

**Conférence  
Sauvons le Climat**

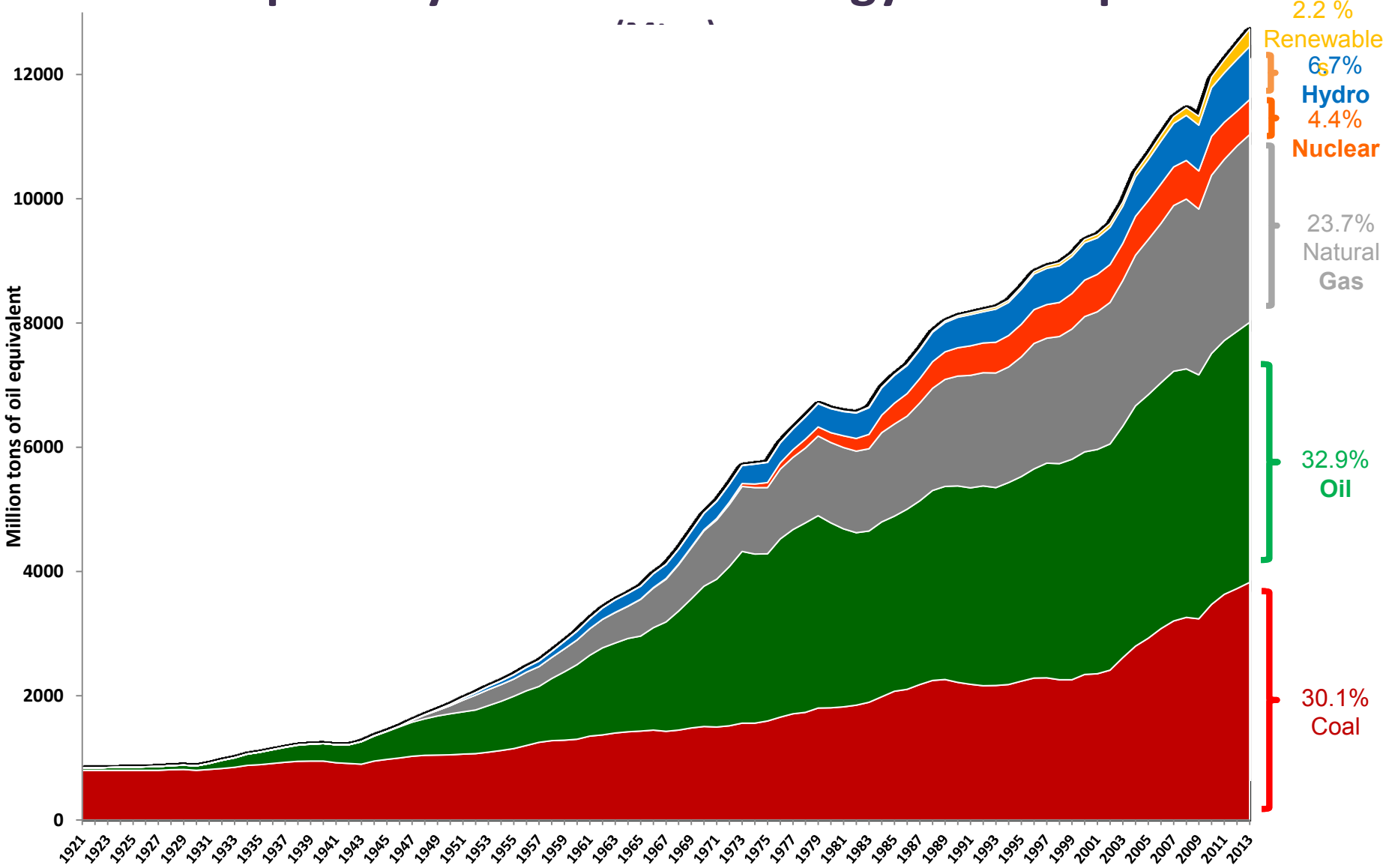
**26 Septembre 2015**

**Géopolitique de l'énergie**

**Jean-Pierre Favennec  
IFP School Professor**

**[jpfavennec@yahoo.fr](mailto:jpfavennec@yahoo.fr)**

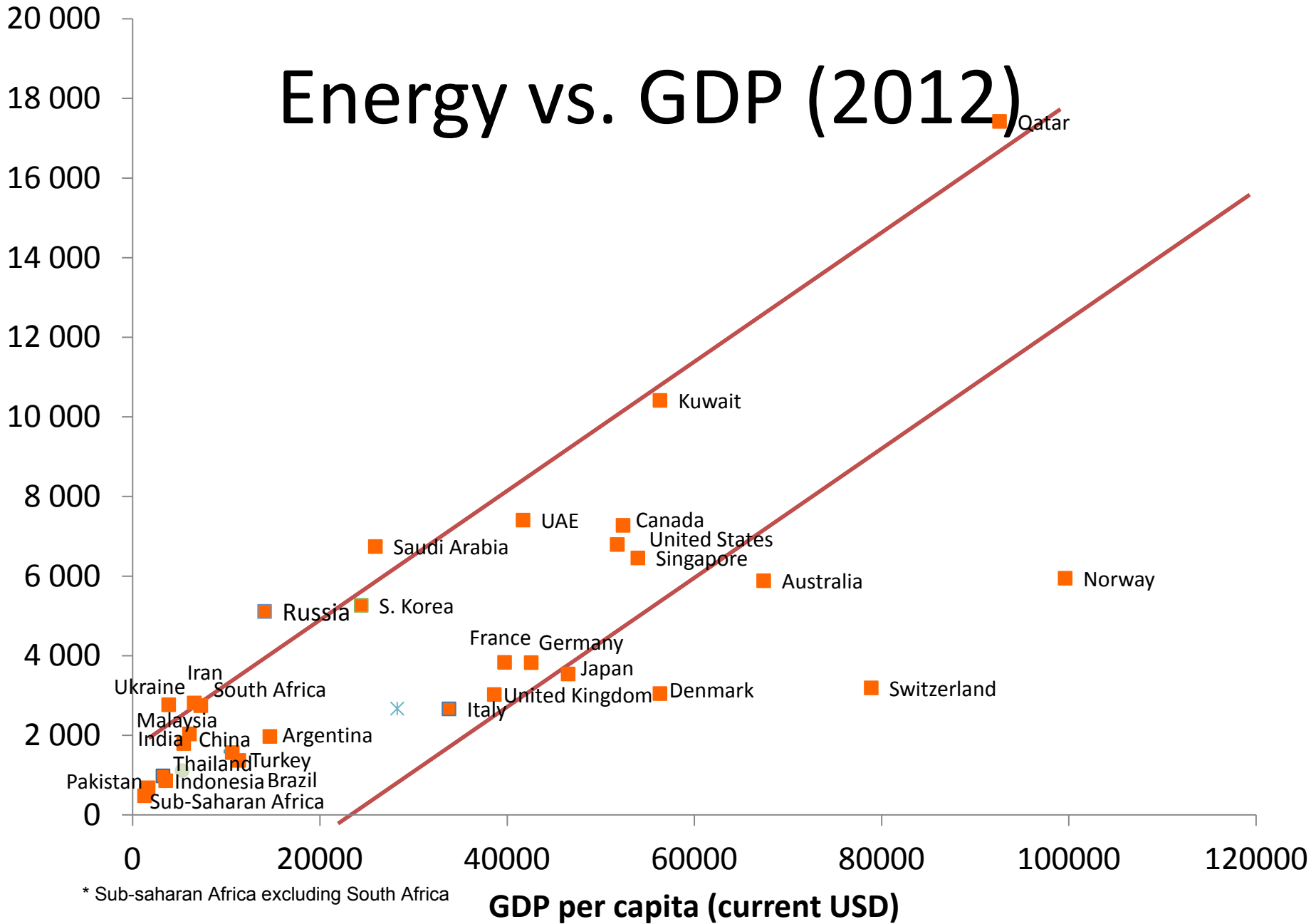
# World primary commercial energy consumption



Sources : Schilling & Al. (1977), BP Statistical 2014

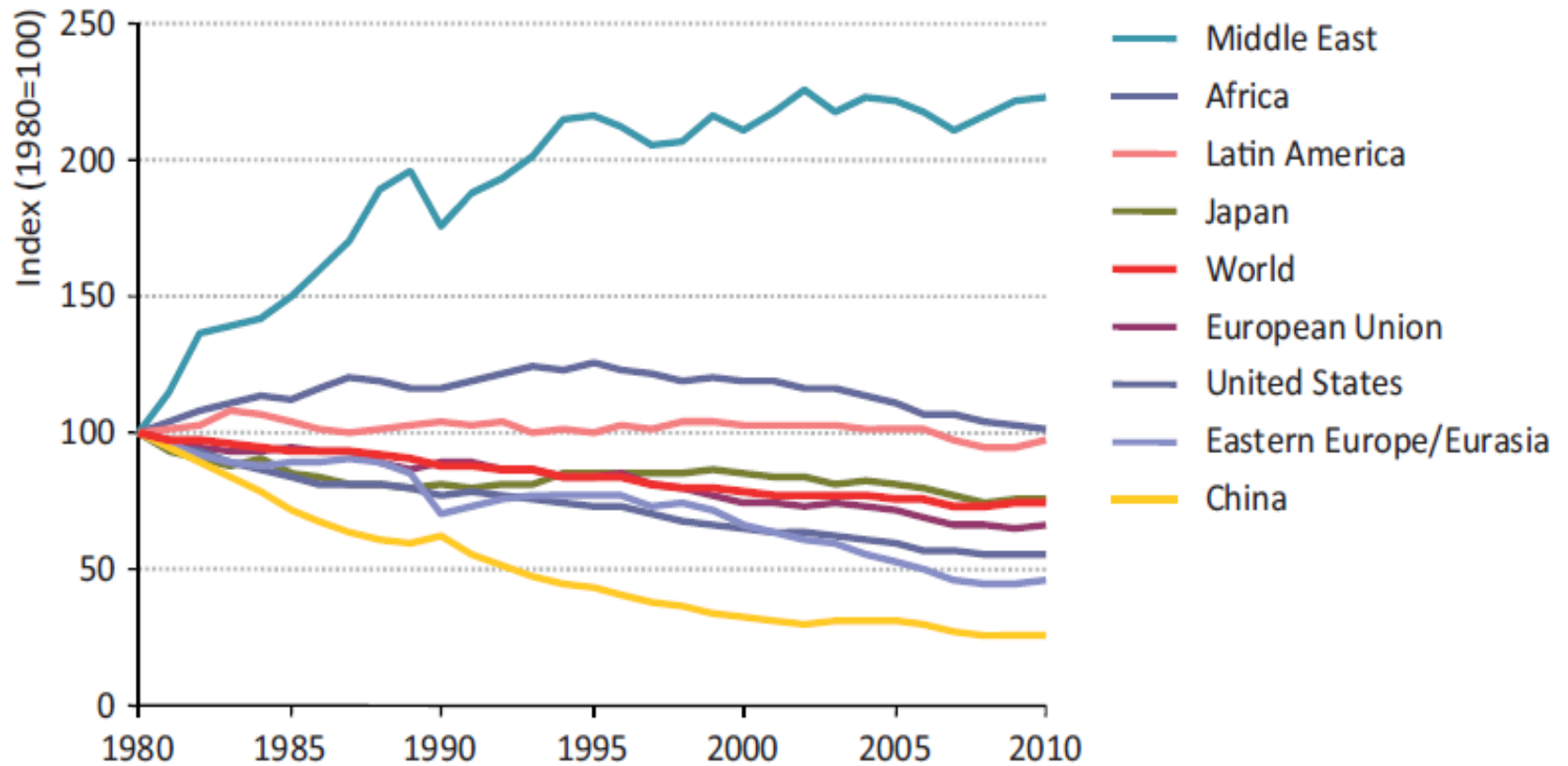
# Energy vs. GDP (2012)

Energy use per capita (kgoe)



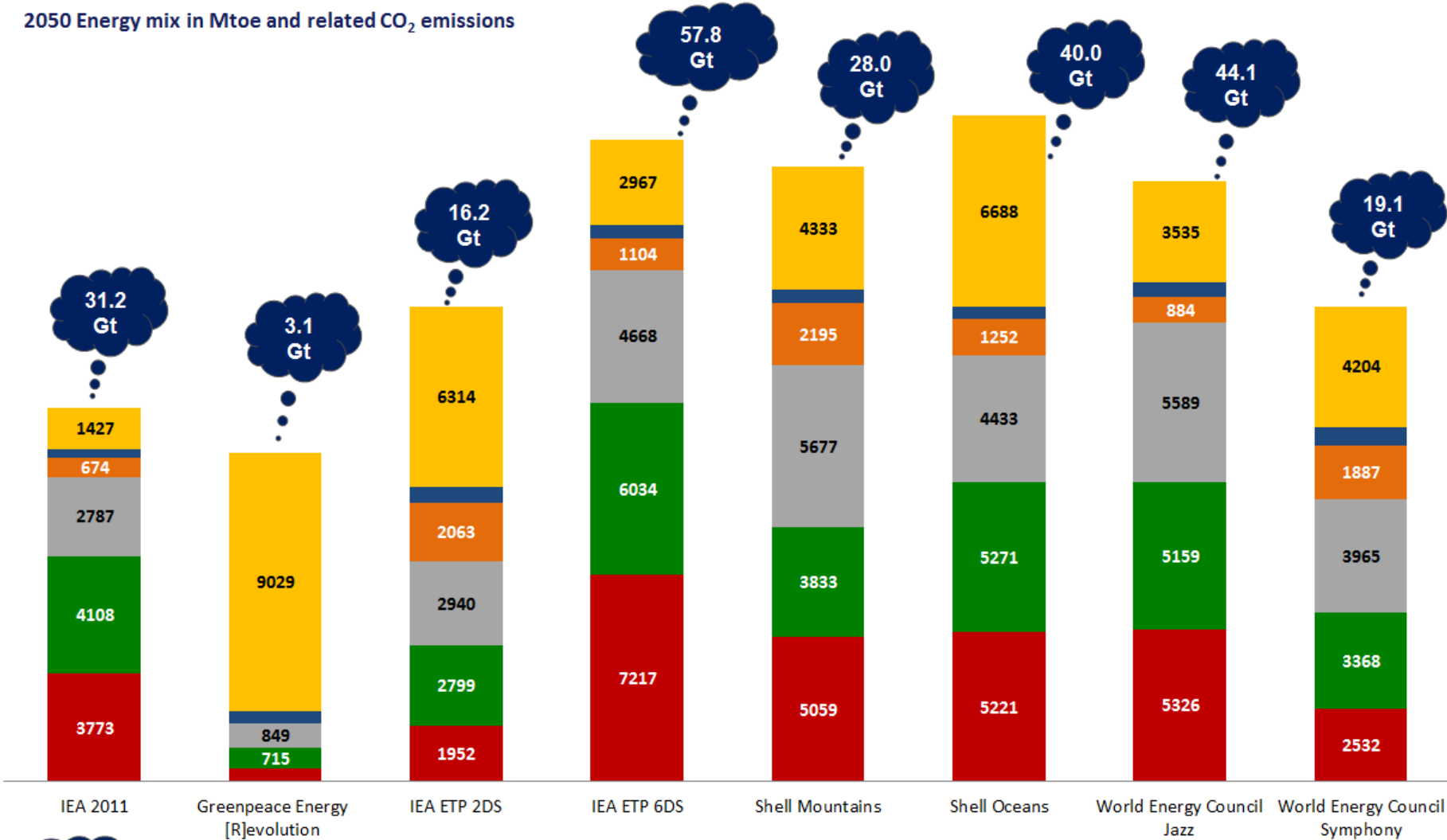
\* Sub-saharan Africa excluding South Africa

# Energy intensity trends per region



# Which energy mix in 2050?

2050 Energy mix in Mtoe and related CO<sub>2</sub> emissions

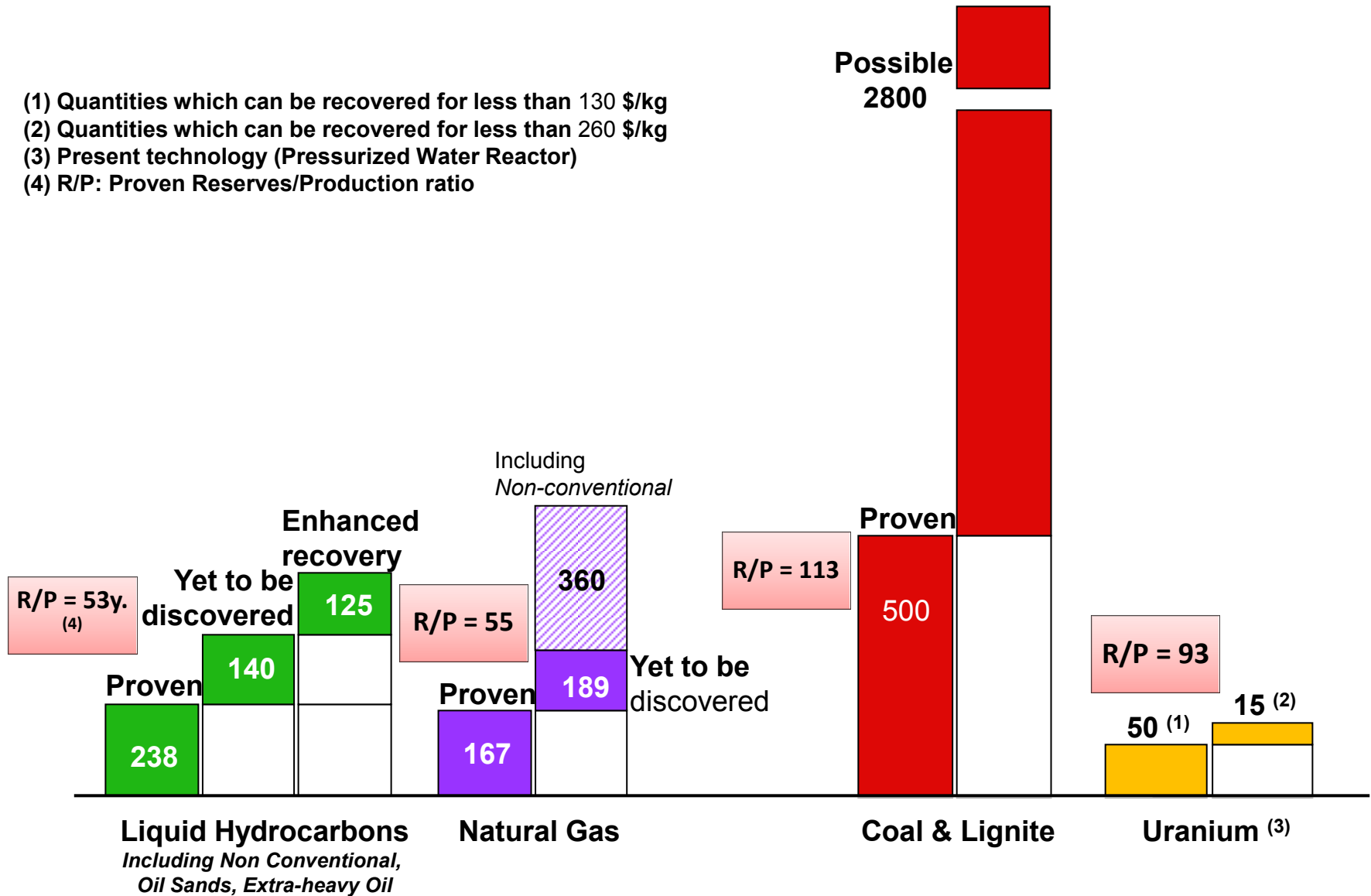


Energy related CO<sub>2</sub> emissions

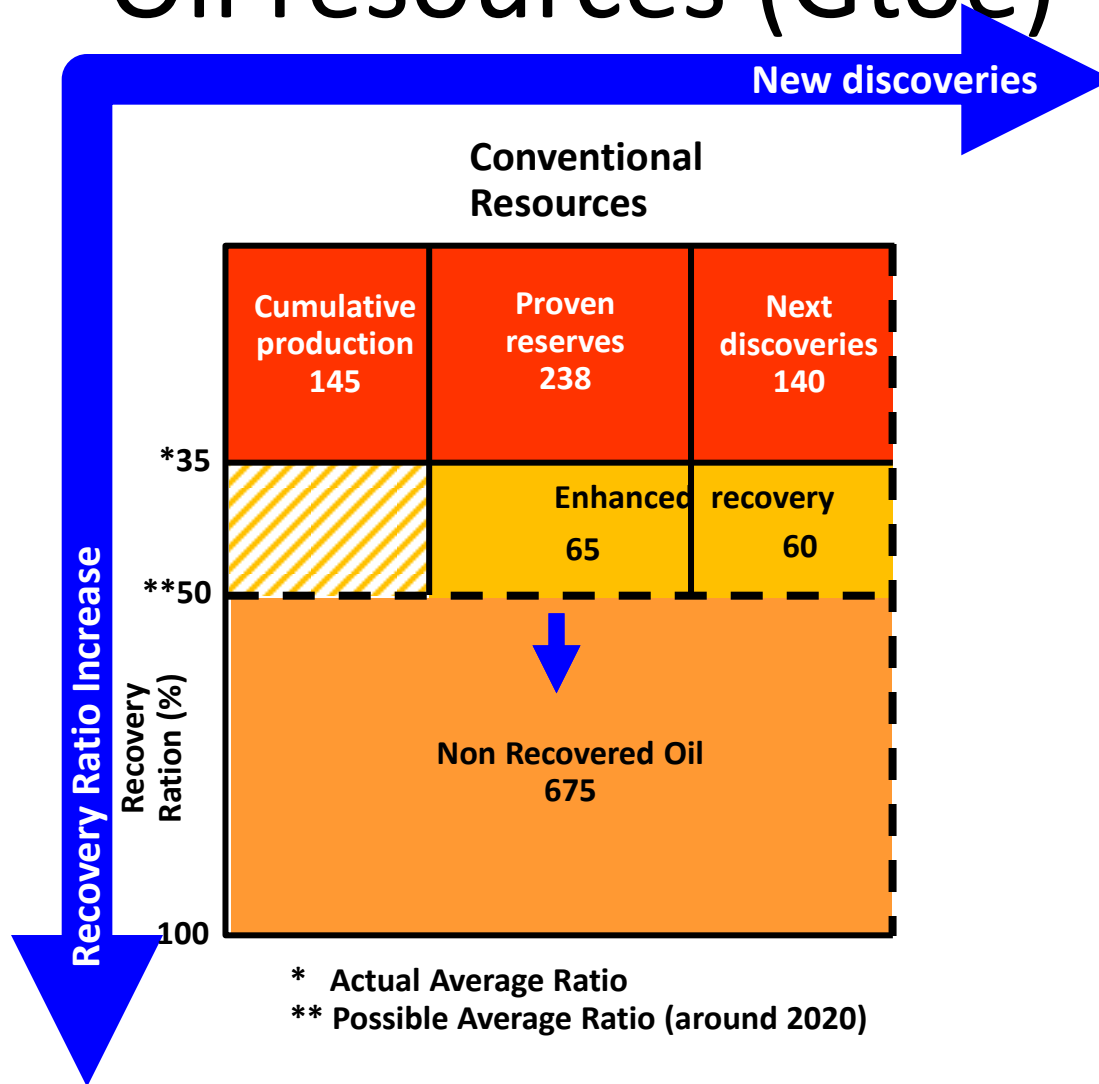
■ Coal ■ Oil ■ Natural Gas ■ Nuclear ■ Hydro ■ New Renewables

# World reserves (Gtoe) - 2014

- (1) Quantities which can be recovered for less than 130 \$/kg
- (2) Quantities which can be recovered for less than 260 \$/kg
- (3) Present technology (Pressurized Water Reactor)
- (4) R/P: Proven Reserves/Production ratio



# Oil resources (Gtoe)



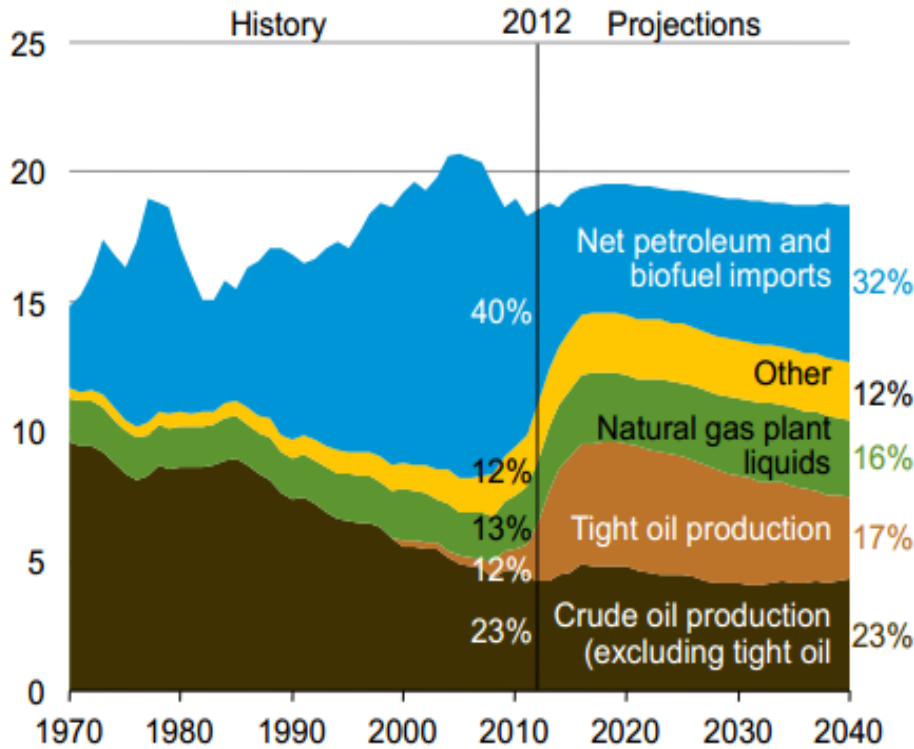
# Unconventional gas basics: what it is, how and why it grew

- Natural gas (methane) produced using “new” techniques that enable production from sources previously considered un-commercial
  - **Horizontal wells, hydraulic fracturing at multiple intervals and acidizing**
- This includes today:
  - **Tight gas: gas contained in low permeability rock**
  - **Coal bed methane (CBM): gas contained and trapped in coal beds**
  - **Shale gas: gas in low-permeability “shale”, typically source rock**
- Conditions in the US that made it possible:
  - **Techniques available, good economics, entrepreneurs**

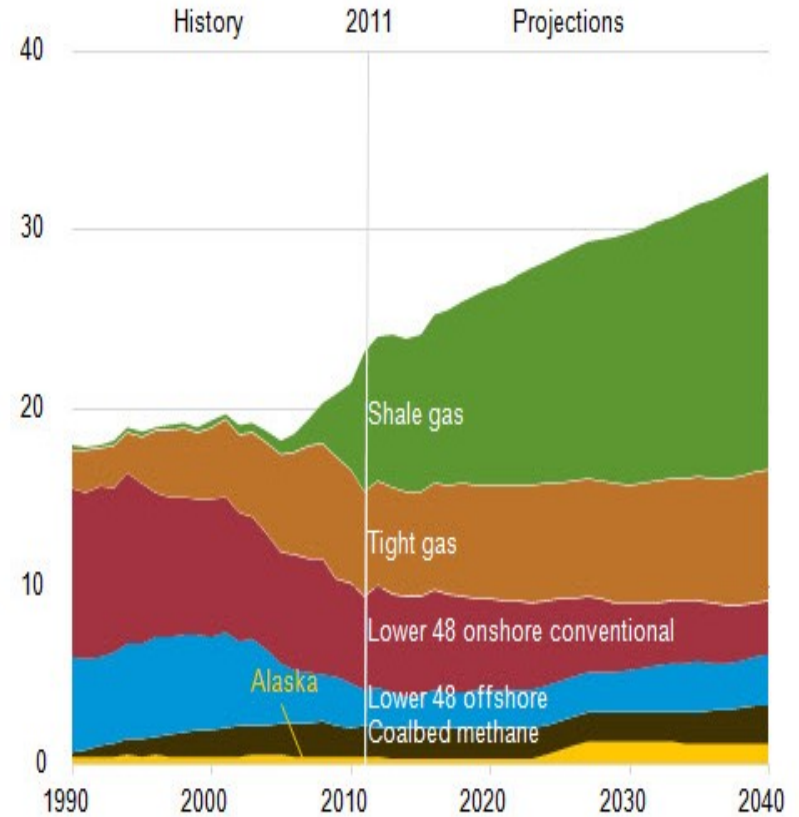


# US Oil & Gas production today and tomorrow

U.S. petroleum and other liquid fuels supply by source, 1970-2040 (million barrels per day)



Natural gas production by source, 1990-2040 (trillion cubic feet)

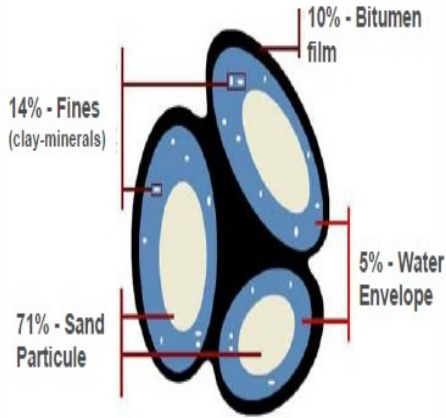


# Oil

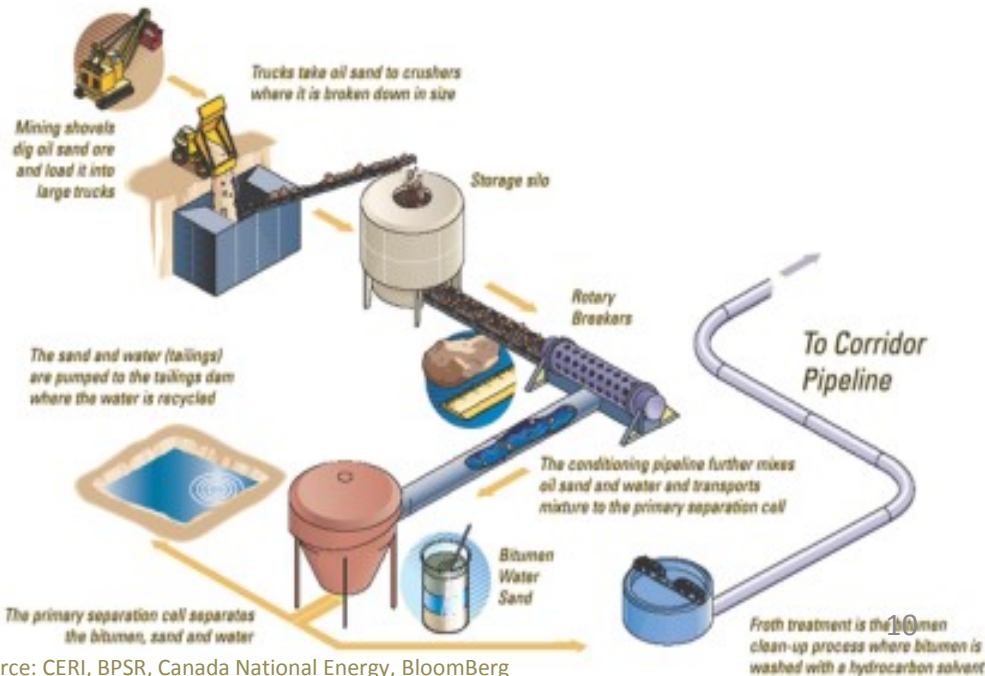
**Proved Reserves = 173 Gb.**  
**Probable reserves = 1800**

### Characteristics of the Bitumen in Athabasca:

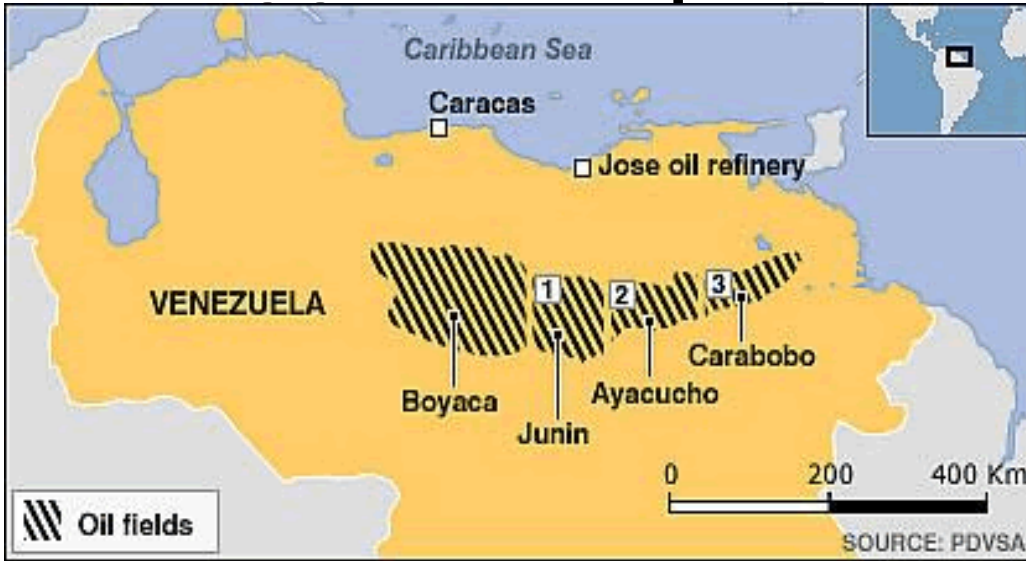
- 7-9 °API
  - Not mobile at reservoir conditions (10°C)
  - Bitumen requires:
    - dilution for pipeline transport
- and/or
- Upgrading to produce Synthetic Crude Oil (SCO)



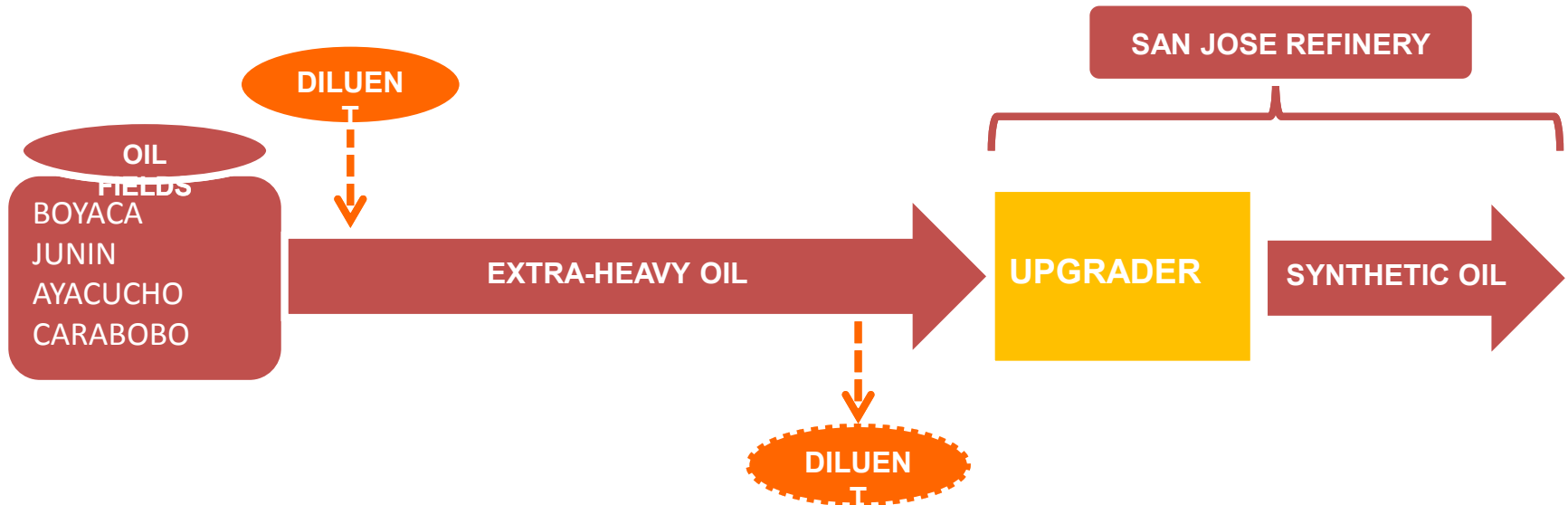
### PROCESS DIAGRAM



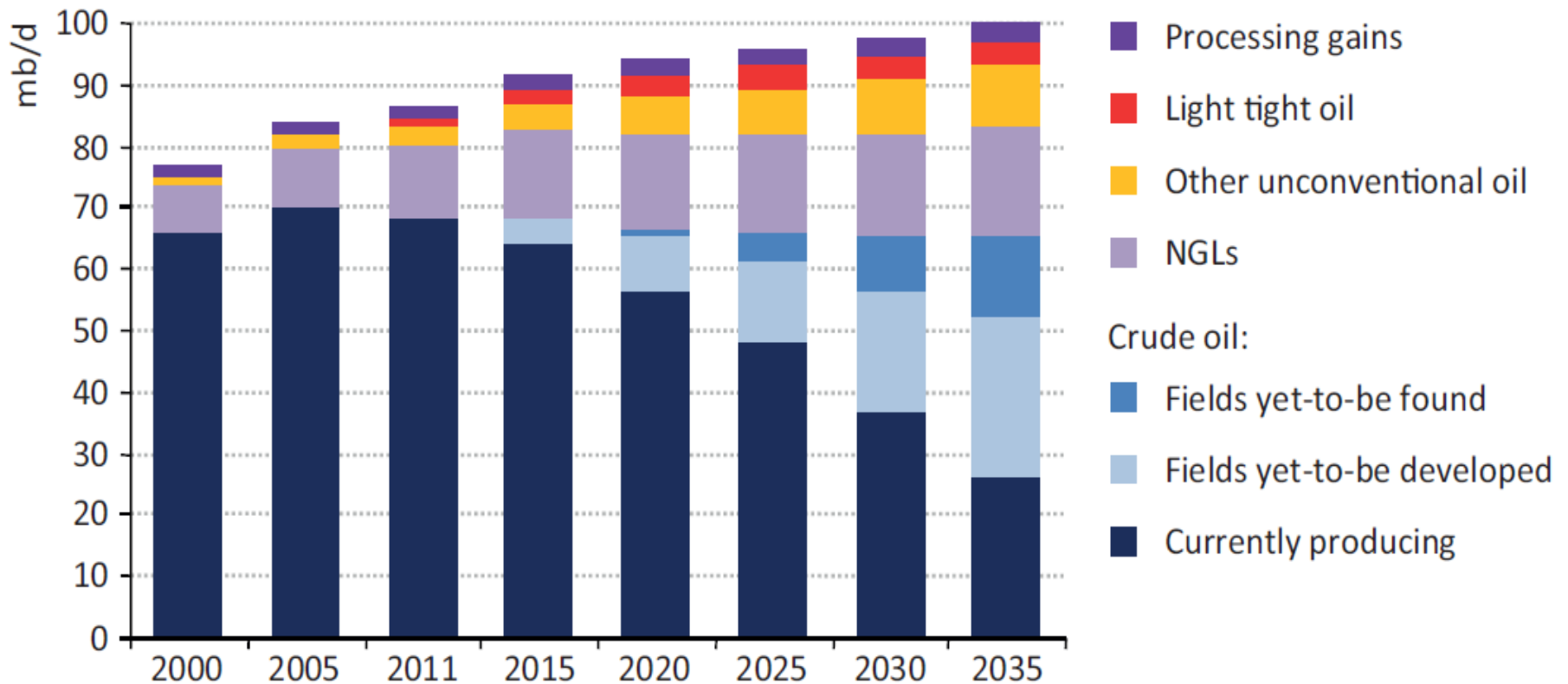
# Heavy Oil



**Proved Reserves = 297 Gb.**  
Probable reserves = 1300

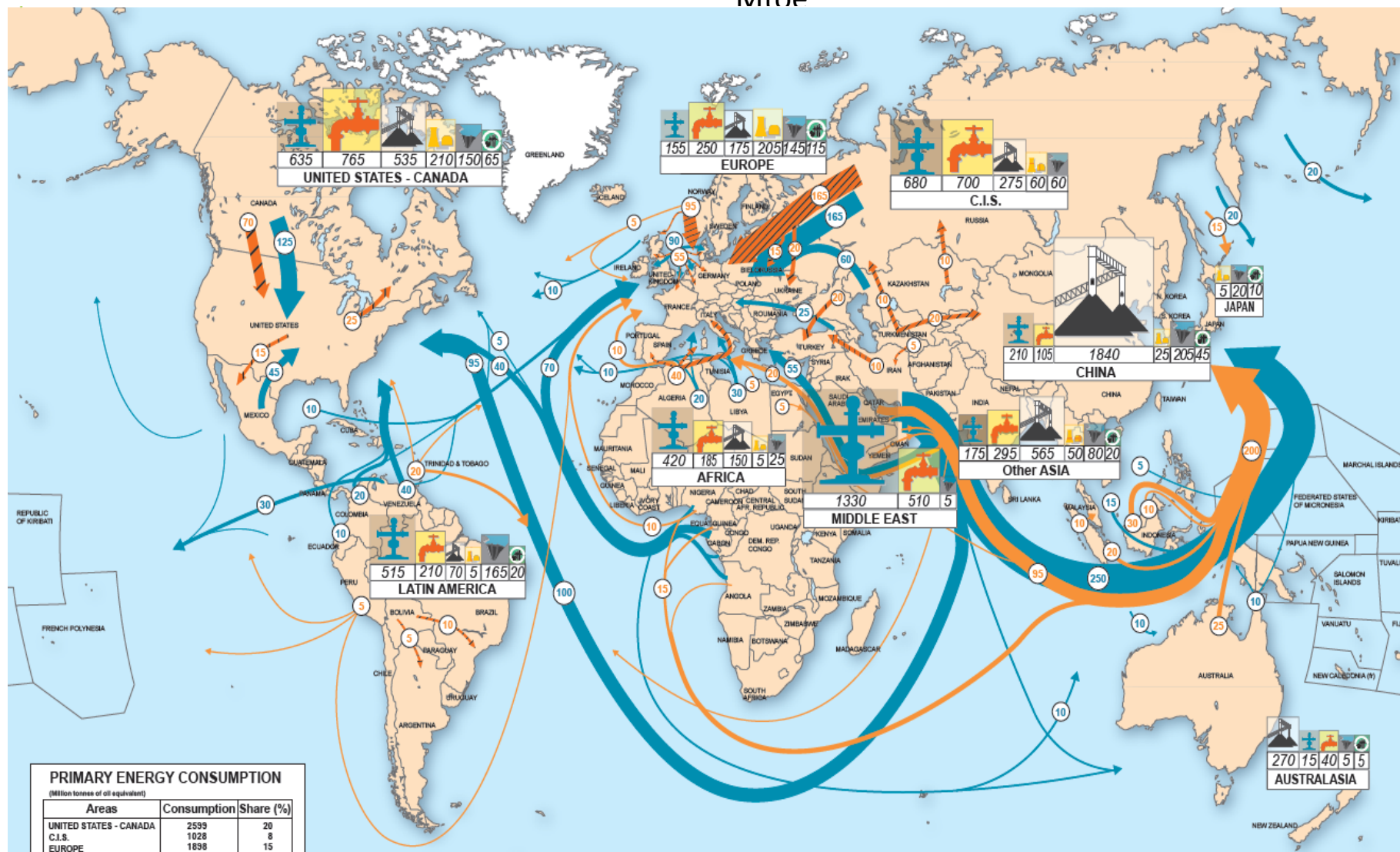


# Energy today, energy tomorrow



# Worldwide energy flows: 2013

Mtoe



**PRIMARY ENERGY CONSUMPTION**  
(Million tonnes of oil equivalent)

Areas	Consumption	Share (%)
UNITED STATES - CANADA	2539	20
C.I.S.	1028	8
EUROPE	1898	15
CHINA	2880	23
JAPAN	474	4
INDIA	595	5
Other ASIA	1066	8
LATIN AMERICA	862	7
MIDDLE EAST	785	6
AFRICA	408	3
AUSTRALASIA	136	1
<b>WORLD TOTAL</b>	<b>12731</b>	<b>100</b>

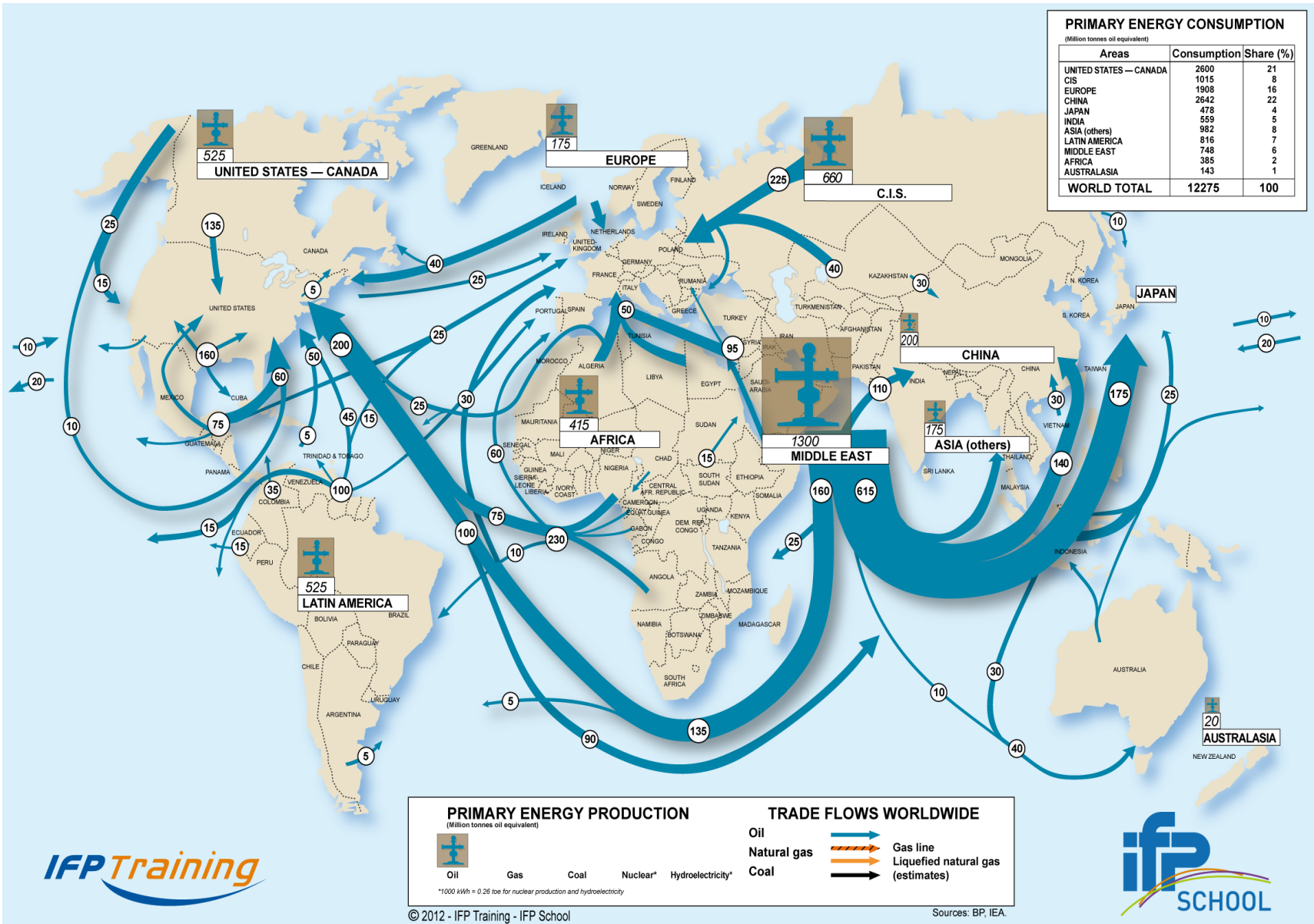
**PRIMARY ENERGY PRODUCTION**  
(Million tonnes of oil equivalent)

**OIL & GAS TRADE FLOWS WORLDWIDE**

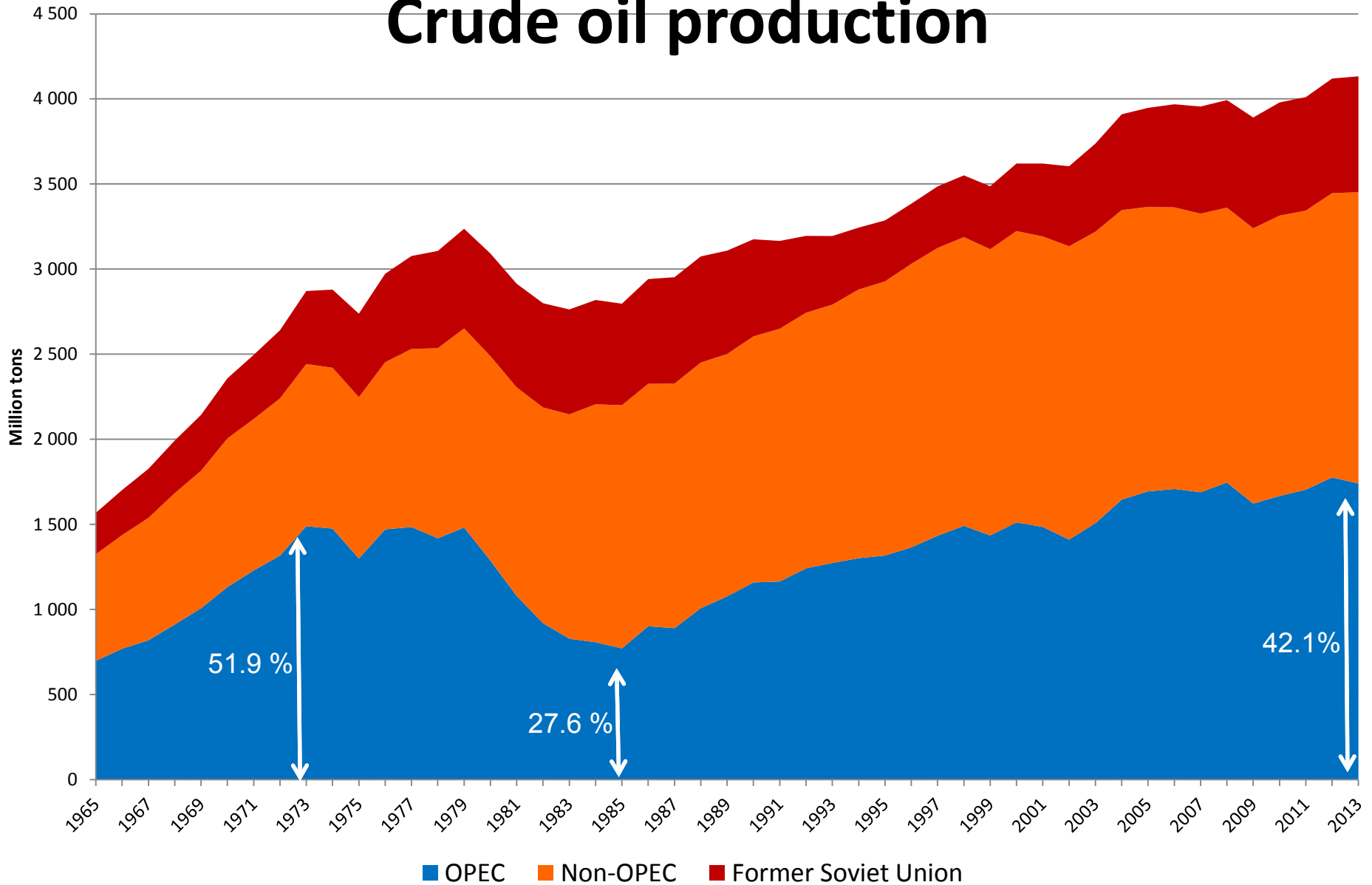
Oil: Blue arrow  
 Natural gas: Orange arrow  
 Gas line: Blue arrow with orange border  
 Liquefied natural gas: Orange arrow with blue border

\*1000 kWh = 0.26 toe for nuclear production and hydroelectricity  
 \*\* Modern renewables used to generate electricity. Stofvela

# Worldwide crude flows: 2011

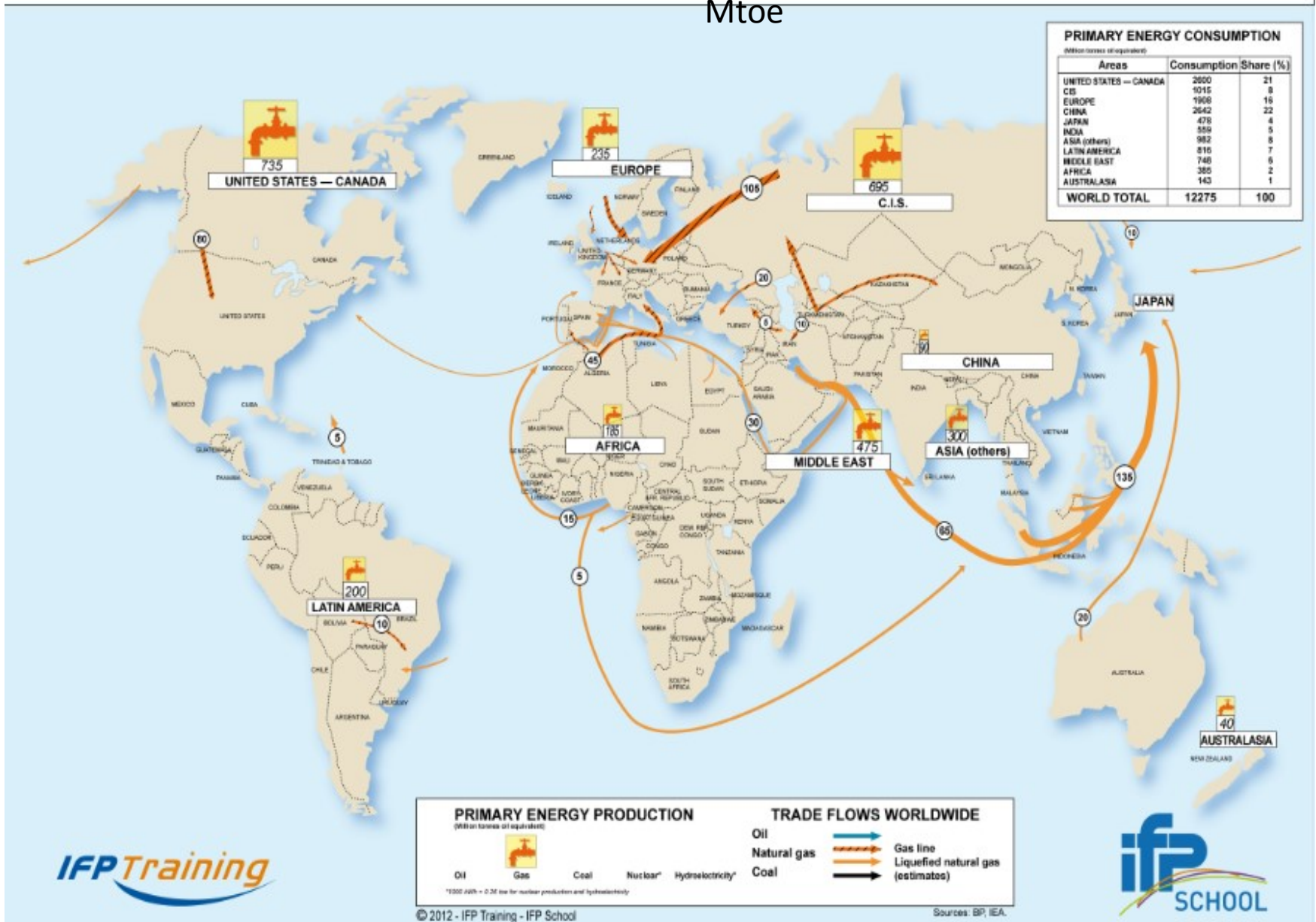


# Crude oil production



# Worldwide gas flows: 2011

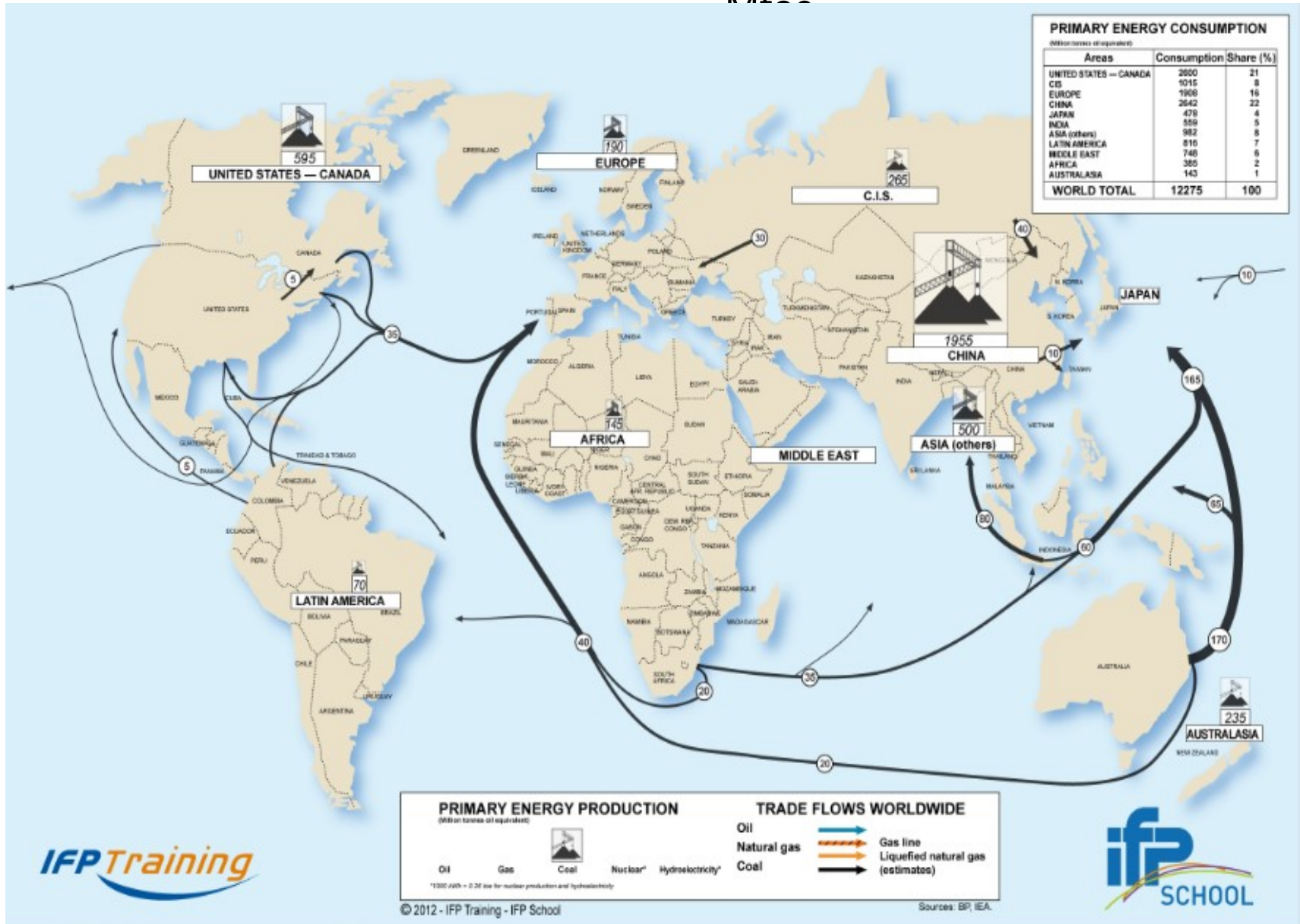
Mtoe



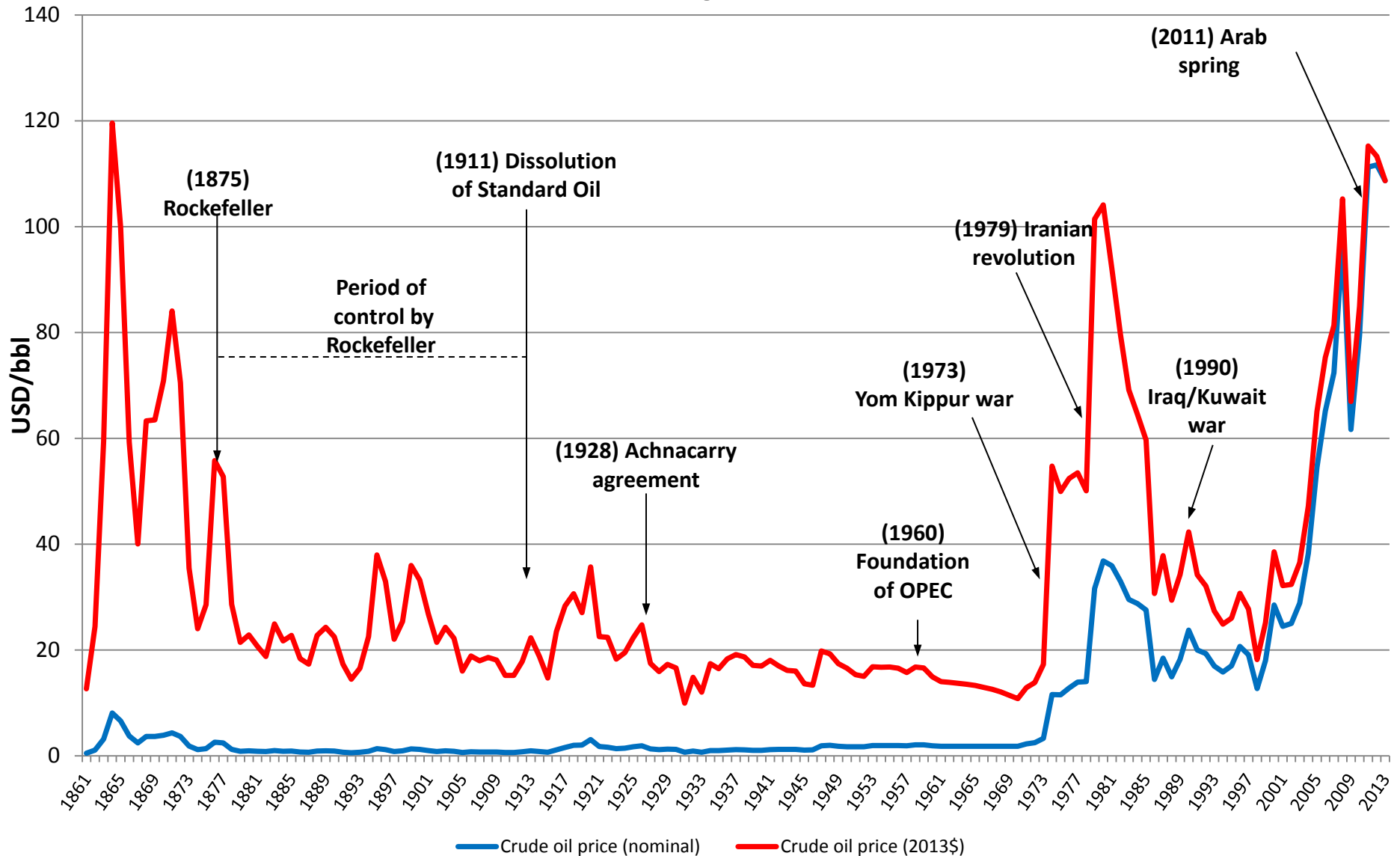


# Worldwide coal flows: 2011

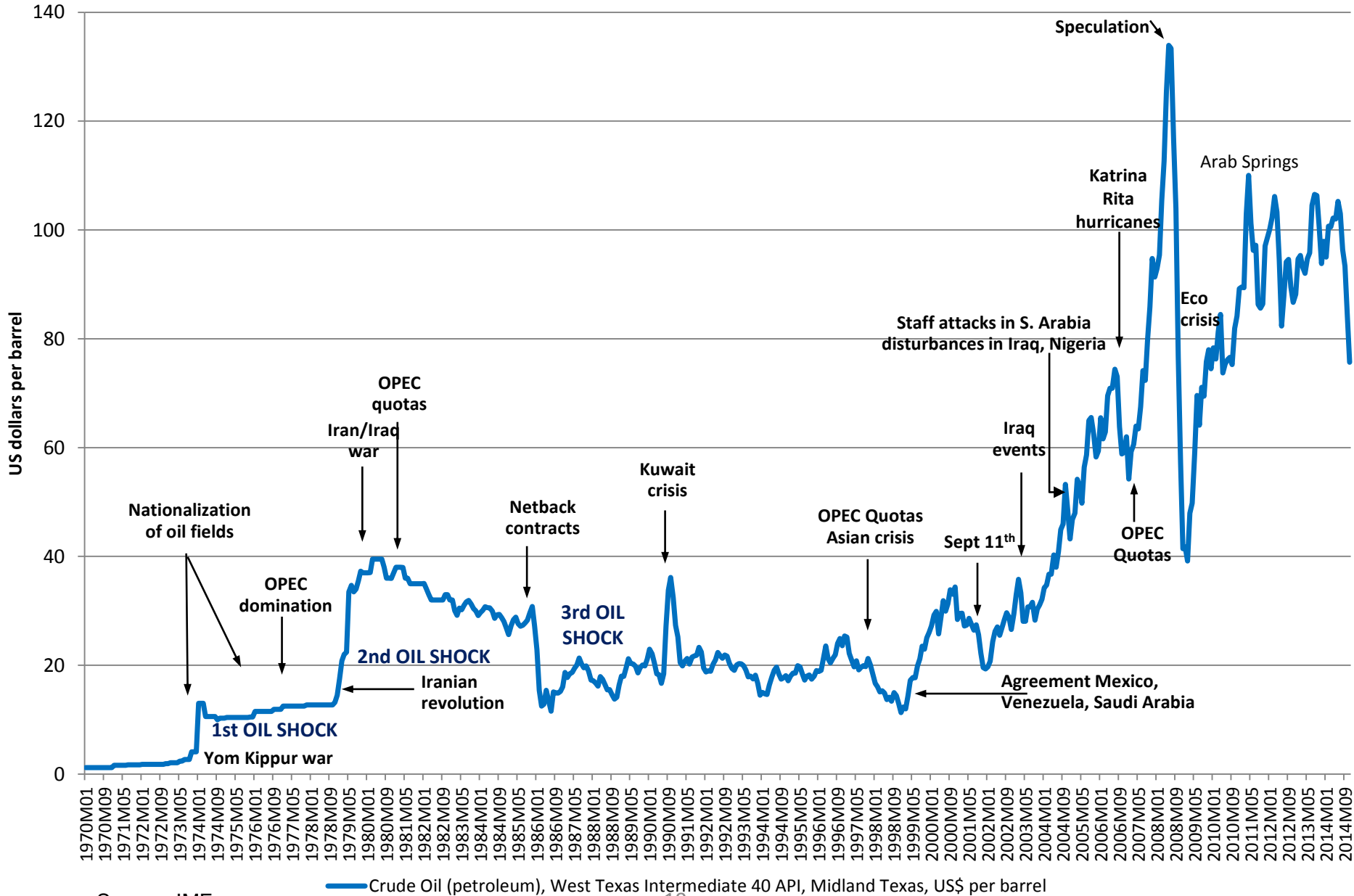
Map



# Crude price variation

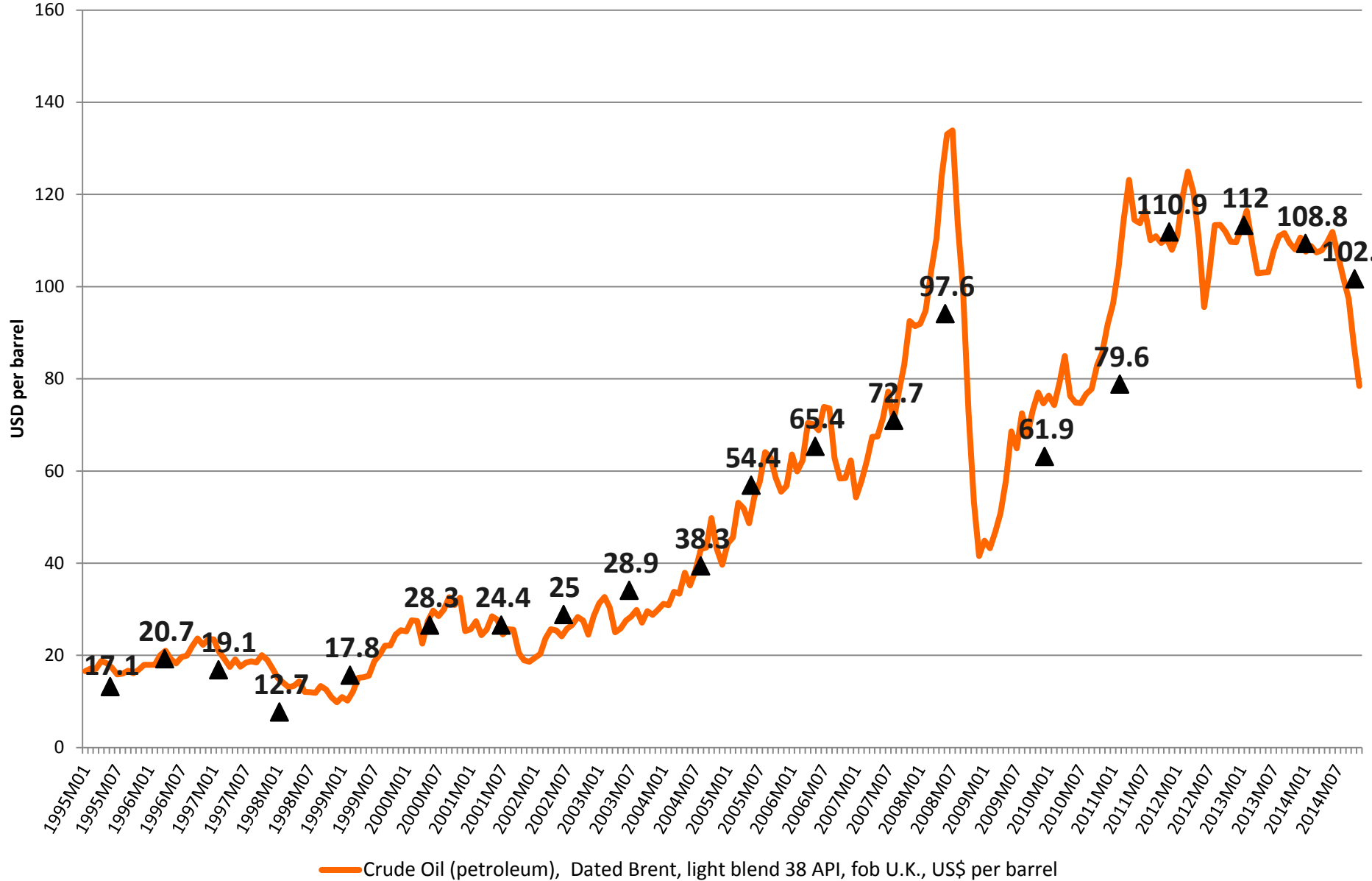


# Crude oil price



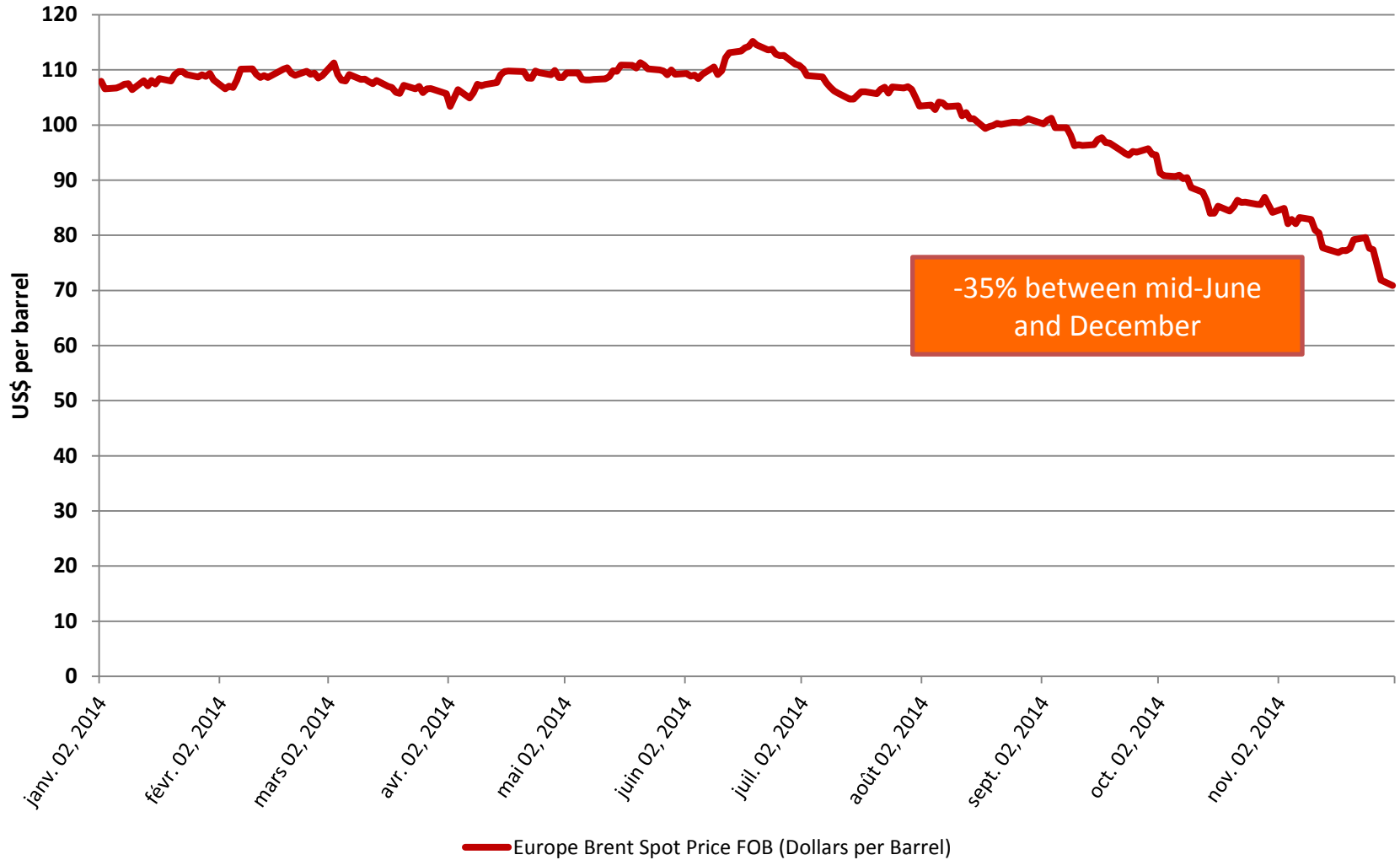
Source: IMF

# Dated Brent price (monthly) – 1996-2015

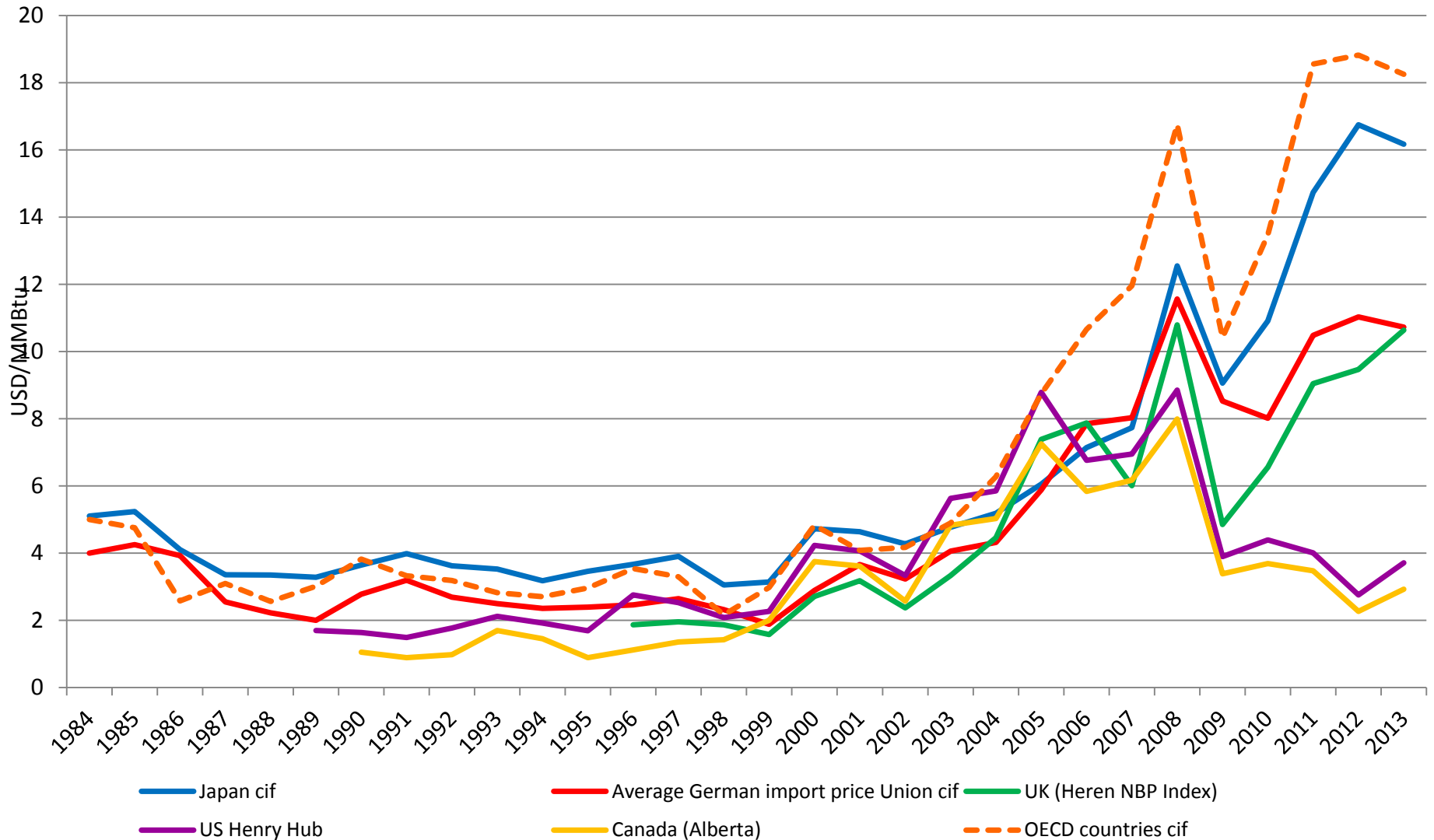


Crude Oil (petroleum), Dated Brent, light blend 38 API, fob U.K., US\$ per barrel

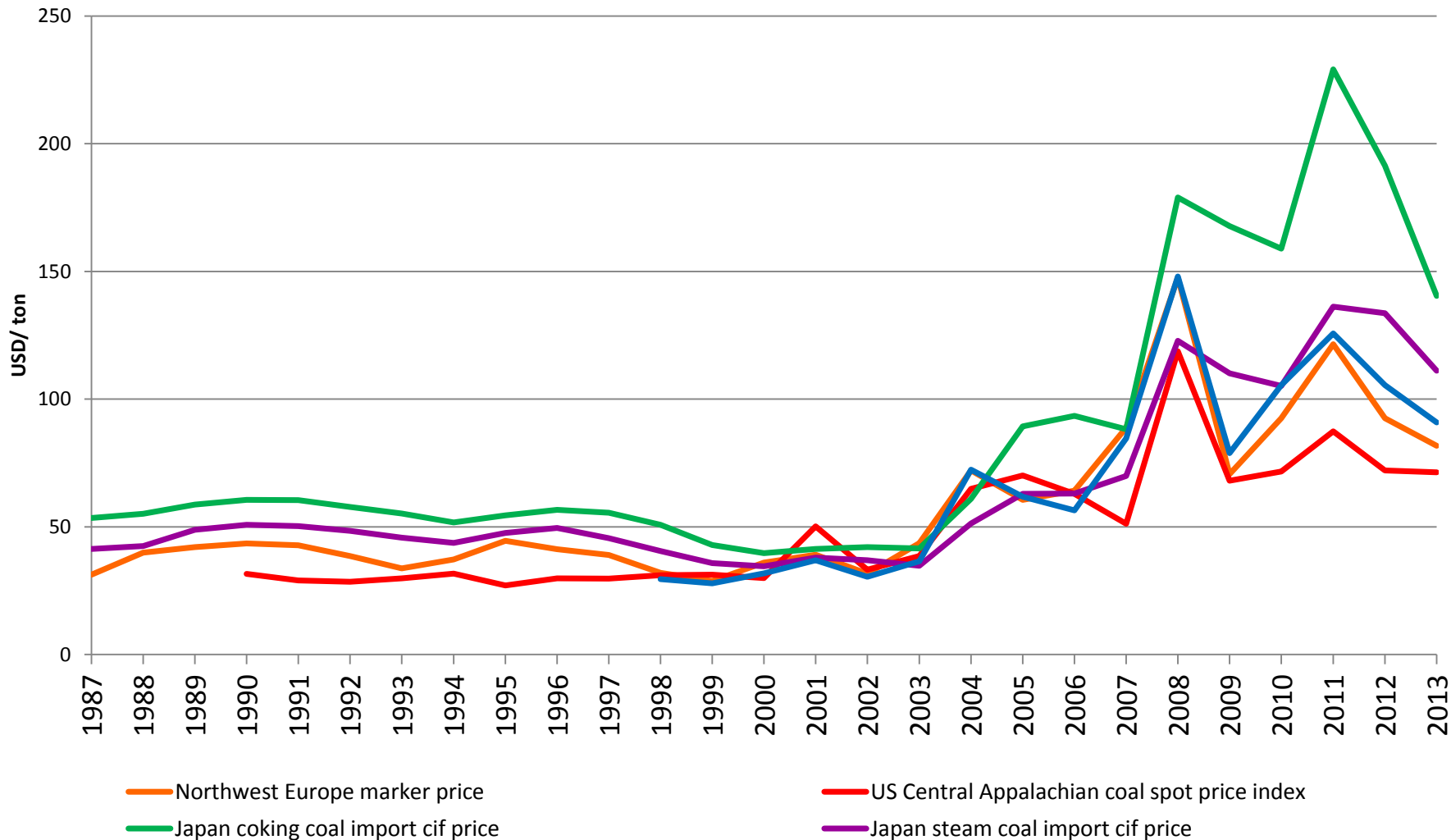
# 2014 oil price drop



# Natural gas price evolution



# Coal price evolution



# Oil and gas in the Arctic

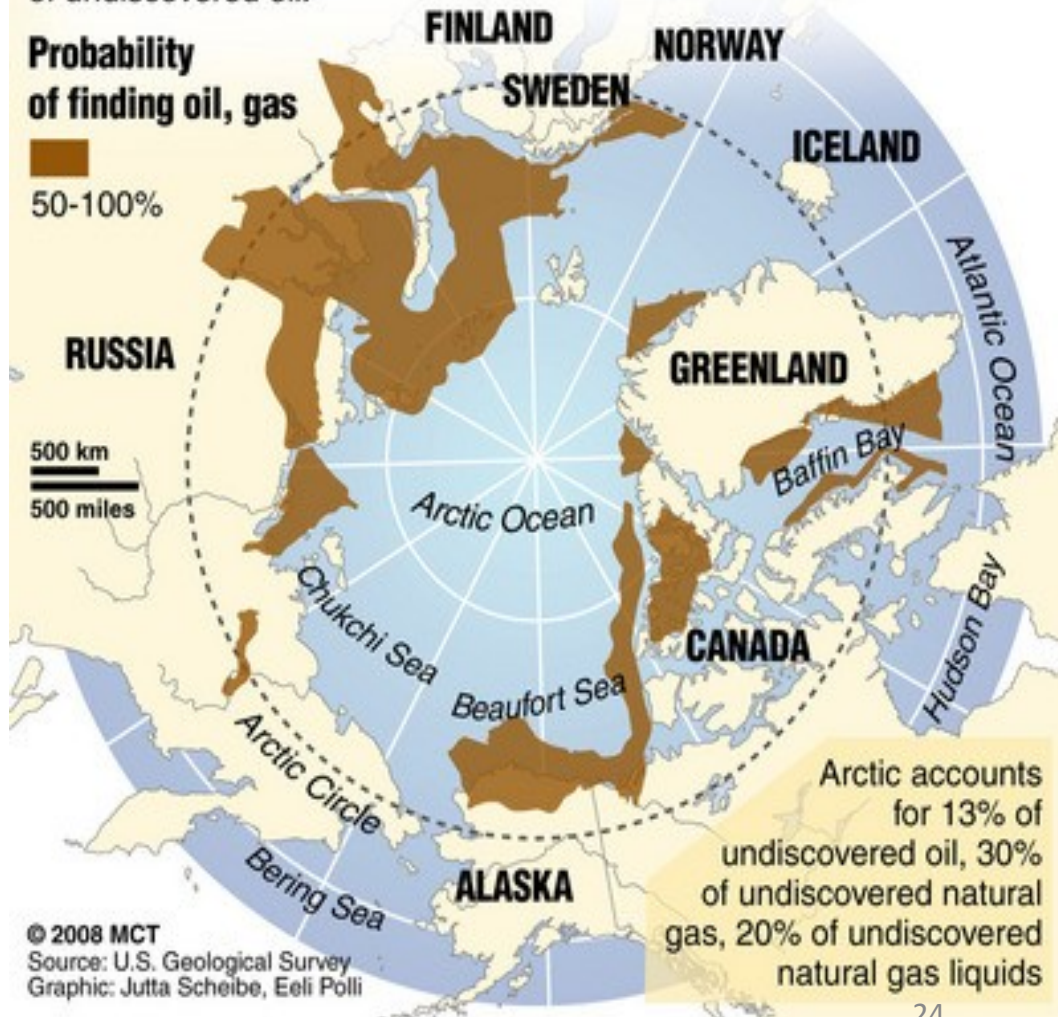
## Oil and gas in the Arctic

Area north of the Arctic Circle has an estimated 90 billion barrels of undiscovered oil.

Probability of finding oil, gas



50-100%



- First public estimate of the petroleum resources north of the Arctic Circle: 90 billion barrels of oil and 1,670 trillion cubic feet of natural gas. (U.S. Geological Survey)
- Arctic Seabed contains up to 25% of the world's oil and natural gas reserves.
- Alaska's offshore waters hold 26.6 billion barrels of oil that are technically recoverable, and that nearly 90 percent of it is in the Arctic.

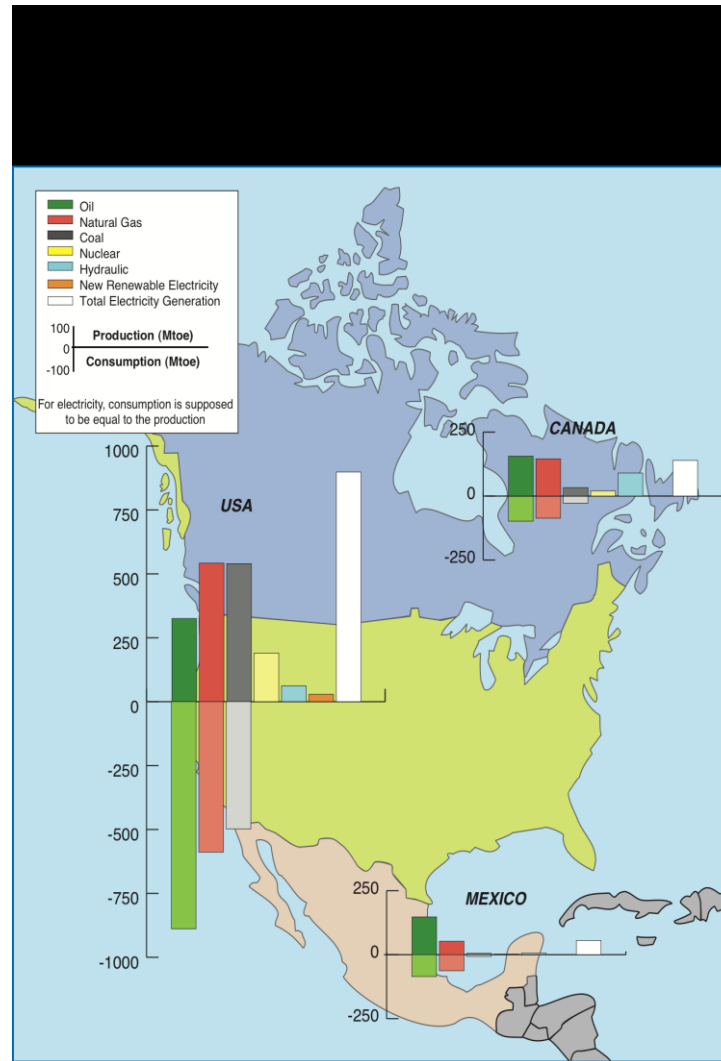


# **Geopolitics of Energy**

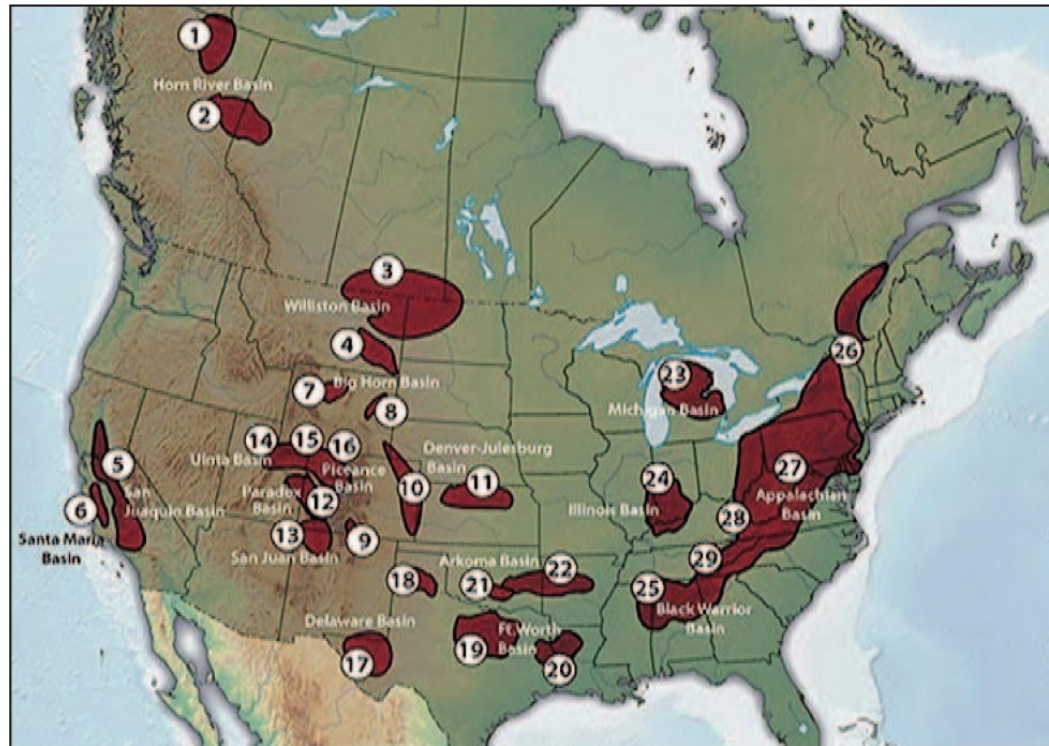
## **Part 2 - North America**

**Jean-Pierre Favennec**  
**IFP School Professor**

# Energy balance in North America



# Main areas for shale gas production in the US



# Oil and gas

n



# Energy supply in the USA

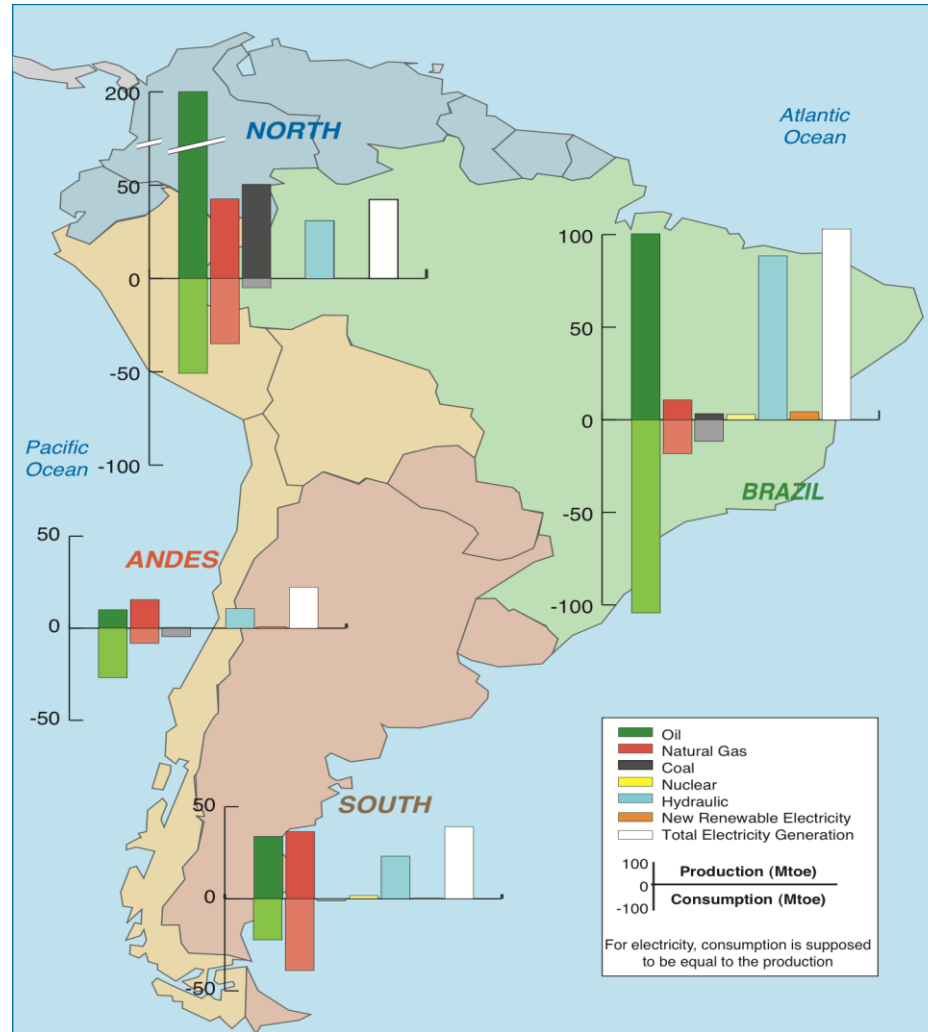


# **Geopolitics of Energy**

## **Part 3 - South America**

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**IFP School Professor**

# Energy balance in South America



# Energy re

# America



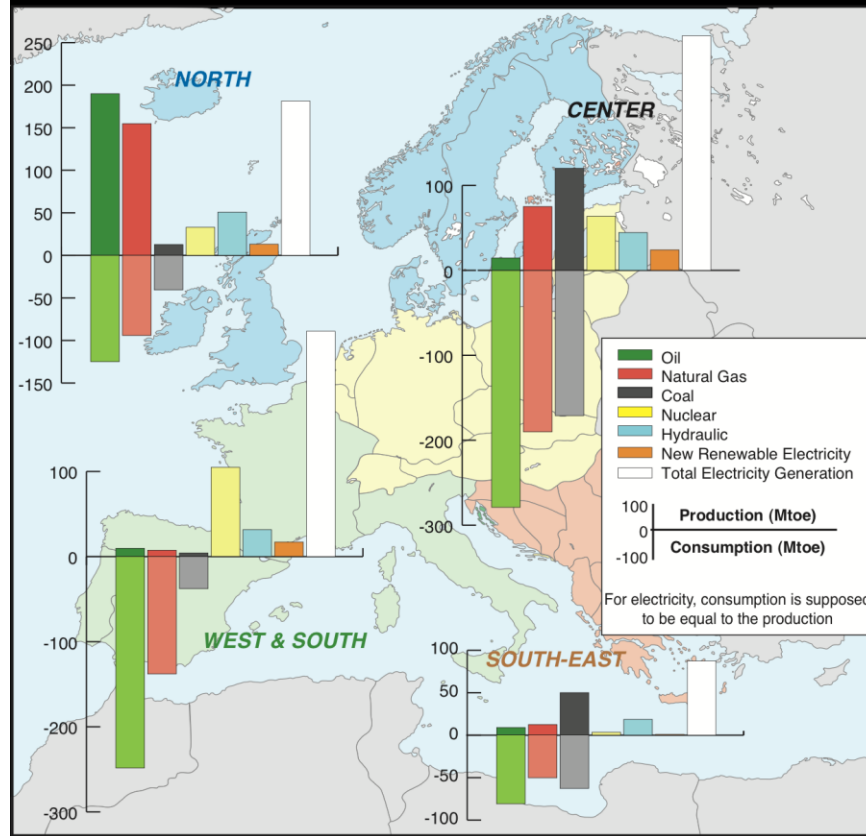


# **Geopolitics of Energy**

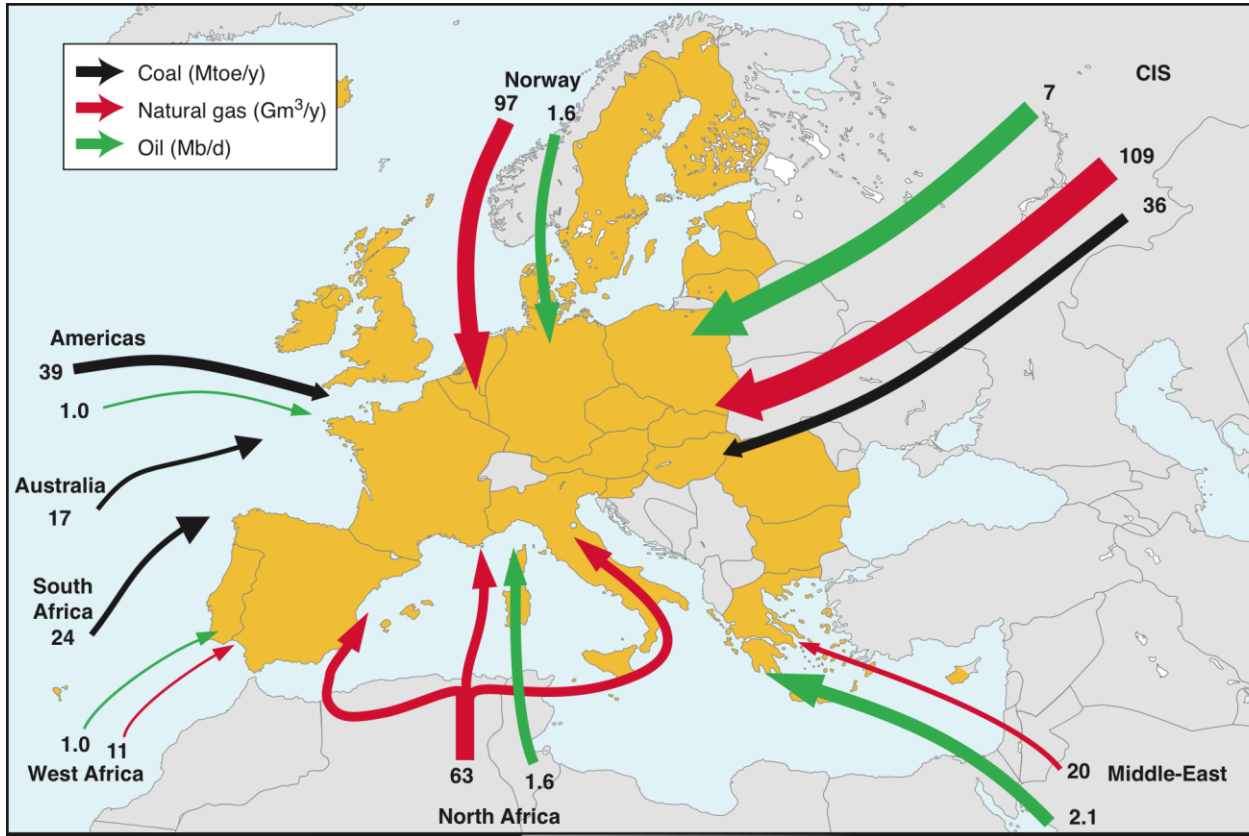
## **Part 4 - Europe**

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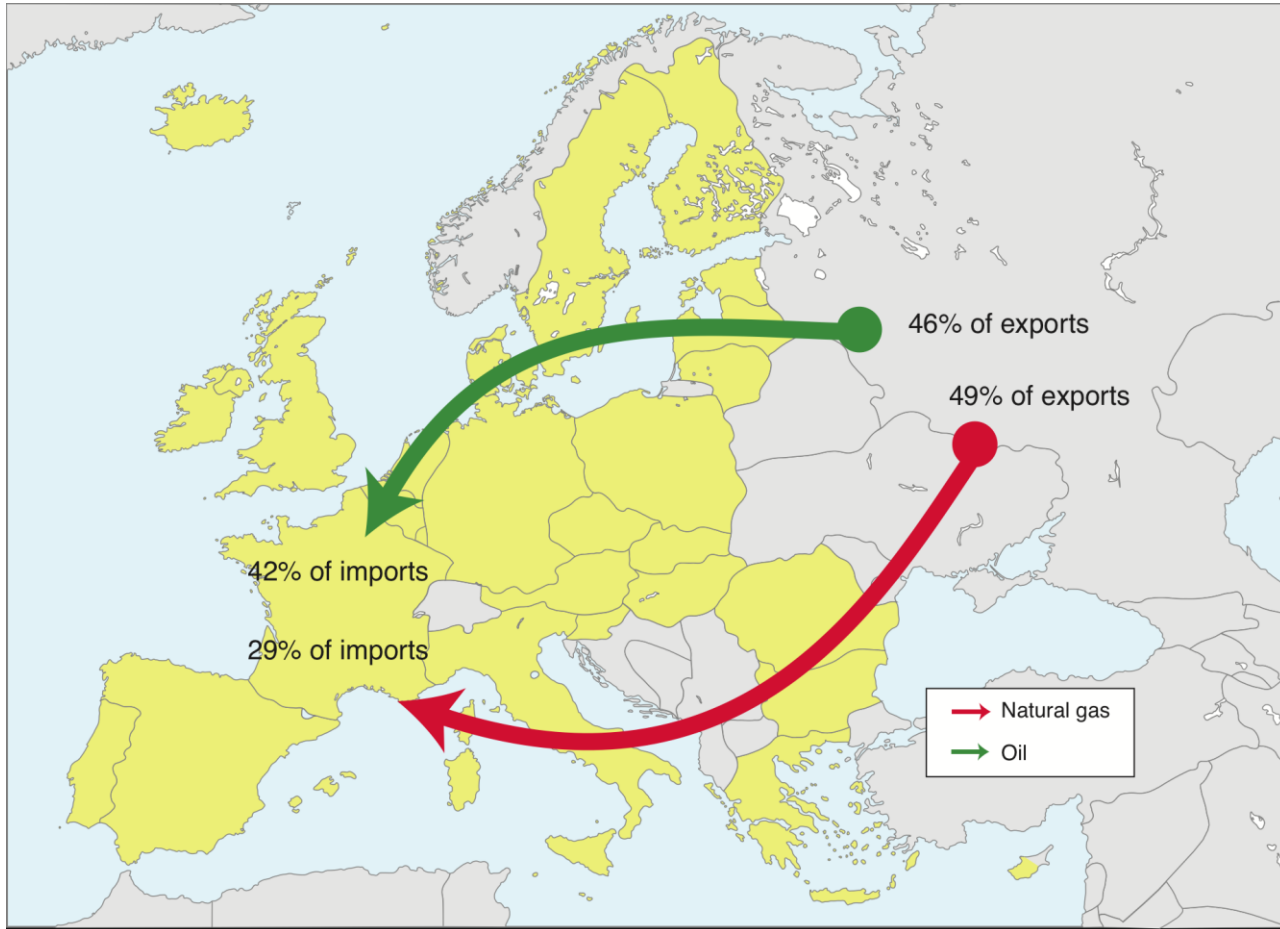
# Energy balance in Europe



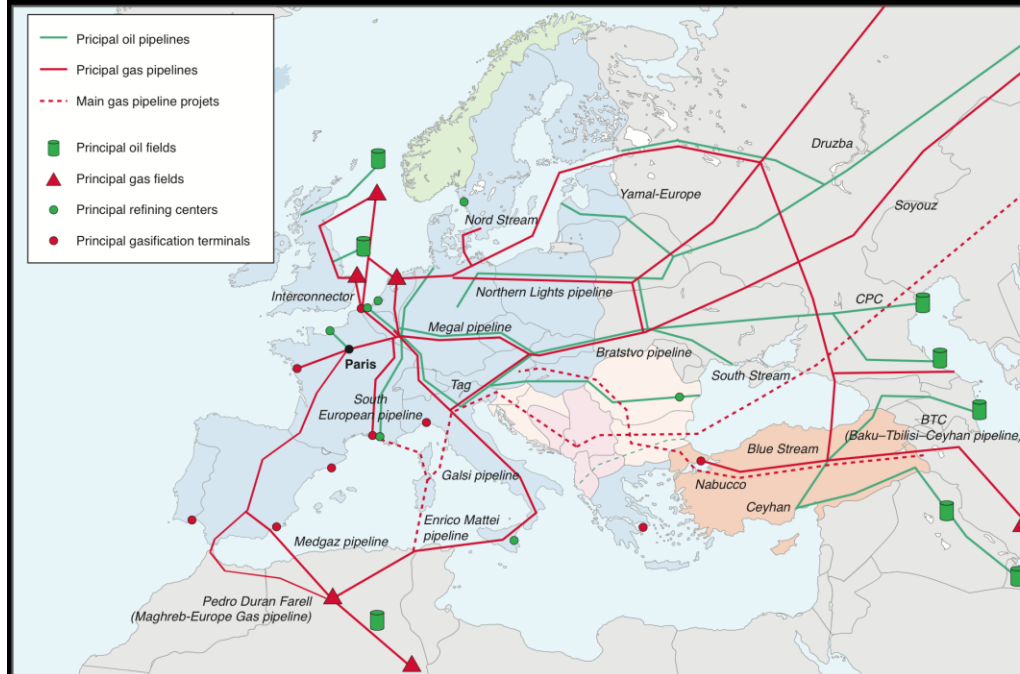
# Energy supply to Europe



# Oil and gas flows between EU and Russia



# Main o

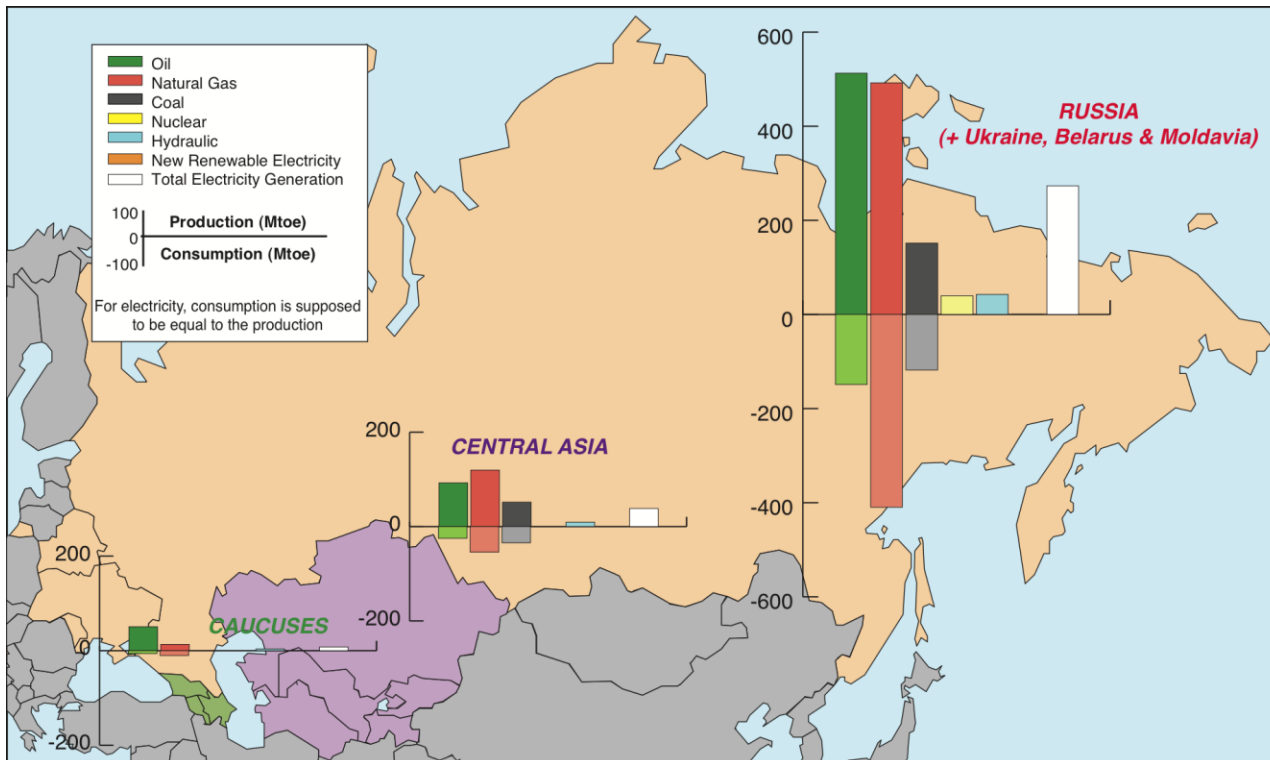


# **Geopolitics of Energy**

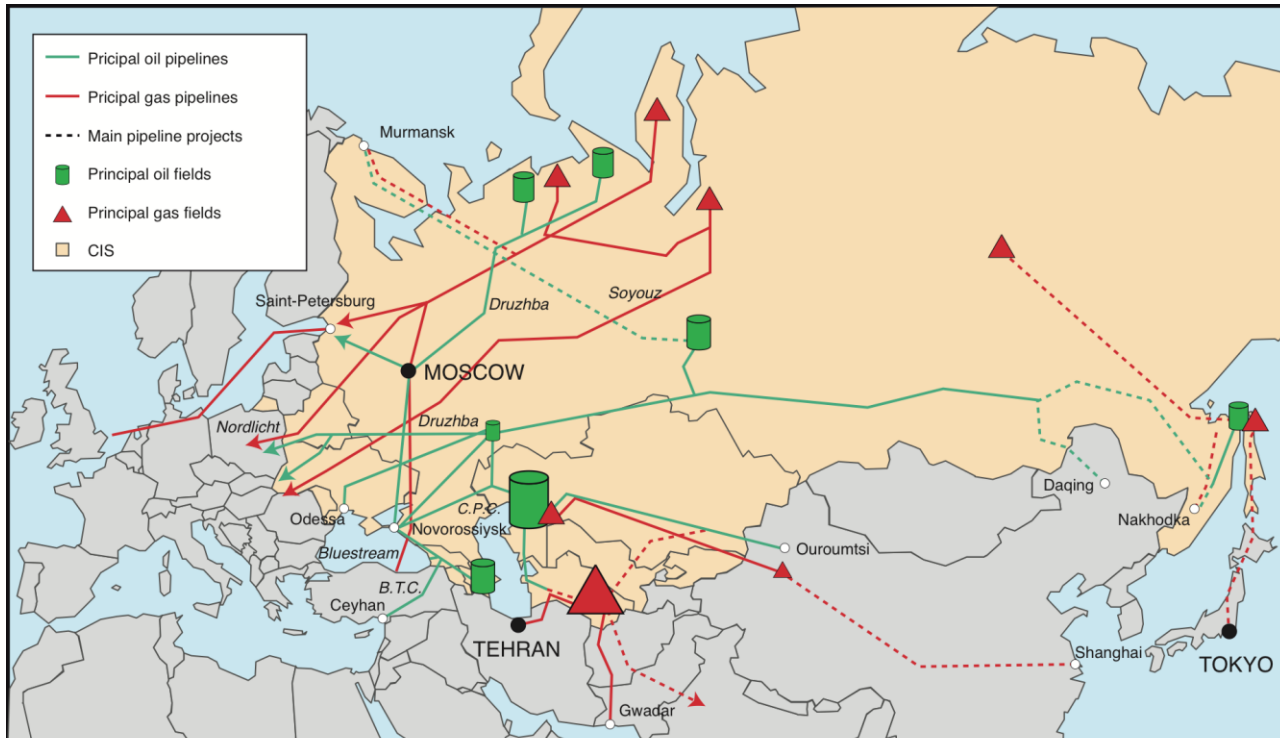
## **Part 5 - CIS**

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# Energy balance in the CIS



# Oil and gas pipelines in the CIS



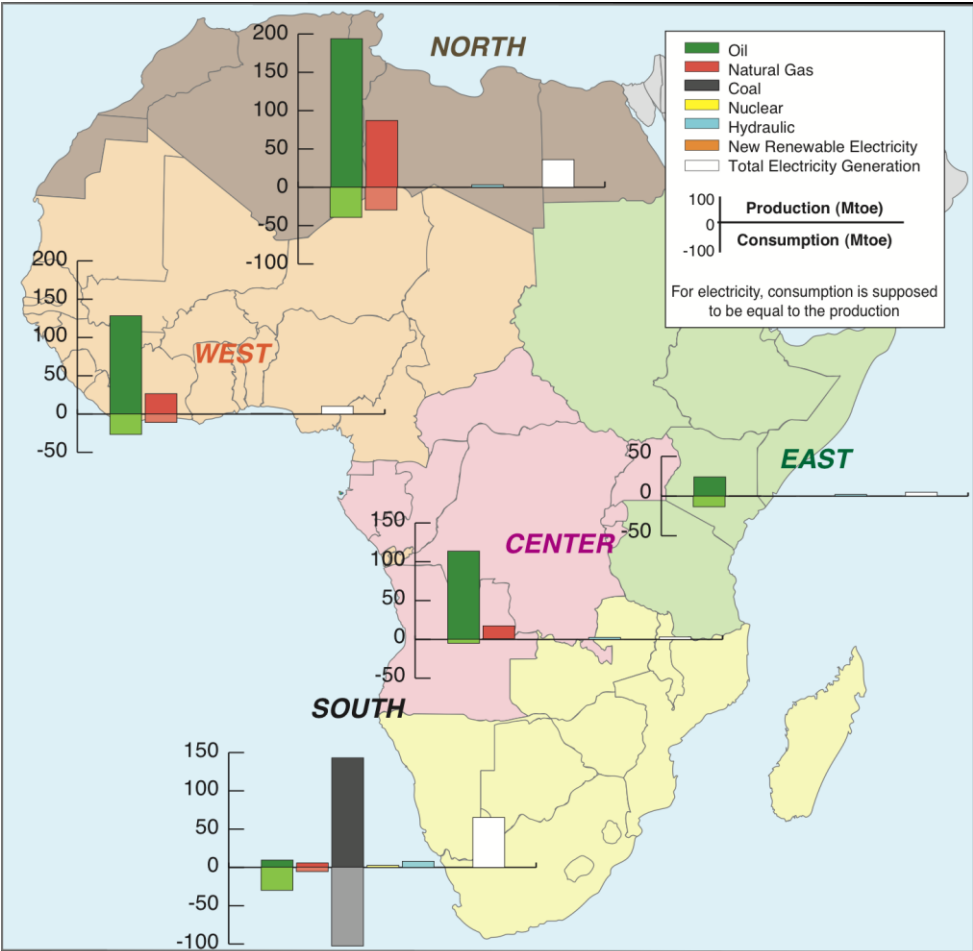


# **Geopolitics of Energy**

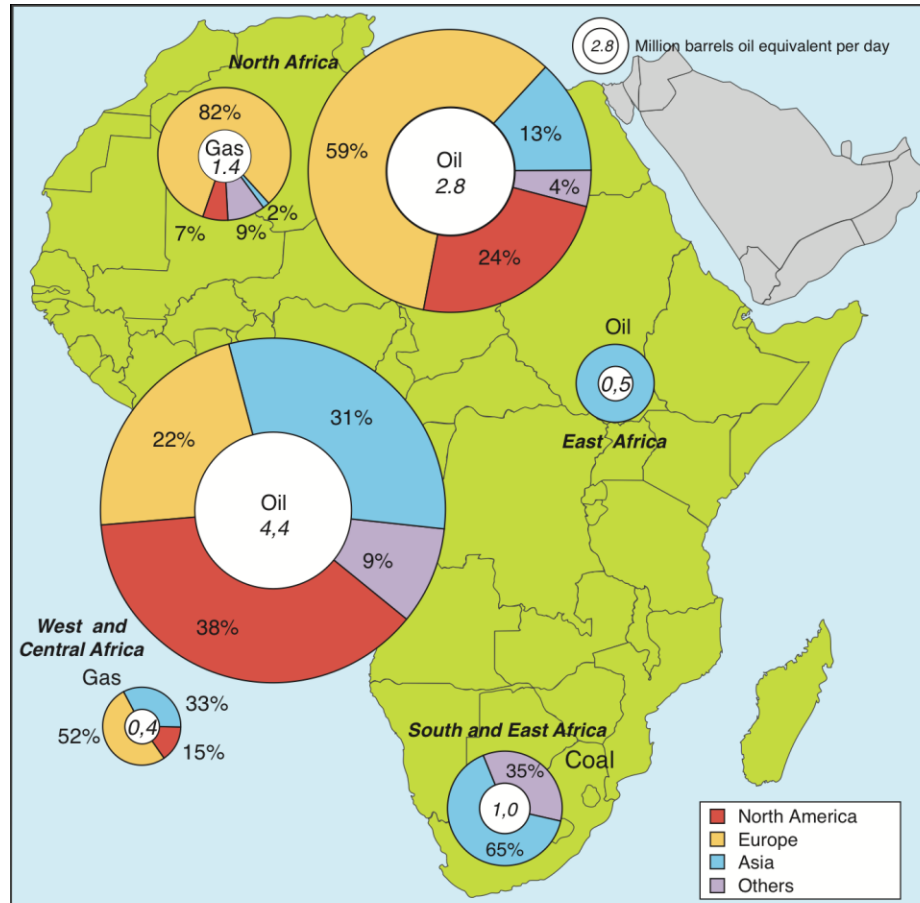
## **Part 6 - Africa**

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# Africa energy balance



# Destinations of energy exports from Africa

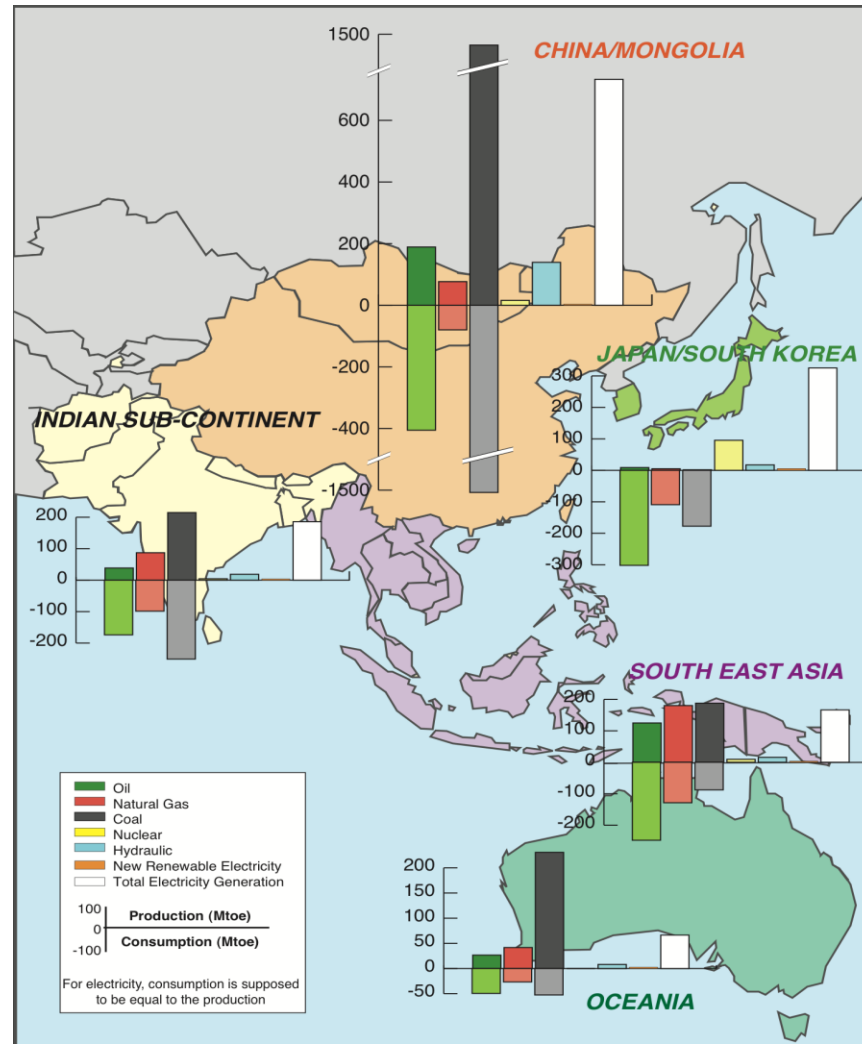


# **Geopolitics of Energy**

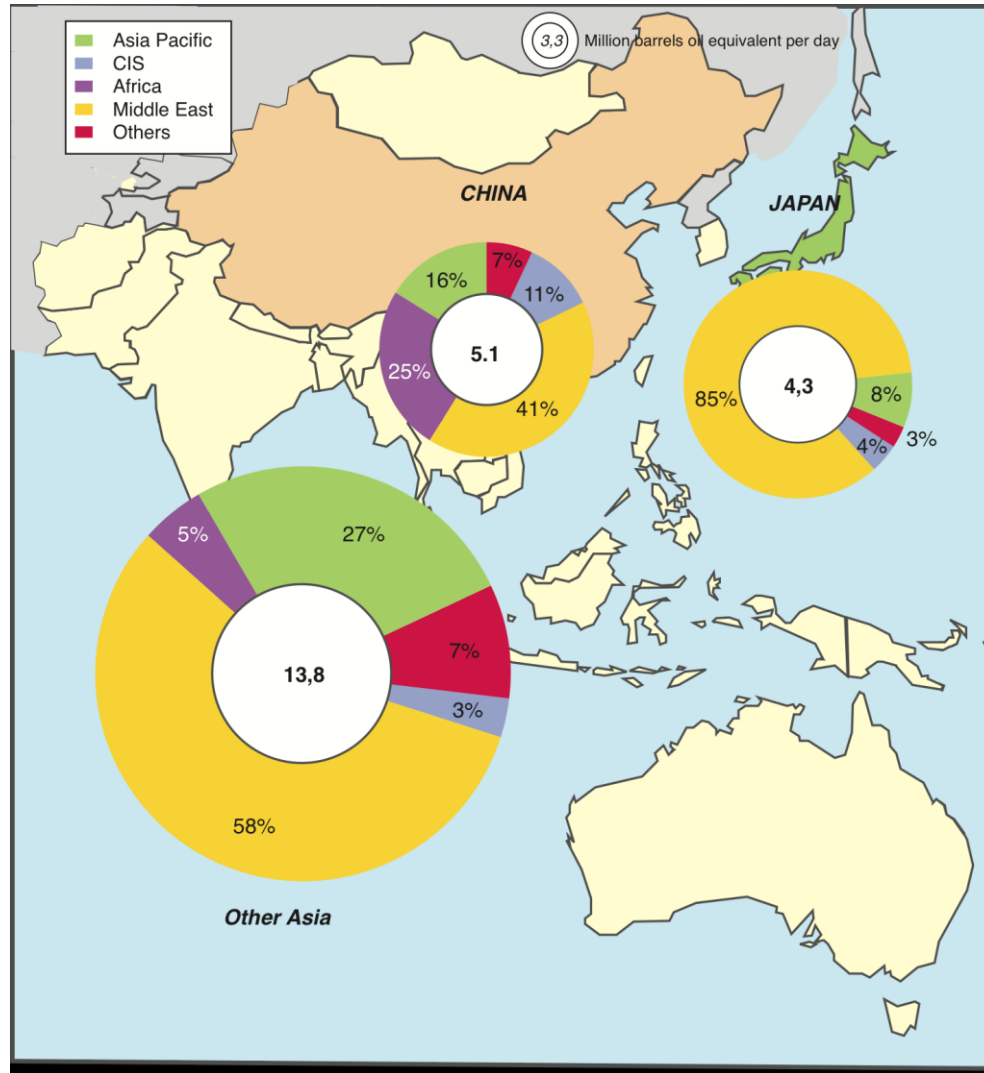
## **Part 7 - Asia**

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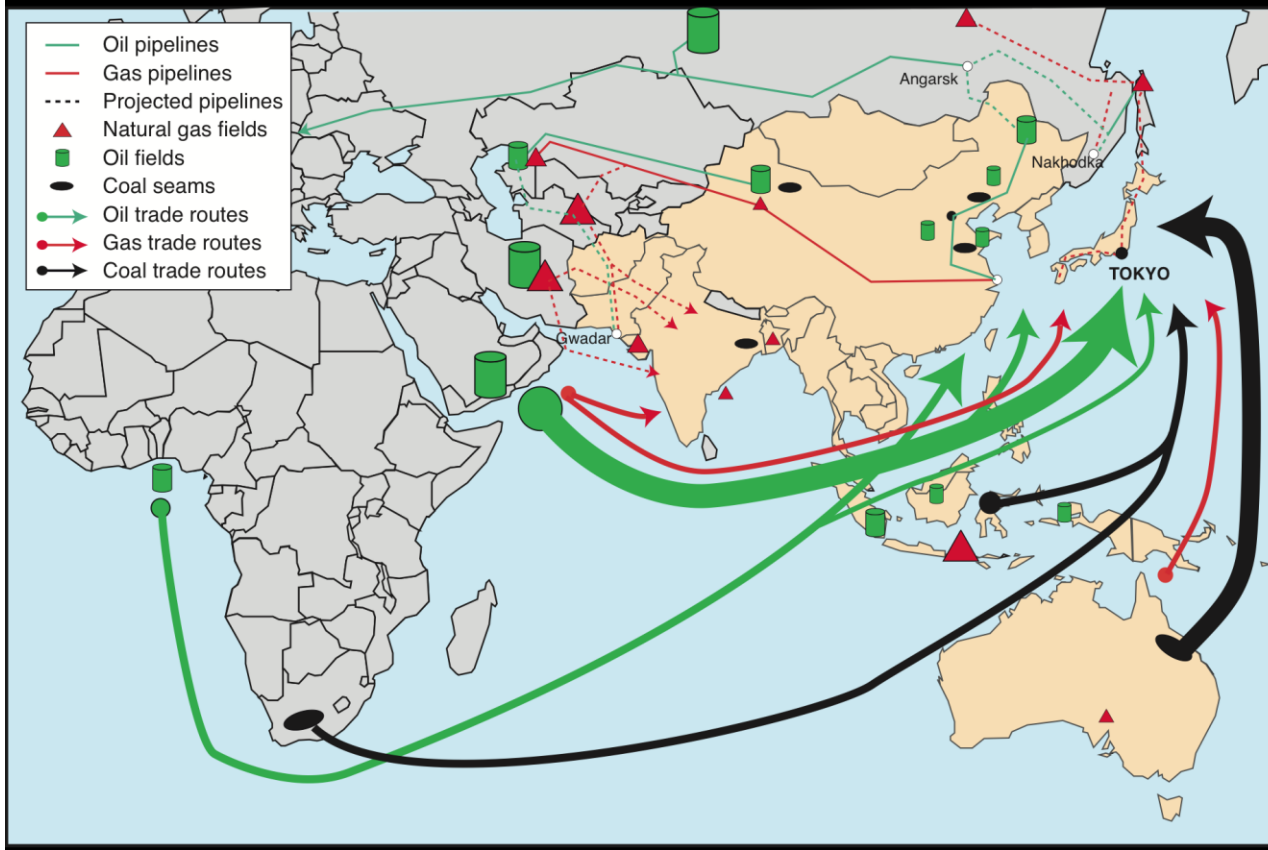
# Energy balance in Asia



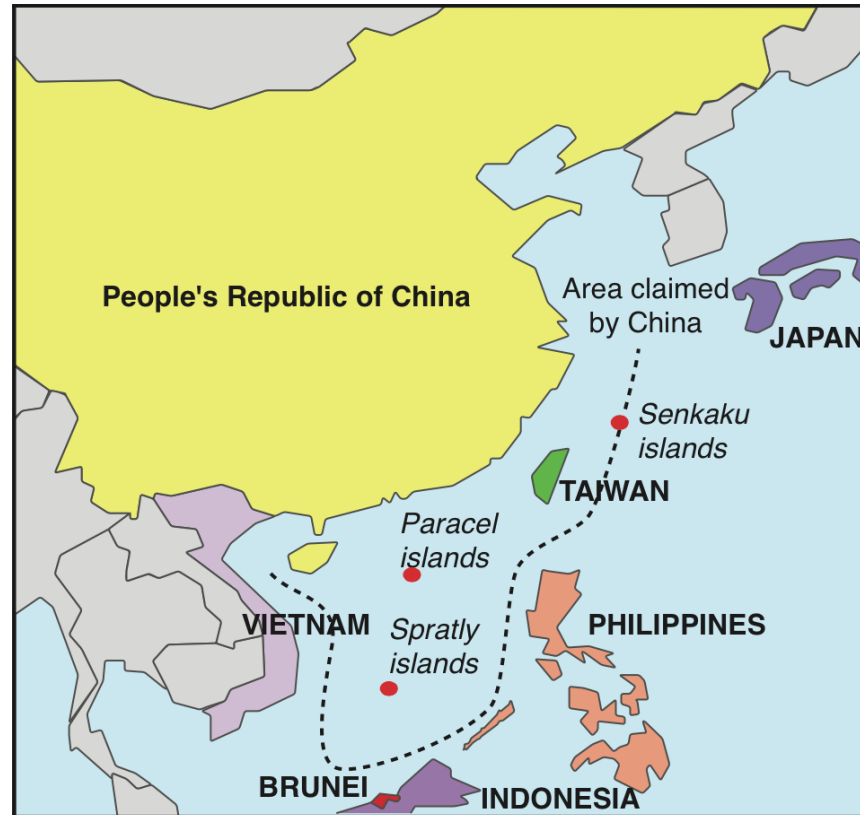
# Origin of Asian oil imports



# Trade routes for the Asia energy



# Territorial claims by the People's Republic of China



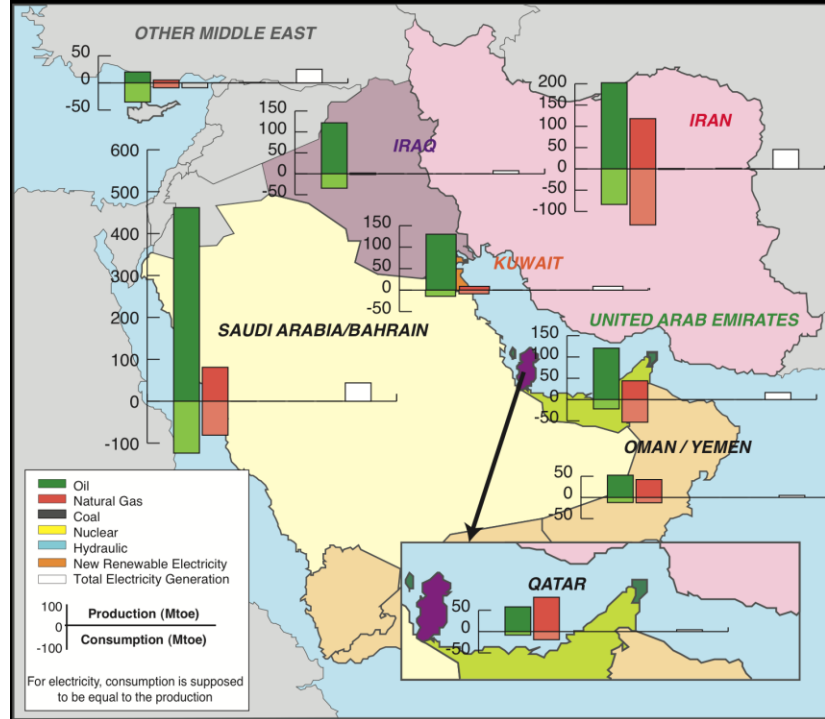


# **Geopolitics of Energy**

## **Part 8 - Middle East**

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# Energy



# Middle East exports – by country

