

Around GaseTM

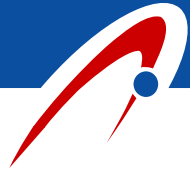
Technological Solutions for XTL/GTL Projects

Stéphane Fédou

Axens



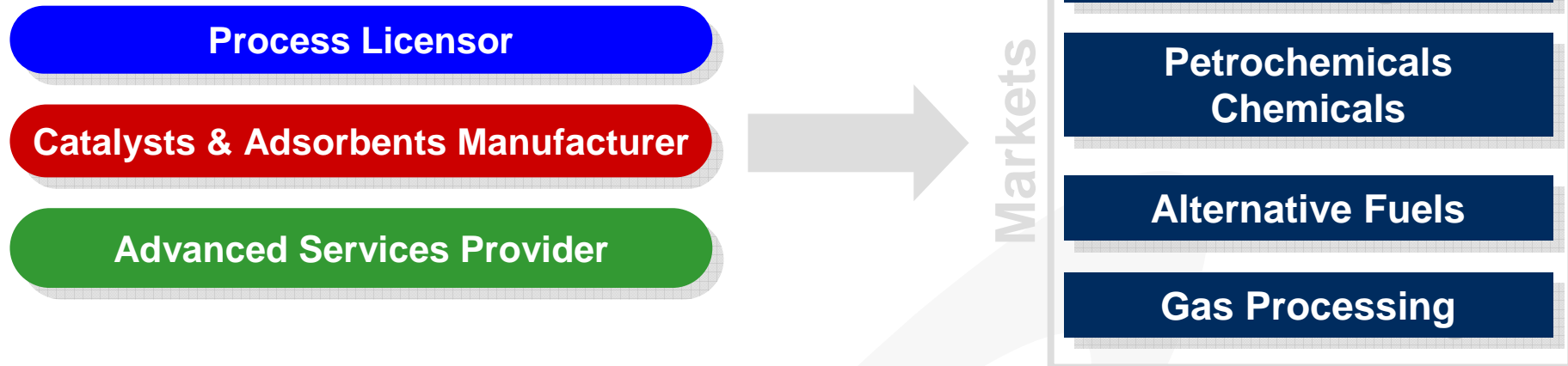
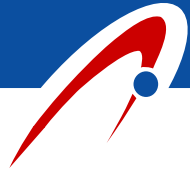
- **Which XTL projects in the near future ?**
- **Economic relevance of GTL**
- **Axens' technological solutions for XTL projects**



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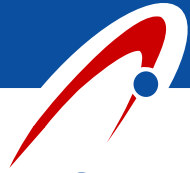
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Markets Served & Ambitions



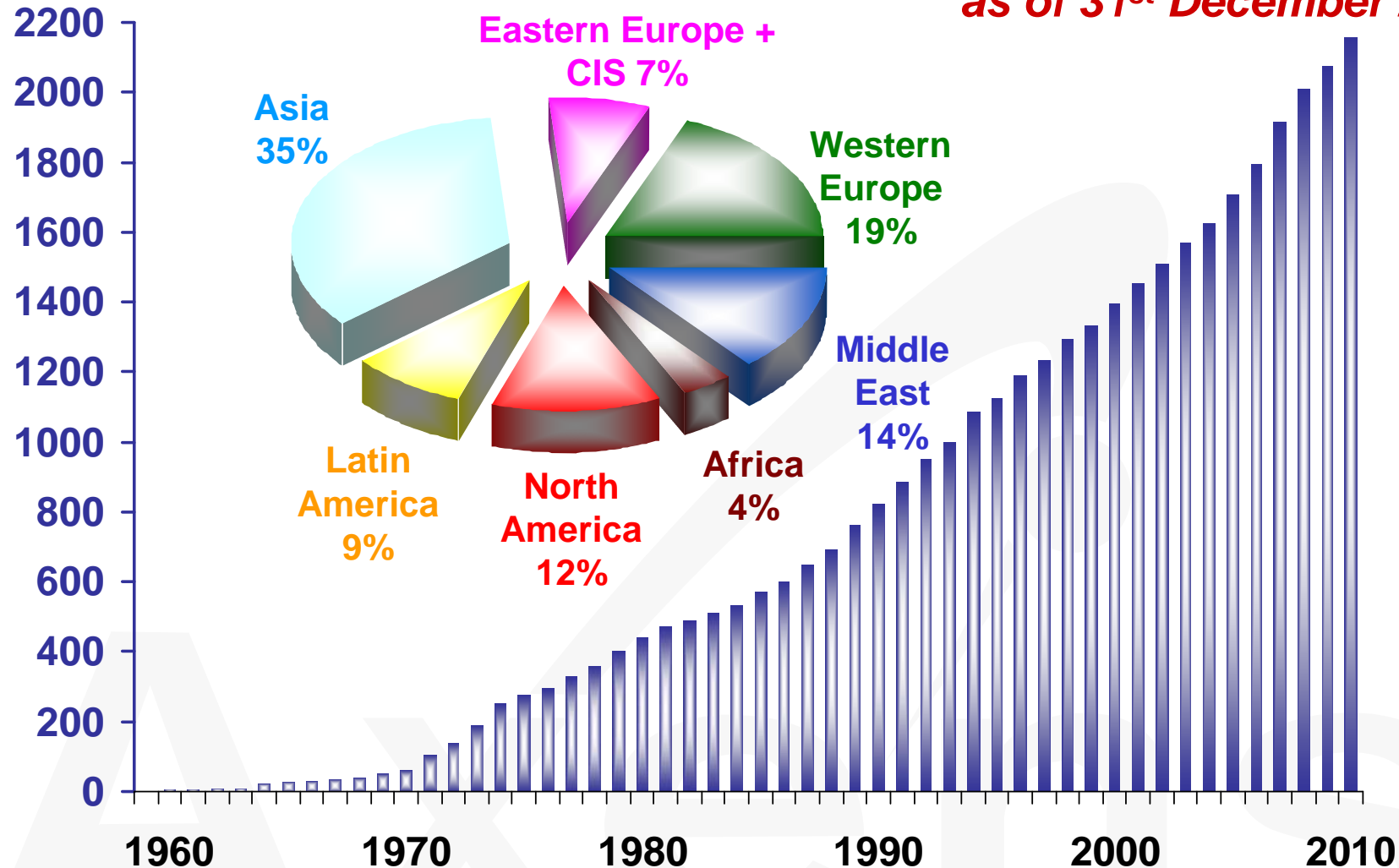
Ambitions

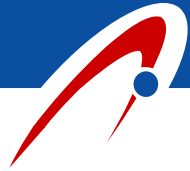
- **Benchmark company for Clean Fuels and Aromatics production,**
- **Leader in purification for olefins/polyolefins, syngas, refining and petrochemical, and natural gas streams**
- **Innovator in the biodiesel market and syngas to liquids technology.**



Cumulative Number of Licenses

**2158 licenses
as of 31st December 2010**



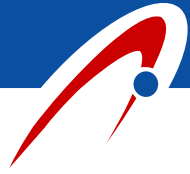


XTL through FT is one of the most promising route to alternate fuels and petrochemicals

FT provides very high quality products, adapted to the existing network and markets ...

- **Fuel market : Middle-distillates (Jet, Gas-Oil) ~70% adapted to Diesel engines and Specifications**
- **Petrochemicals Market : Paraffinic Naphtha ~30% perfectly suited for existing steam crackers**

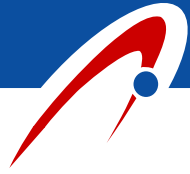
... and adapted to the future market demand of biofuels and green petrochemicals (BTL-FT)



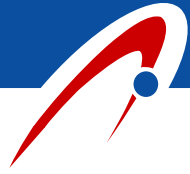
Main Types of Future XTL Projects

3 main types of future XTL projects:

- **G/CtL** Promoted by gas/coal producers (countries / private operators)
Competition/Synergy: LNG, DCL
- **B+PtL** Co-treatment of Biomass and Petroleum feedstocks in Refineries
- **100% BtL** New operators in the fuel market (Paper industry, Agro-business)

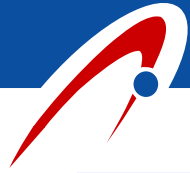


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GTL Valorisation for Gas Fields

Fields: 1 - 3 Tcf / 30 – 80 Bcm

- ⇒ not enough gas for LNG
- ⇒ 1 to 3 GTL trains of 15,000 bpd each
- ⇒ existing pipe, power, other liquid products

Stranded gas

Fields: 5 - 10 Tcf / 135 – 270 Bcm

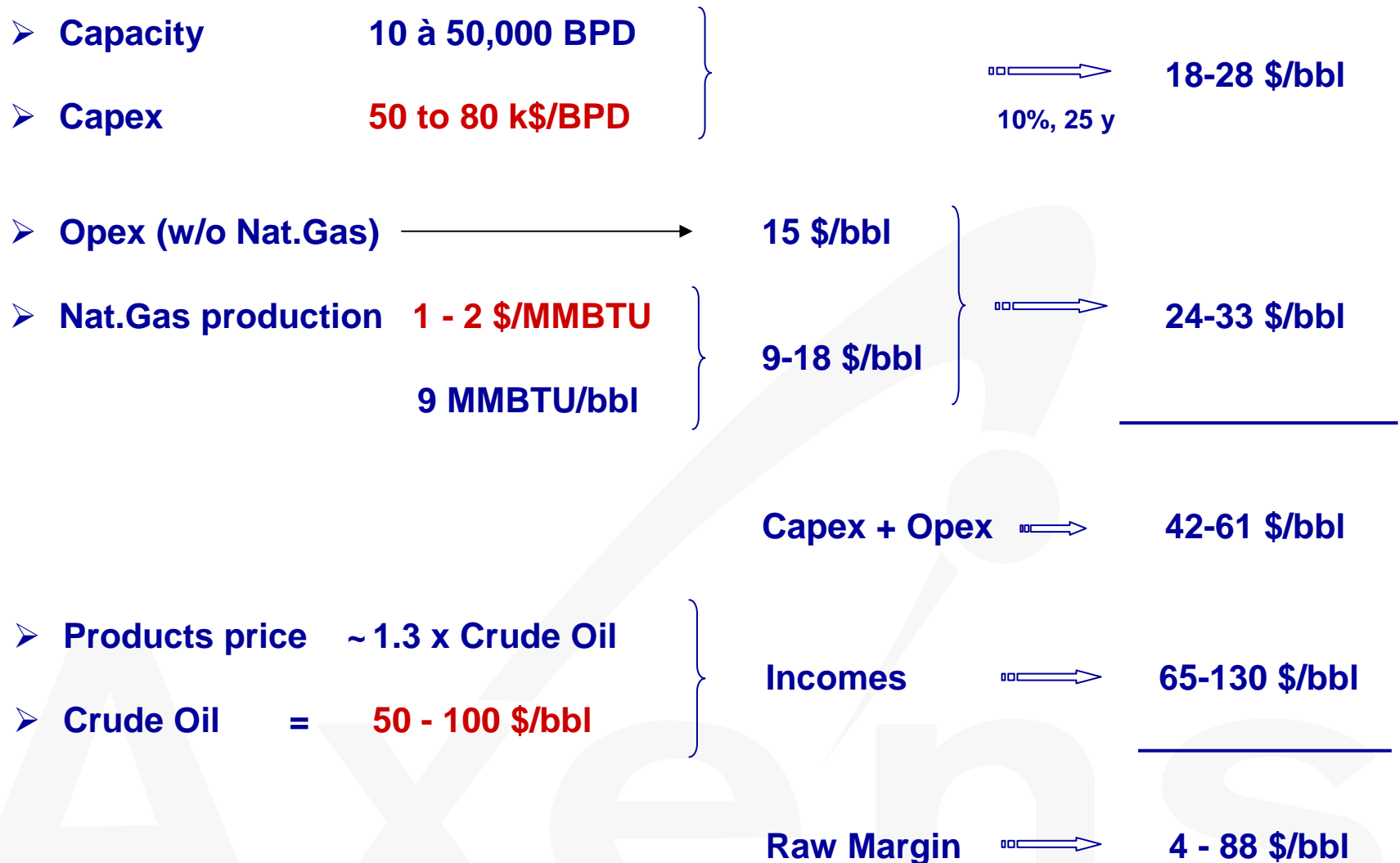
- ⇒ 5 to 10 GTL trains of 15,000 bpd
- ⇒ 1 to 2 LNG trains of 5 MTY each
- ⇒ New pipeline ...

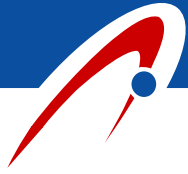
GTL competes with LNG

Economic Relevance of GTL



Production Cost and Incomes per Barrel of GTL product





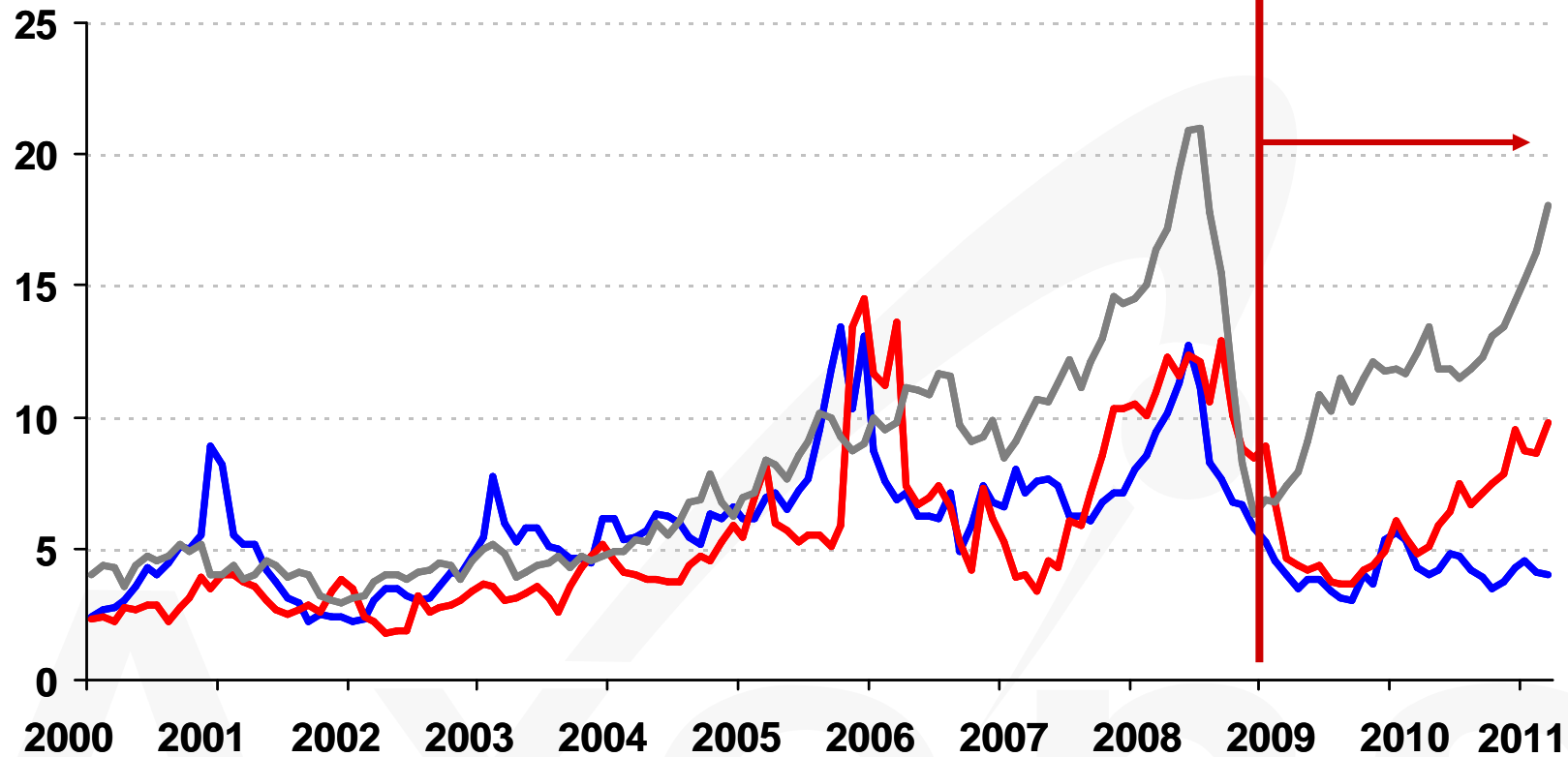
GTL Competition with Transported Natural Gas (Pipe, LNG)

Zeebrugge (European Natural Gas)

Henry Hub (US Natural Gas)

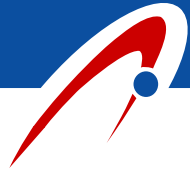
Brent

\$/MMBtu



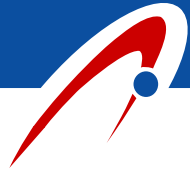
Source: Axens

IChE Natural Gas Conference — Tel Aviv — June 16th, 2011



GTL is relevant and competitive ...

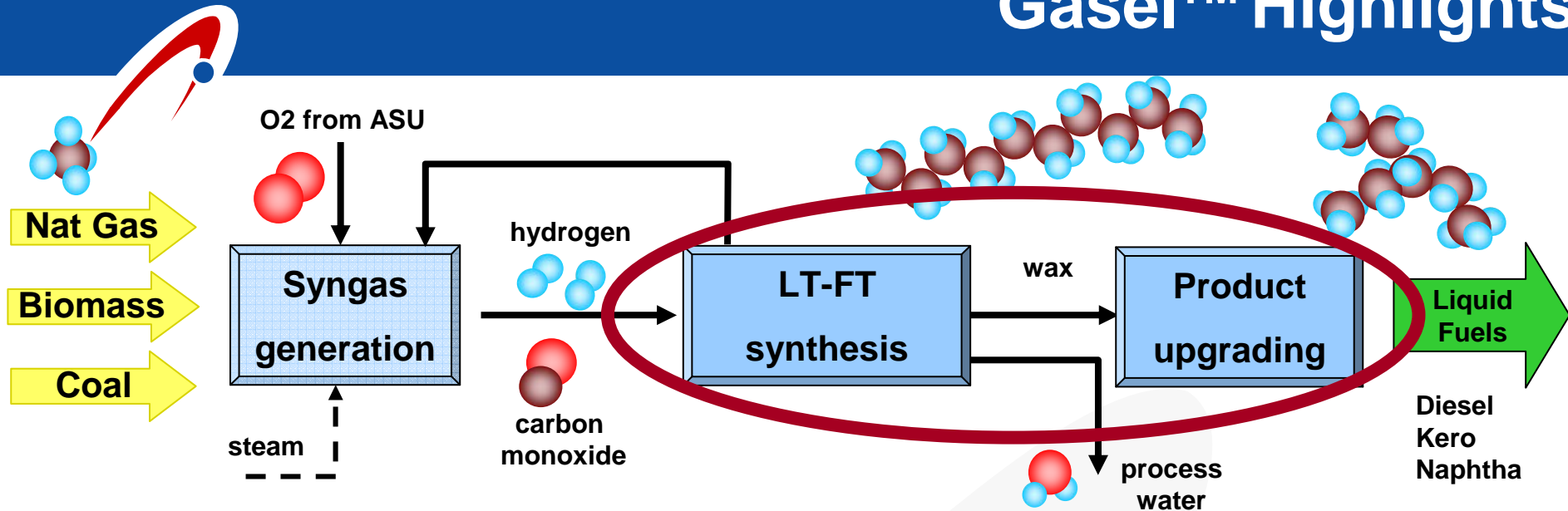
- **For Gas Producers/Owners (a way to valorize the gas production), not for Gas Buyers**
- **For medium size gas reserves (1-5 Tcf) or as a co-monetization for larger fields (ex:Qatar)**
- **For Crude Oil prices above 50 \$/bbl**
- **If Oil vs Gas price gap remains stable or increases**



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GaseI™ Highlights



- Development and scale-up by Eni & IFP Energies nouvelles since 1996
- Process design, integration and licensing by Axens
- LT-FT in Slurry Bubble Column
- Axens hydrocracking technology for Upgrading
- Tailored Cobalt FT and upgrading catalysts
- Formulated and validated by Eni & IFP Energies nouvelles
- Developed and manufactured by Axens



Fischer-Tropsch Pilot Plant Eni's Sannazzaro Refinery Start-up in 2001



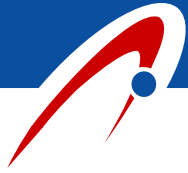
A photograph of a large industrial facility, the Fischer-Tropsch Pilot Plant at Eni's Sannazzaro Refinery. The plant features a complex network of steel structures, including tall towers, ladders, and walkways. The background shows a clear sky and some distant industrial structures.

Fischer-Tropsch Pilot Plant Eni's Sannazzaro Refinery Start-up in 2001

Main items tested and validated:

- **Catalyst Performance (activity, selectivity)**
- **Liquid/Solid separation (4 systems tested)**
- **Slurry handling (mixed waxes + solid catalyst)**
- **Operation skill: 20,000 hours-on-stream since 2001**

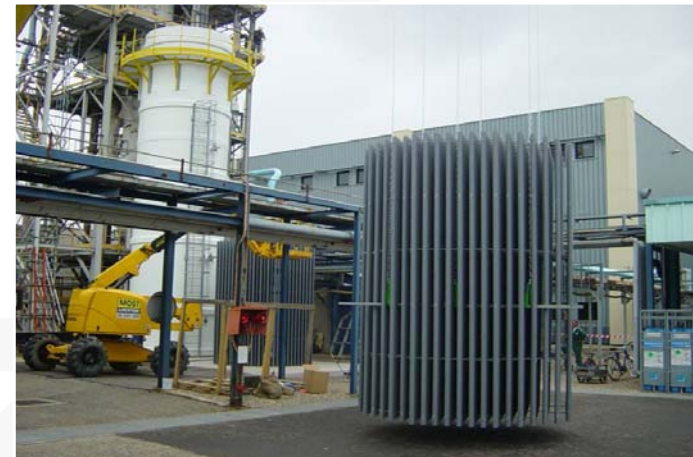
Large Cold Mock-ups for Hydrodynamics Scale-Up



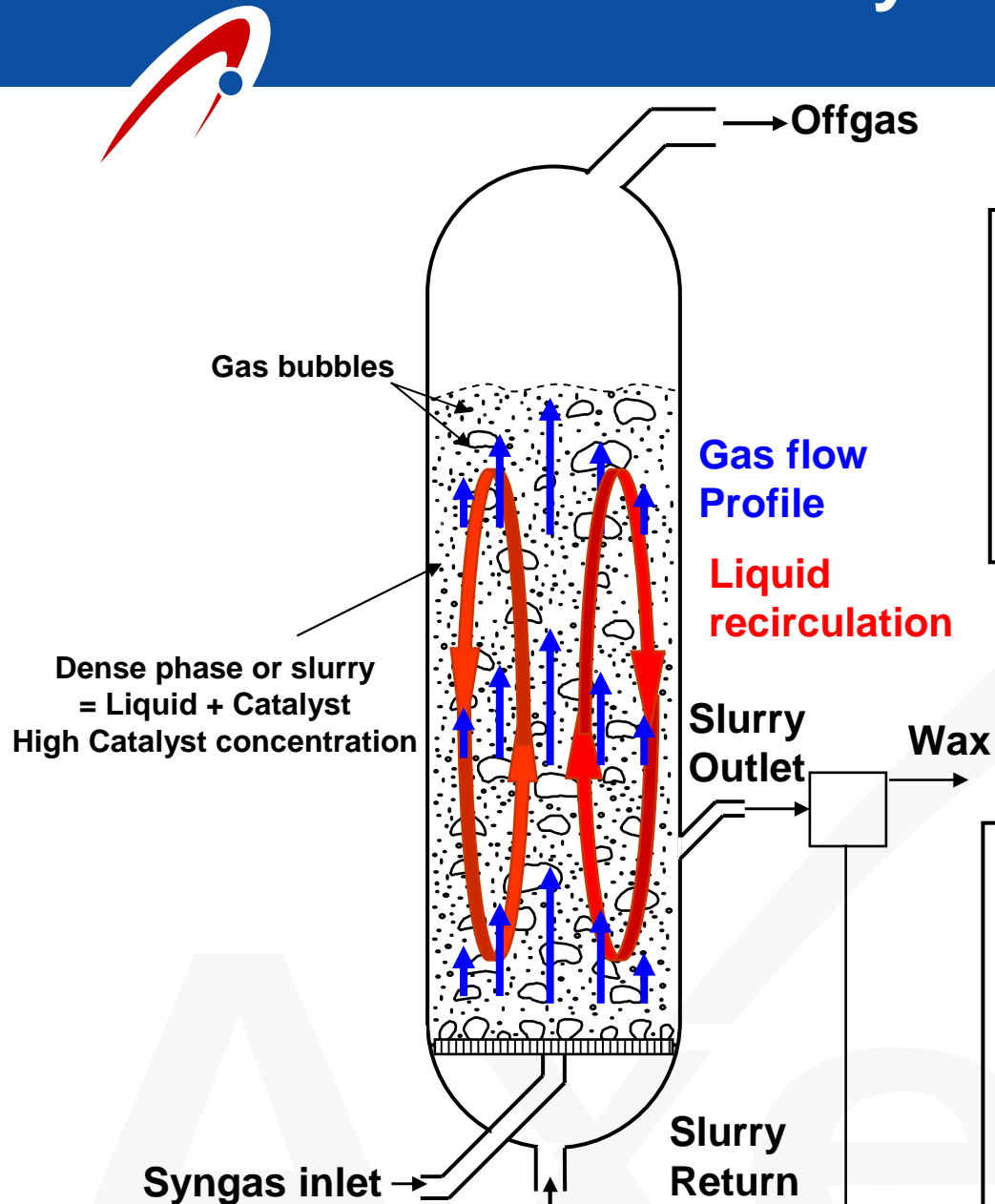
3m/1000 bpd cold mock-up



5m/3000 bpd Gas Distributor



Slurry Bubble Column Reactor Hydrodynamics



Gas flows upwards (~ plug flow) and induces slurry recirculation

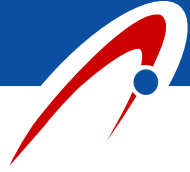
catalyst concentration in the slurry and Operating Temperature are constant in the reactor

SBCR system allows

- Nearly isothermal conditions
- High catalyst efficiency
- High capacities per Reactor

but

- Complex reactor design
- Catalyst mechanical stress



Catalyst Resistance to Attrition

- **Catalyst resistance tests with a specific tool** reproducing the stress of an Industrial Reactor (10 m dia – 15,000 bpd)
 - chemical stress (reactive conditions)
 - mechanical stress (recirculation velocity)

Large Validation Tool (LVT)

=

Reactive Conditions

+

**Recirculation Velocities
up to a SBC-FT Reactor
of 10 m diameter**



Wax Production from Pilot Plant up to FT Diesel for Engine Tests

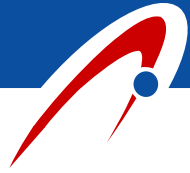


**Wax from FT Pilot Plant
Hydro-cracked & isomerized
in IFP HDK Pilot Plant**



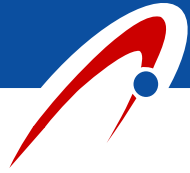
**for further
FT Diesel Engine Tests**





- **Axens Hydrocracking process is a fully developed & proven technology**
 - more than 70 references worldwide
 - over 3.0 MBPSD capacity on various feedstocks (VGO)
 - basic design for FT paraffins upgrading already performed
- **Specific catalyst**
 - very selective towards Middle Distillates
 - with enhanced isomerization (better cold flow properties)





Axens is the only technology provider to

- **Propose a complete FT + Upgrading technology chain for the conversion of Syngas to Middle Distillates (Jet, Diesel)**
- **Manufacturing associated FT and Upgrading catalysts**
- **Providing a single point guarantee from Syngas to Final Products**

→ Gase/™

Around GaseTM

Technological Solutions for XTL/GTL Projects

Thank you for your attention

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