

# Research and development

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X. Prével – M. Lepoutre

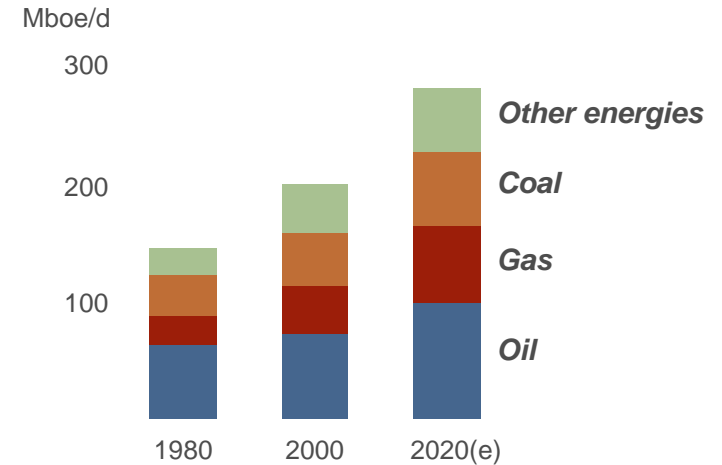
Paris – November 14-15, 2006



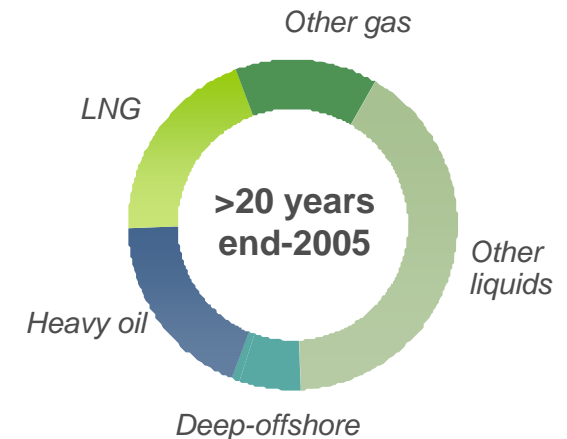
# Expand Total's position as a major energy supplier over the very long term

- ▶ **Extend production from existing fields**
- ▶ **Explore, discover and develop new oil & gas fields**
- ▶ **Access to high-tech plays through technology**
  - Heavy oil
  - Tight gas & sour gas
- ▶ **Prepare options for unconventional liquids**
  - Medium term : GTL, DME technologies...
  - Long term : CTL, oil shale
- ▶ **Address CO<sub>2</sub> issues**
  - Addressing long-term concerns over heavy oil developments and/or unconventional plays

Global energy demand\*



Proved and probable reserves\*\*



\* source : IEA, Total estimates

\*\* limited to proved and probable reserves at year-end covered by E&P contracts on fields that have been drilled and for which technical studies have demonstrated economic development in a 40 \$/b Brent environment end 2005, also includes Joslyn tar sands to be developed with mining



# Extracting more production and value from existing fields

## ► Average recovery rate in Total's portfolio

- Oil : 40%
- Gas : 60%

## ► Scope for increased recovery in fields where

- Hydrocarbons in place > 100 Mboe\*
- Recovery for oil < 40% and for gas < 60%

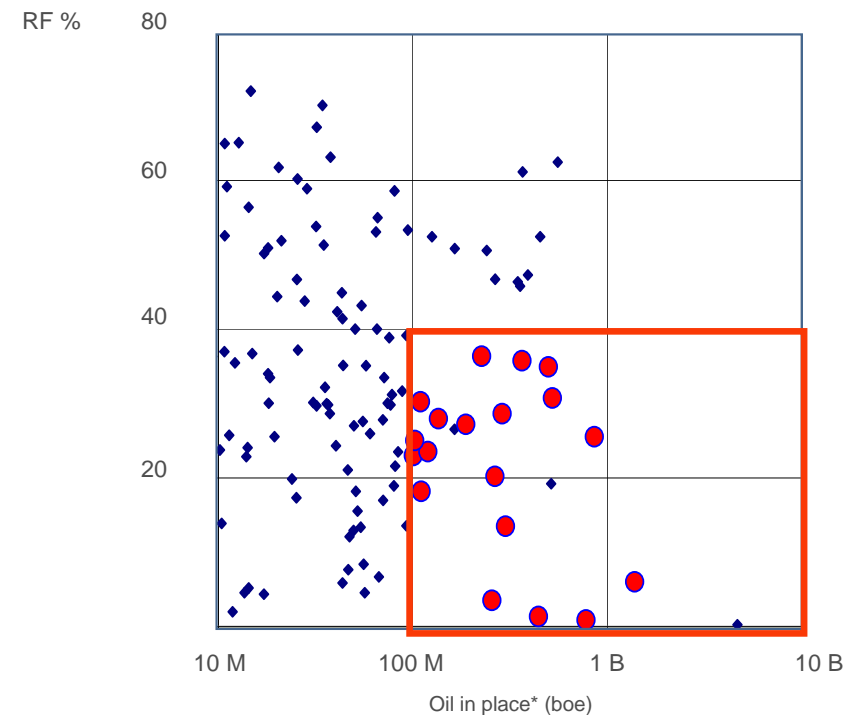
+10% in  
recovery  
factor



30 operated fields : > + 1 Bboe(e)\*  
16 non-operated fields : ~ + 0.5 Bboe(e)\*

- Half of this potential in 10 fields (9 Total-operated)

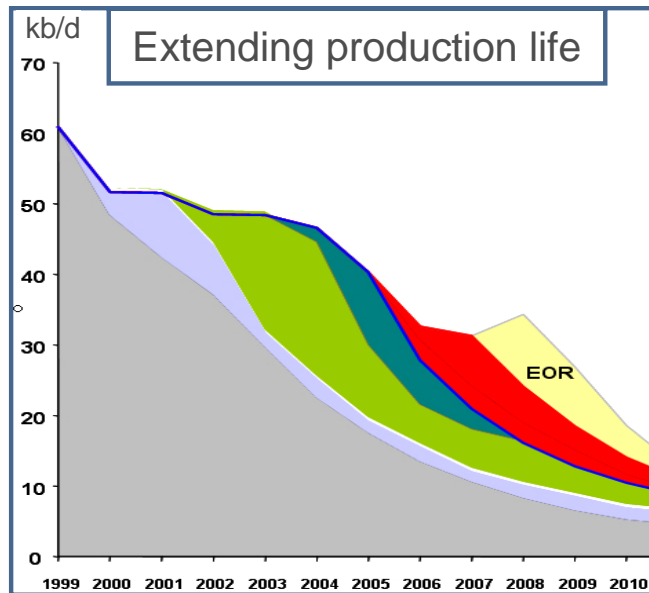
## Total-operated producing oil fields (with more than 10 Mboe\*)



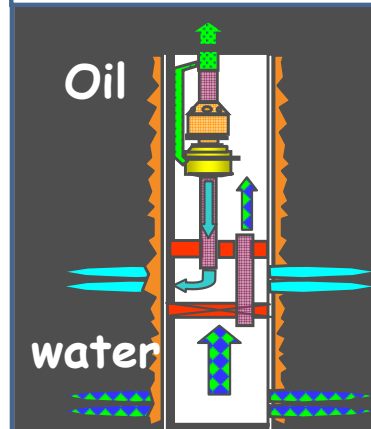
\* Total share



# Research and technology to produce more from existing resources



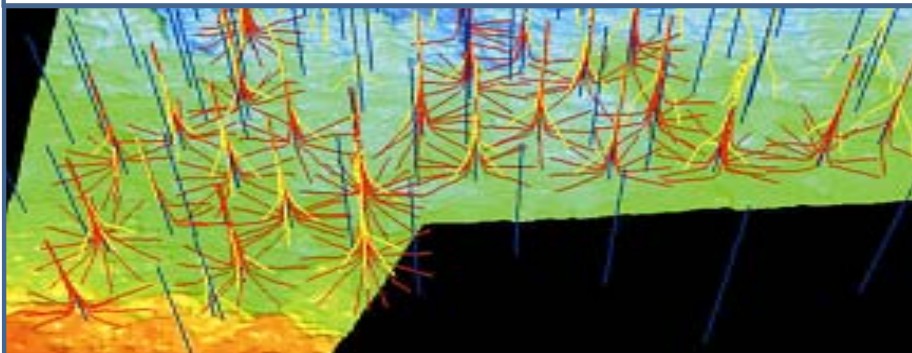
## Water management : separation, reinjection



Water shut off and  
DOWS-PWRI pilots

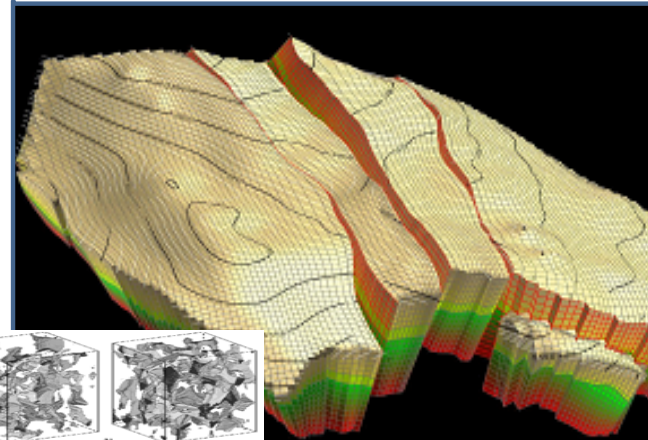
Optisep™

## Monitoring and reservoir engineering



Seismic interpretation and Geosteering : ex Sismage™

## Earth modeling and reservoir characterization



Active role in  
gOcad™, and  
proprietary plug-in  
Alea, Jacta, Est®,  
or others Wakeup,  
GeoSI...

# Accelerate production and increase recovery factors : enhanced oil recovery

Program including experimentation, simulations and operational experience

## Chemical methods

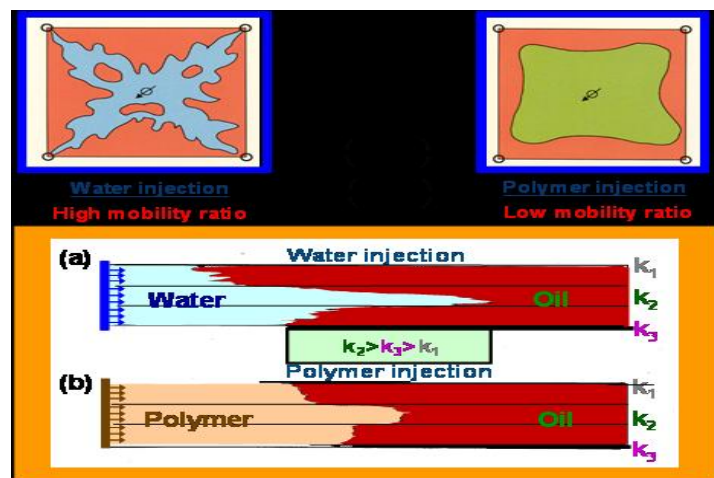
### Polymers

- Viscosification, filterability
- Behavior in temperature, salinity, mechanical degradation, adsorption

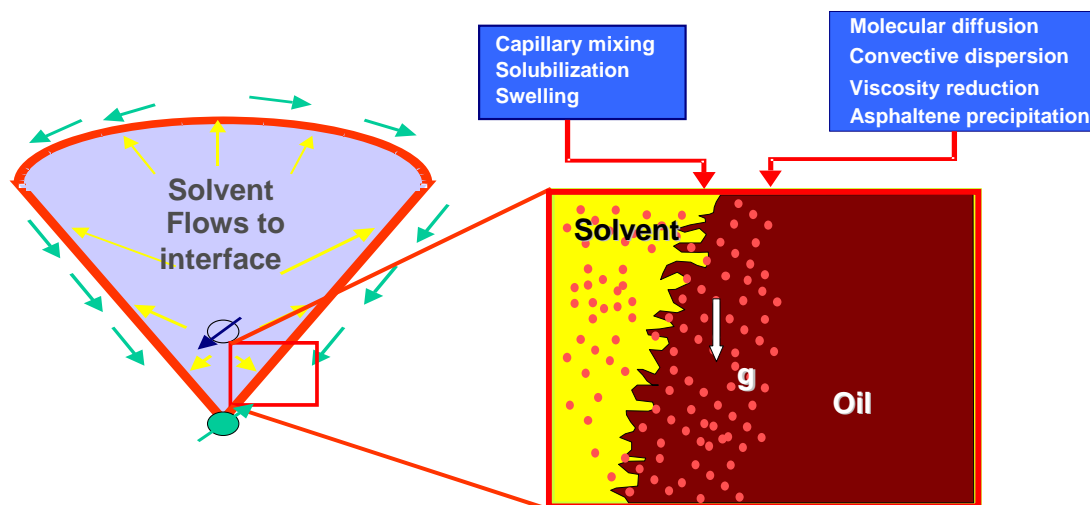
### Surfactants

- Lower oil-water interfacial tension
- Microemulsion viscosity, adsorption, costs

## Dalia project

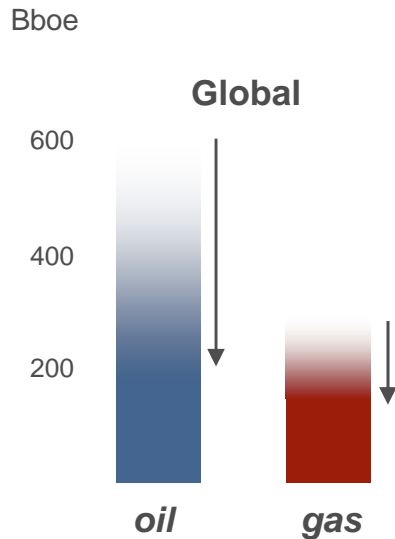


## Solvent

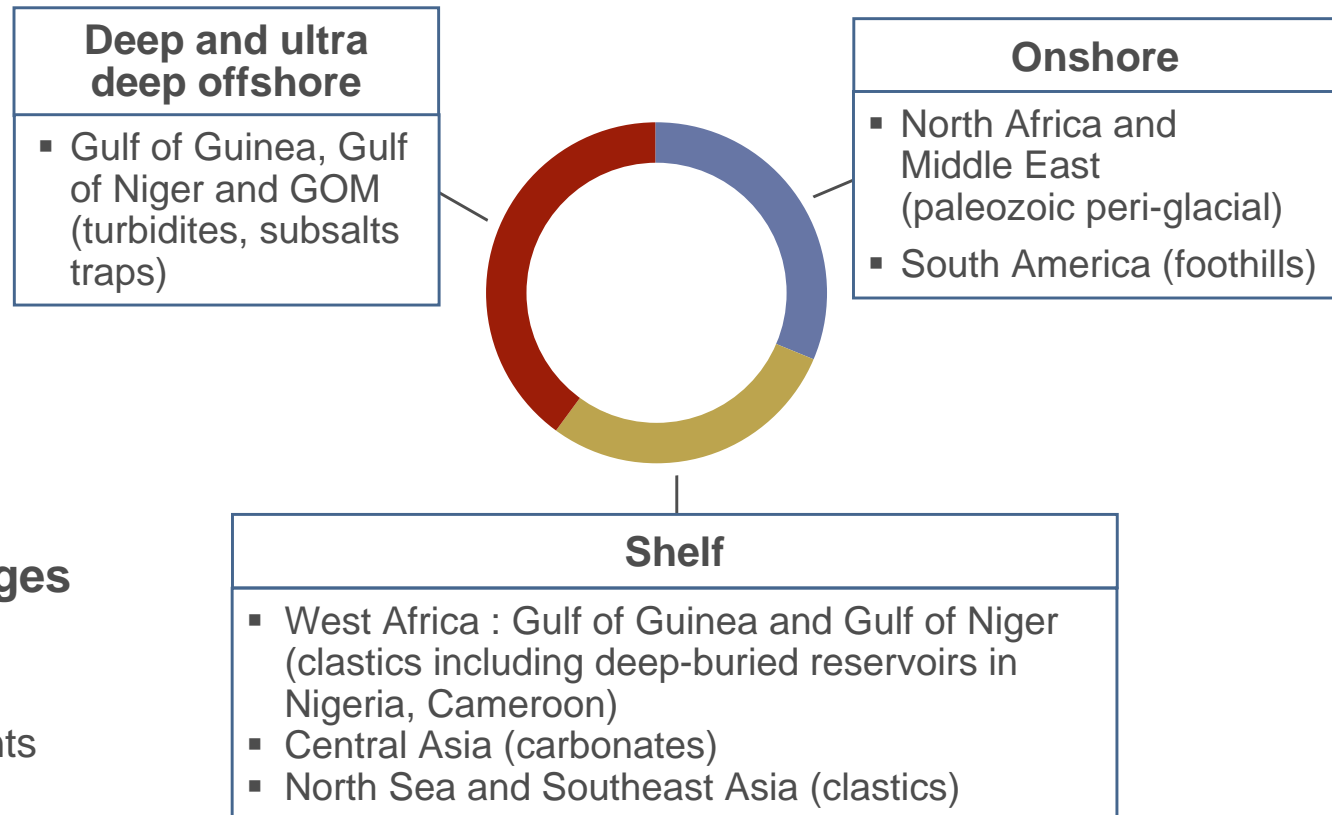


# Explore, discover & develop new fields : a technology leader

## Yet-to-find oil & gas conventional resources\*



## Total's exploration potential by plays



## Main technological challenges

- Subsurface imaging, seismic
- Reservoir characterization
- Deep & ultra-deep developments (incl. satellites) :
  - Drilling, subsea development, flow assurance...

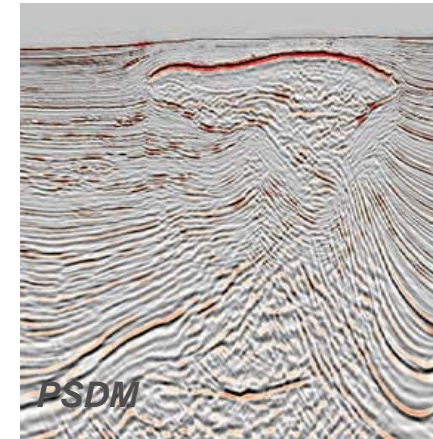
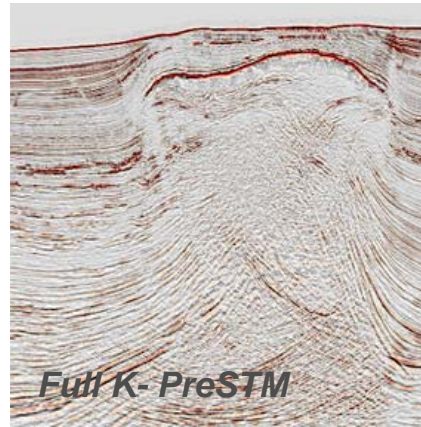
\* Total estimates, excluding heavy oil

# Research and technology to sustain growth : frontier exploration

Foothills areas



Geology concepts



Deep & HP/HT reservoirs



Sub-surface imaging

Seismic acquisition, time pre-processing and QC, depth imaging, seismic reservoir characterization, multicomponent seismic, passive seismic...

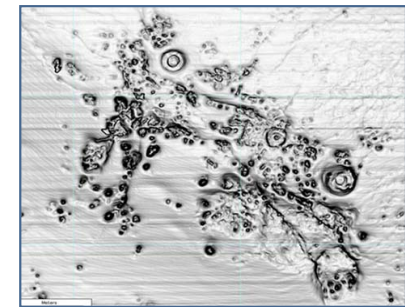
Drilling

Operational expertise: Elgin-Franklin, Light subsea well intervention

Subsea technology

Expertise in long tie-back, flow assurance, geotechnic

All electrical subsea wellhead (pilot K5F NL)  
Energy transportation,  
Pumping, compression



Arctic areas



Environment, logistics, surface facilities



# Access to new plays through technology : heavy oil

Global ultimate heavy oil resources\* > 600 Bboe

## ► Improve recovery factors

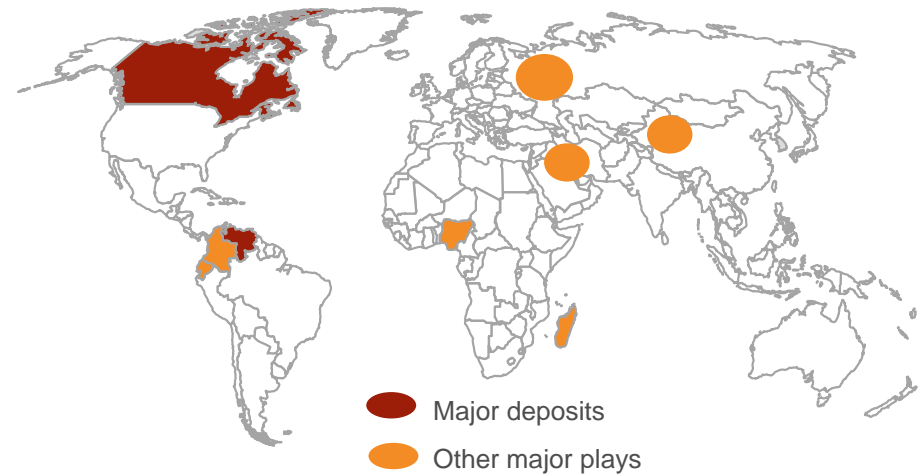
- Cold production Orinoco 7-11%
- Canada SAGD ~15-35%
- Canada mining ~80%

## ► Extend SAGD application

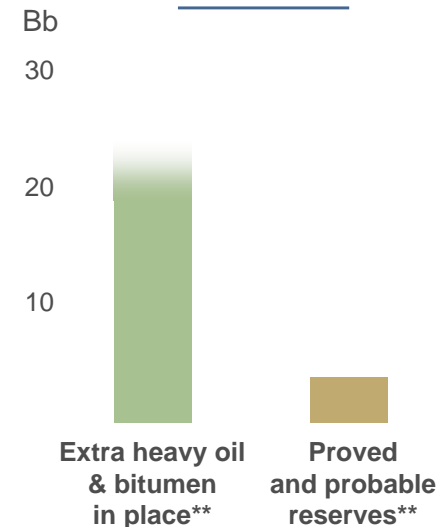
- Thin (< 15 m) layers
- Complex geological deposits

## ► Address CO<sub>2</sub> issues

- Improve energy efficiency
- CO<sub>2</sub> capture and storage



**Extra heavy oil & bitumen in place  
in Total's portfolio > 20 Bb  
(end-2005)**

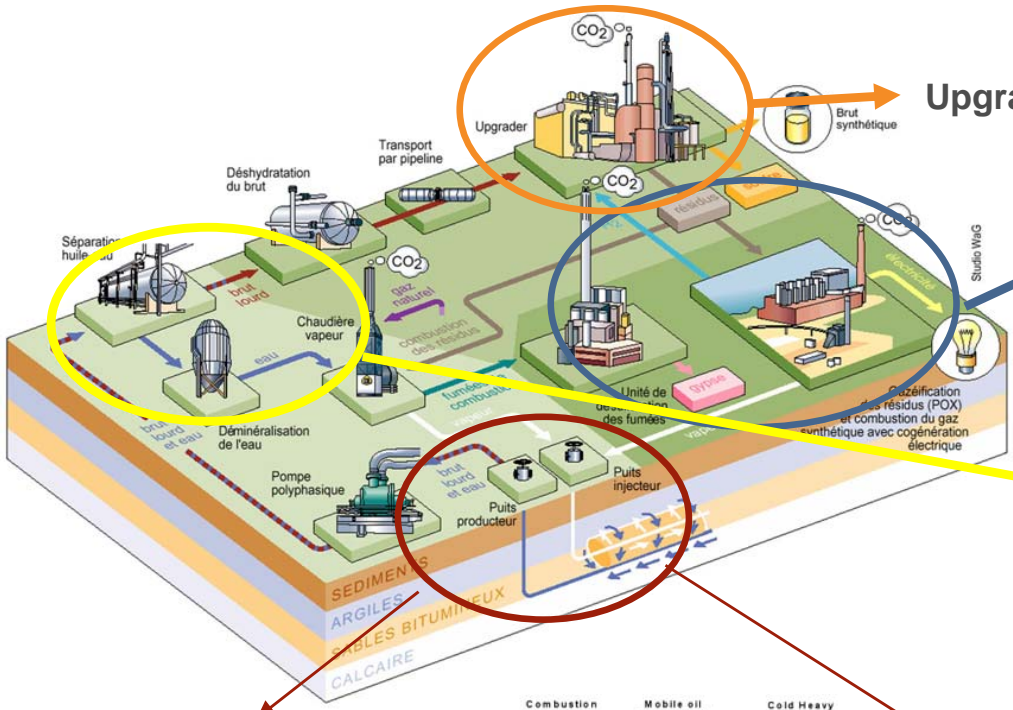


**Leverage Sincor industrial success  
to monetize further resources**

\* Total estimates

\*\* Total share

# Heavy oil research and technology



Upgrading technology

Alternate fuels :  
Bitumen emulsions, petcoke, asphalt  
CO<sub>2</sub> : reduced emissions, capture

Processing center :  
Oil separation  
Water treatment



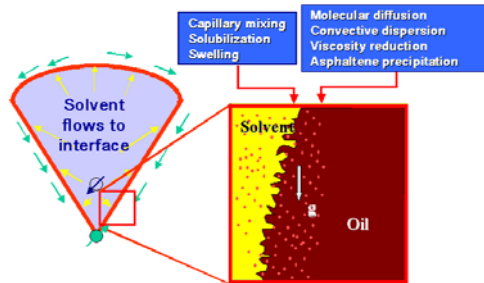
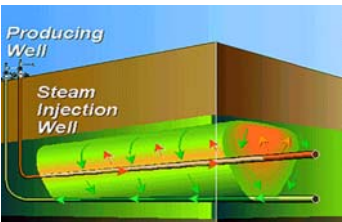
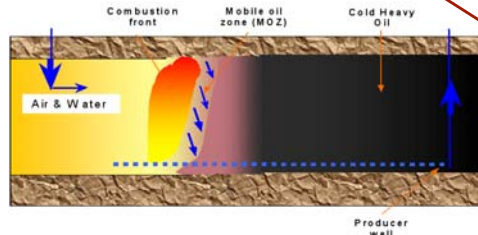
High water recycle

HT well technology



Steam diversion  
Flow simulation  
HT pumping & artificial lift  
Rock mechanics engineering

Enhanced Production/reserves



Lab experiments

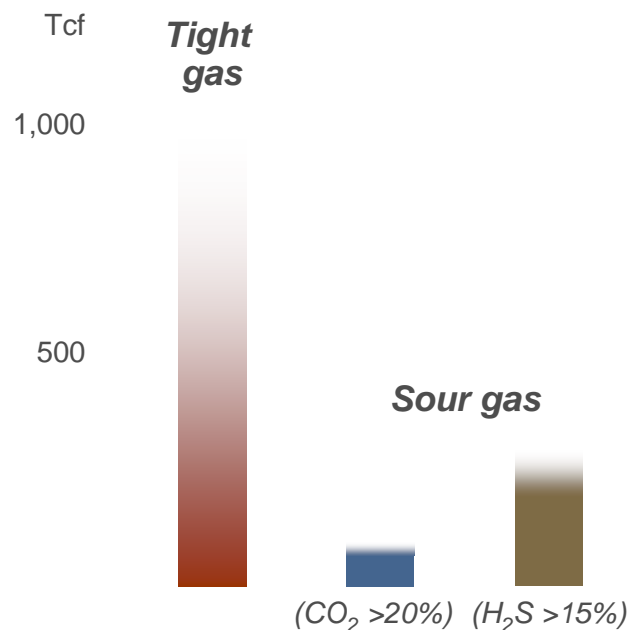
Simulation : Hot module in Intersect project\*

Pilots : Surmont, Joslyn, Dovap

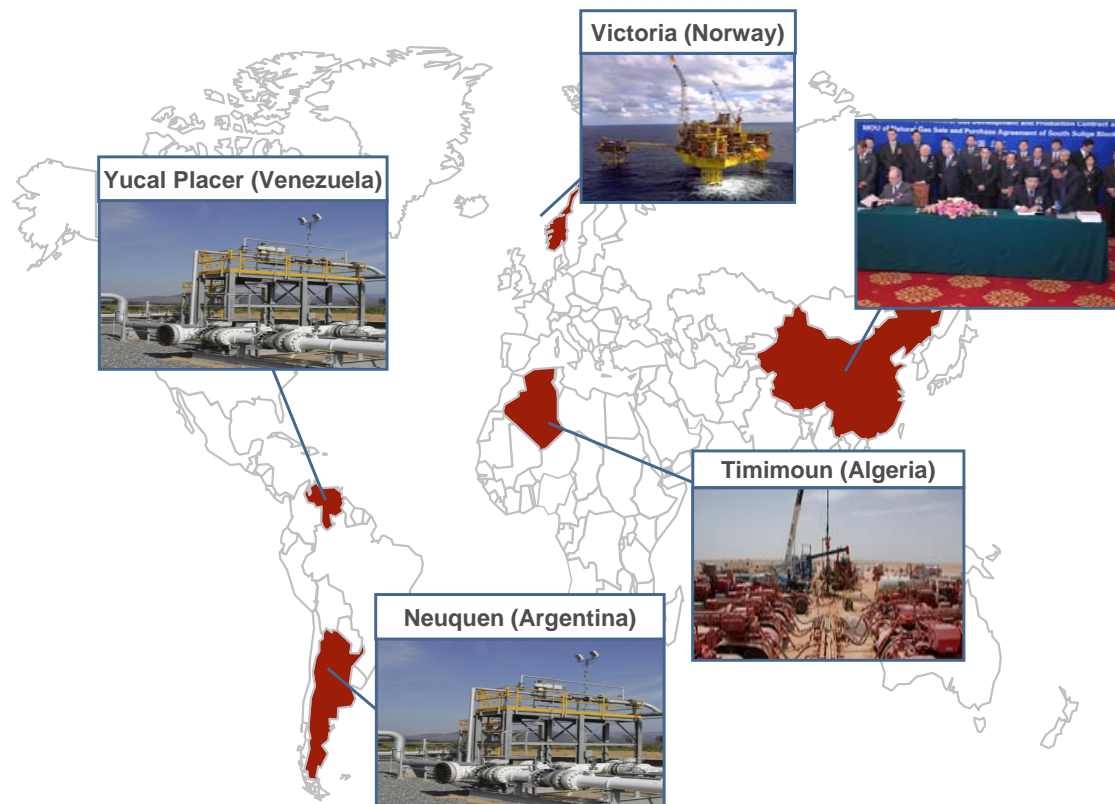
\* Total, Schlumberger, Chevron

# Access to plays through technology : tight gas & sour gas

## Global tight gas & sour gas resources



## Total's tight gas plays ~10 Tcf\*



## Leverage industrial know-how to access more resources

resources include proved and probable reserves, plus those quantities of hydrocarbons estimated to be potentially recoverable from known accumulations but which are not currently considered commercially recoverable (based on SPE draft definition, September 2006)

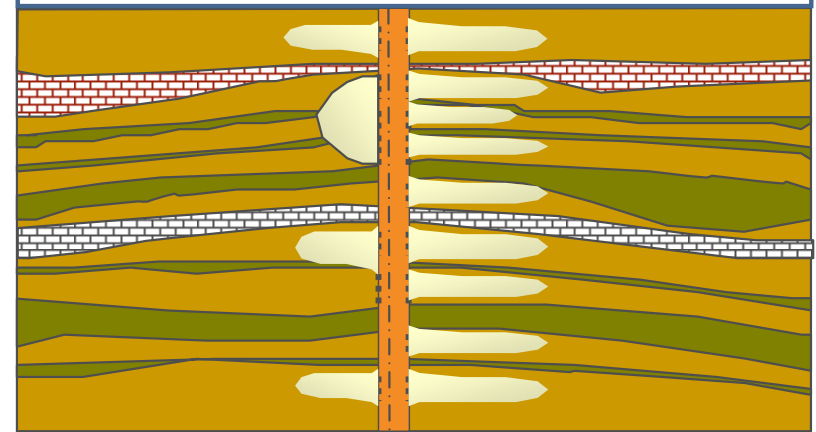
\* Total estimates

# Tight gas and sour gas : maintain aggressive R&D to keep competitive advantage

Ultra-sour gas



Tight gas



## Strong positions for Total

- Broad amine license portfolio
  - Advamine series HiLoad DEA<sup>®</sup>, MDEAmax<sup>®</sup>, energizedMDEA<sup>®</sup>
- Operational track record
  - Lacq, Tchibouela, Middle East, Sleipner...
- Sprex<sup>®</sup> pilot : validated
- R&D : Sprex<sup>®</sup> CO<sub>2</sub>, new hybrid solvent, membrane technology

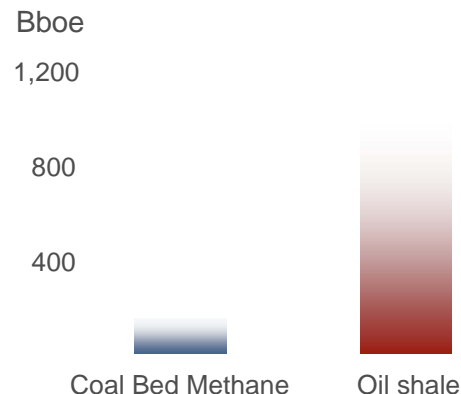
## Combined field tests and lab work

- Water blocking in Indonesia
- Micro seismic for frac monitoring in Texas
- Massive and multi-drain hydraulic fracturing in Argentina

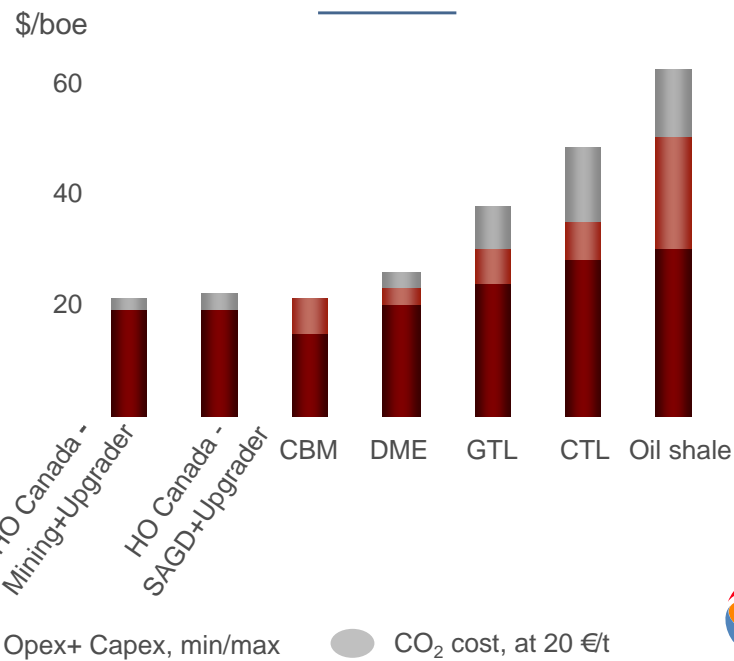
# Take long-term options on x-to-liquids plays

- ▶ **XTL : DME, GTL, CTL**
- ▶ **Gas or coal transformed into high-value liquid hydrocarbons**
  - Leverage relatively low cost of feedstock
  - Capital intensive
  - Energy efficiency does matter
  - DME and improved GTL : best current options
- ▶ **Oil shale : very long-term play (80-100 \$/b)**
- ▶ **CO<sub>2</sub> emissions to be addressed**

Global unconventional resources(e)



Typical costs



source : HIS, USGS, Total estimates

# Gas conversion, promising technologies

## GTL micro-technologies



- ▶ Aiming at efficiency improvement on
  - CO<sub>2</sub> emissions
  - Flexibility
  - Safety

***Partnership with Velocys to develop an improved catalyst process***

## DME : another GTL option

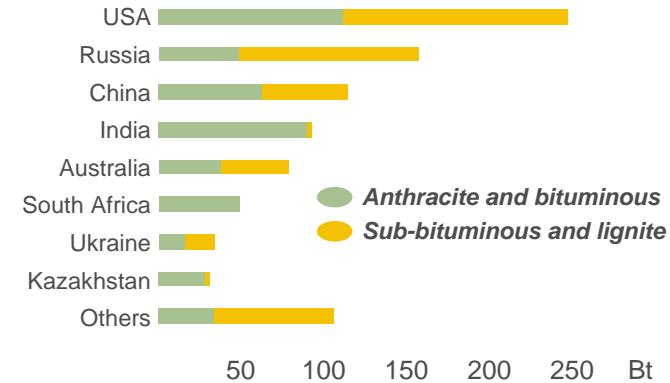


- ▶ A simple molecule (CH<sub>3</sub>-O-CH<sub>3</sub>) burning without any soot => clean fuel
- ▶ Easy to transport and store (comparable to LPG)
- ▶ Premium fuel for diesel engine
- ▶ Competitive production process

***Direct Synthesis Process developed since 2001 by Total and a Japanese consortium***

***Ongoing feasibility study for a commercial plant***

## CTL, an option to be considered for the long term



- ▶ Abundant reserves
- ▶ Lower and more stable prices
- ▶ Growing markets
- ▶ Costly process + CO<sub>2</sub> issues
- ▶ Technical improvements needed

***Pursuing feasibility studies and monitoring technology***

# CO<sub>2</sub> capture and storage : much needed for heavy oil and x-to-liquids

## Full demonstration Lacq project

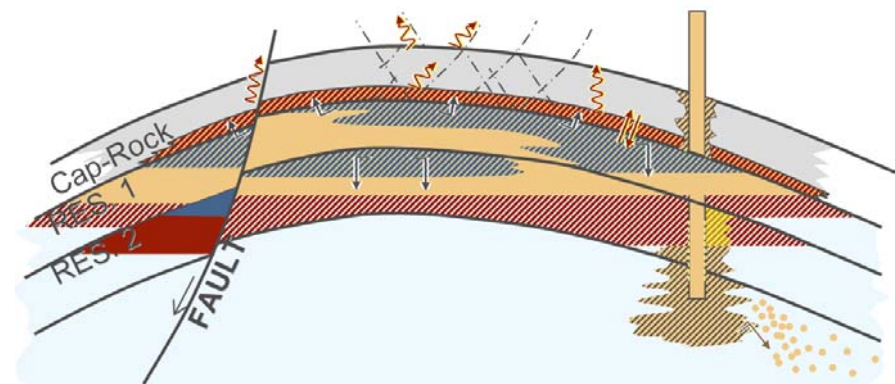


### ■ Oxycombustion for CO<sub>2</sub> capture :

- Attractive cost and energy efficient solution for CO<sub>2</sub> capture on steam boilers
- Reduce by 50% direct and indirect emissions associated with EHO hot production

### ■ R&D program :

- CO<sub>2</sub> and acid gas injection
- Storage and well integrity
- Long-term monitoring



● CO<sub>2</sub> or acid gas ● Oil ● HC gas ● Water

*Preparing for the long term by addressing effective industry challenges and mastering the necessary technologies*

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The business segment information is presented in accordance with the Group internal reporting system used by the Chief operating decision maker to measure performance and allocate resources internally. Due to their particular nature or significance, certain transactions qualified as "special items" are excluded from the business segment figures. In general, special items relate to transactions that are significant, infrequent or unusual. However, in certain instances, certain transactions such as restructuring costs or assets disposals, which are not considered to be representative of normal course of business, may be qualified as special items although they may have occurred within prior years or are likely to recur within following years.

In accordance with IAS 2, the Group values inventories of crude oil and petroleum products in the financial statements in accordance with the FIFO (First in, First out) method and other inventories using the weighted-average cost method. However, in the note setting forth information by business segment, the Group continues to present the results for the Downstream segment according to the replacement cost method and those of the Chemicals segment according to the LIFO (Last in, First out) method in order to ensure the comparability of the Group's results with those of its main competitors, notably from North America. The inventory valuation effect is the difference between the results according to the FIFO method and the results according to the replacement cost or LIFO method.

In this framework, performance measures such as adjusted operating income, adjusted net operating income and adjusted net income are defined as incomes using replacement cost, adjusted for special items and excluding Total's equity share of the amortization of intangibles related to the Sanofi-Aventis merger. They are meant to facilitate the analysis of the financial performance and the comparison of income between periods.

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