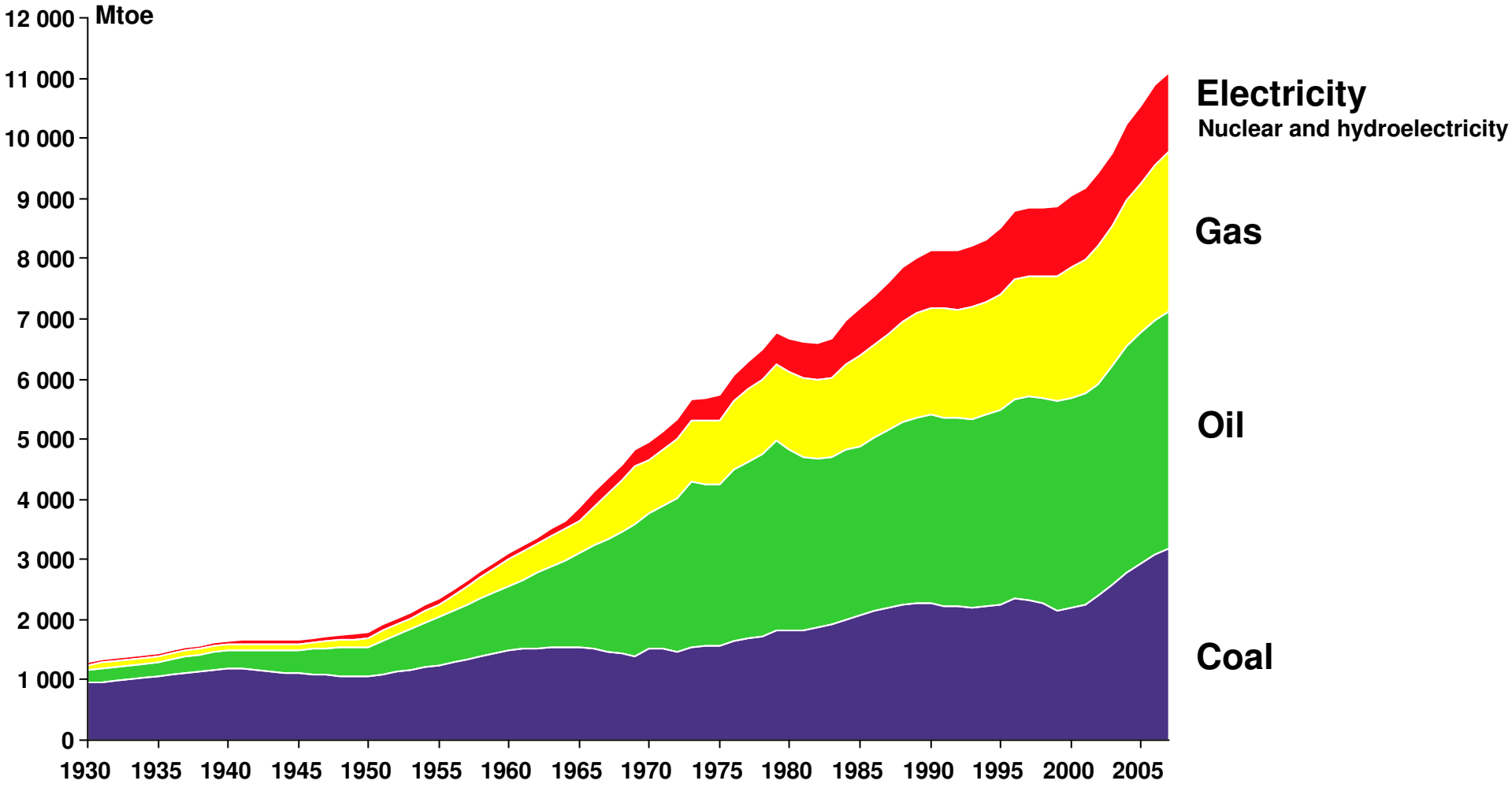
French South Africa Chamber of Commerce and Industry

Which energy for South Africa in the XXIrst century ?

Jean-Pierre FAVENNEC
j-pierre.favennec@ifp.fr

1. Energy in the world

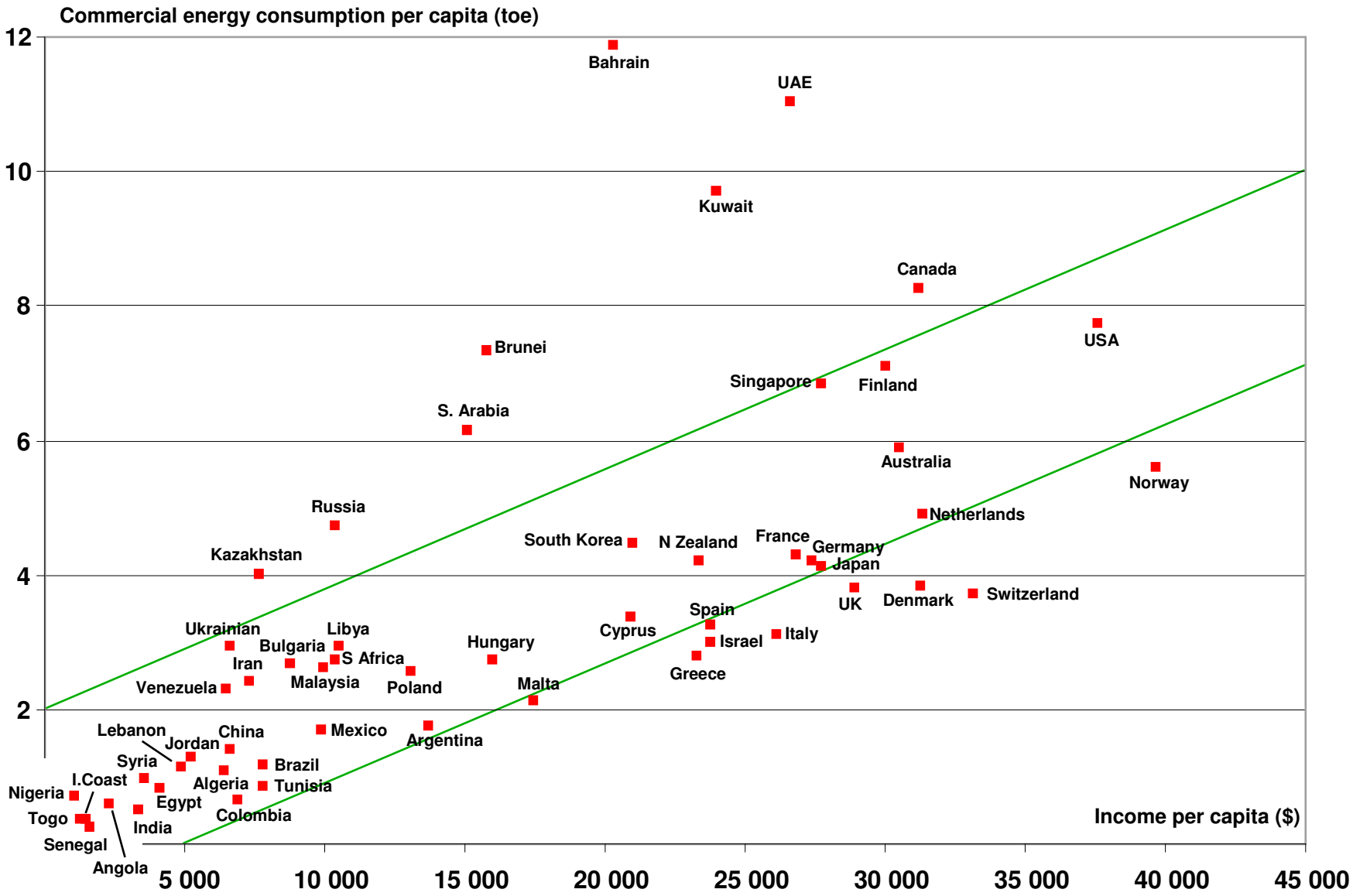
World commercial primary energy consumption



Source : BP Statistical Review

SEG - S 121*1 – July 2008

Commercial energy consumption and income in 2006



Source : AIE – Energy balances of OECD & Non OECD countries

SEG - S 112*2 – December 2008

Per capita consumption of commercial primary energy - 2007

	Energy consumption (Mtoe)	Population (M)	Energy consumption (toe/ per cap)
North America	2 838	447	6,4
South & Central America	553	451	1,2
Western Europe	1 952	476	4,1
CIS + Eastern Europe	1 035	331	3,1
Africa	345	934	0,4
Middle East	574	171	3,3
OECD Asia	488	201	4,4
Non OECD Asia	3 314	3 572	0,8
WORLD TOTAL	11 099	6 584	1,7

Source: BP Statistical Review and Etat du Monde

SEG - S 115*6 - July 2008

World energy demand

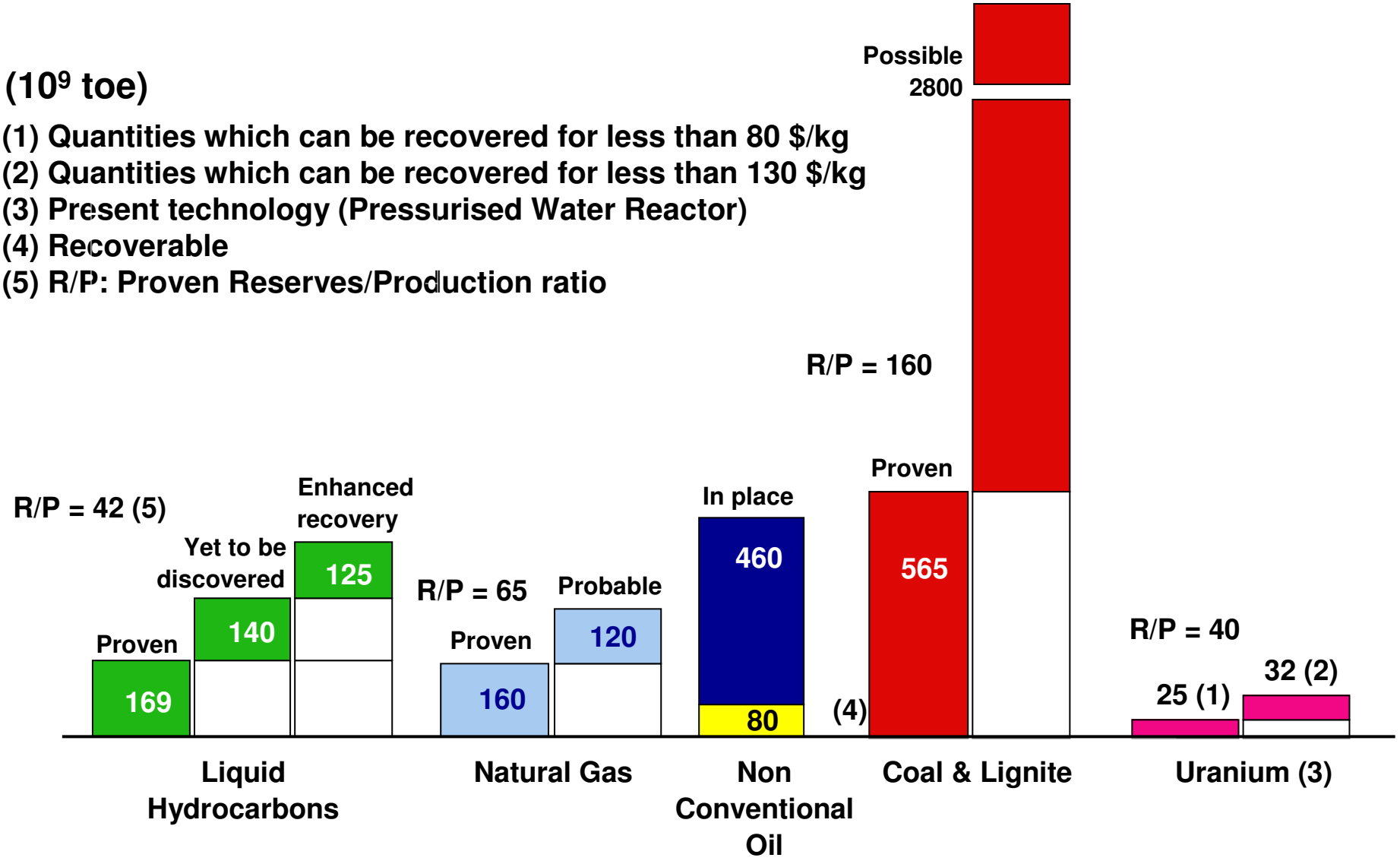
Btoe (10^9 toe)			2050		
	1960	2007	A1	B	C1
Oil	1,0	4,0	7,9	4,0	2,7
Gas	0,4	2,6	4,7	4,5	3,9
Coal	1,3	3,2	3,8	4,1	1,5
Nuclear	0,0	0,6	2,9	2,7	0,5
SUB TOTAL	2,7	10,4	19,3	15,3	8,6
Renewables	0,6	2,2	5,5	4,5	5,6
TOTAL	3,3	12,6	24,8	19,8	14,2

Source: United Nations, BP Stat. Review, WEC, EU and IFP-CEG

World reserves - 1.1.2008

(10^9 toe)

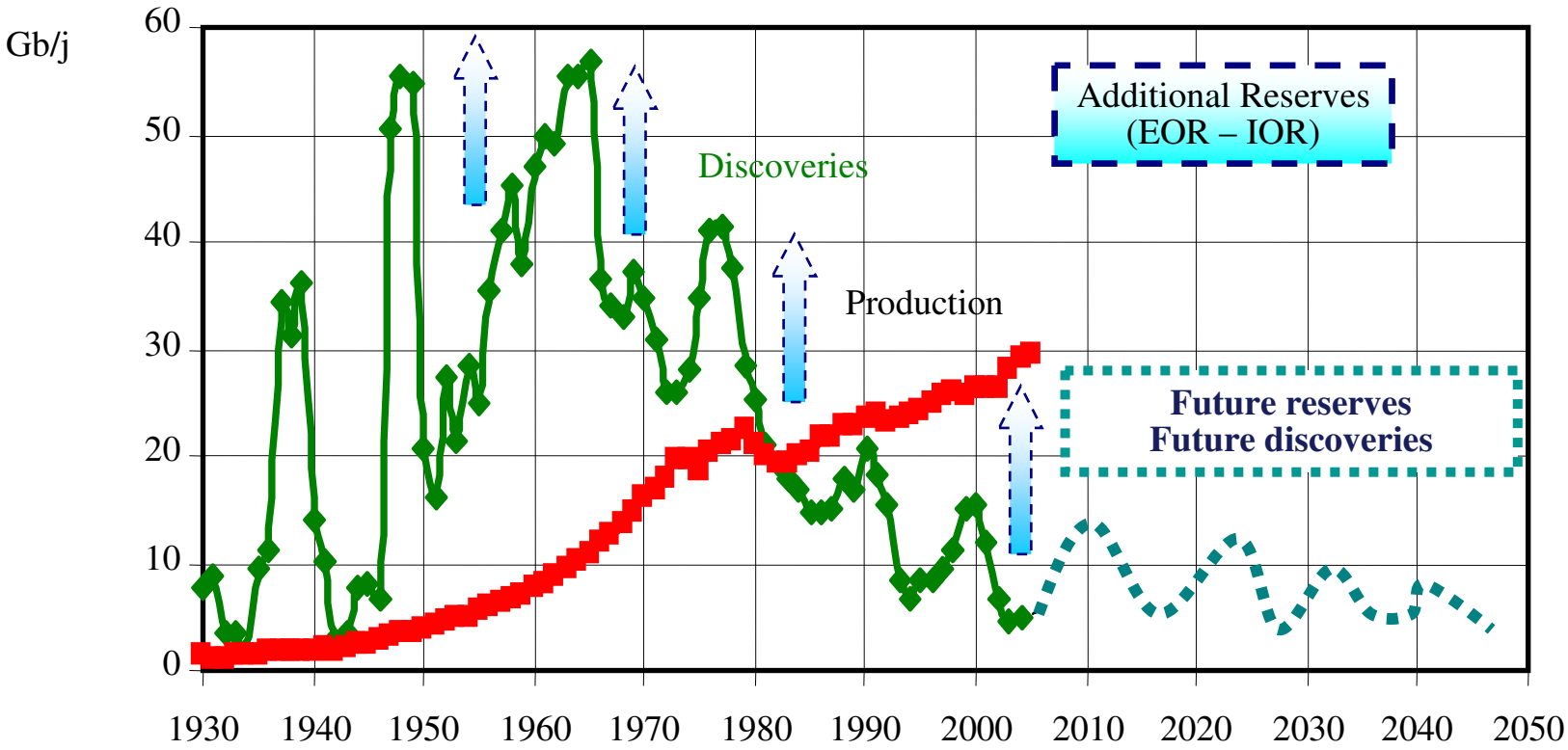
(1) Quantities which can be recovered for less than 80 $/kg
(2) Quantities which can be recovered for less than 130 $/kg
(3) Present technology (Pressurised Water Reactor)
(4) Recoverable
(5) R/P: Proven Reserves/Production ratio



Source : BP Statistical Review, CEA, IFP / DEE

Oil reserves evolution

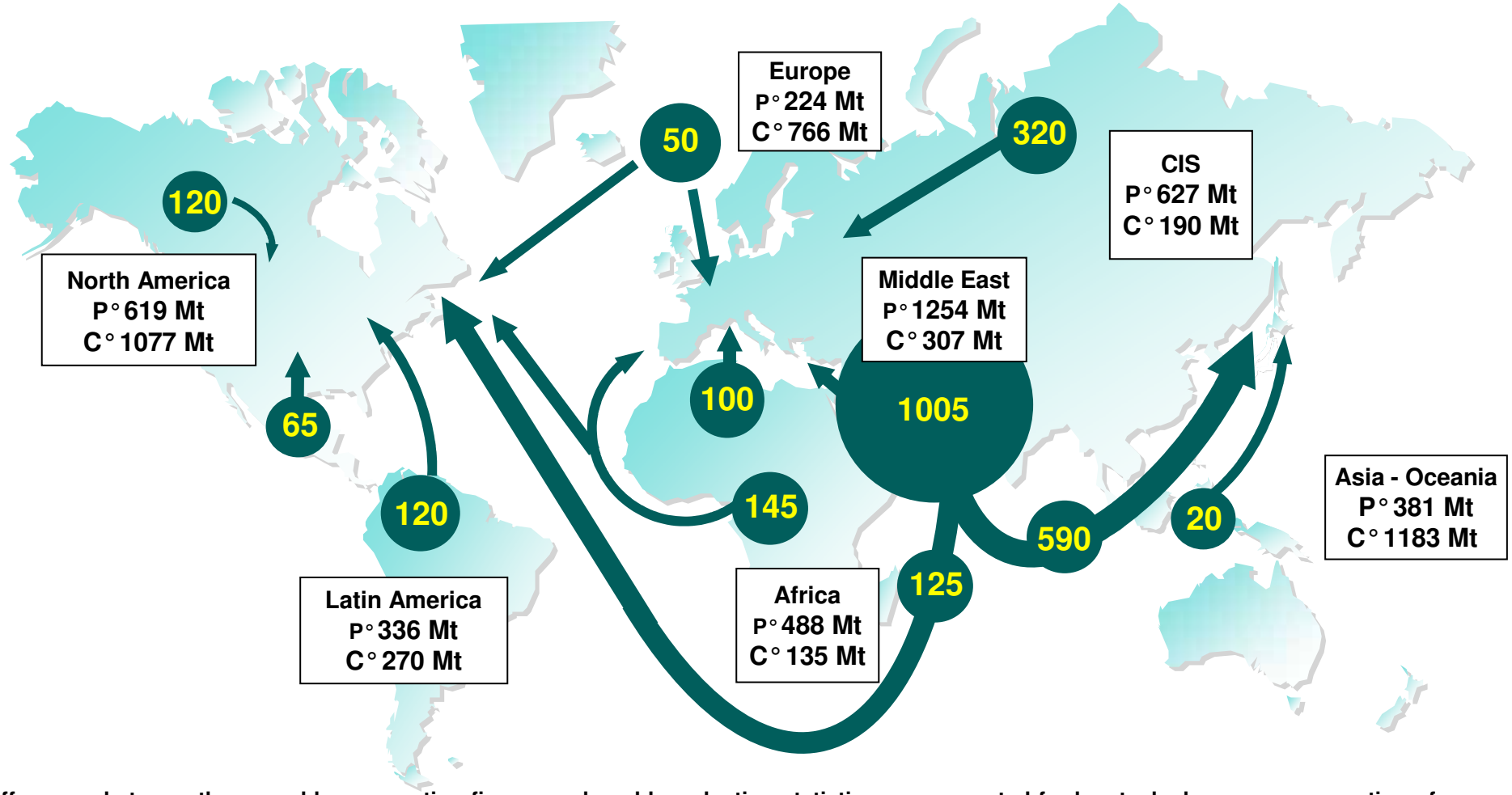
Discoveries and production since 1930



SEG - Source : IFP

Production, consumption and oil flows in 2008

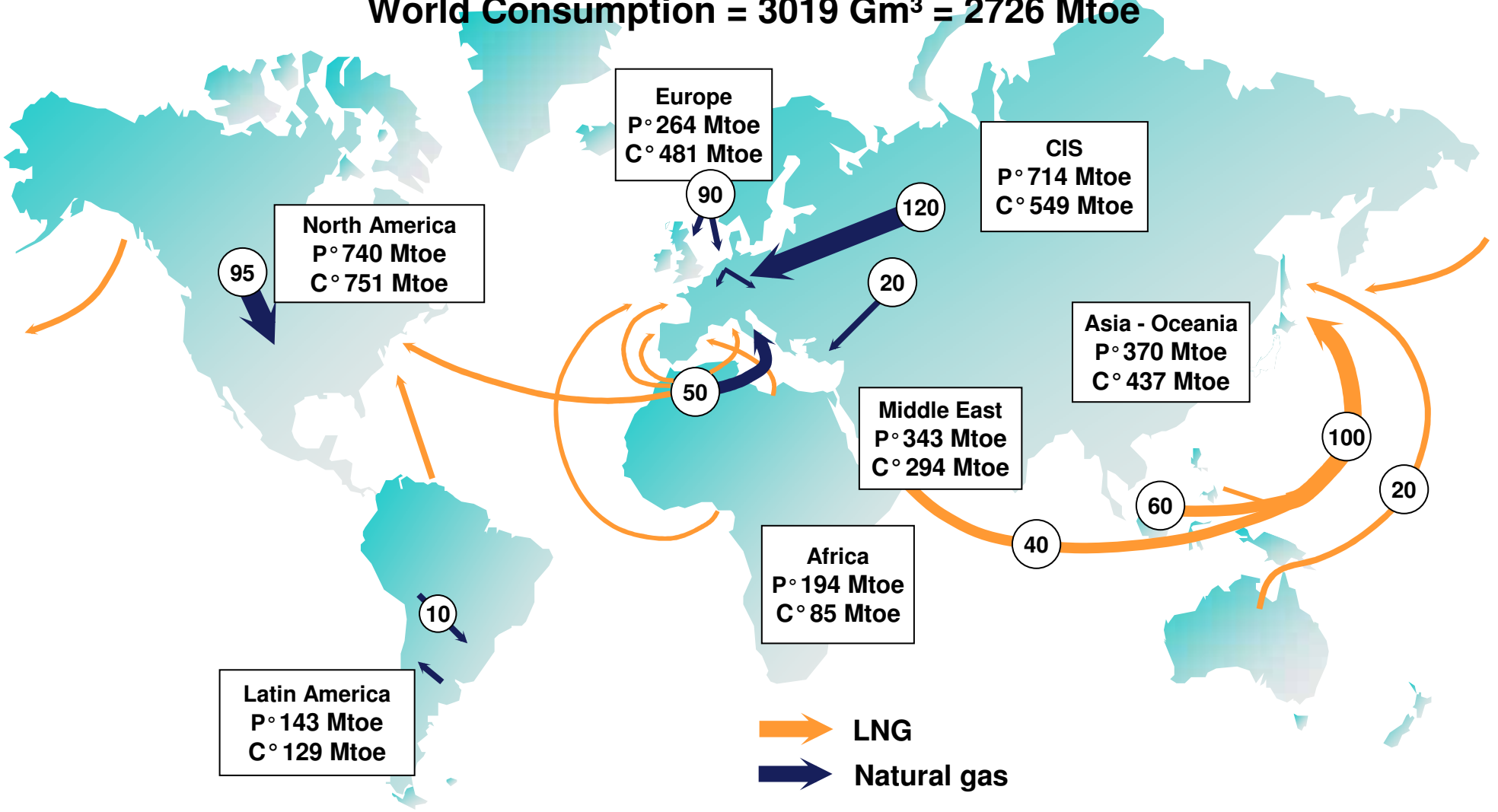
World Production = 3929 Mt
World Consumption= 3928 Mt



Differences between these world consumption figures and world production statistics are accounted for by stock changes, consumption of non-petroleum additives and substitute fuels, and unavoidable disparities in the definition, measurement or conversion of oil supply and demand data.

Gas production, consumption and flows in 2008

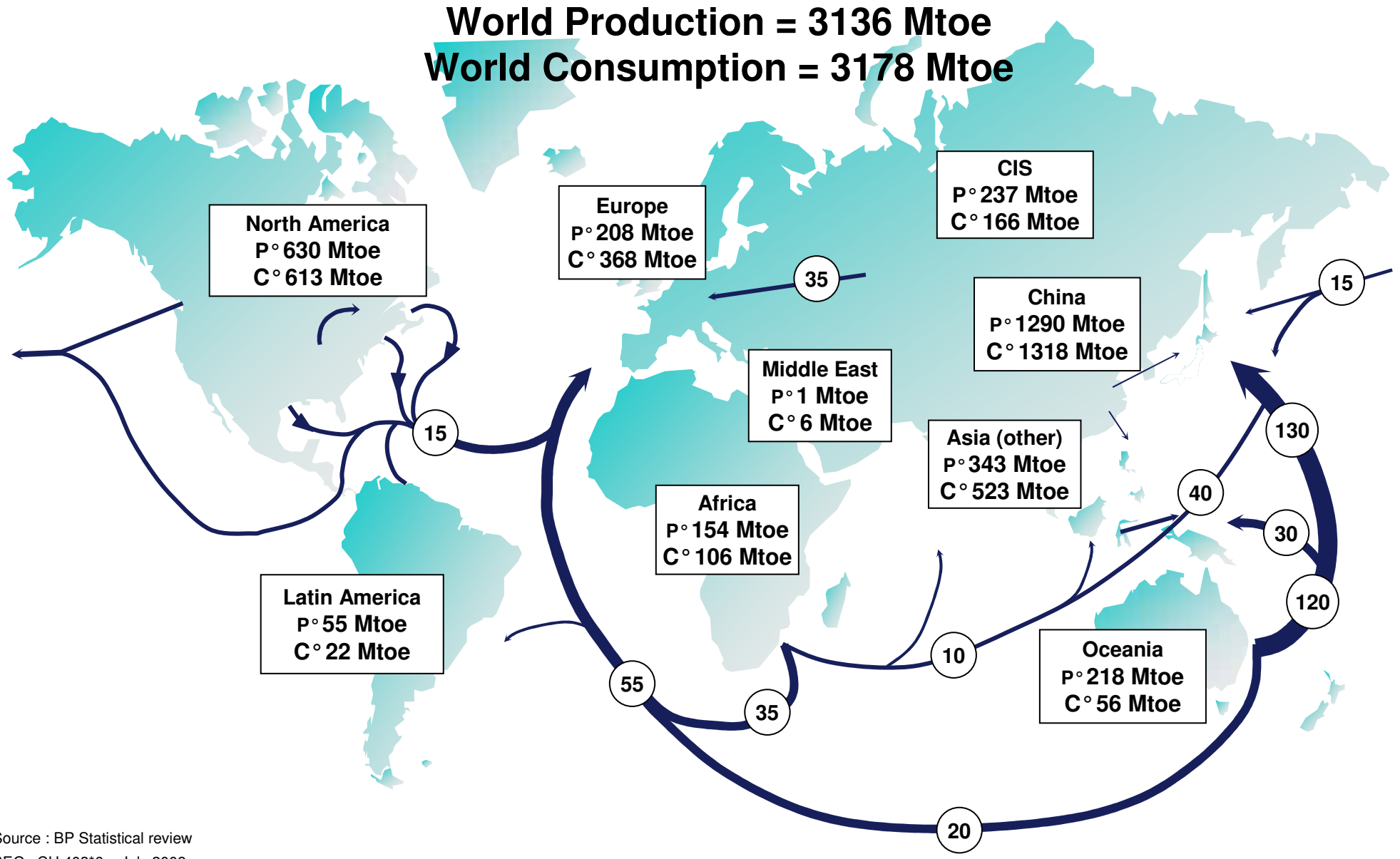
World Production = 3065 Gm³ = 2768 Mtoe
World Consumption = 3019 Gm³ = 2726 Mtoe



Source : BP Stat. Review

SEG - G340 – July 2009

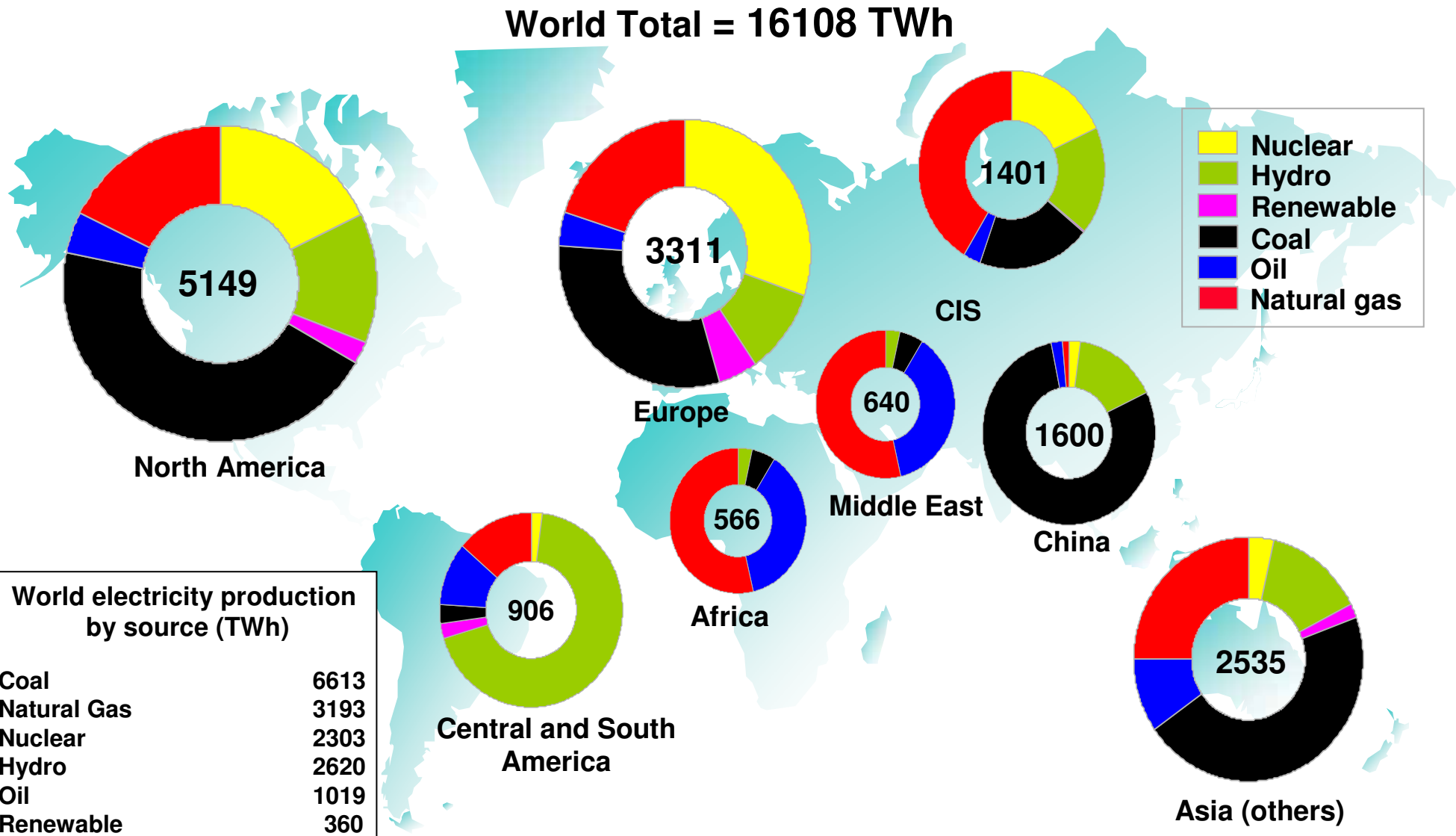
Coal production, consumption and flows in 2007



Source : BP Statistical review

SEG - CH 403*6 – July 2008

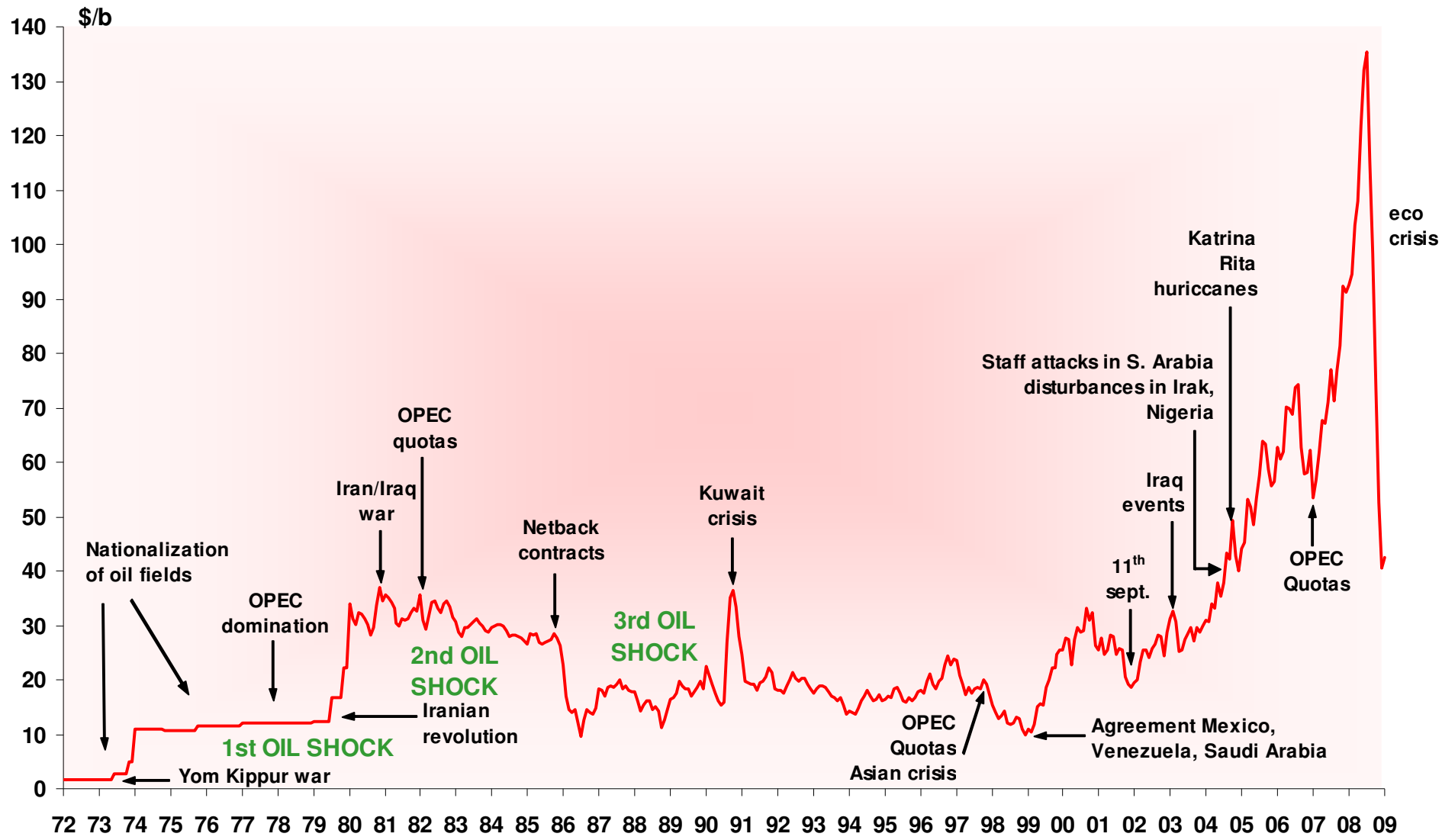
World electricity production in 2005



World electricity production by source (TWh)	
Coal	6613
Natural Gas	3193
Nuclear	2303
Hydro	2620
Oil	1019
Renewable	360

Source : AIE

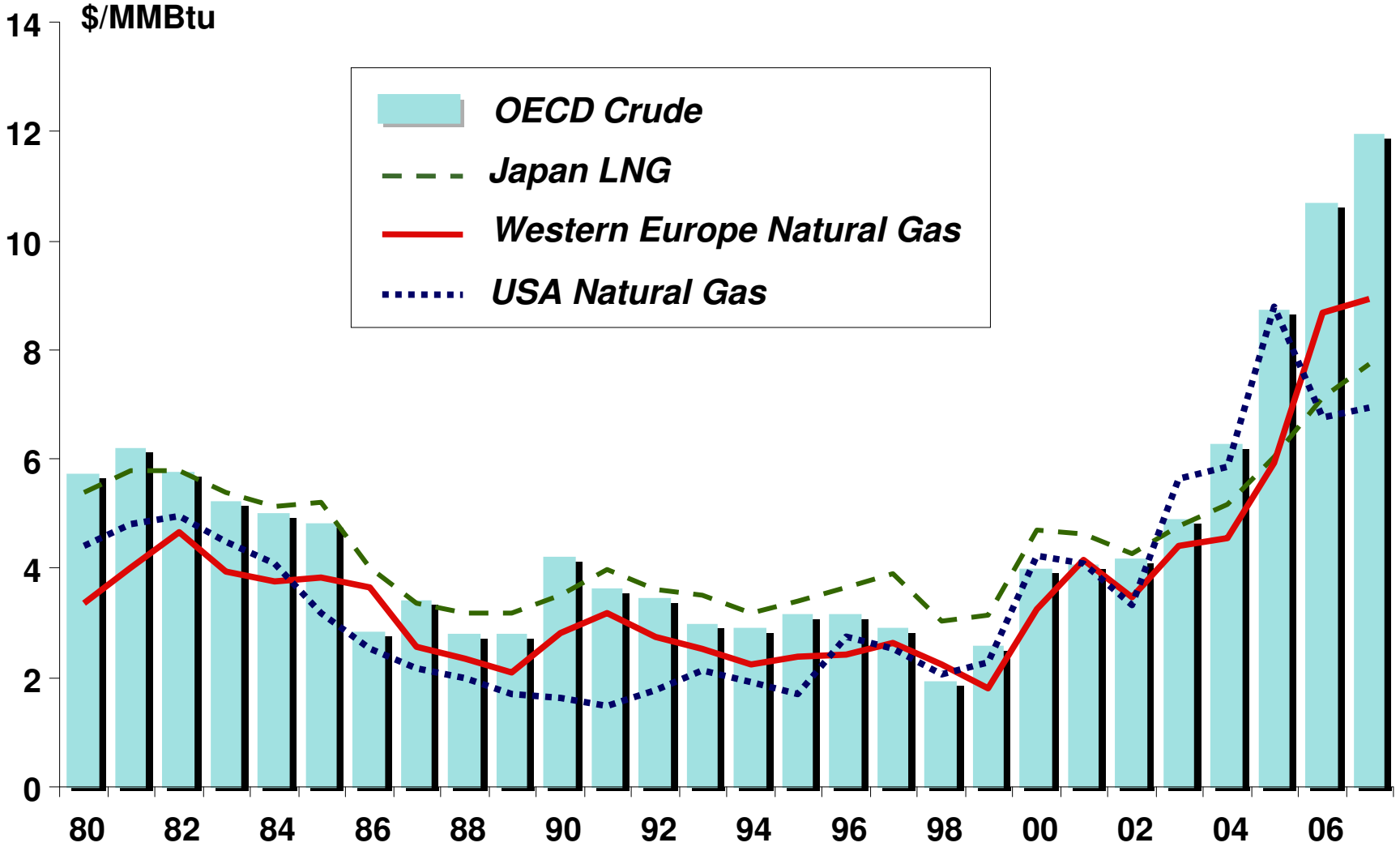
Crude oil price



Source : Platt's

SEG - S 402*16 – February 2009

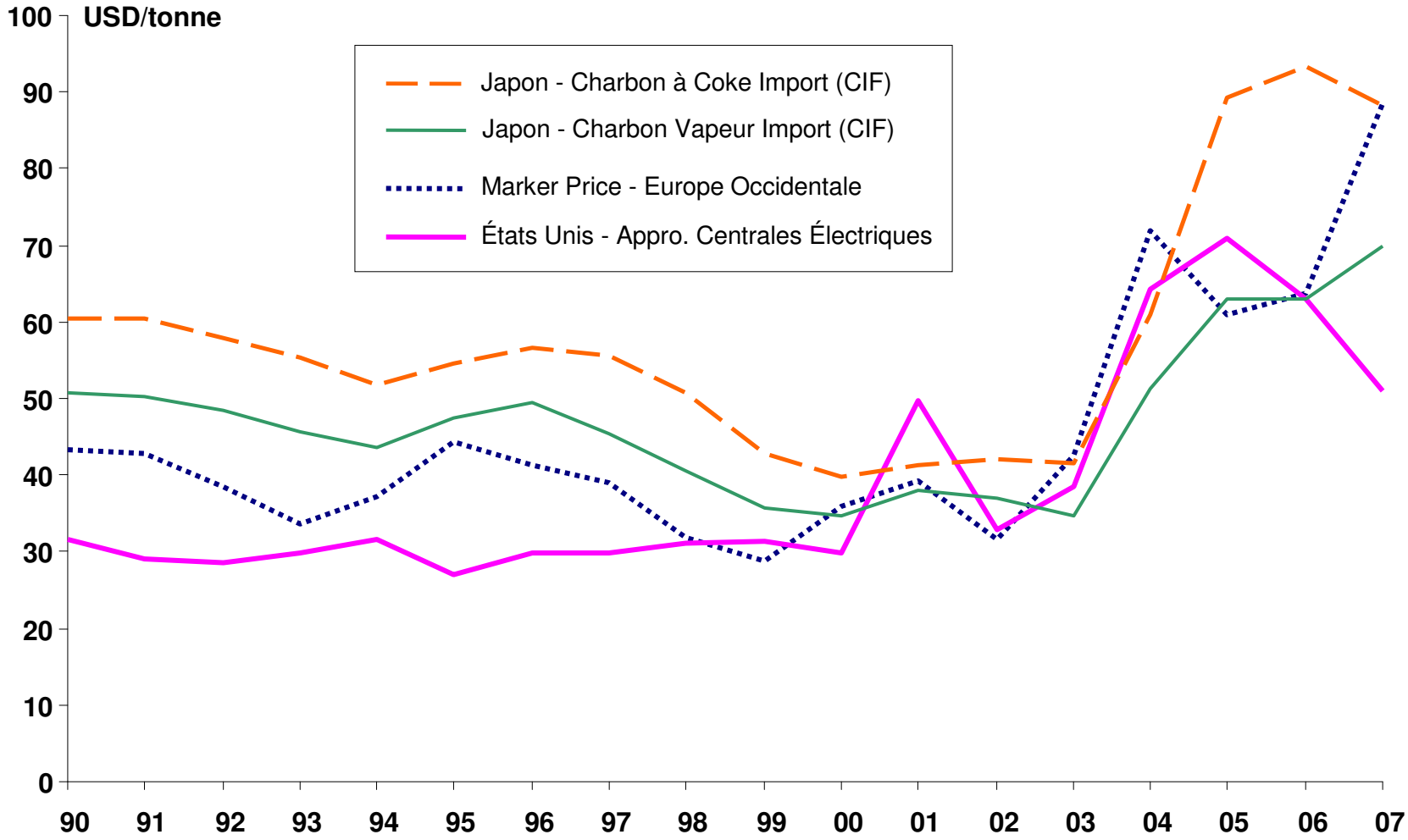
Evolution of import natural gas prices



Source : BP Stat. Review

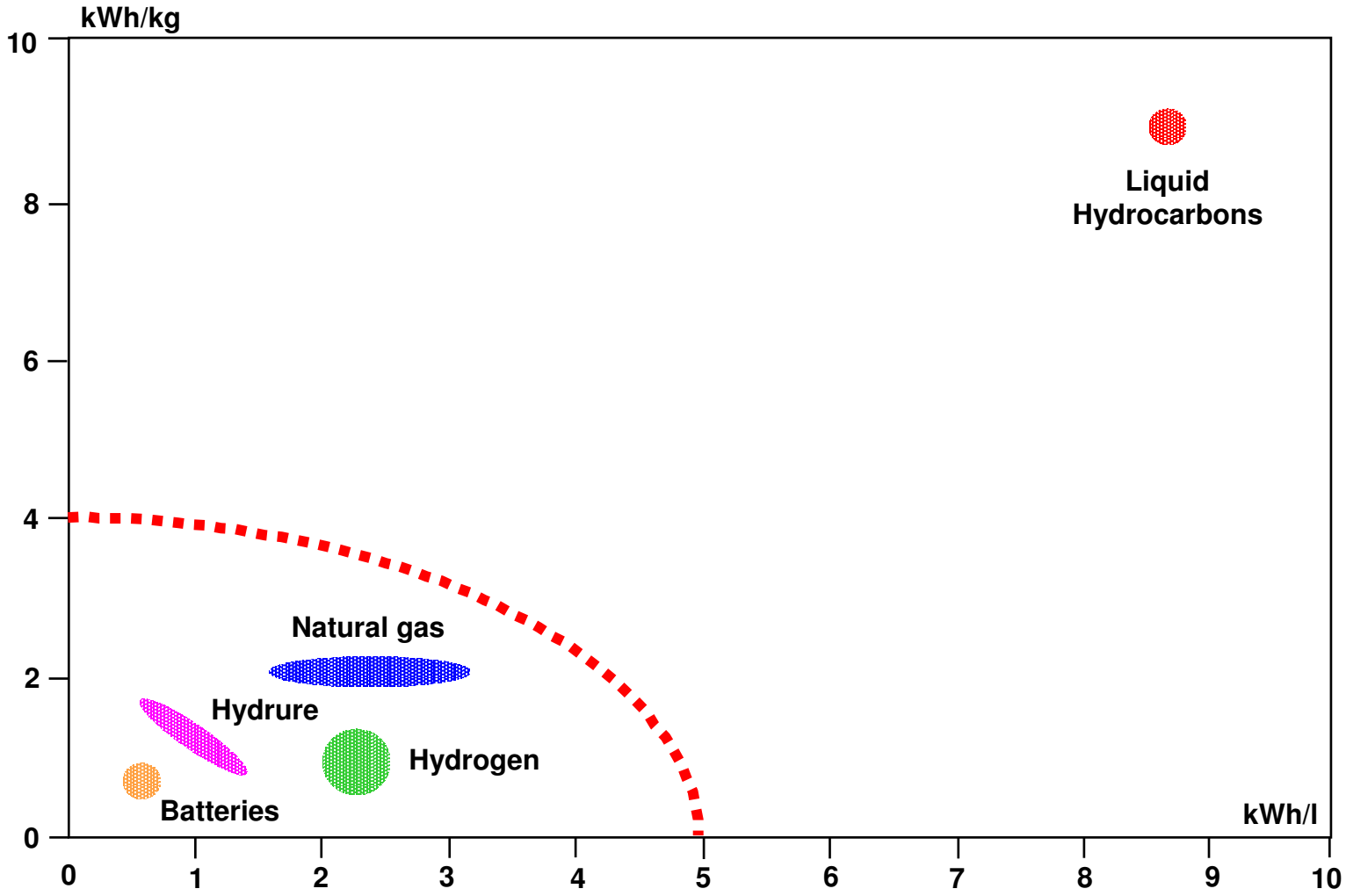
SEG - G352*36 – June 2008

Coal price evolution



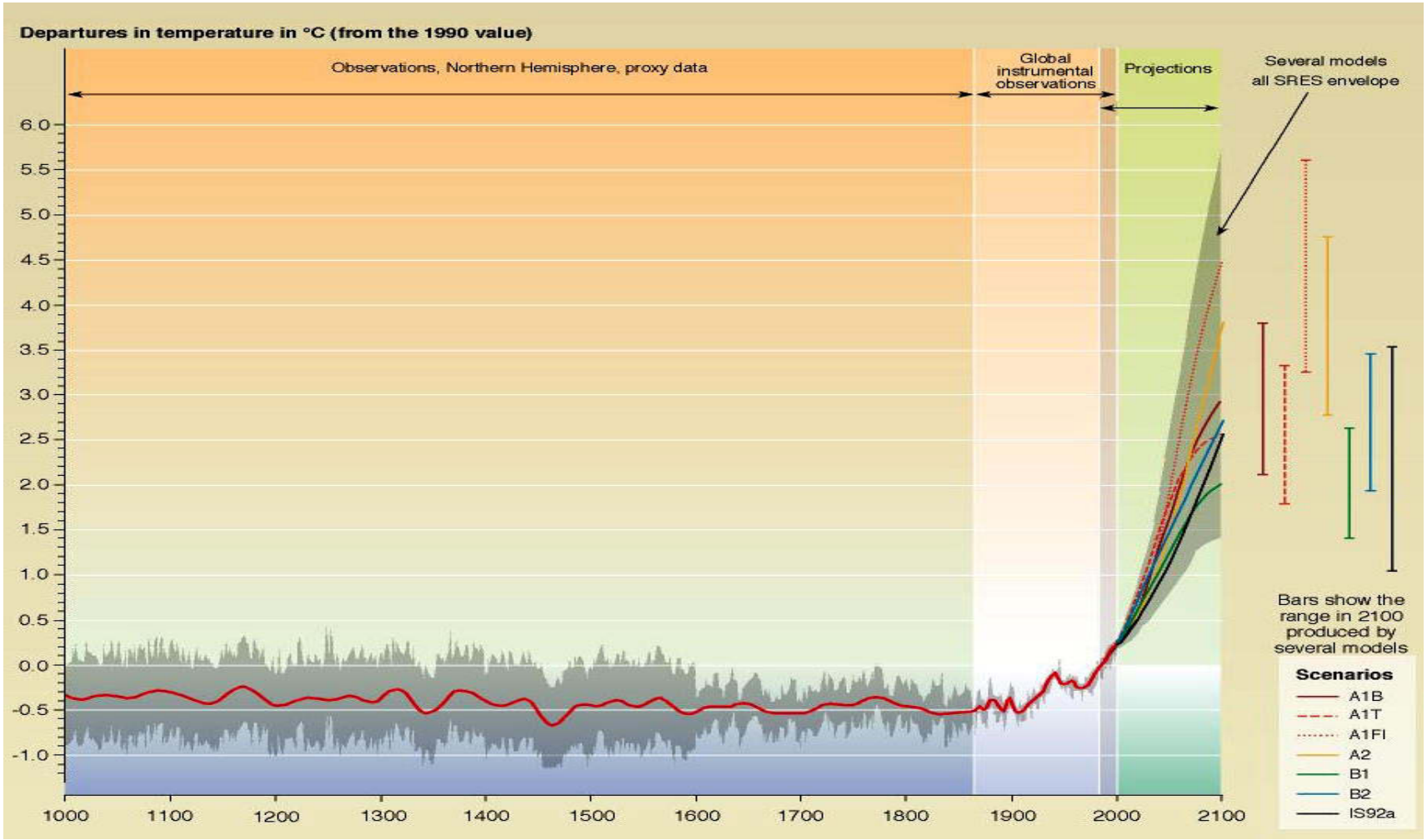
Source : BP Statistical Review

Liquid hydrocarbons : A cutting edge energetic intensity



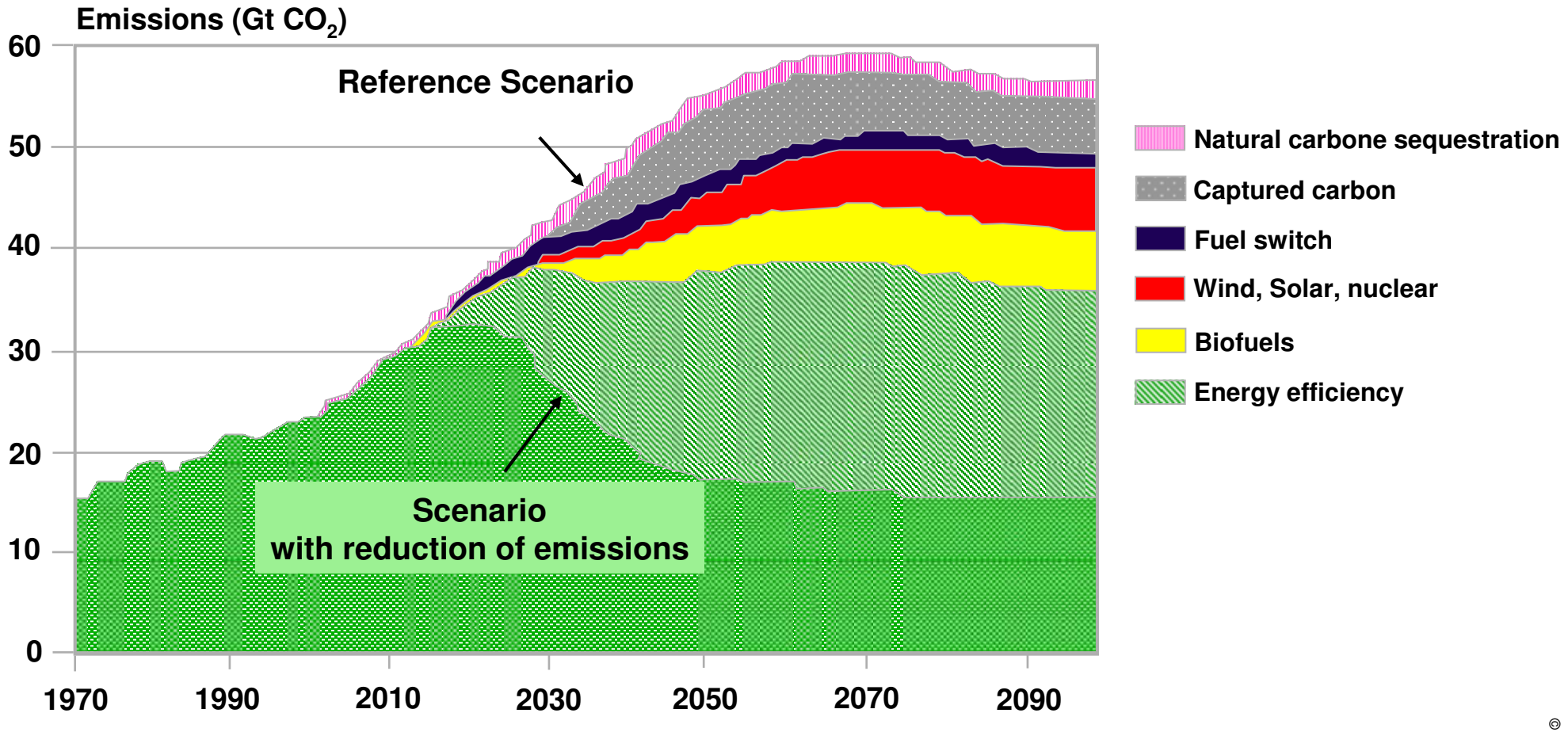
SEG Source : PR Bauquis – Revue de l'énergie - 2004

Temperature development



SEG - Source : Commission Européenne

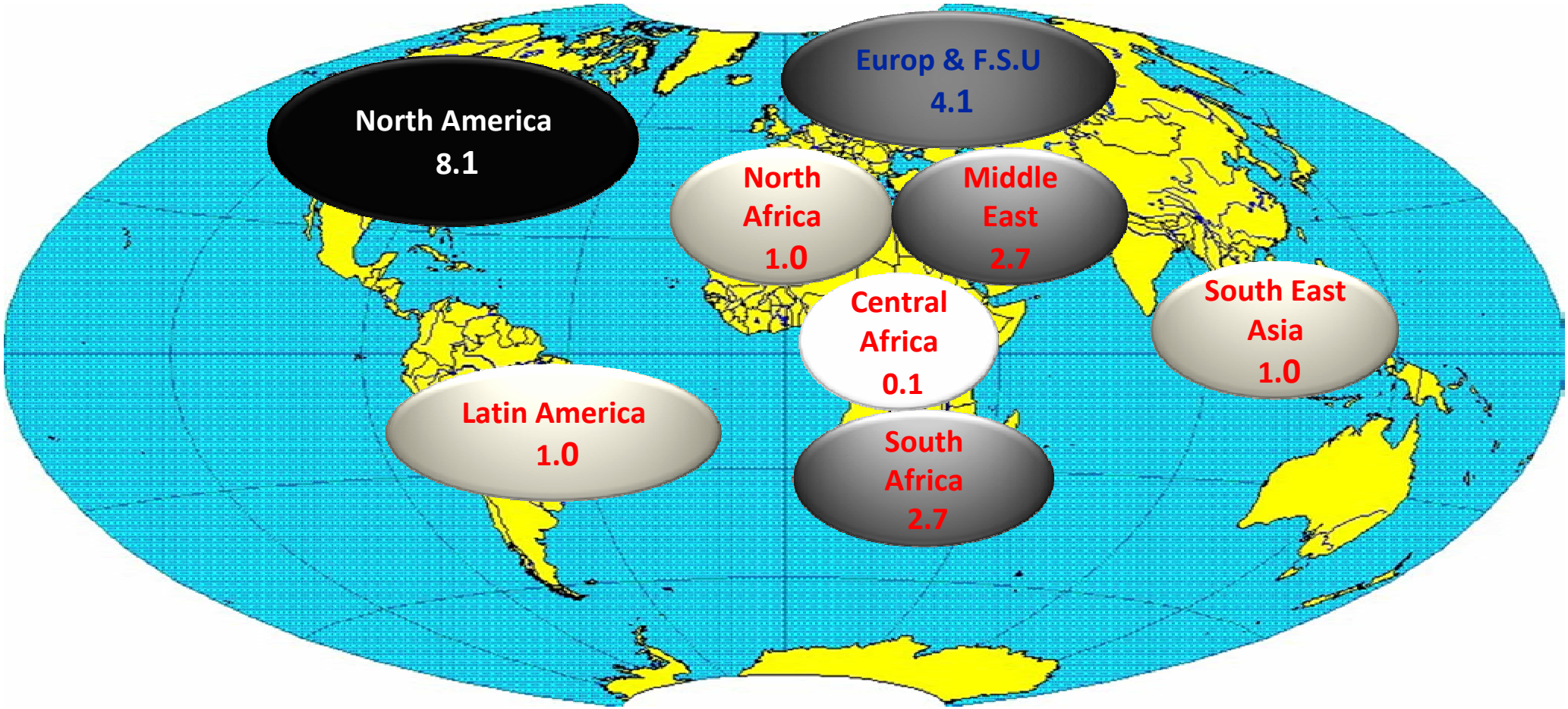
CO_2 emissions



SEG Source : Commission Européenne

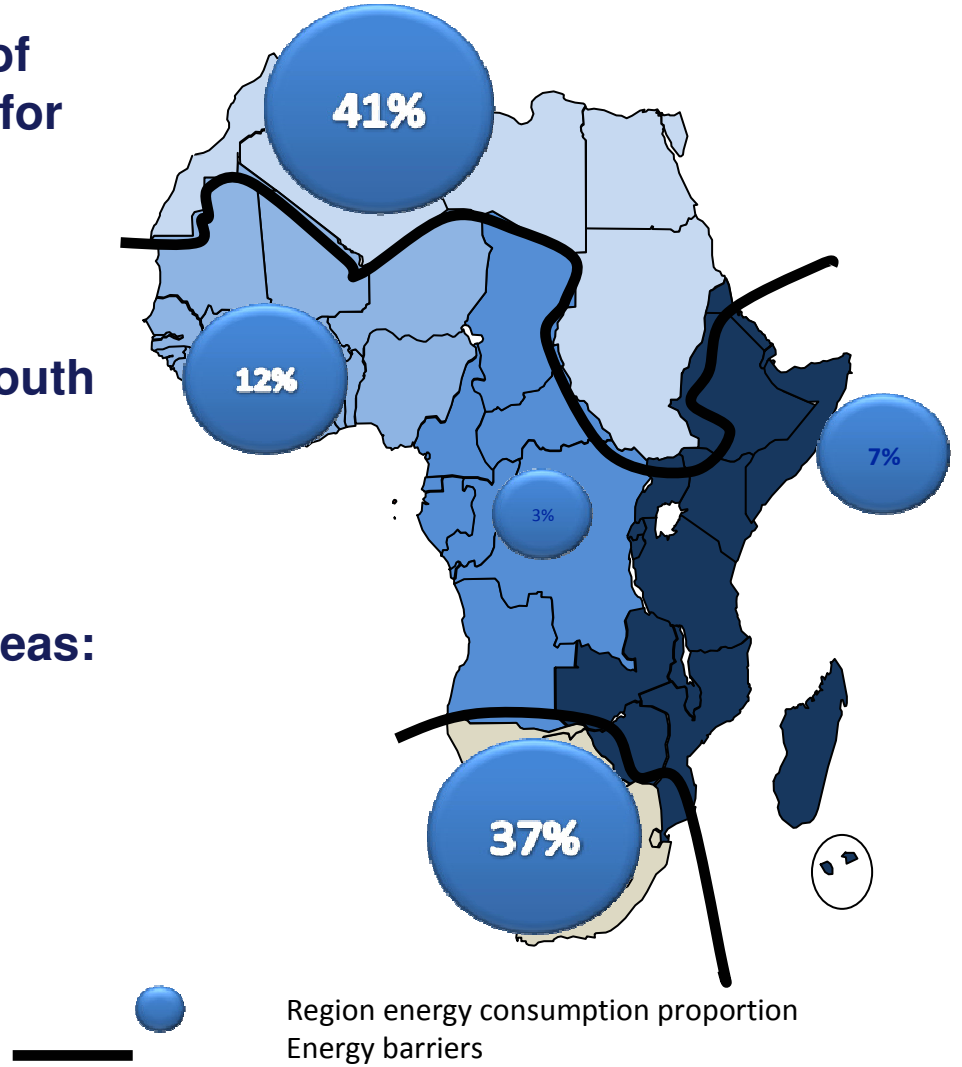
2. Energy in South Africa

World energy consumption (toe/capita)

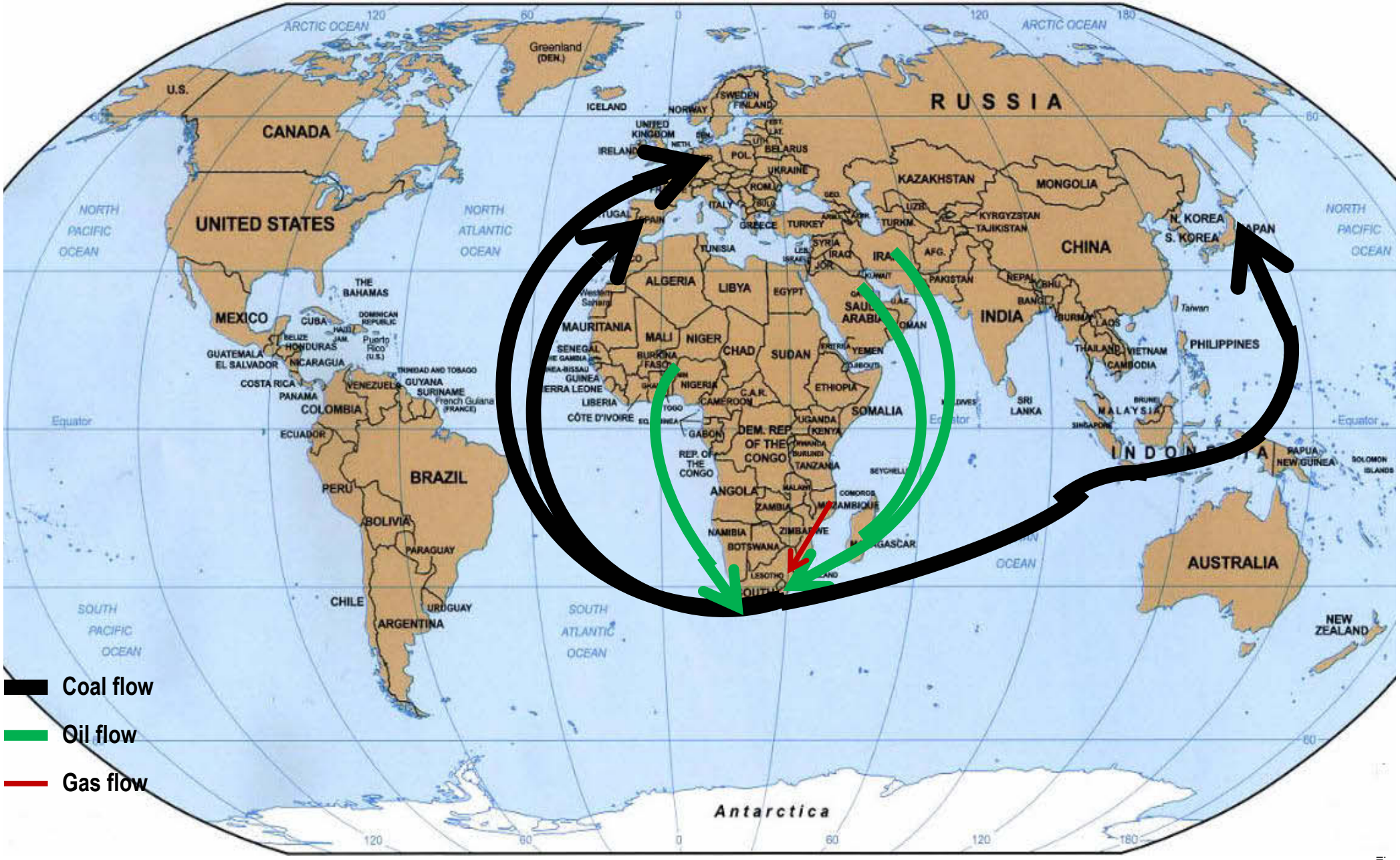


- **Divide between Africa and the rest of the world (15% of world population for 3% of world energy consumption)**
- **Divide between North Africa-South Africa and the rest of Africa**
- **Divide between urban and rural areas: Urban areas look like energy spots**

North and South Africa: two specific areas



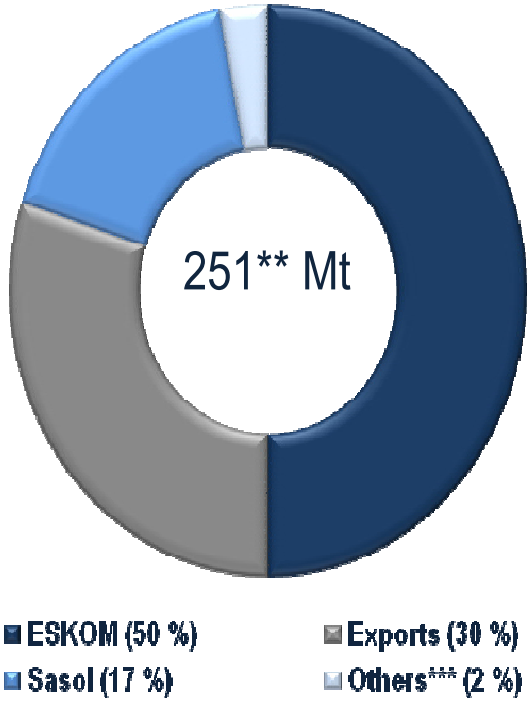
South Africa international primary energy trade main partners



Sources: US Energy Information Agency (South Africa Country Energy Briefing)

Coal: Production and consumption

Consumption of the Coal produced in 2008*



South Africa Coal Figures

- ✓ Primary energy mix proportion: 82.6 %
- ✓ Proved reserves: 54 Bt
- ✓ Production : 251 Mt
- ✓ R/P ratio: > 200 years
- ✓ESKOM Number of coal-fired power stations : 13 out of 20
- ✓SA coal-based electricity proportion: 90 %
- ✓Liquid from coal/ Total liquid: 1/3

Production and consumption of coal in South Africa have grown steadily over the past 25 years at an **average annual rate of 2.7 percent**

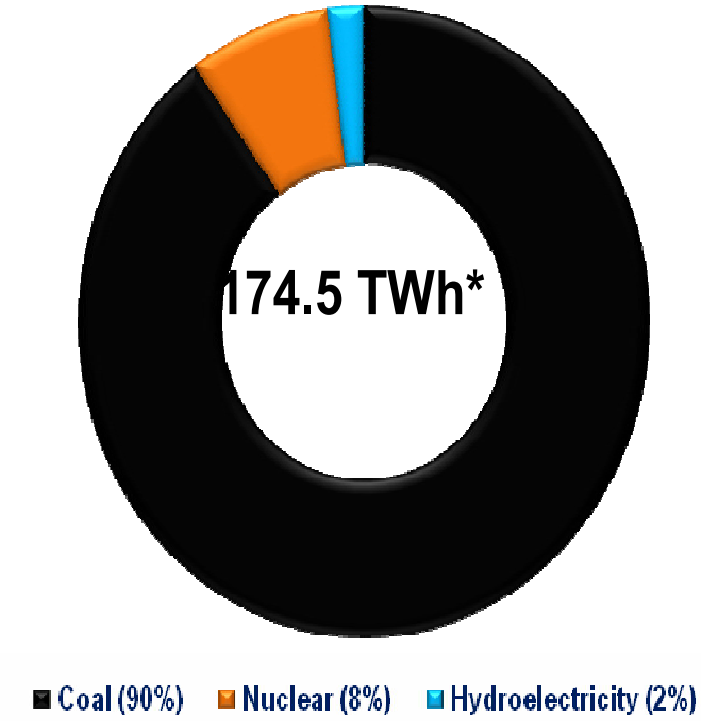
Source: **SACMA (South Africa Collieries Managers Association) /Presentation « ESKOM recovery plan » by Koos Jordan, June 2009
Sasol Annual report (produces 43 Mt pa for gasification)

* The production in 2008 was 251 Mt but the actual consumption in 2008 was 266 Mt as 15 Mt of dumps were used

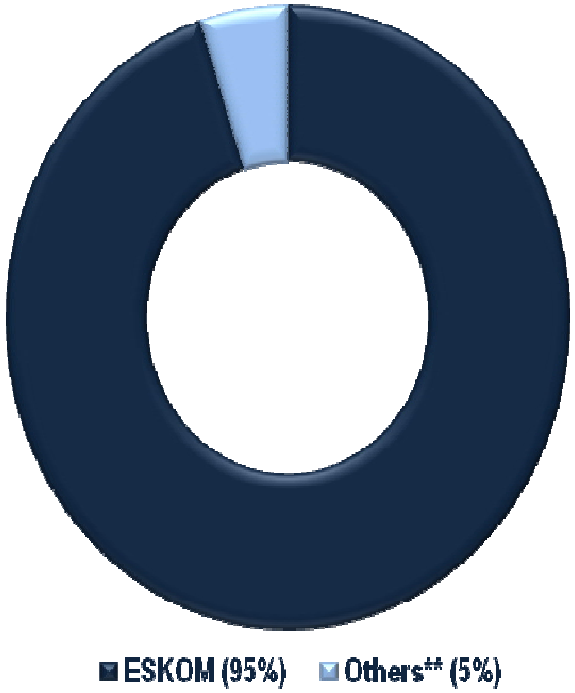
*** Others include Households, Metallurgical, Transport,

Electricity Production

ESKOM'S energy sources used to generate electricity



Power producers



South Africa Electricity Figures

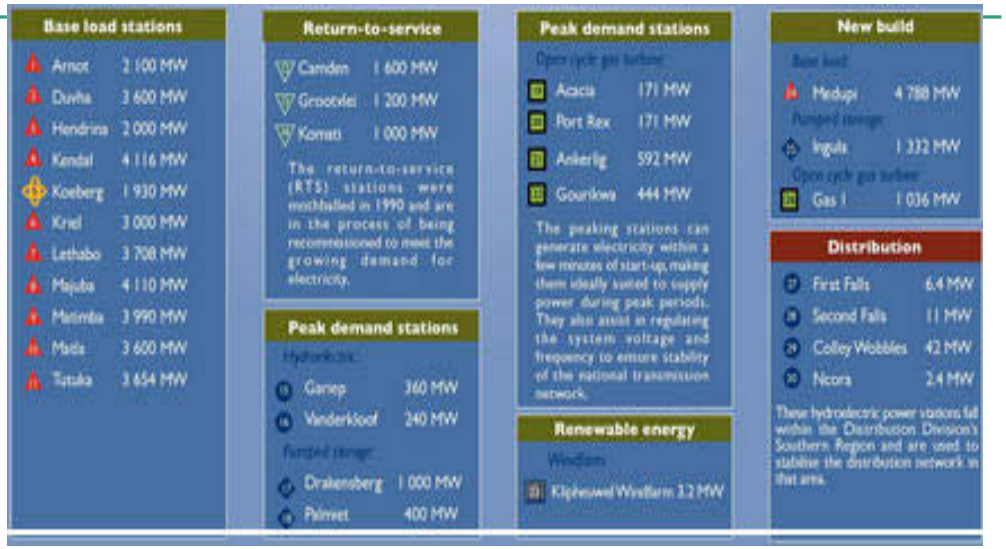
- ✓ Installed Capacity: 40 GW
- ✓ More than 20 power station including the single nuclear station in Africa
- ✓ National power grid: 27,000 Km of power line
- ✓ Share in Africa generation Capacity : 40%
- ✓Share in Africa generated electricity: 66%

Electricity is also produced from **Natural** gas, **diesel** at tiny scale and from **solar** , **wind** experimentally

Source: * Based on ESKOM'S average production for every power plant over the past 3 years
Department of Minerals and Energy (Energy sources / Producers share breakdown)

* Electricity production in 2008, ** Others include Municipalities and Private companies

ESKOM Power plants



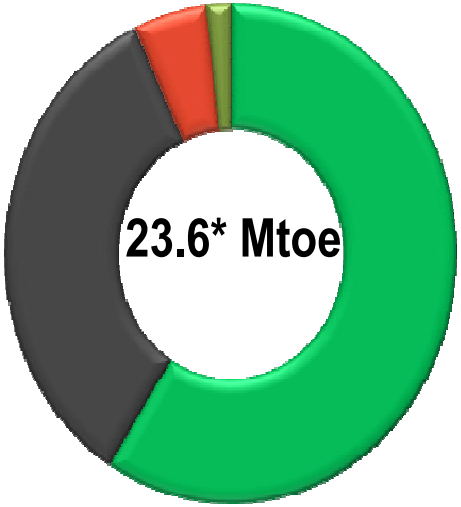
- ✓ 20 stations in service
- ✓ 3 stations in construction and 3 in renovation
- ✓ Base load capacity : 35 800 MW
- ✓ Peak demand capacity : 3378 MW

Source : ESKOM

WD cooperation

Oil: Production & Importation

Source of the oil consumed in SA in 2008



- Imported crude oil (59%)
- Coal-to-liquid (34%)
- Gas-to-liquid (5.3%)
- Produced crude oil (1.7%)

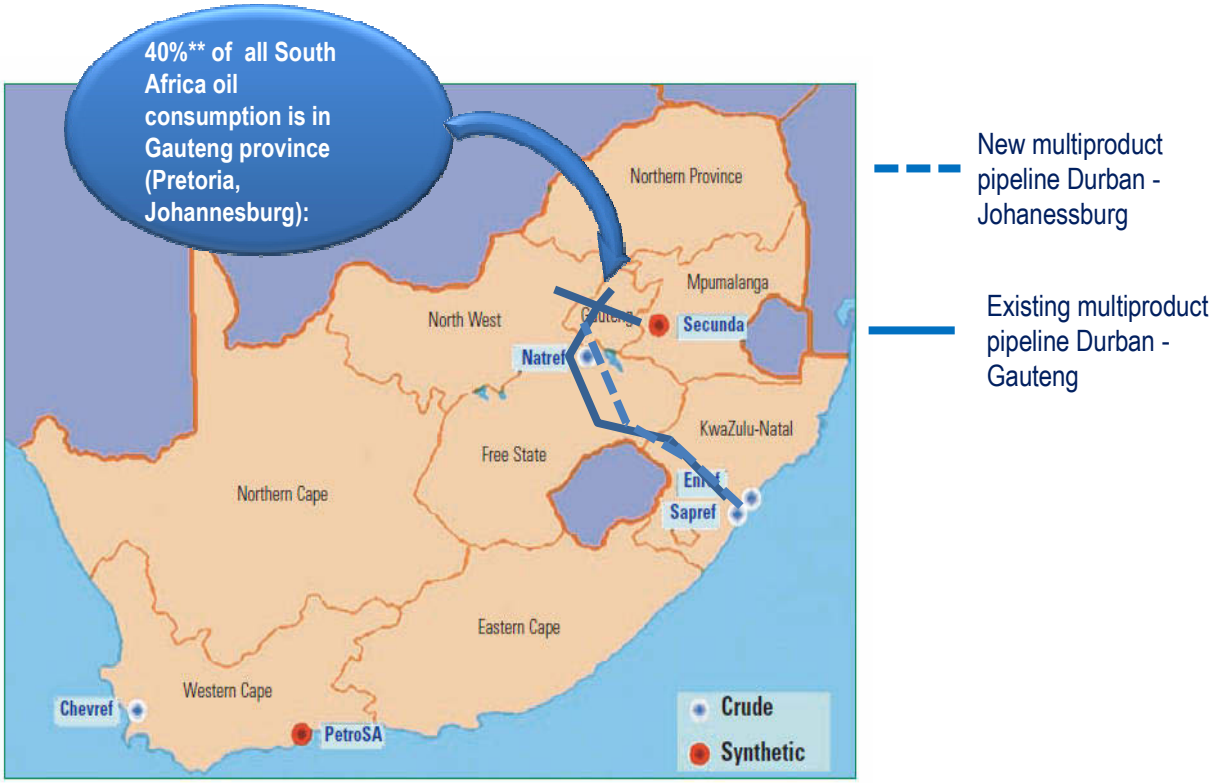


Figure 1: South African Refinery Locations

- ✓ 4 crude refineries and 2 synfuel refineries (GTL/CTL)
- ✓ Total refining capacity (2008): 692,000 bbl/d including **497,000 bbl/d of crude** oil refining capacity, and **195,000 bbl/d of synfuel** oil equivalent refining capacity
- ✓ Petroleum products consumption (2007): **25.8 billion litres** including **10 billion litres of Diesel and 11.5 litres of petrol**
- ✓ Imported petroleum product (2007) : 1.2 billion

Source: * BP Statistical Review 2009, ** Energy for Africa N°5 May 2008 , page 27
Notes: Conversion factor from CTL/GTL to toe is 1.25 based on Mossel Bay GTL plant 36,000 b/d equivalent to 45,000 boe/d
1 ton of oil = 7 bbl of oil assumed
Imported crude quantity infered from total consumption from BP Statistical figure and local crude and synfuel production figures
Gas-to-liquid and Produced crude oil figures from PetroSA 2008 annual Report, Coal-to-liquid figure from Sasol 2008 annual report

Challenges: Fossil Fuels

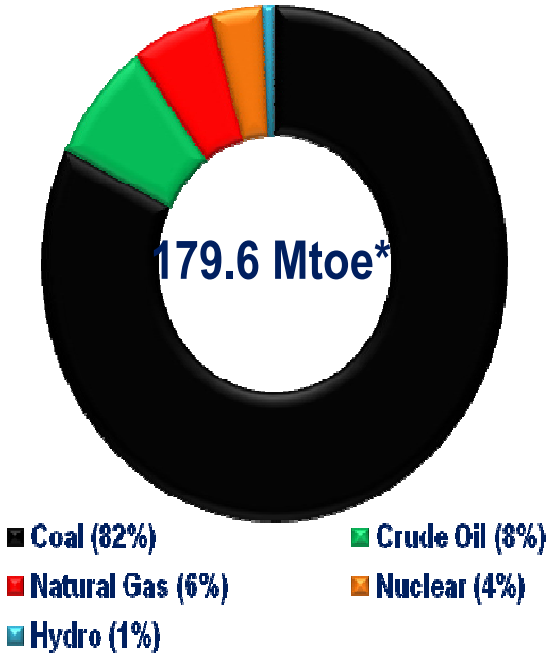
	Coal	Oil	Natural Gas	Refining
Actual	175 Mt consumed in 2008 in country and 75 Mt exported and 32 066 MW	26.3 Mt consumed. The majority is imported crude and synthetic oil	3.2 bcm imported and 1.4 bcm produced and used for GTL	Refining capacity is 692 000 bbl/d. 4 crude refineries and 2 synfuel refineries
Observed average growth	Consumption and production grow 2.7% pa on the last 25 years	On average, over the past 5 years, diesel grows at 8% per year and petrol at 1.6% per year	Gas will grow faster. But so far very limited growth	stable
Challenges	Reduction of dependency on coal that represents 76% of commercial primary energy consumed in SA	Maintain oil flow to supply refineries and meet growing demand. Increase synfuel production	Increase local gas production and secure gas flow from Mozambique and Namibia to meet growing demand (electricity, households, industrials)	Increase capacity to meet ever increasing local demand and reduce importation. Strengthen distribution network
Projects approved or in progress	Power plants. Recommission: 3800 MW Medupi: 4800 MW. (in progress) Bravo: 5400 MW (approved)	Sasol and PetroSA have interests in foreign countries (Nigeria, Equatorial Guinea) SA offshore fields: Oribi and oryx oil fields in production. Condensate produced from SCG field(South Coast Gas)	Sasol, PetroSA have upstream interests in foreign countries(Mozambique). In SA offshore fields: SCG(South Coast Gas) commissioned, Sable injected gas, Jabulani, ,etc, to be produced	Coega deep conversion refinery: 400,000 b/d. Mafutha CTL plant: 80 000 bbl/d and Secunda expansion: + 30,000 bbl/d
Optimistic scenario around 2018	47 000 MW based on coal Coal-based plants fitted with clean coal technologies: CCS, IGCC, Underground coal gasification. Coal share in primary energy: 82 %	614,000 bbl/d consumed broken down is 50 % imported crude oil 50% synfuel (GTL, CTL) (South Africa Oil & Gas publication, July 15th 2009)	Gas consumption is 11.3 bcm with 5.3 bcm imported (South Africa Oil & Gas publication, July 15th 2009)	Refining capacity is 1,202,000 bbl/d. 5 crude refineries and 3 synfuel refineries (Secunda, Mossel Bay, Mafutha)

Challenges: Nuclear & Renewables

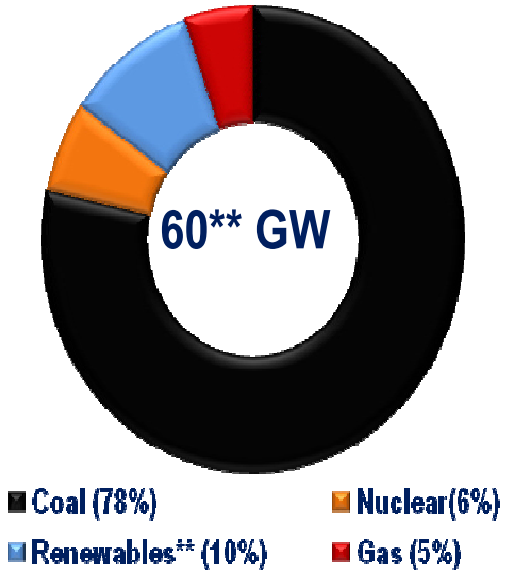
	Nuclear	Hydroelectricity & Pumped storage	Other Renewables (Wind, Solar)	Electricity
Actual	Installed capacity:1800 MW average annual production: 13.66 TWh	Installed capacity:2000 MW Average annual production: 3.9 Twh	Embryonic stage	40 GW installed capacity and 174.5 Twh produced in 2008
observed average growth	Stable. Only a 1800 Mw built so far at Koegen	Insignificant growth	Embryonic. Only some small scales experimental project	1500 Mwh pa
Challenges	Maintain safe nuclear operations and increase production. Commission the first PBMR around 2020	In 2003, the white paper on renewable energy set a target of 10 000 GWh of energy to be produced from renewable energy by 2013.		Reduce demand, universal access to electricity, increase generation capacity while reducing dependency on coal
Projects approved or in progress	PBMR experimental projects in progress. X-Ray 2000 MW nuclear plant in feasibility and approval process	INGULA pumped storage in progress	ESKOM'S Solar Water Heating programme in progress	coal-based: 14 000 MW OCGT projects approved Experiments on renewables
Optimistic scenario around 2018	3800 MW installed capacity	Target on renewables reached: Electricity produced by renewables above 10 Twh per year		60 GW installed capacity with a pretty stable coal share and increase in renewables share. Independant producers share increase.

South Africa energy forecasts 2018

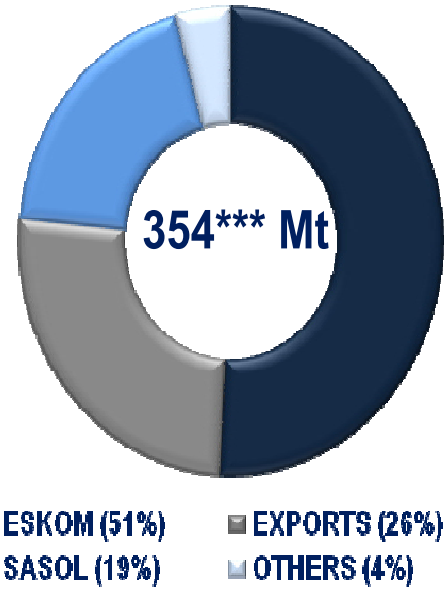
SA commercial primary energy consumption. Forecast 2018



ESKOM'S installed capacity forecast 2018



SA coal consumption forecast 2018



In 2018, in comparison to 2008, coal and crude oil shares in commercial primary consumption would decline while hydroelectricity, nuclear and gas shares will increase

Sources:
*** ESKOM recovery plan by Koos Jordan, What future for coal in SA ? By Doug Low,
** Eskom recovery plan, The future of coal in Eskom energy mix, Rob Lines Eskom 's GM
* Eskom recovery plan, South Africa Oil & Gas Report (for oil and gas forecasts), July 15th 2009
Notes: Forecasts made for a GDP growth scenario comprises between 3% and 4%
Power stations availability and efficiencies based on ESKOM'S averages over 2006, 2007 and 2008

3. The french potential

Innovating for energy

Innovation
Energy
Environment

IFP

- **IFP**
- **Research and development**
- **Training and knowledge sharing**
- **Industrial outlets for R&D results**

Research and development

Controlled CO_2

CONTROLLED CO_2

▼

Capturing and storing CO_2 to combat the greenhouse effect

- Because IFP places sustainable development at the heart of its work
- Because the bulk of CO_2 emissions result from energy use
- Because IFP has all the expertise and technological skills required to develop efficient solutions at all stages in the process, from capture to storage

3 R&D themes

- CO_2 capture
- Transporting and injecting CO_2
- Geological storage of CO_2

Research and development

Diversified fuels

DIVERSIFIED FUELS

▼

Diversifying fuel sources

- Because fossil fuels are non-renewable sources
- To complement and replace oil and gas in the transport and petrochemicals sectors
- To reduce greenhouse gas emissions

3 R&D themes

- The production of first- and second-generation biofuels
- The use of natural gas and coal to produce synfuels
- Hydrogen production

Research and development

Fuel-efficient vehicles

FUEL-EFFICIENT VEHICLES

▼

Developing clean, fuel-efficient vehicles

- Reducing the CO_2 emissions of vehicles
- Enhancing the reduction of regulated pollutants
- Developing innovative powertrains for sustainable transport

5 R&D themes

- Clean high-efficiency engine technologies
- Low CO_2-emission alternative fuels (biofuels, NGV)
- Hybridization
- Modeling and simulation
- Engine control

Research and development

Clean refining

CLEAN REFINING

▼

Converting as much raw materials as possible into transport energy

- To reduce the impact of refining on the environment by limiting CO_2 emissions through processes that are more energy-efficient
- To develop industrial facilities capable of producing more light fuels from increasingly heavy crudes
- To improve the product quality and material yields

3 R&D themes

- The conversion of heavy crudes, residues and distillates
- The production of high-quality fuels
- The production of petrochemical intermediates

Research and development

Extended reserves

EXTENDED RESERVES

▼

Pushing back the boundaries in oil and gas exploration and production

- Because oil will continue to be the leading source of energy in the transport and chemicals sectors for several decades to come
- Because ongoing research will lead to a significant increase in available oil and gas reserves (better recovery, extreme environments)

3 R&D themes

- Increasing the success rate in exploration
- Improving the recovery ratio in reservoirs
- Developing fields in extreme environments

- ✓ Oil companies : creation of Compagnie Française des Pétroles, of Elf
- ✓ The nuclear plan (1973)
- ✓ The Grenelle de l'Environnement