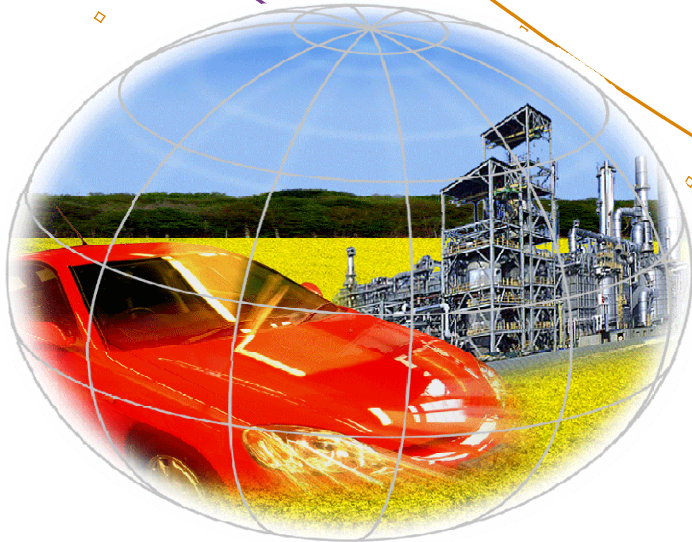
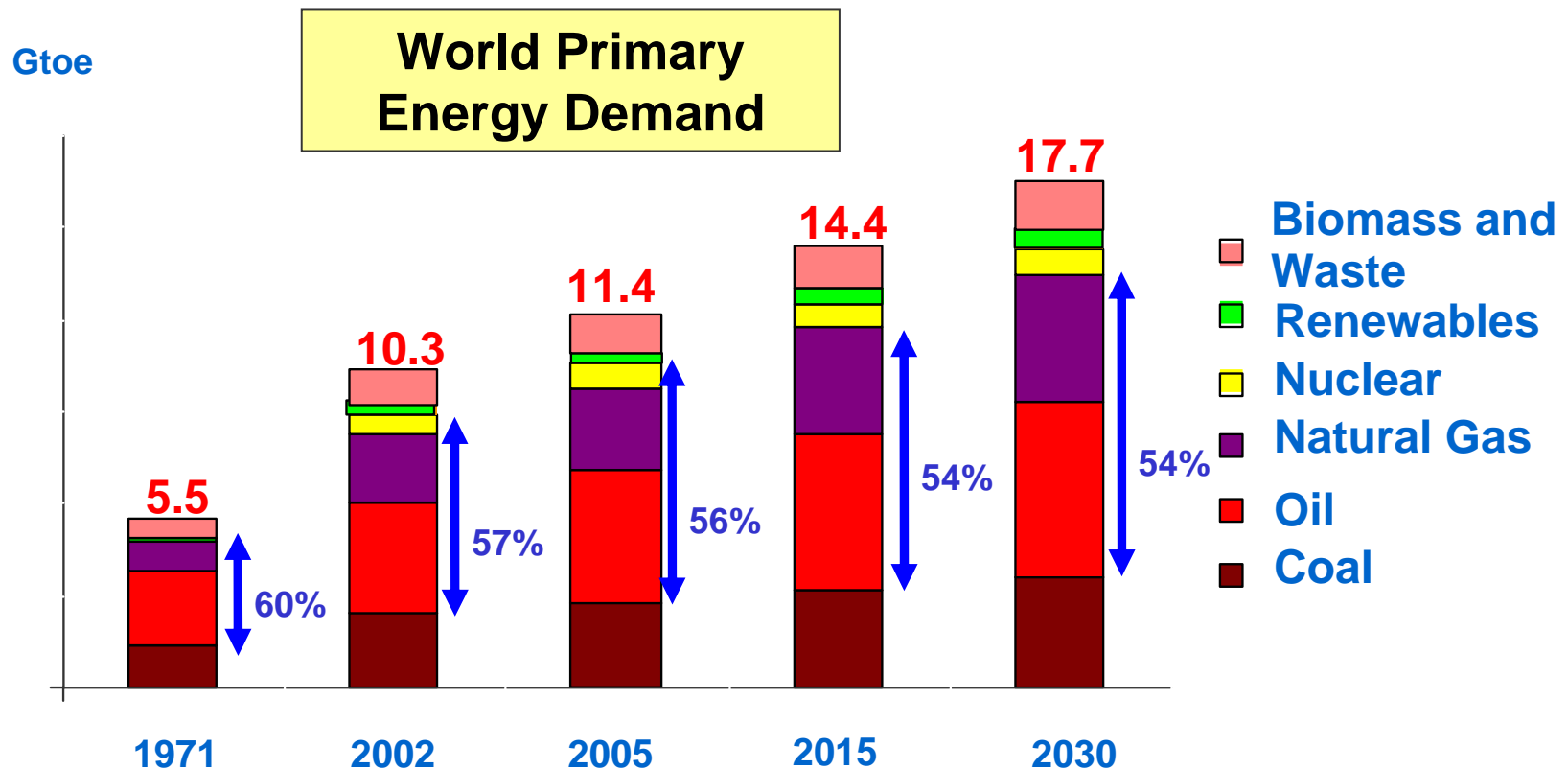


Oil and Gas projects in the next decades

Jean-François Gruson
Head of Economy Department
IFP



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



Global demand grows by more than half over the next quarter of a century, with coal use rising most in absolute terms

Fossil fuels account for most of the increase in global energy demand between now & 2030, though non-hydro renewables grows fastest

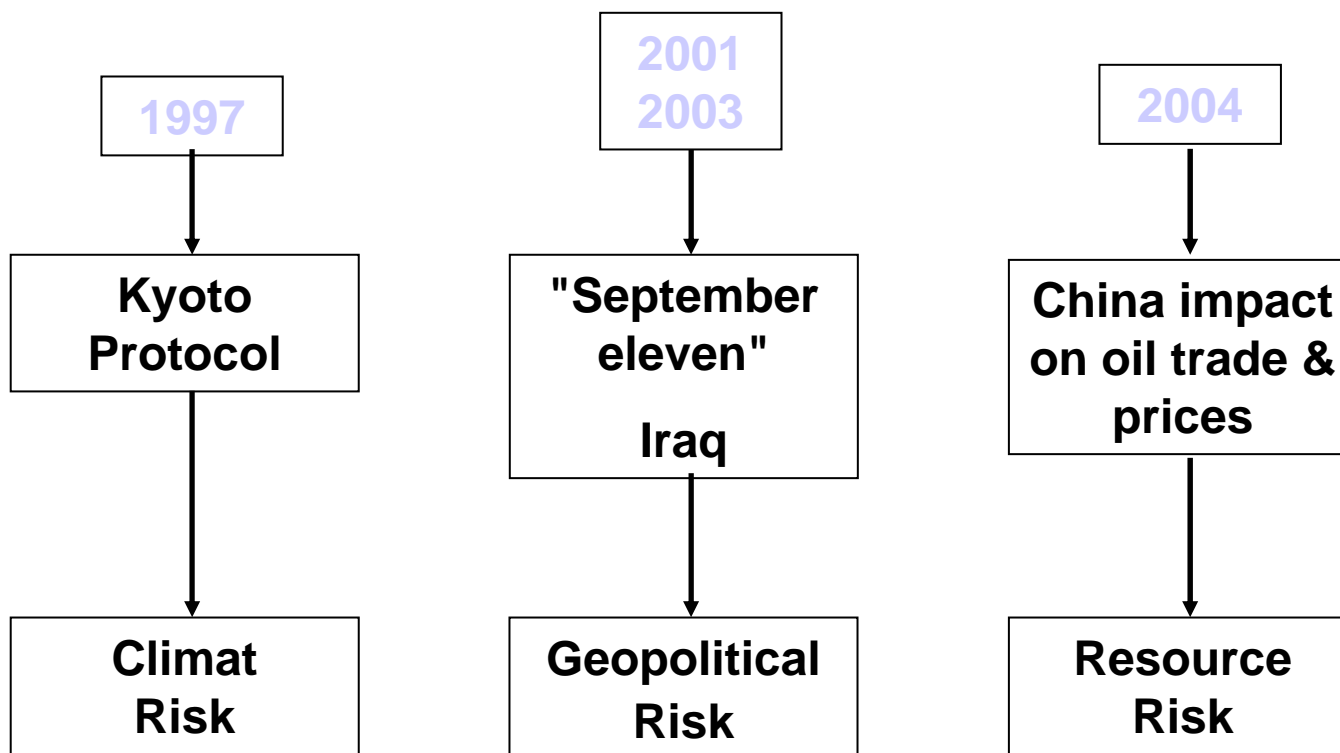


Energy competition (Energy share by sector)

	2005 Gtoe	2030 Gtoe	2030/2005 %/y	Comments
Total Primary Energy	11.43	15.78	1.3	Most of the increase will come from Emerging countries
Power generation	4.26	6.3	1.6	Coal and NG will support the growth; Renewables up to 7% of share and nuclear stable ~17%
Industry	2.83	4.11	1.5	Oil due to non energy use, NG and electricity will account for more than 70%
Residential and services	2.89	3.71	1	Electricity support the growth but oil remains important (16%)
Transport	2.01	2.8	1.3	Oil still dominant (89%) with increasing biofuels (+9%/y)

Source: IEA WEO 2007 – alternative scenario

A changing Energy context: oil price as an indicator



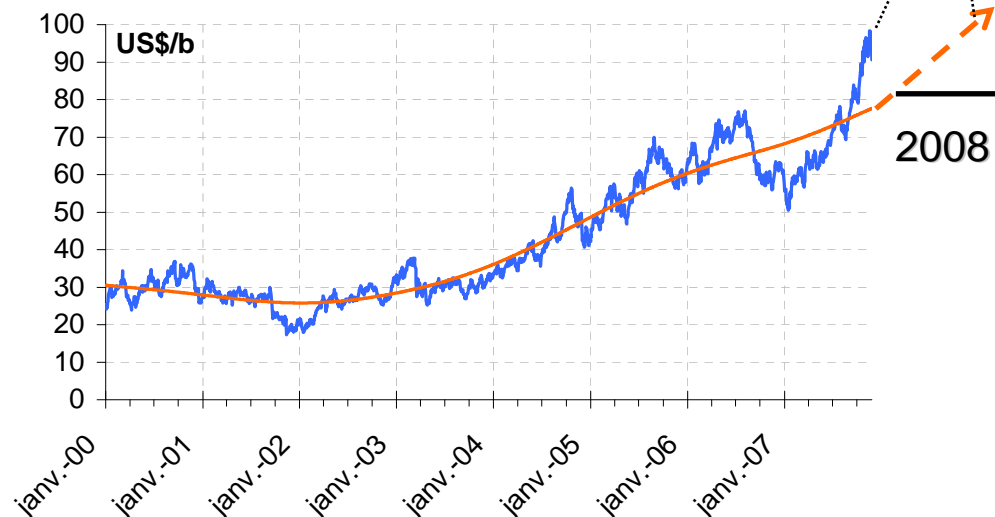
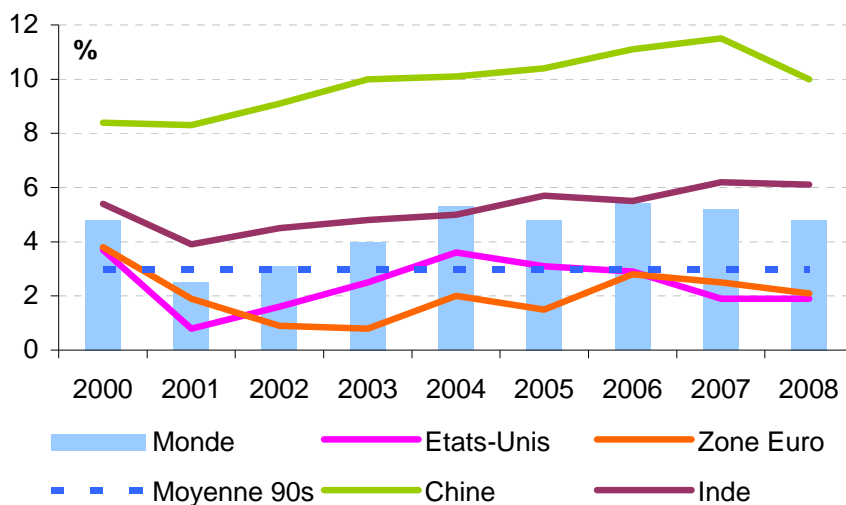
Answers : New Energy Policy

**Energy efficiency, Transportation diversification,
Clean Coal, Nuclear, Renewable....**

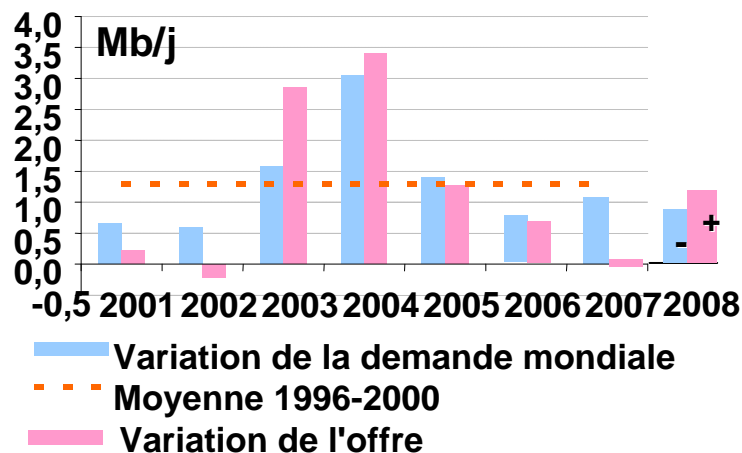
Oil context Mid term

Oil price increase driven by economic growth...

Taux de croissance du PIB réel

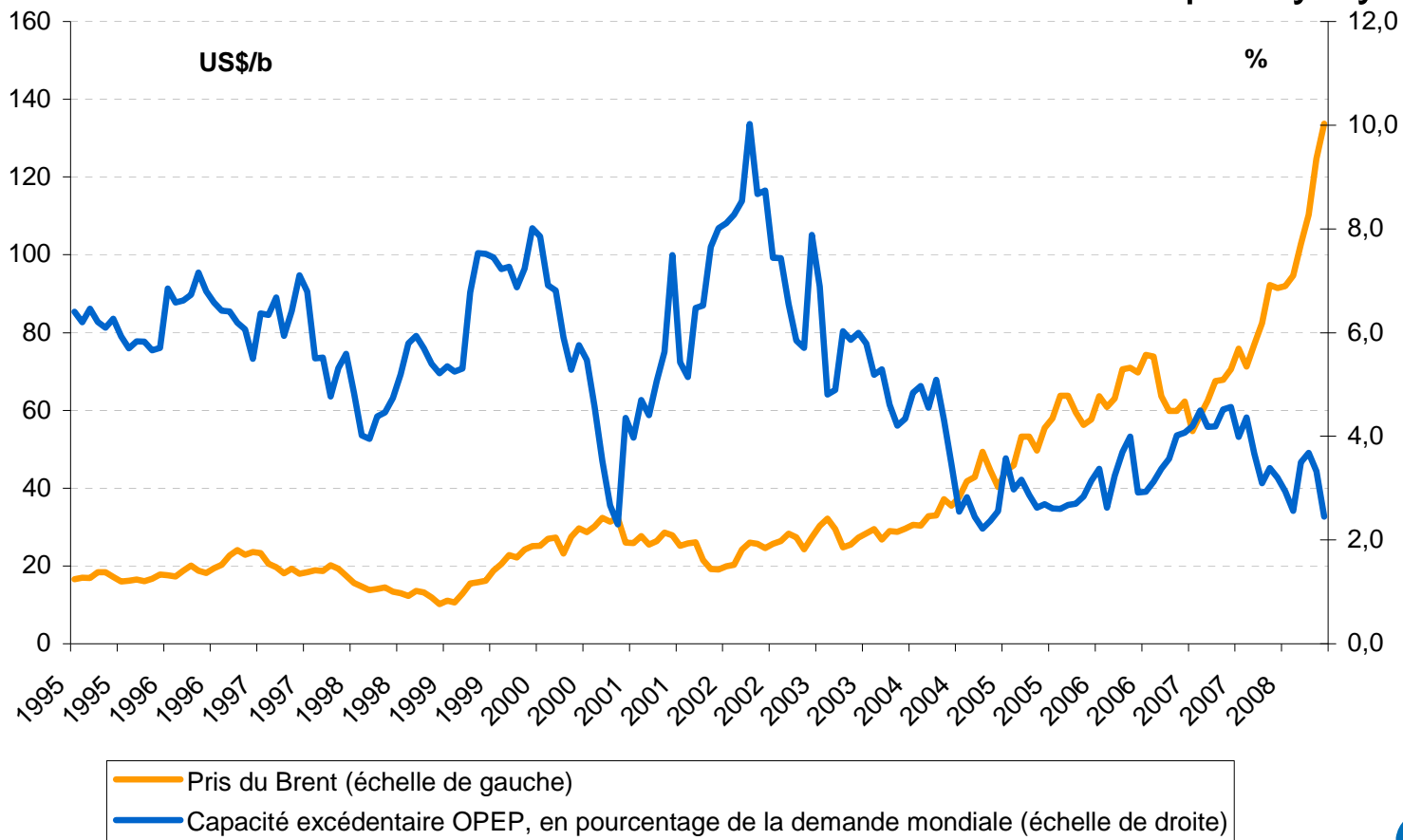


*Suply/Demand increasing
unbalance*



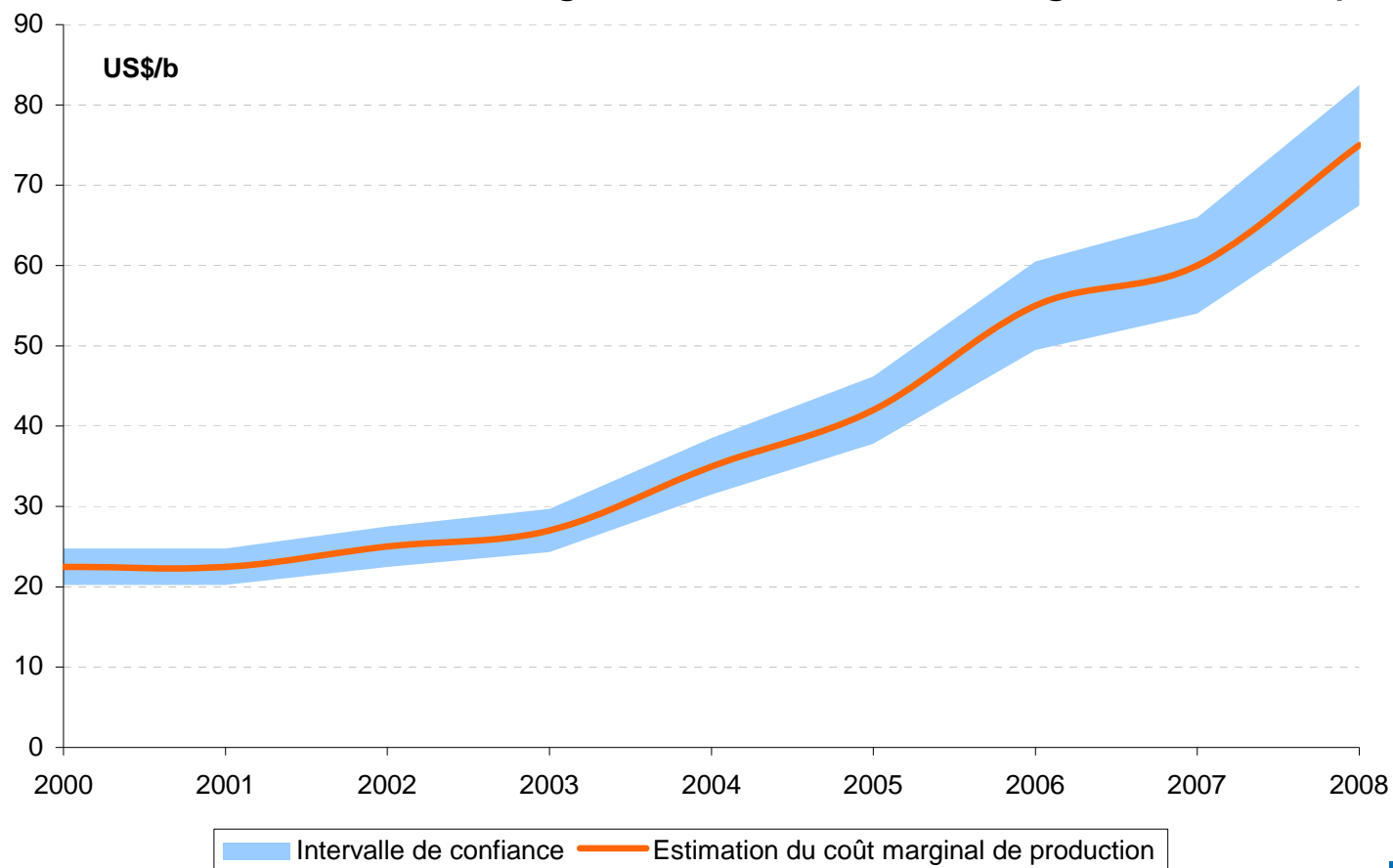
Oil price drivers

The under and over capacity cycles



Oil price drivers

Stong increase of the marginal cost of production





Perspectives

A large scope of situations

Emerging countries

- **ralentissement conjoncturel**
- **hausse rapide du potentiel à LT**
- **croissance qui résiste**
- **et qui tire le prix du brut**

Industrialized countries

- **ralentissement "conjoncturel"**
- **demande énergétique en baisse**
- **prix élevé du brut exogène**
- **risque de stagflation**

under the "unexpected" or "expected" financial crisis pressure

Oil producer countries

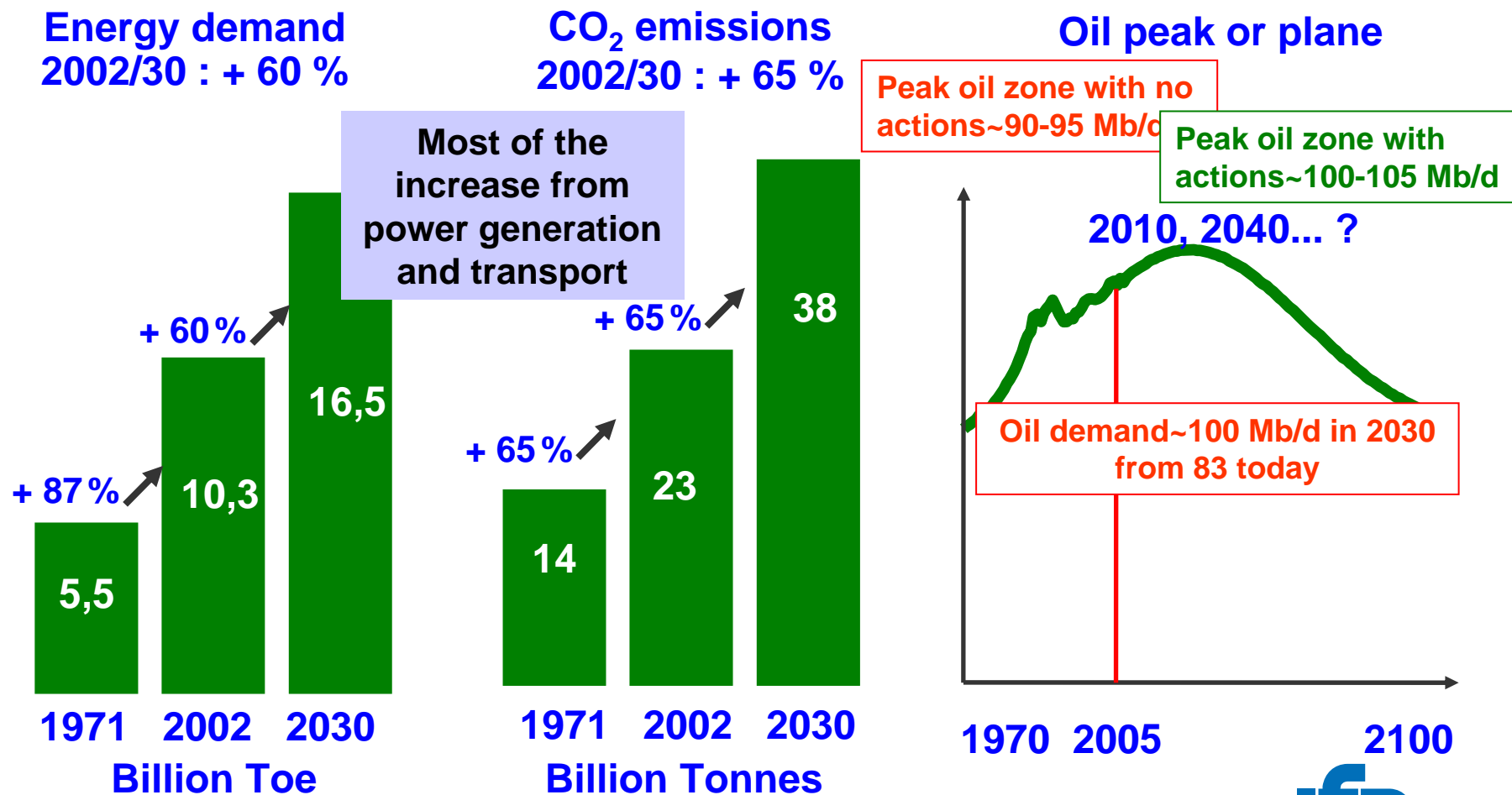
- **explosion des revenus pétroliers**
- **remboursement des dettes**
- **investissements internes et externes**

Rest of the world

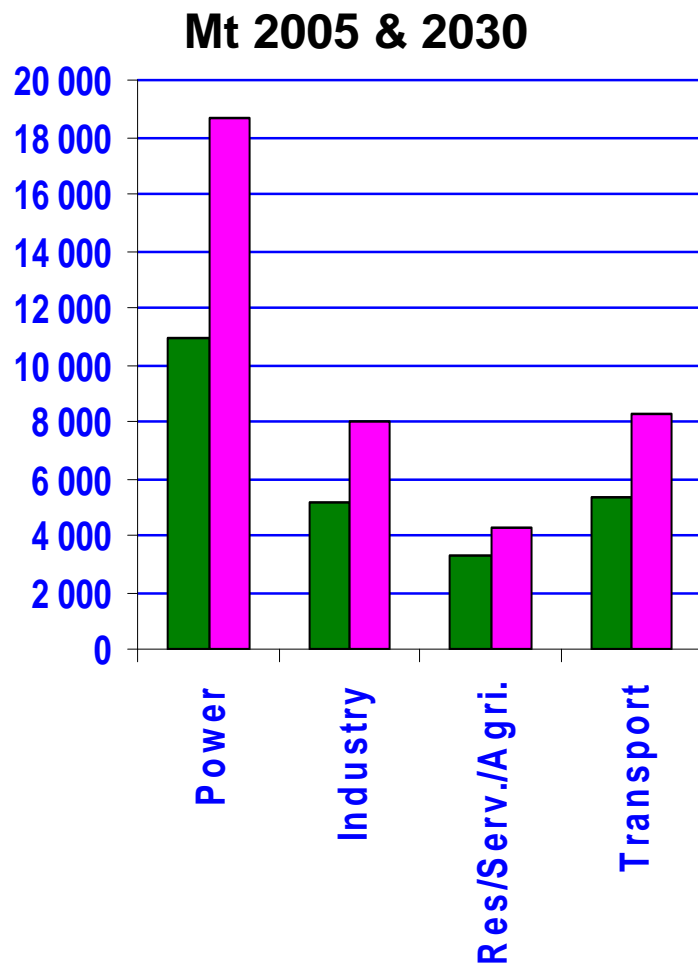
- **dans une situation très inquiétante**

=> In the short term oil price stabilization or decrease with high volatility, in the mid term back to increase

General context : Three worldwide challenges



World CO₂ emissions



Power

45% share

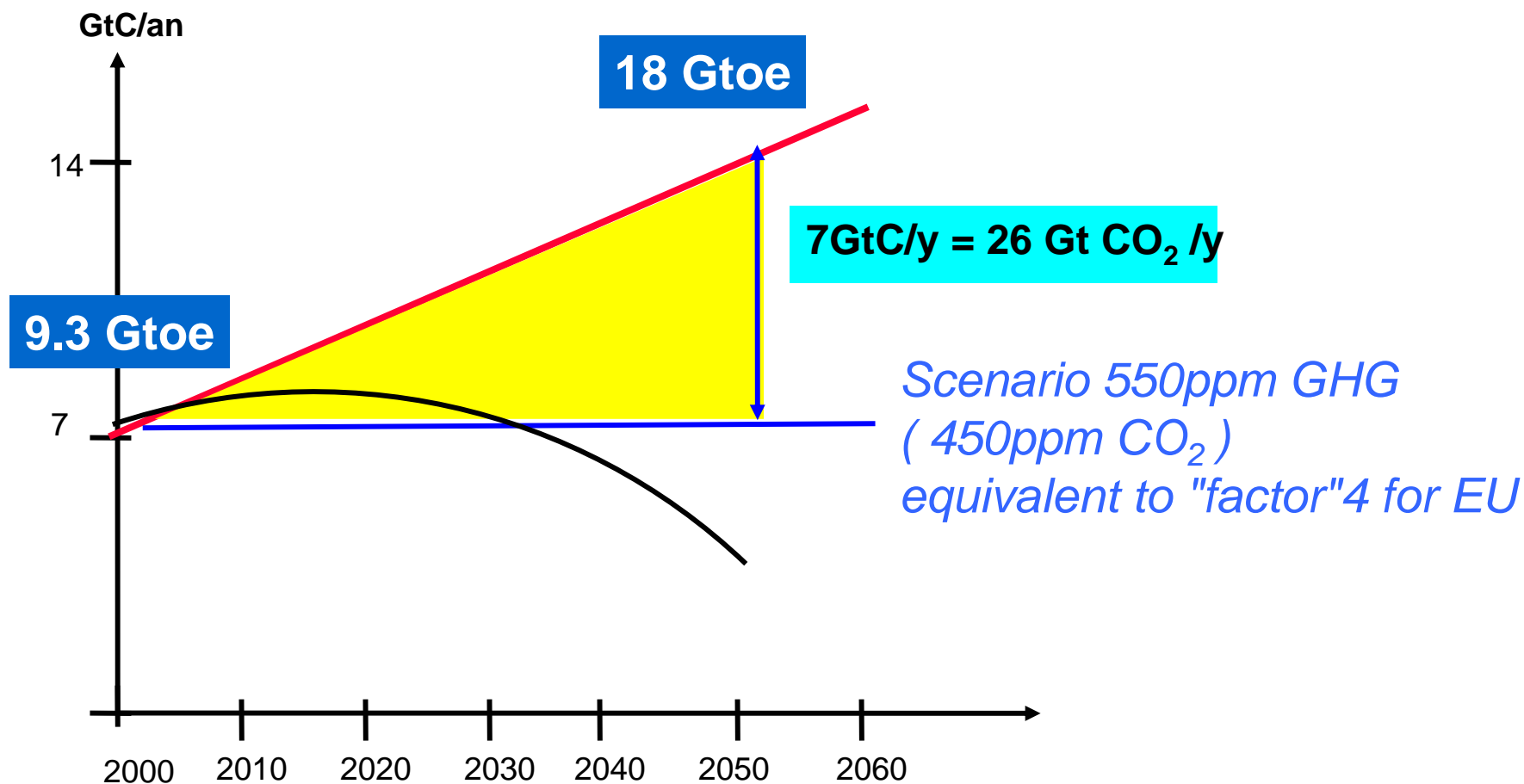
**54% of 2005/2030
growth**

Industry & Transport

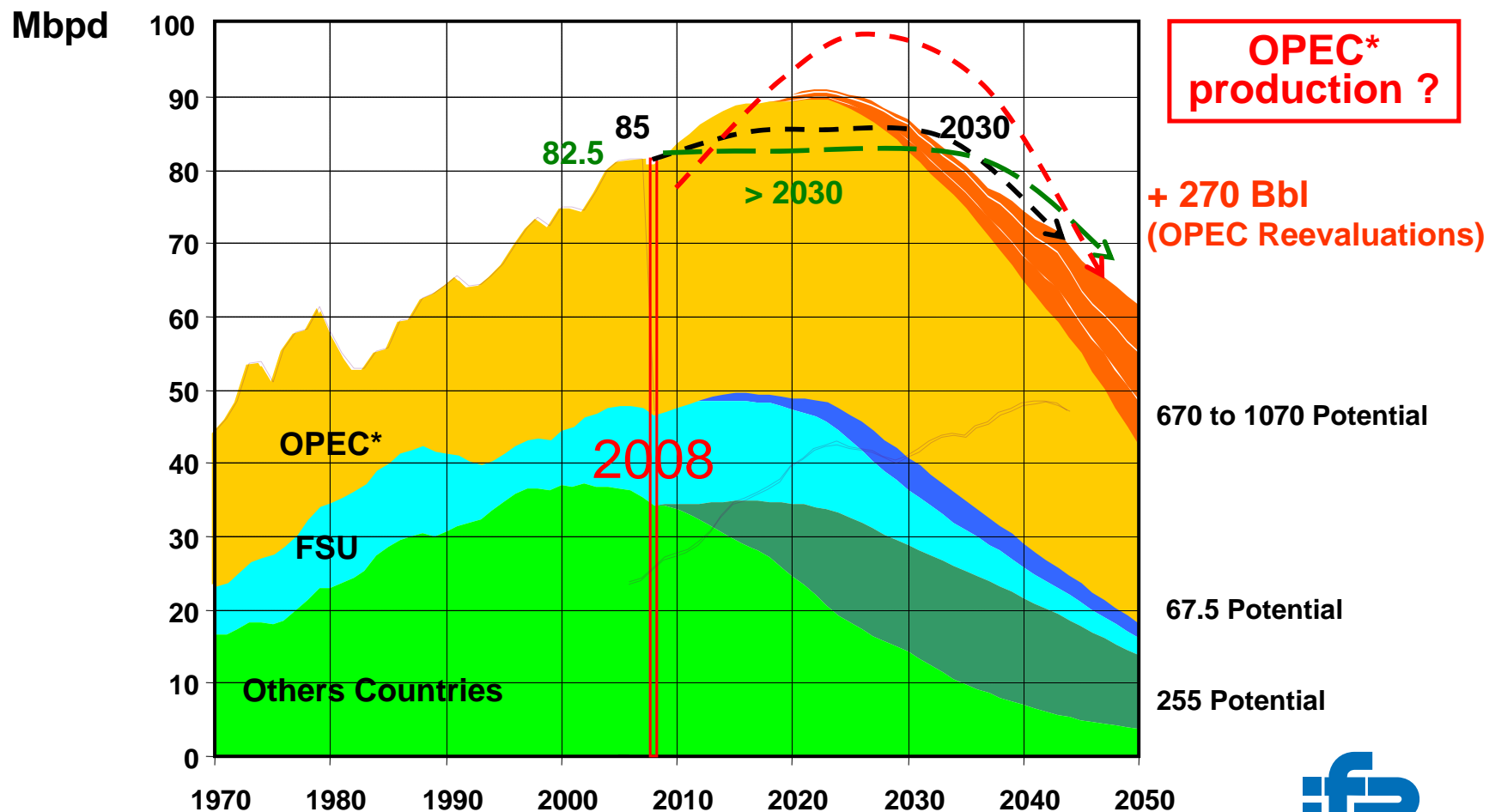
20% share

**20% of 2005/2030
growth**

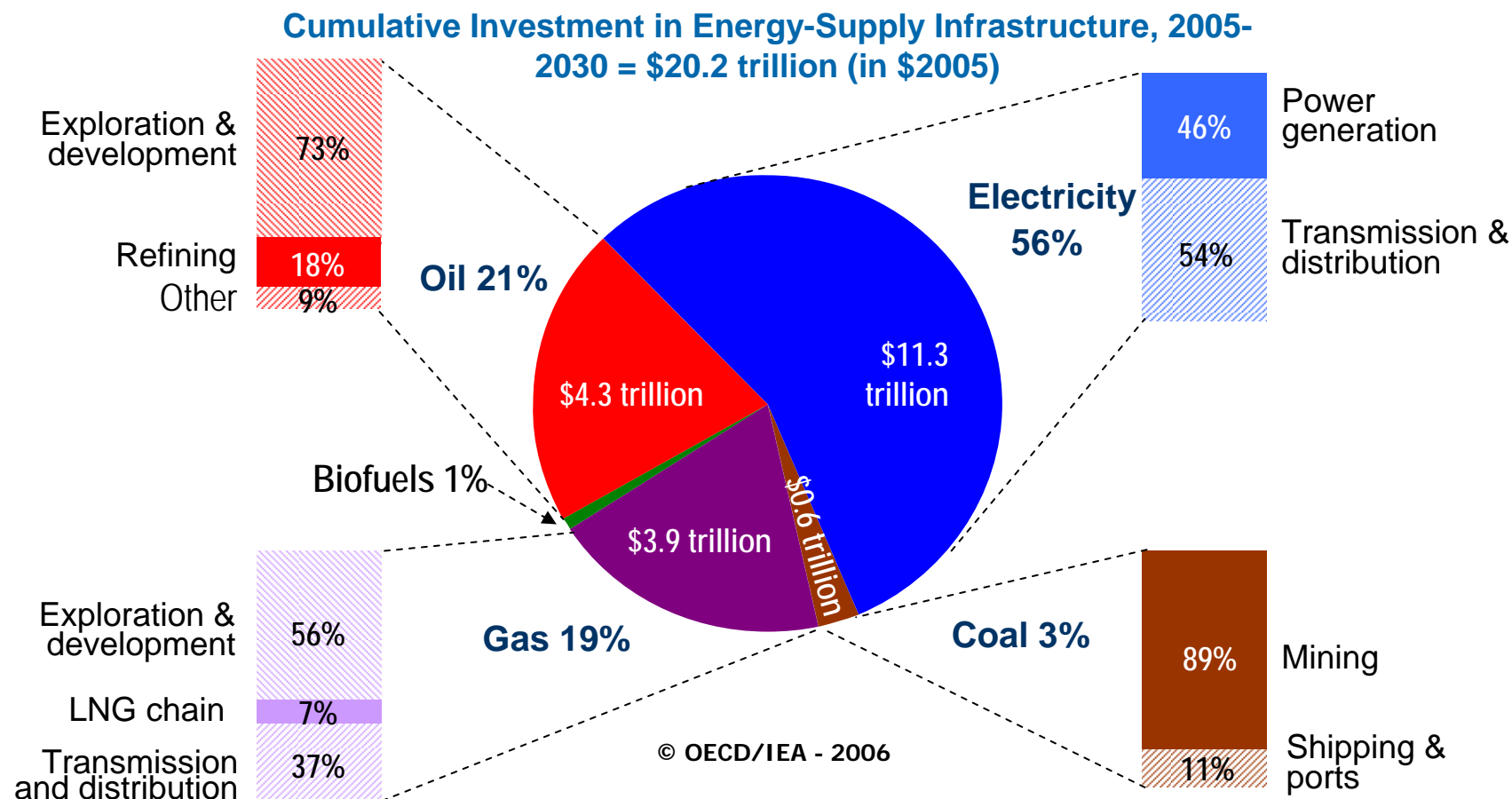
Evolution of CO₂ emissions



Probable future scenarios

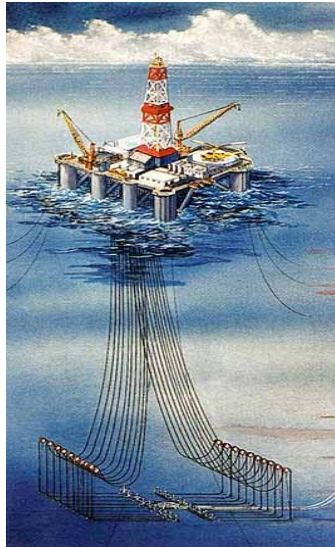


Reference Scenario: Will the Investment Come?



Just over half of all investment needs to 2030 are in developing countries, 18% in China alone

5 Major Challenges For Sustainable Development



Renew and
increase world
hydrocarbon
resources

Develop clean
and high-efficiency
refining and
petrochemical
processes

Master CO₂ capture and
storage

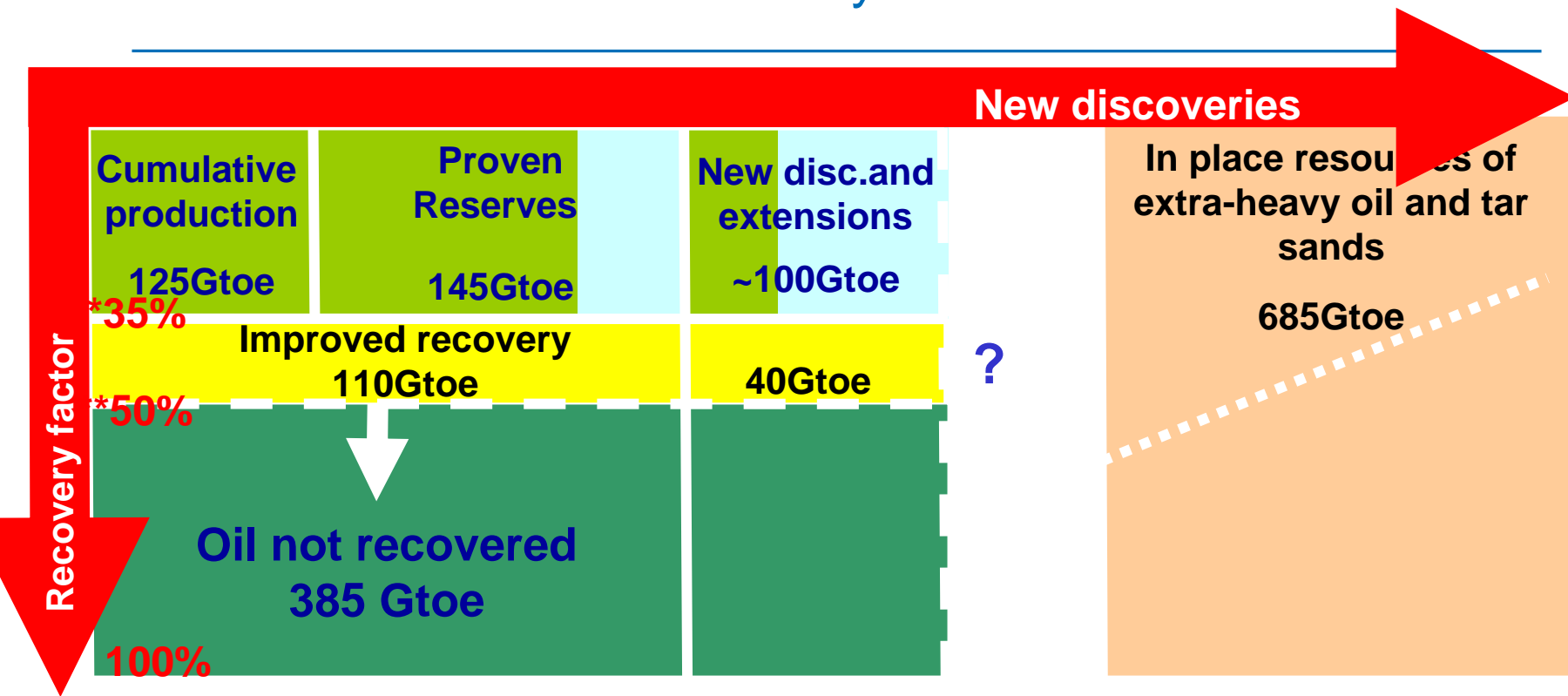
Diversify energy
sources for
production of fuels
and hydrogen

Reduce
emissions and
consumption



What are the technological obstacles ?

Renew And Increase World Hydrocarbon Reserves



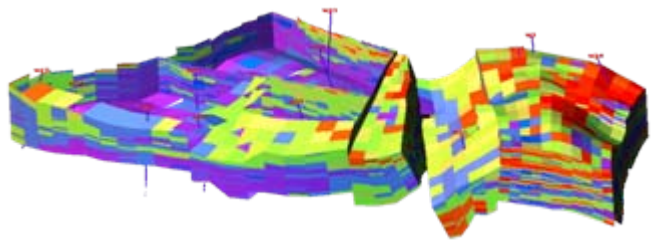
- ✓ Increase the exploration success rate
- ✓ Improve the recovery rate of oil in place
- ✓ ...Reduce the demand...

Develop high technological content hydrocarbons

Promote the development of natural gas

Renew And Increase World Hydrocarbon Resources

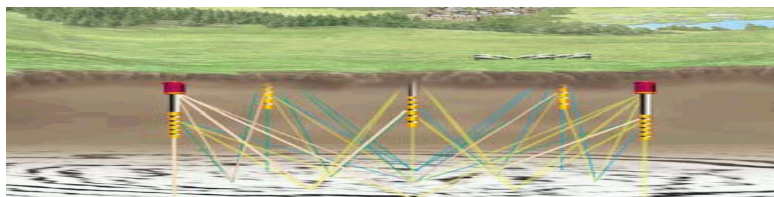
Increase the exploration success rate



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

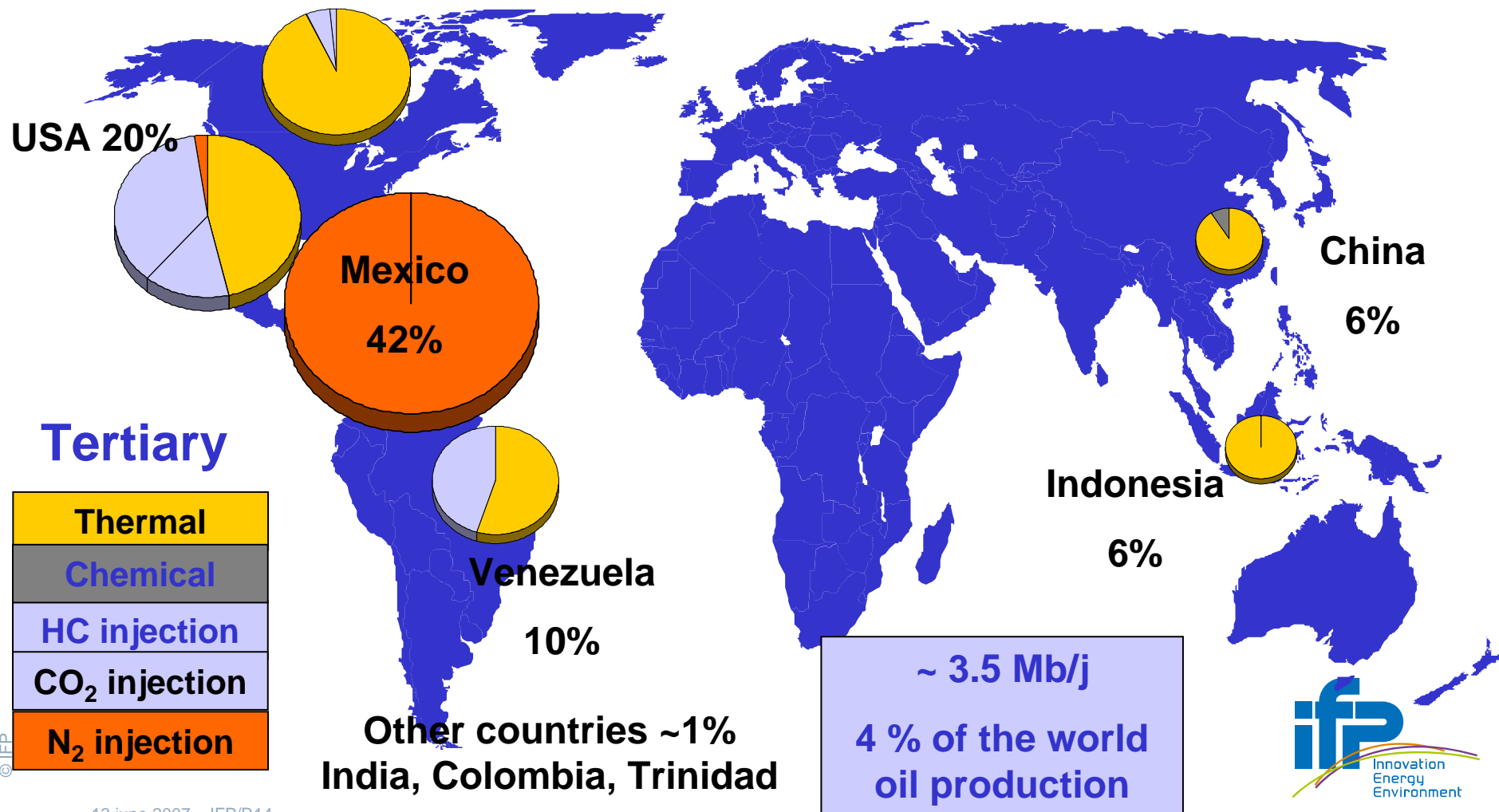




Worldwide Enhanced Oil Recovery production in 2006

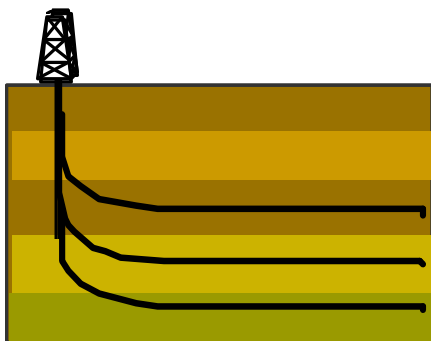
Canada 15%

Source: Oil & Gas Journal + IFP

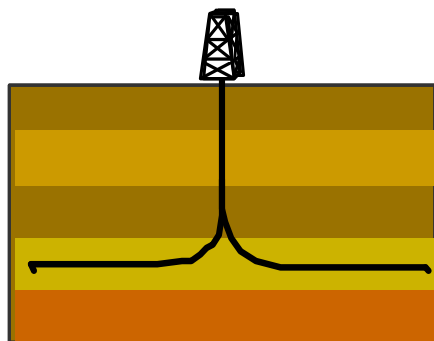




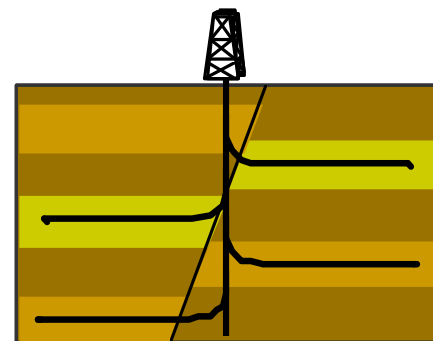
Advanced well technology



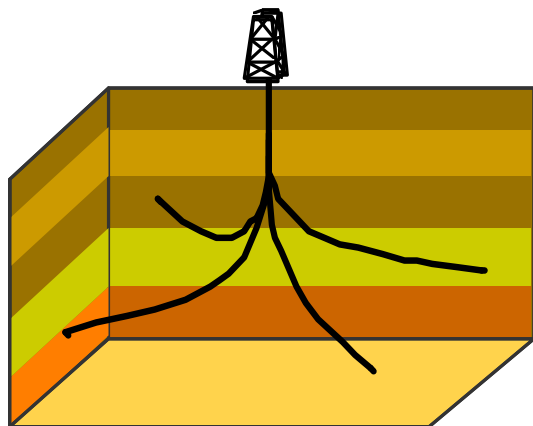
Stacked multibranch well



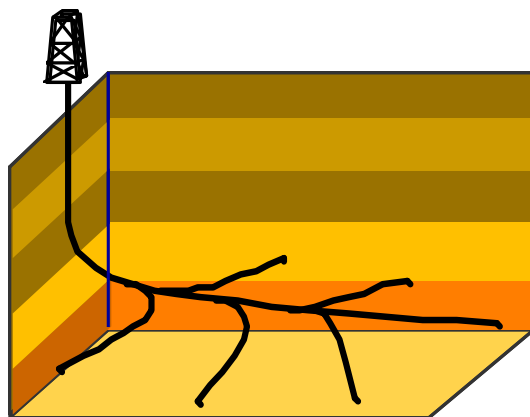
Dual opposing laterals



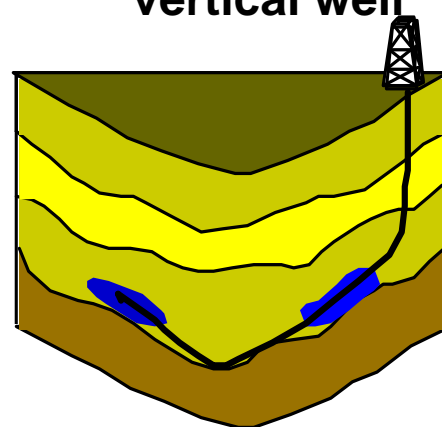
Re-entry laterals from a vertical well



Cluster well

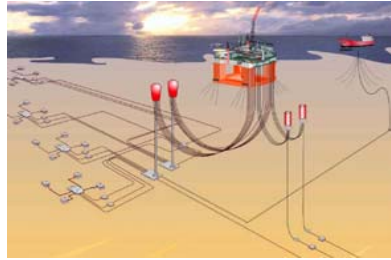


Multidrain or multilateral well



3D Well

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
- Subsea tie-back development

HEAVY CRUDE/TAR SANDS

only 2% of the oil production

- Viscosity control
- Pre-refining in the well
- In-situ combustion
- CO₂ control or reduction

DEEPLY BURIED RESERVOIRS (6000m)

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

From resources to reserves

Wide range of recovery rates: from the worst to the best existing in the petroleum industry!:

<10% with cold production

20% to 40% (or even 70%?) with steam injection

>80% with mining methods

Depending on production technology,

→ reserves volumes can be multiplied by a factor of 8

Production expected to go up to 4.8 Mb/d by 2015 (7 Mb/d? by 2030)

BUT CO₂? ↔ **from 170 kWhth/b up to 296 à 380 kWhth/b**
(if coal~0.2 t CO₂/b)

Reserves are more or less well known in Canada and Venezuela



What about the rest of the world?

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

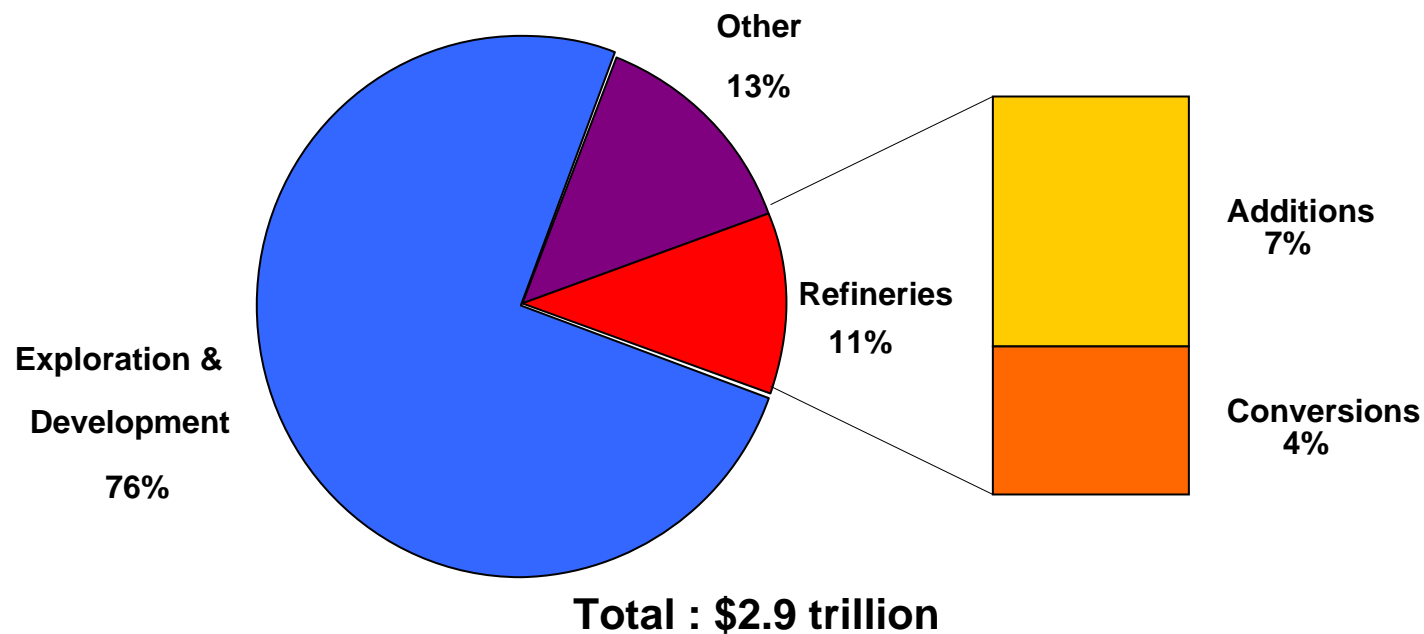


Towards global product quality improvements

Already largely achieved in OECD countries through continuous enhancement of environmental rules:

- no longer lead, very low sulphur content (10-50 ppm), aromatic limits (25-35%)...
 - less sulphur for heavy fuel oil and bunkers and heating oil
-
- Likely to be achieved within 10 years in the rest of the world, particularly for transportation fuels
 - But new constraints on vehicle pollutants (NO_x, PM) could require other changes:
 - Polyaromatics to control soot precursors;
 - new issues for new combustion mode development (HCCI, CAI)

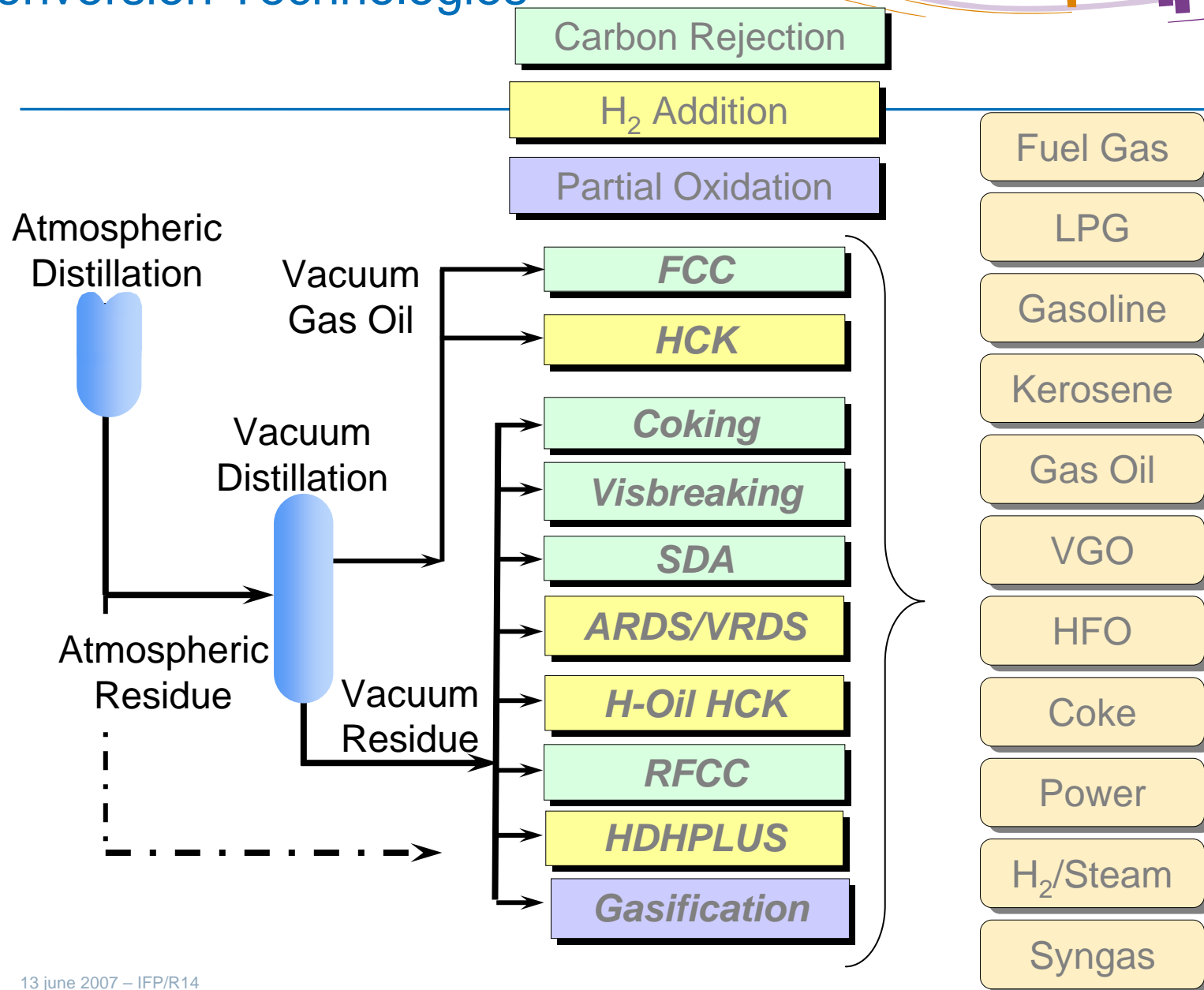
World Cumulative Oil Investment, 2004-2030



Annual refinery investments of \$19 billion – two-thirds for distillation and one-third for conversion capacity

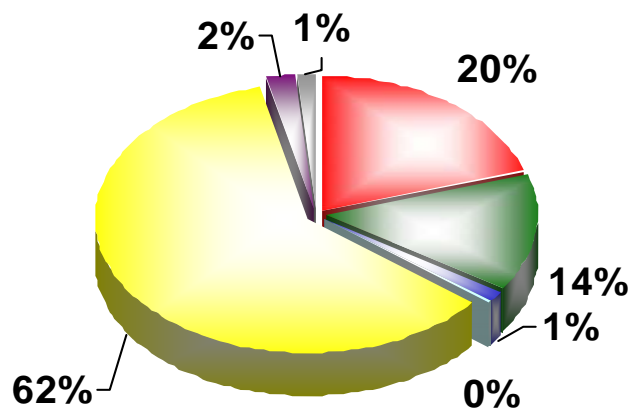
© OECD/IEA (2006)

Conversion Technologies

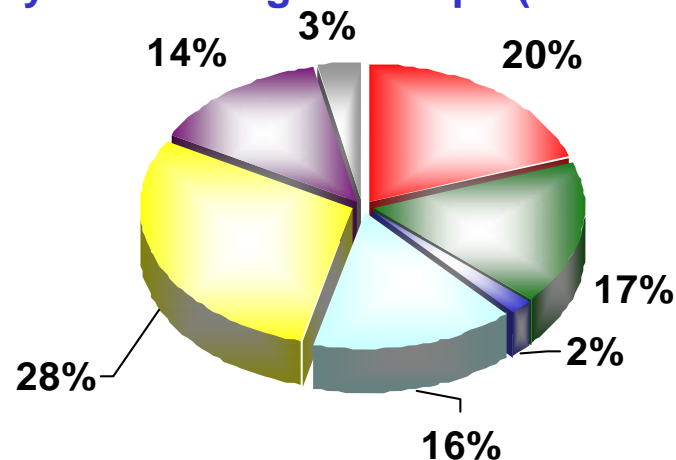


Capacity Expansions 2005-2020 Geographical Breakdown

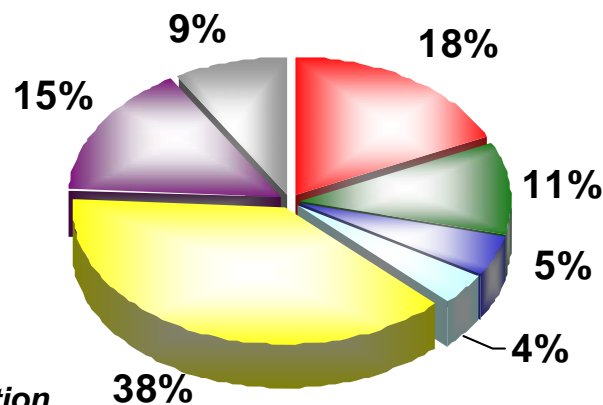
Coking : +3.3 Mbpd (55–70 units)



Catalytic Cracking: + 5 Mbpd (60– 5 units)



**Hydrocracking: + 4 Mbpd (+1.1 AR/VRDS)
(80– 90 units)**



	North America
	Latin America
	EU 28
	CIS + South Eastern Europe
	Asia-Pacific
	Middle East
	Africa

Source: Axens & Hart WRFS, 2005 Edition

Diversify Energy Sources



GAS

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

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

BIOMASS

- Vegetable oil esters and ethanol from grains
- Thermochemical treatment Biomass to Liquids
- Cellulases for ethanol production
- Hydrogen production
- Energy production

COAL

- Liquefaction and upgrading of liquefied products/CTL



FISCHER-TROPSCH Diesel : X to L



- **High quality**

- High cetane number
- No sulfur, no aromatics

☞ **Lower emissions than an average european diesel**

- **High production cost**

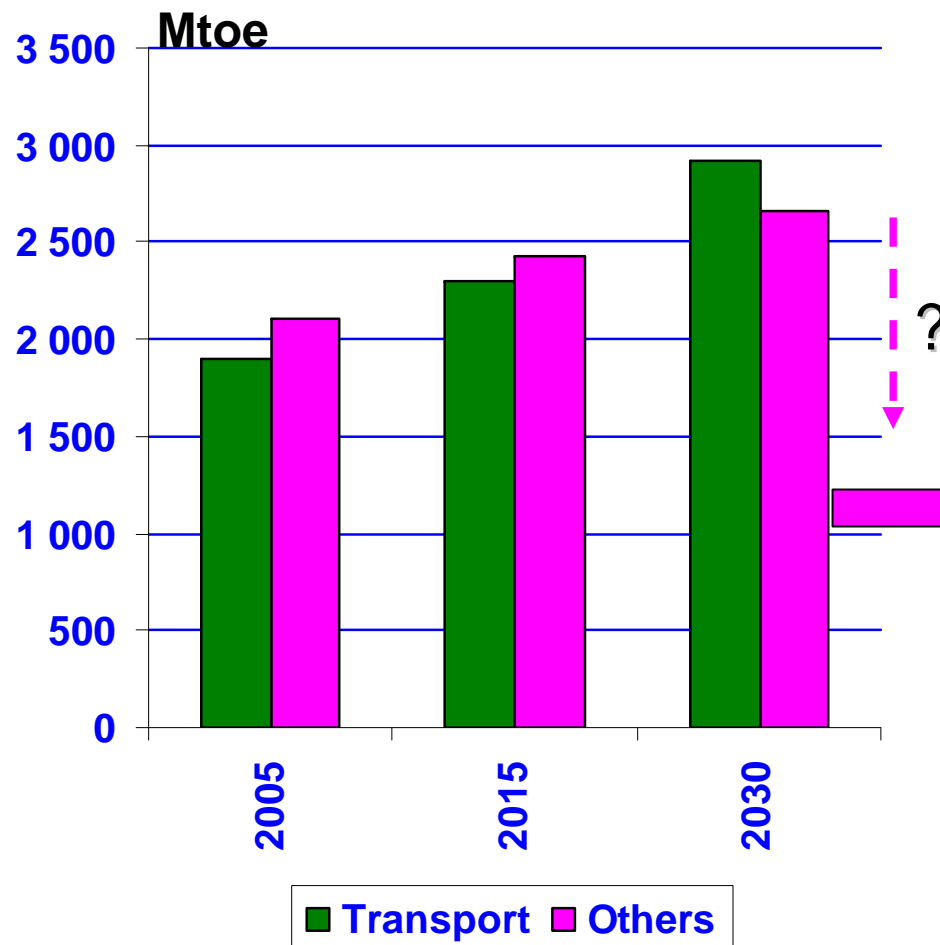
☞ **Objective: reduction of investment costs through technical progress**

from 30 000 \$/bbl/d
to 15 000 \$/bbl/d in 2010
BUT CO2 penalty to face with



EniTecnologie

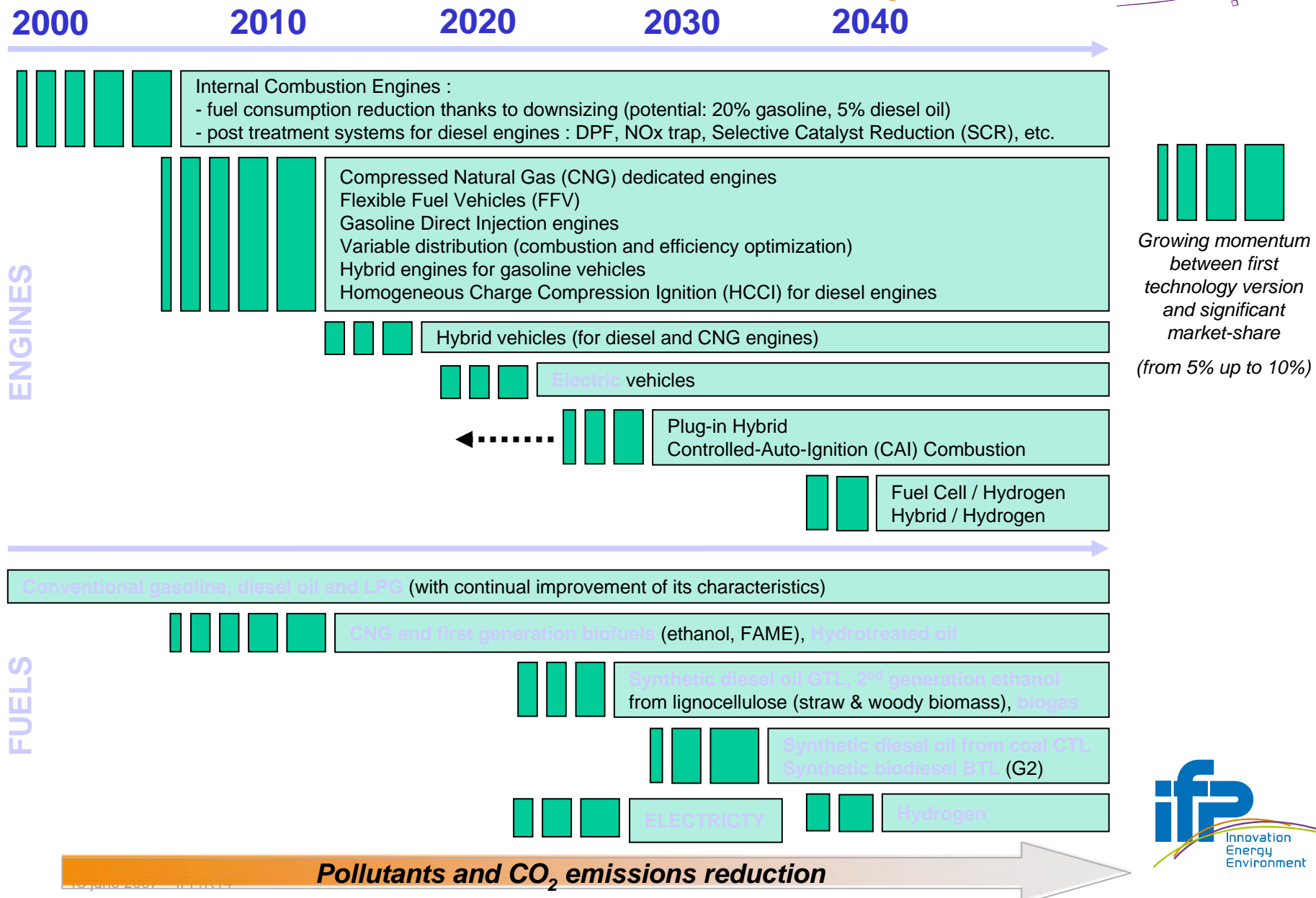
Transport and oil demand



Transport :
Oil demand Share:
48% in 2005;
52% in 2030.
Share of growth:
(2005/2030)
72%

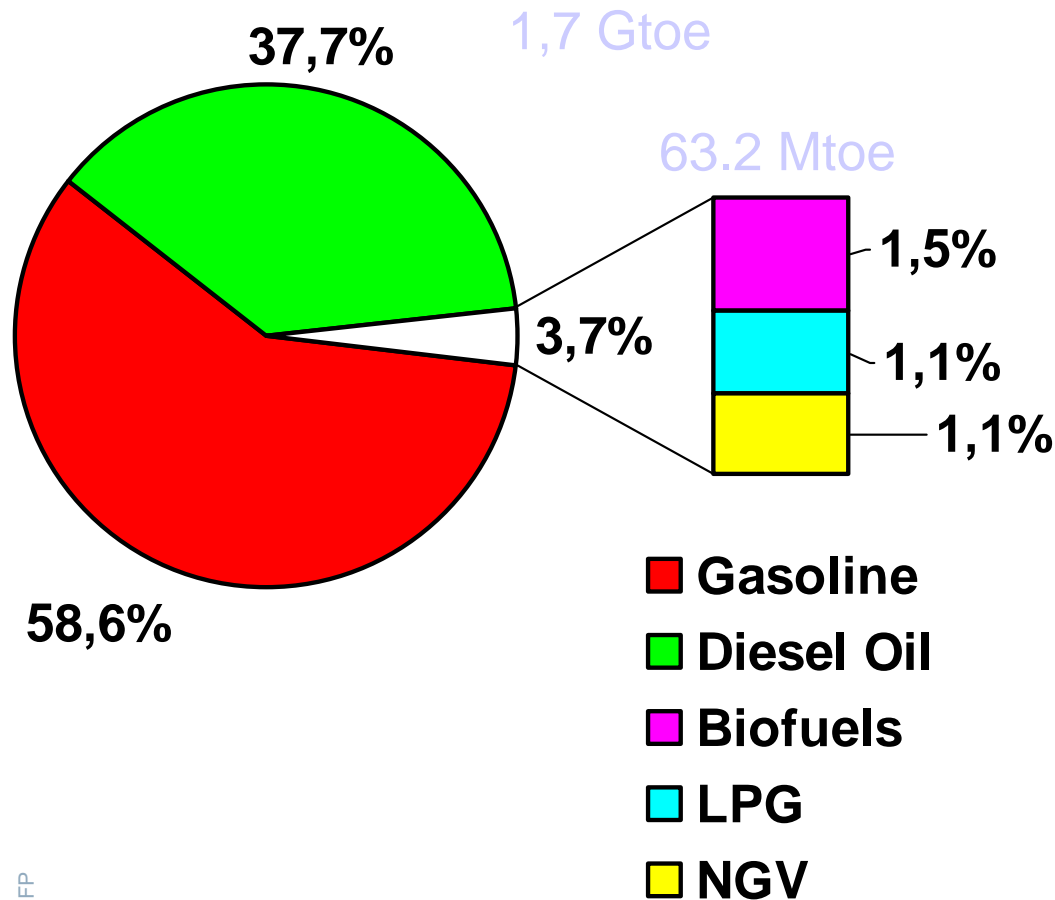
could be reduced drastically:
heating oil, petrochemicals?
(recycling, other material...)

Which vehicles and fuels in the World for the next 30 years ?



Alternative fuels today : worldwide consumption

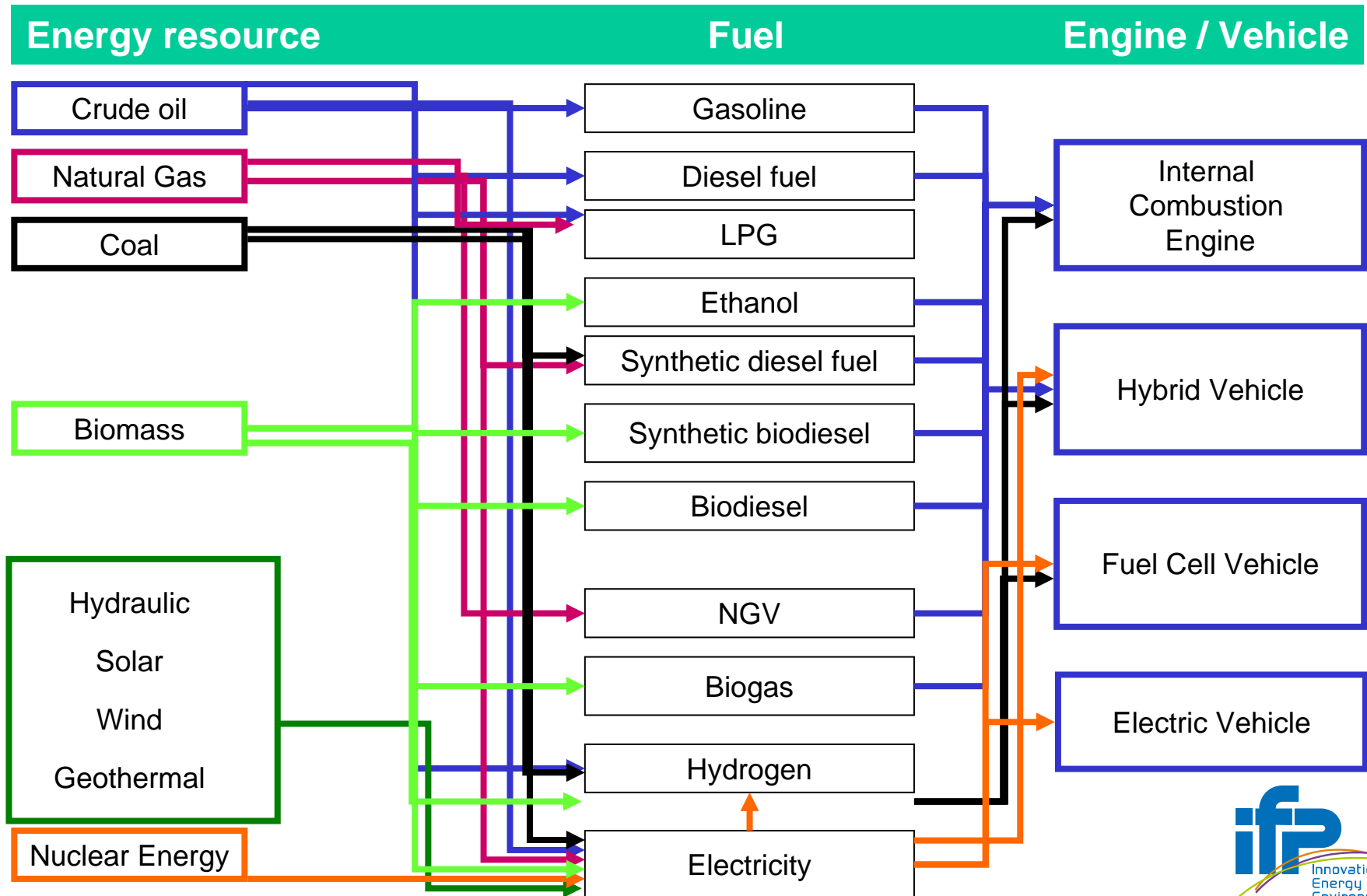
Worldwide energy consumption in the road transport sector in 2006



In 2006, the worldwide road transport sector :

- was dependent on oil at 98%
- represented 42 % of the crude oil primary consumption
- represents about 21 % of the final energy consumption
- follows an annual average growth rate of more than 2%/y

Alternative fuels pathways

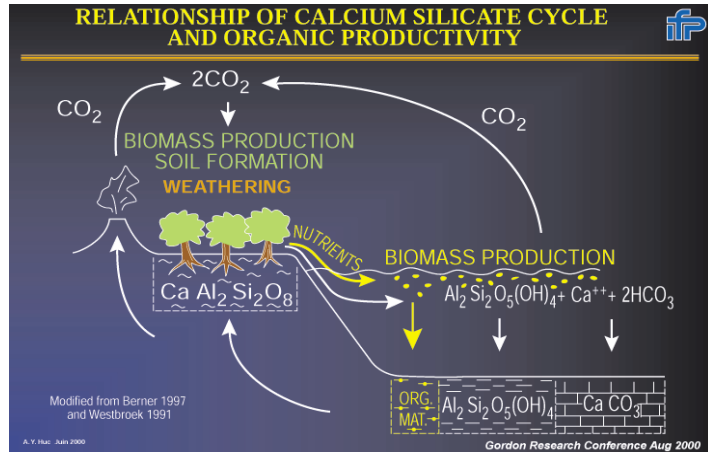




Transportation drivers and oil future

- CO2 constraints (plus urban air quality)
- Oil Resources Risk
- Technological breakthrough (Battery, Fuel cell) ?
- Electricity (EE) main vector versus liquids (ICE) ?
- AND New policy (City...), new behaviour (customer and car industry)...?
- AND Geographical diversity (Future Markets are now in New zones ...Russia, China...)
- liquids (...up to "hydrogen") required for aircraft and marine even with technologies

CO₂ Capture And Storage



The facts: Energy 64% of global GHG and Chemicals and Oil-Gas for 11% today

Develop efficient and safe technologies having an acceptable cost

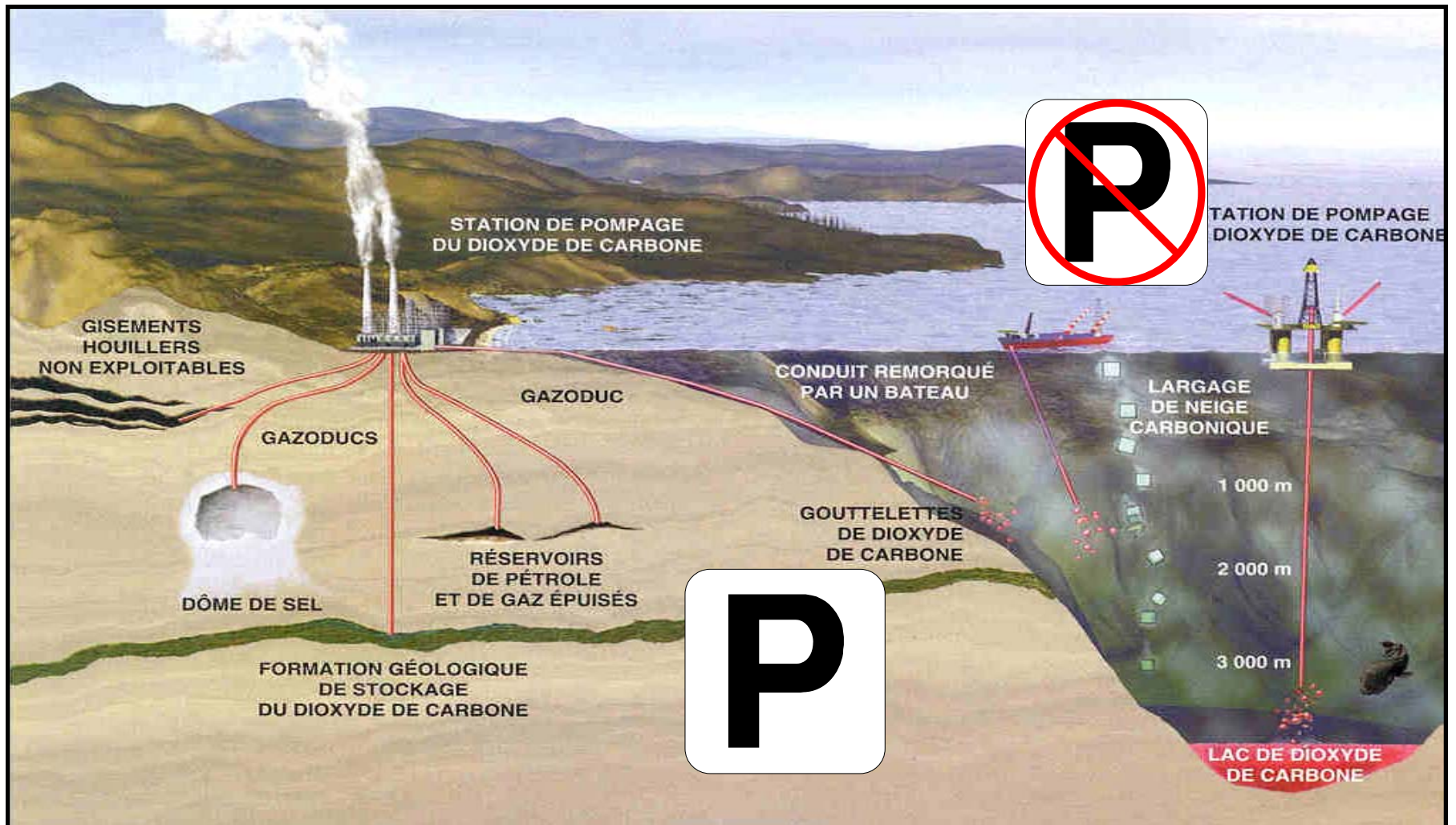
Capture

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

Storage

- Control of CO₂/rock interactions
- Storage surveillance
- Biomineralization

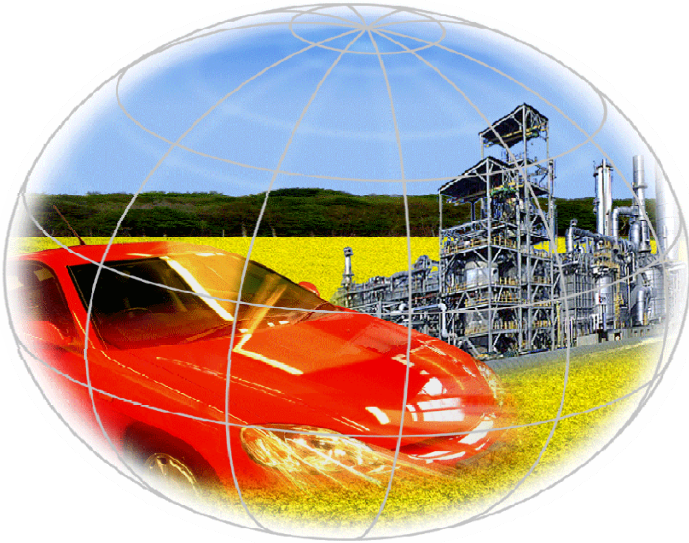
Several options for storage CO2



Source: "Pour la science".

Conclusion

In the coming decades ... Faced with major economical and societal concerns, oil & gas and motor industries will have to respond to ambitious and diversified scientific and technological challenges



Technological innovations will be necessary