



# LES DEFIS TECHNOLOGIQUES DU SECTEUR DES HYDROCARBURES

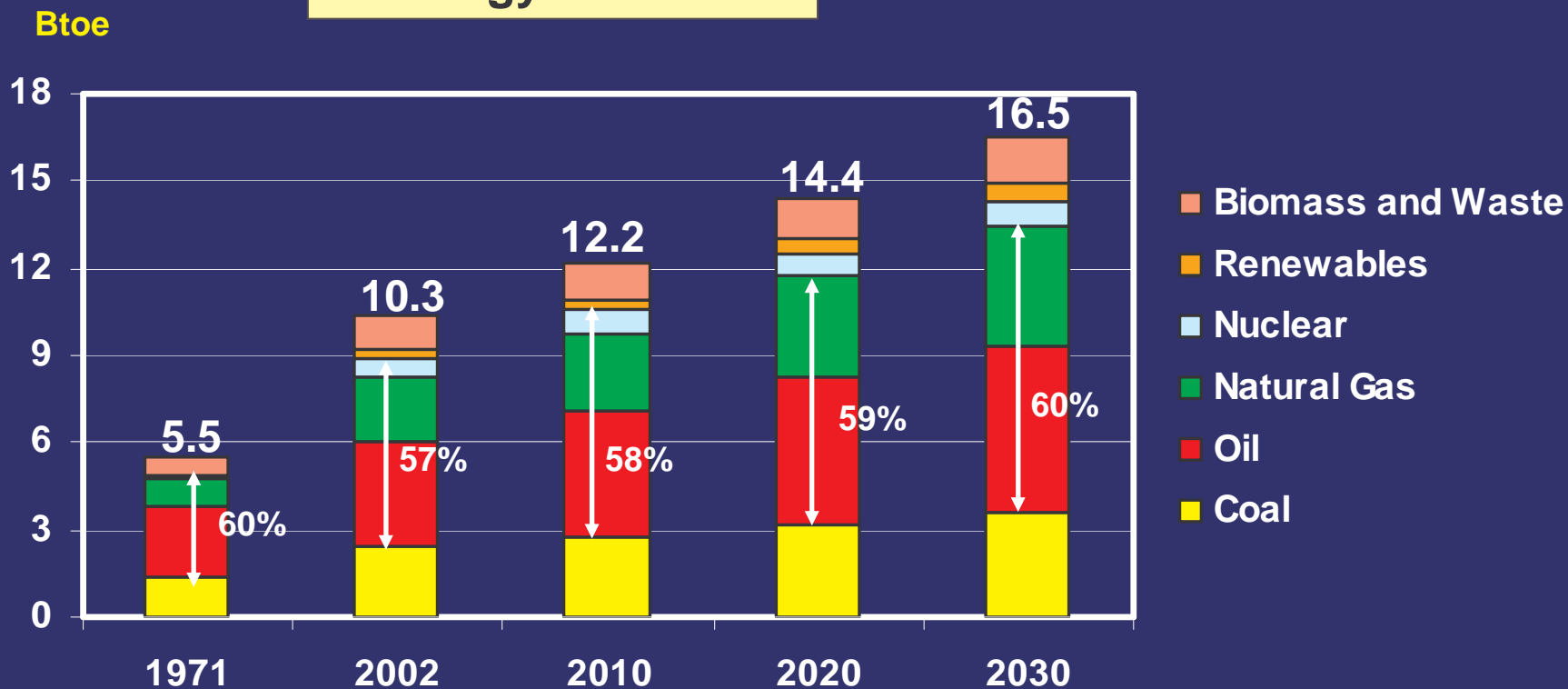
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*Président IFP*

*Club Mines Energie*  
*Ecole des Mines de Paris*  
*Mardi 23 mai 2006*



# 1970 - 2030 Evolution of World Energy Balance (incl. Biomass and Waste)

## World Primary Energy Demand



Reference scenario: + 60% for 2000 – 2030 period



## Long Term Challenges of the Energy Sector

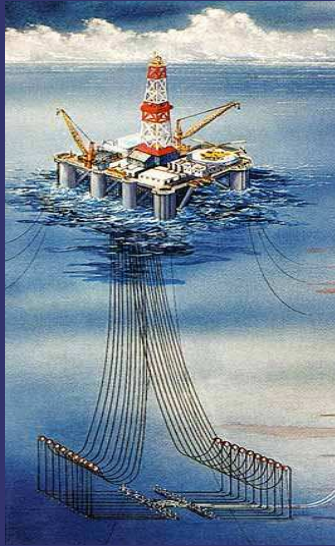
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### Three Challenges :

- on going growth of demand
- finite resources
- climate change



## 5 Major Challenges for Sustainable Development



Renew and increase world hydrocarbon resources

Develop clean and high-efficiency refining and petrochemical processes

Master CO<sub>2</sub> capture and storage

Diversify energy sources for production of fuels and hydrogen

Reduce vehicle emissions and consumption

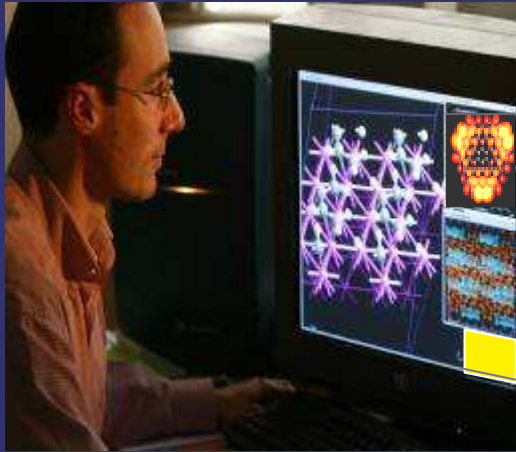


**What are the technological obstacles ?**



## What Are The Tools?

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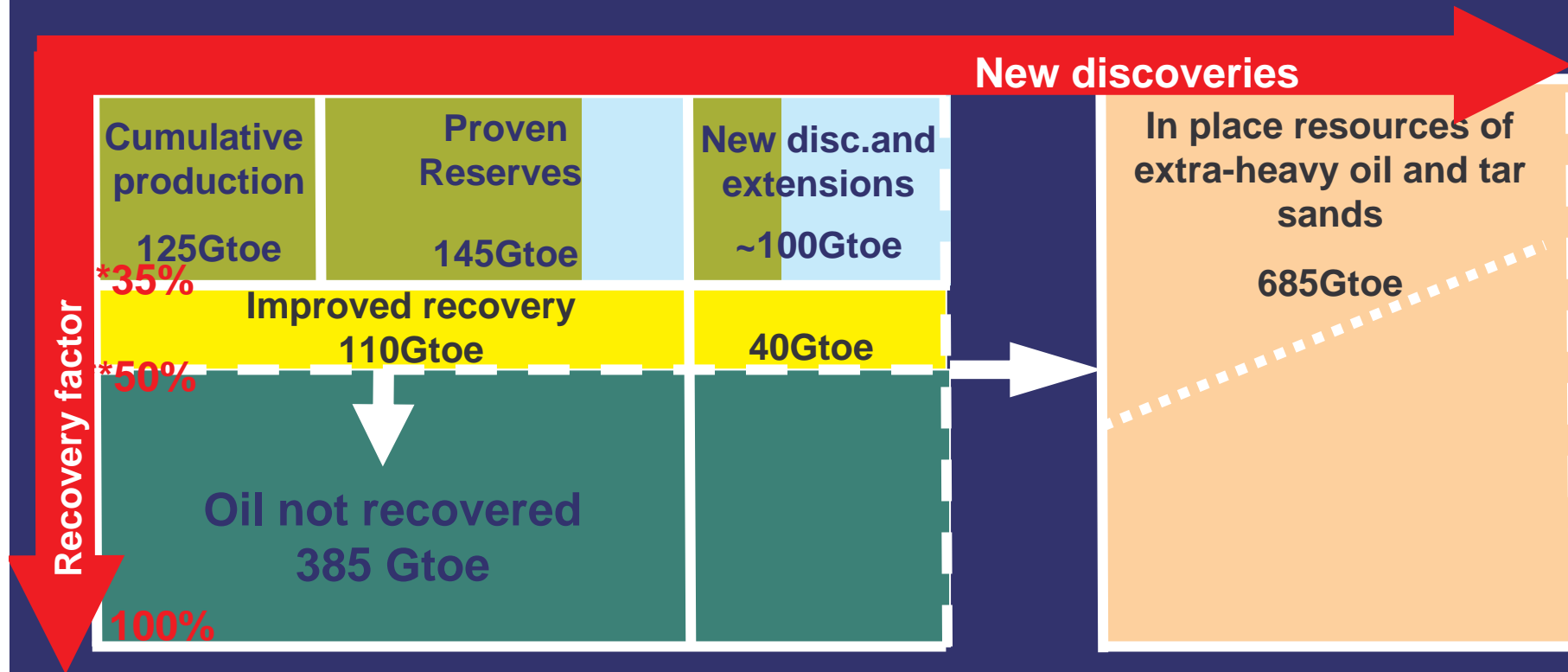


- Information and communication sciences and technologies
- Nanotechnologies/nanosciences
- high-throughput and high-performance testing techniques
- Numerical fluid engineering
- New concepts from life sciences





# Renew and Increase World Hydrocarbon Resources



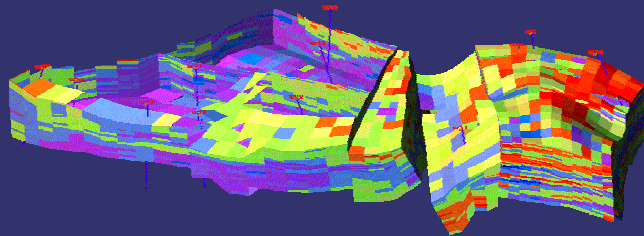
- Increase the exploration success rate
- Improve the recovery rate of oil in place

- Develop high technological content hydrocarbons
- Promote the development of natural gas



# Renew And Increase World Hydrocarbon Resources

**Increase the exploration success rate**



- seismic imaging of complex geological structures
- integration : seismic interpretation reinforced by geology
- basin modeling

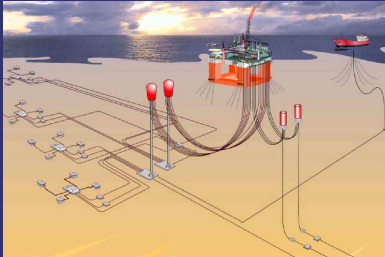
**Improve the average recovery rate  
( from 35% to 50% )**



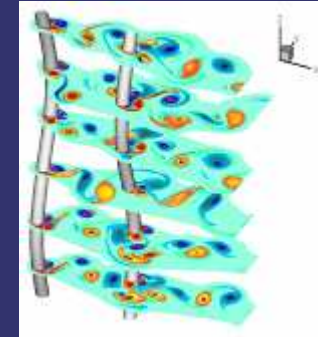
- upscaling: pore to reservoir  
→ enhanced recovery
- reservoir modeling :  
management of uncertainties
- monitoring
- complex well architecture and  
well productivity



# Renew And Increase World Hydrocarbon Resources



**Produce hydrocarbons having high technological content**



## **ULTRA DEEP OFFSHORE (target 3 000m)**

- Master flow assurance from bottom to surface
- New materials to reduce the weight of structures

## **HEAVY CRUDE**

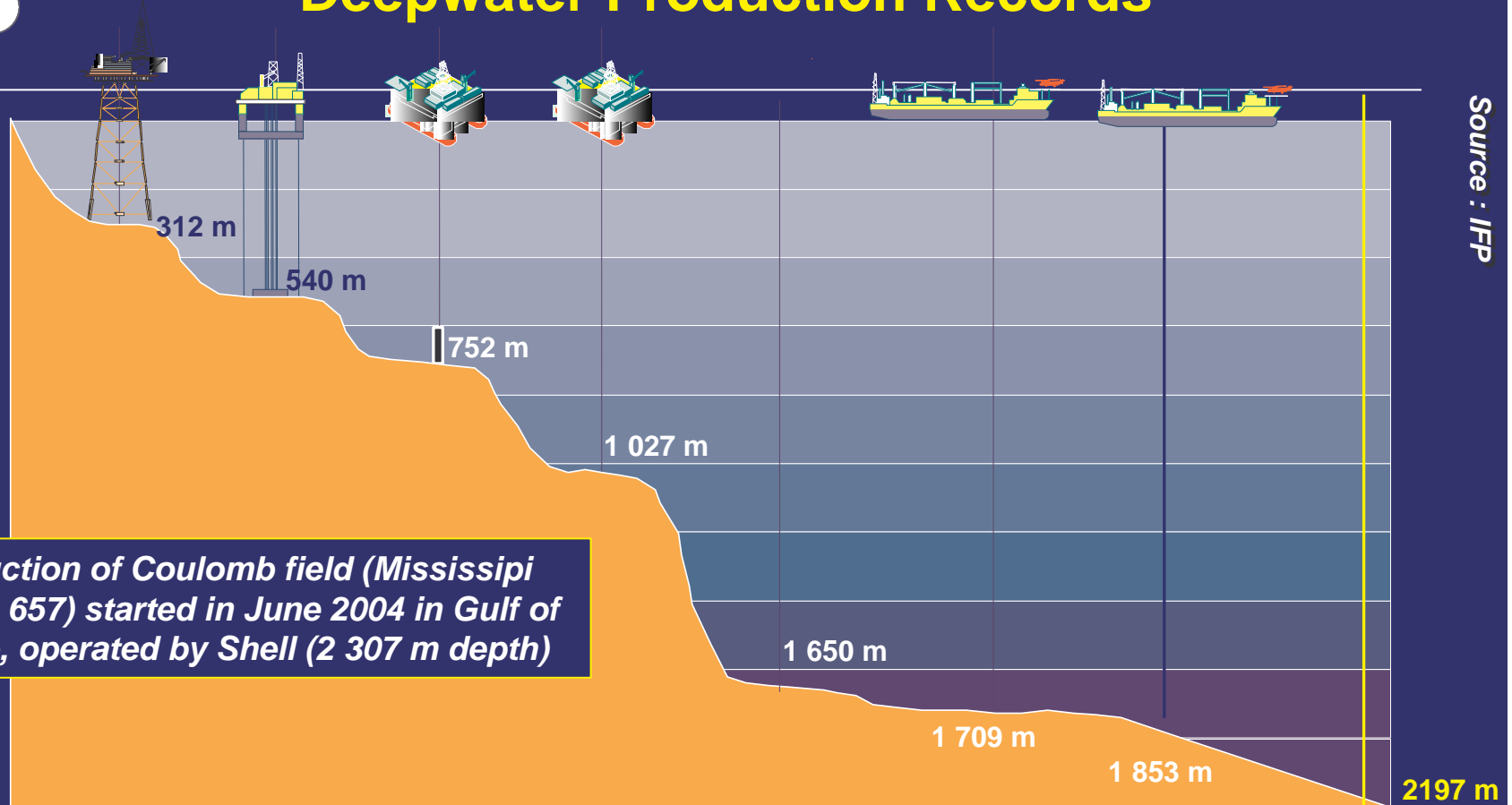
- Viscosity control
- Pre-refining in the well
- In-situ combustion

## **DEEPLY BURIED RESERVOIRS (6000m)**

- Characterization: seismic imaging
- Prediction of overpressured zones
- Drilling technologies adapted to high depth



# Deepwater Production Records



Source : IFP

*Production of Coulomb field (Mississippi Canyon 657) started in June 2004 in Gulf of Mexico, operated by Shell (2 307 m depth)*

Year	1978	1989	1991	1994	1997	1997	2000	October 2002
Place	Cognac, Gulf of Mexico, US	Jolliet, Gulf of Mexico, US	Marlim, Brazil	Marlim, Brazil	Année	Marlim Sul, Brazil	Roncado Brazil	Camdem Hills, Gulf of Mexico, US
Operator	Shell	Conoco	Petrobras	Petrobras	Shell	Petrobras	Petrobras	Marathon
Production flowsheet	Fixed Platform	Tension-line Platform	Semi-submersible	Semi-submersible	Subsea tie-back	FPSO	FPSO	Subsea tie-back



# Renew And Increase Hydrocarbons World Resources

## Promote the development of natural gas



### Reduce the costs of transport

- Long haul gas pipelines
- Liquefaction processes and transport of LNG
- Transportation of compressed NG by ship

### Acid gas treatment

- Treatment processes for highly acid gas ( $H_2S/CO_2$ ) + reinjection

**New outlet : chemical conversion**



# Develop Clean and Highly Efficient Processes



**Intensify refining and petrochemical processes**



## CONCEPTION AND CONTROL

- Multifunctional and structured reactor
- Micro-technologies
- In line analysis systems
- Real time modeling

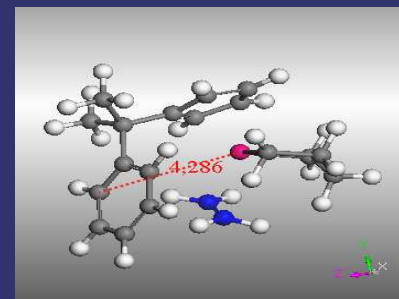
## CATALYSTS AND ADSORBENTS

- Molecular modeling
- High-throughput experimentation
- Nanotechnologies to optimize structure, texture and functionalization



## WASTES

- Supercritical solvents
- Ionic liquids





## Diversify Energy Sources



Develop processes allowing the production of quality fuels at an acceptable cost

### **GAS**

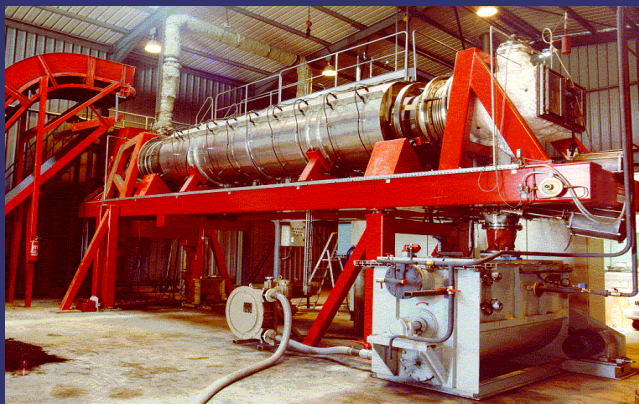
- Gas To Liquids: Fischer-Tropsch diesel
- Hydrogen production

### **BIOMASS**

- Thermochemical treatment  
→ Biomass to Liquids
- Vegetable oil esters
- Cellulases for ethanol production
- Hydrogen production

### **COAL**

- Liquefaction and upgrading of liquefied products





# Reduce Vehicle Emissions and Consumption



Reconsider conventional engines  
from the sustainable development  
perspective



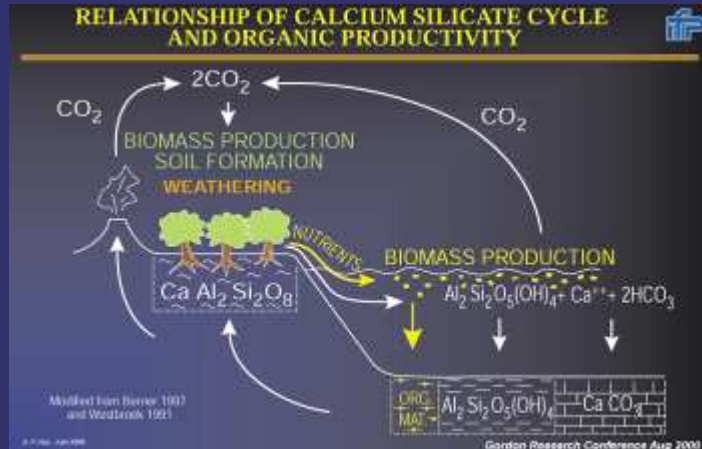
## Reduce local pollutant emissions (NO<sub>x</sub>, CO, HC and particulates)

- New homogeneous combustion processes
  - HCCI for diesel engine
  - CAI for gasoline engine
- Engine control techniques
- Post-treatment technologies

## Reduce vehicle consumption

- Direct injection (gasoline and diesel engine)
- « downsizing »:
  - Turbocharging
  - Variable timing

👉 in synergy with improvement  
of fuel quality



Develop efficient and safe technologies having an acceptable cost

## Capture

- Fume-scrubbing processes using solvents
- Treatments by adsorption
- Cryogenic techniques

## Storage

- Control of CO<sub>2</sub>/rock interactions
- Storage surveillance
- Biomineralization



<http://www.ifp.fr>