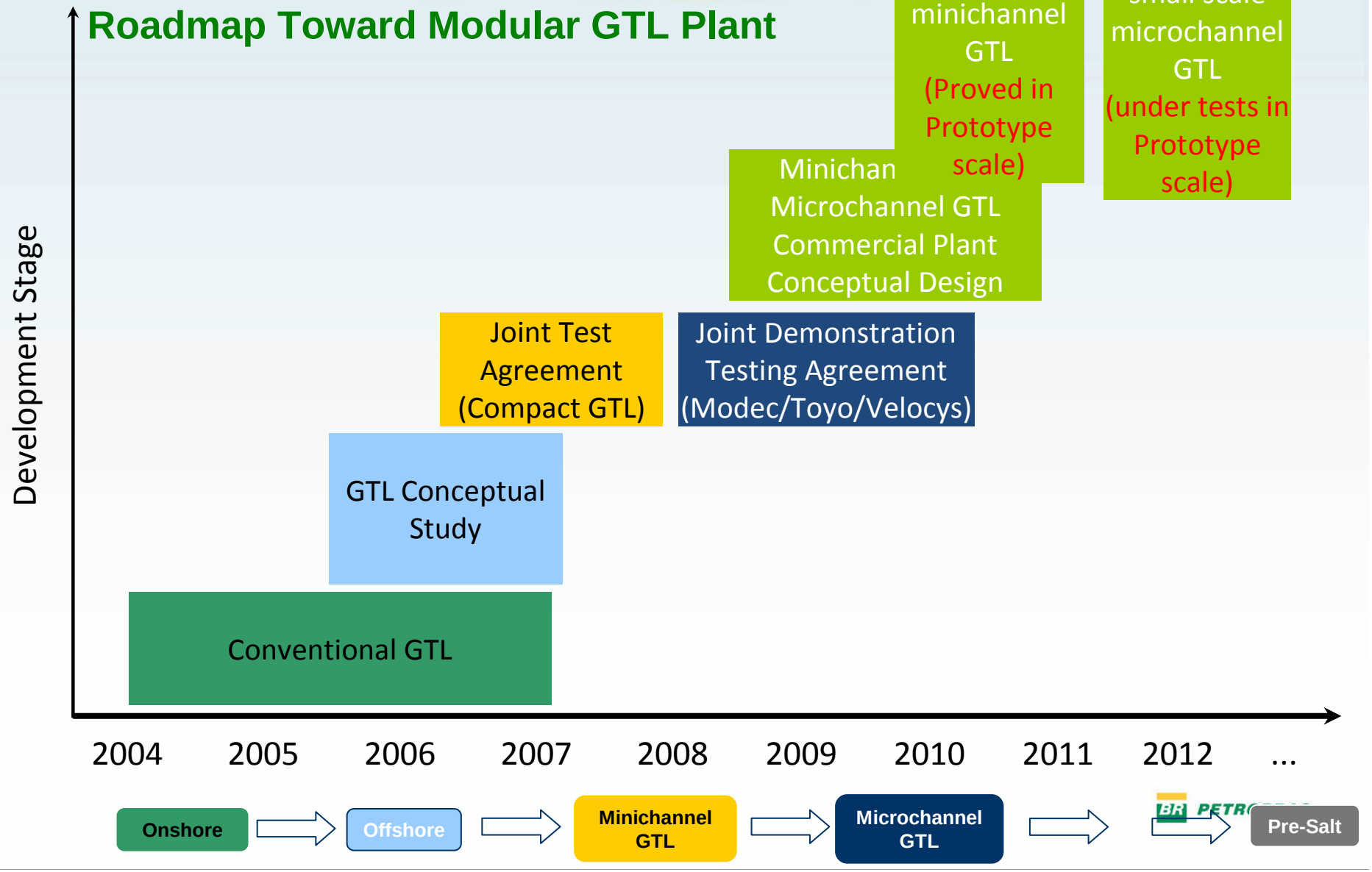
Roadmap Toward Modular GTL Plant



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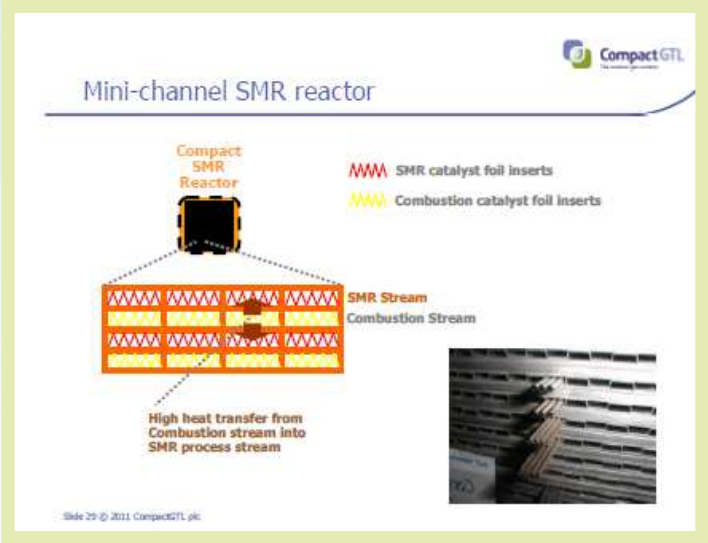
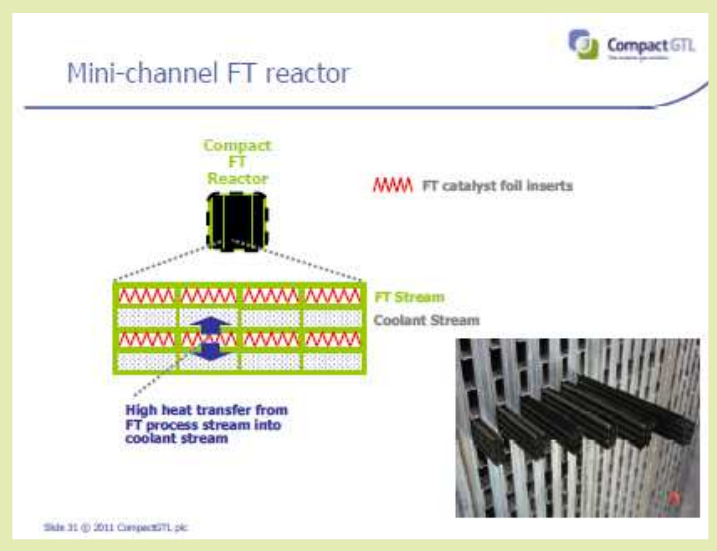
Modular GTL Demonstration Plant





Milichannel GTL 20 BPD (Compact GTL Technology)

Pólo de Atalaia/SE

- » Dec/2010 – Final comissioning;
- » Jan/2011 – First syncrude;
- » Nov/2011 – proved in prototype scale
- » May/2012 – Positive tests with high natural gas CO_2 content

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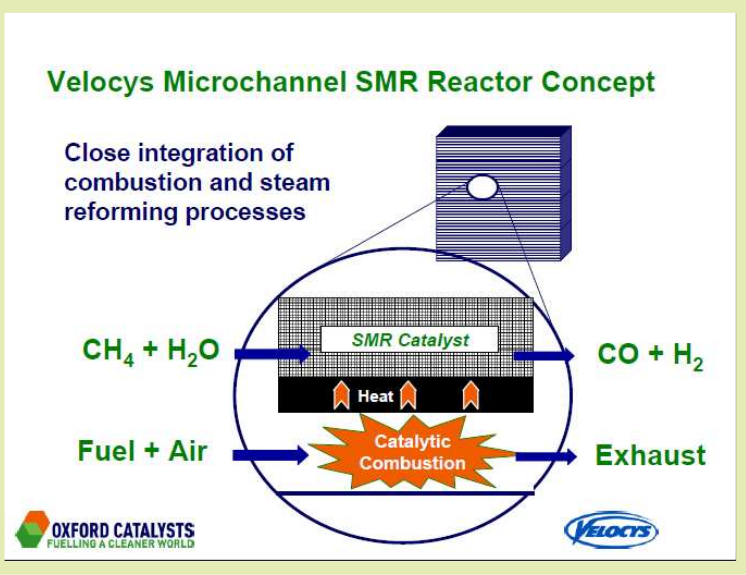
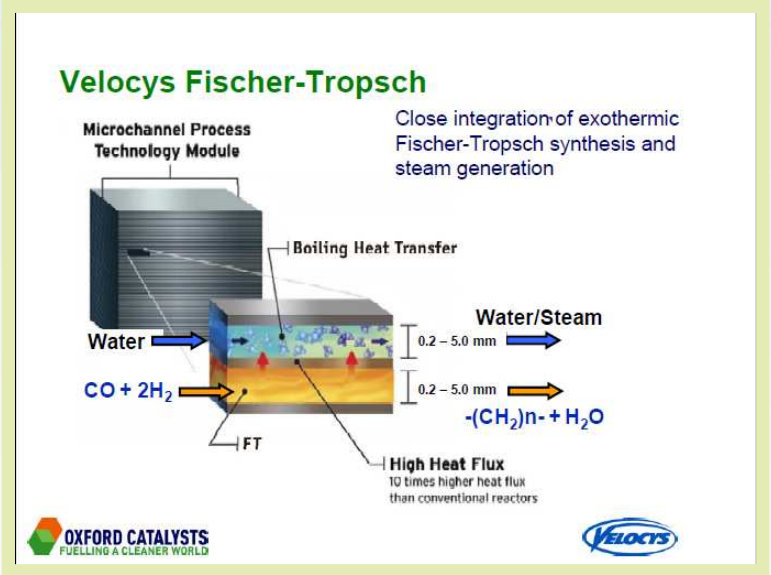
Modular GTL Demonstration Plant





Microchannel GTL 10 BPD (Velocys Technology) *Fortaleza/CE*

» Under tests in prototype scale

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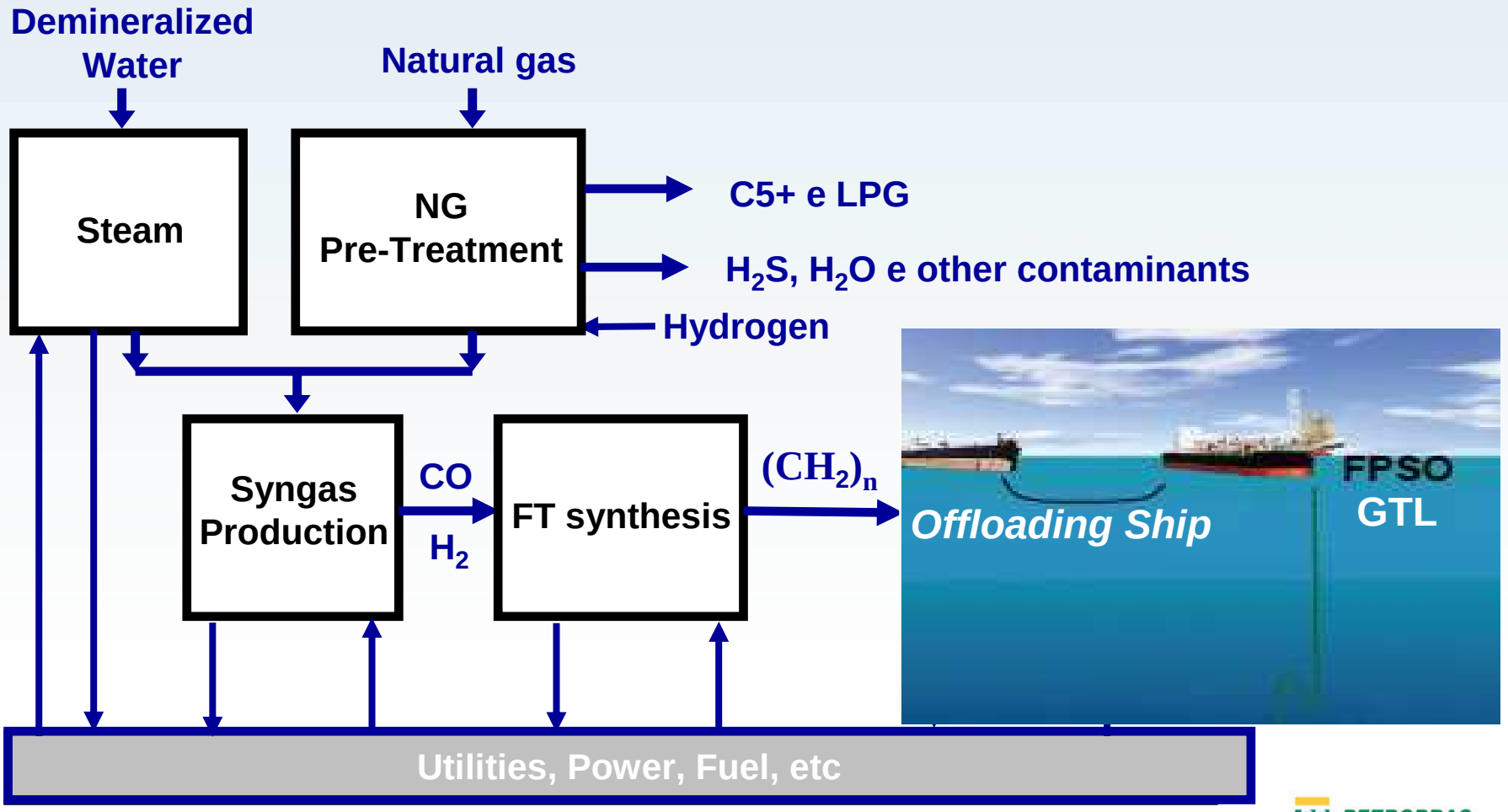
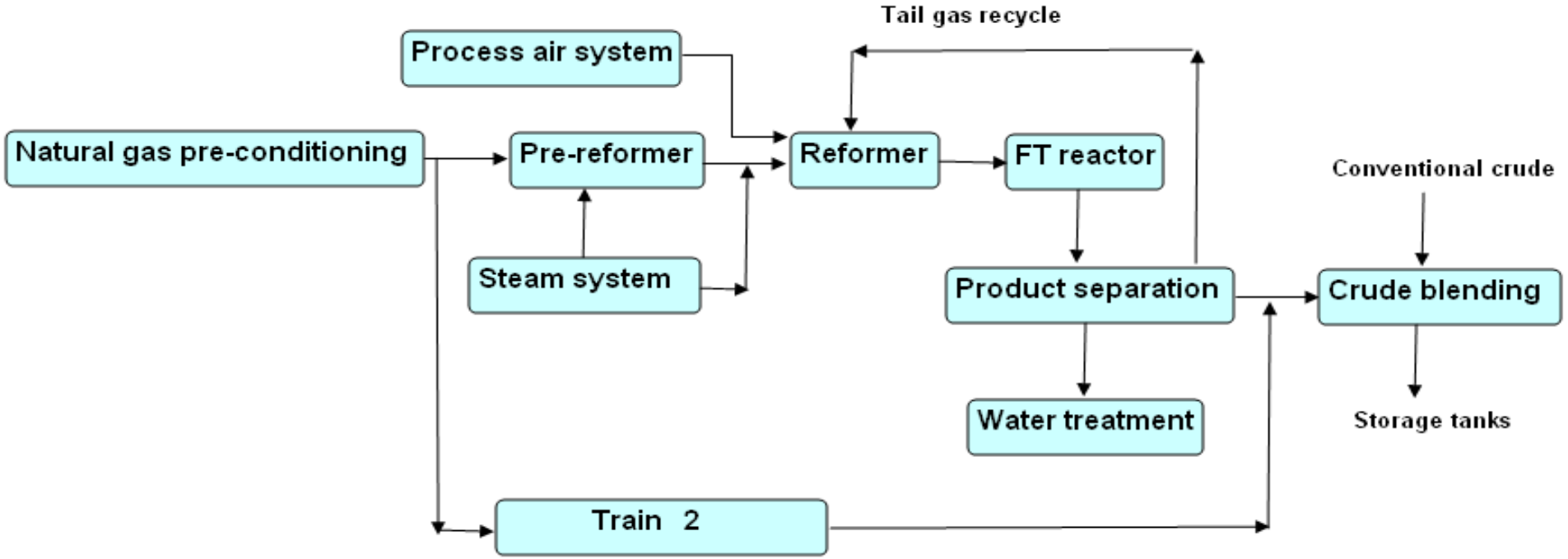
SUMMARY

Offshore GTL Process



Process Block Diagram



Premisses:

- Total process capacity: 600.000 Sm^3/d of natural gas feed;
- CO_2 content in the natural gas from 1.6 to 35%;
- SMR at 760 ^oC and 4.0 bara;
- FT reaction at 230 ^oC and 25 bara;

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Floating GTL

Source: CompactGTL e SBM

Source: MODEC, Toyo and Velocys

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Obrigada!

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