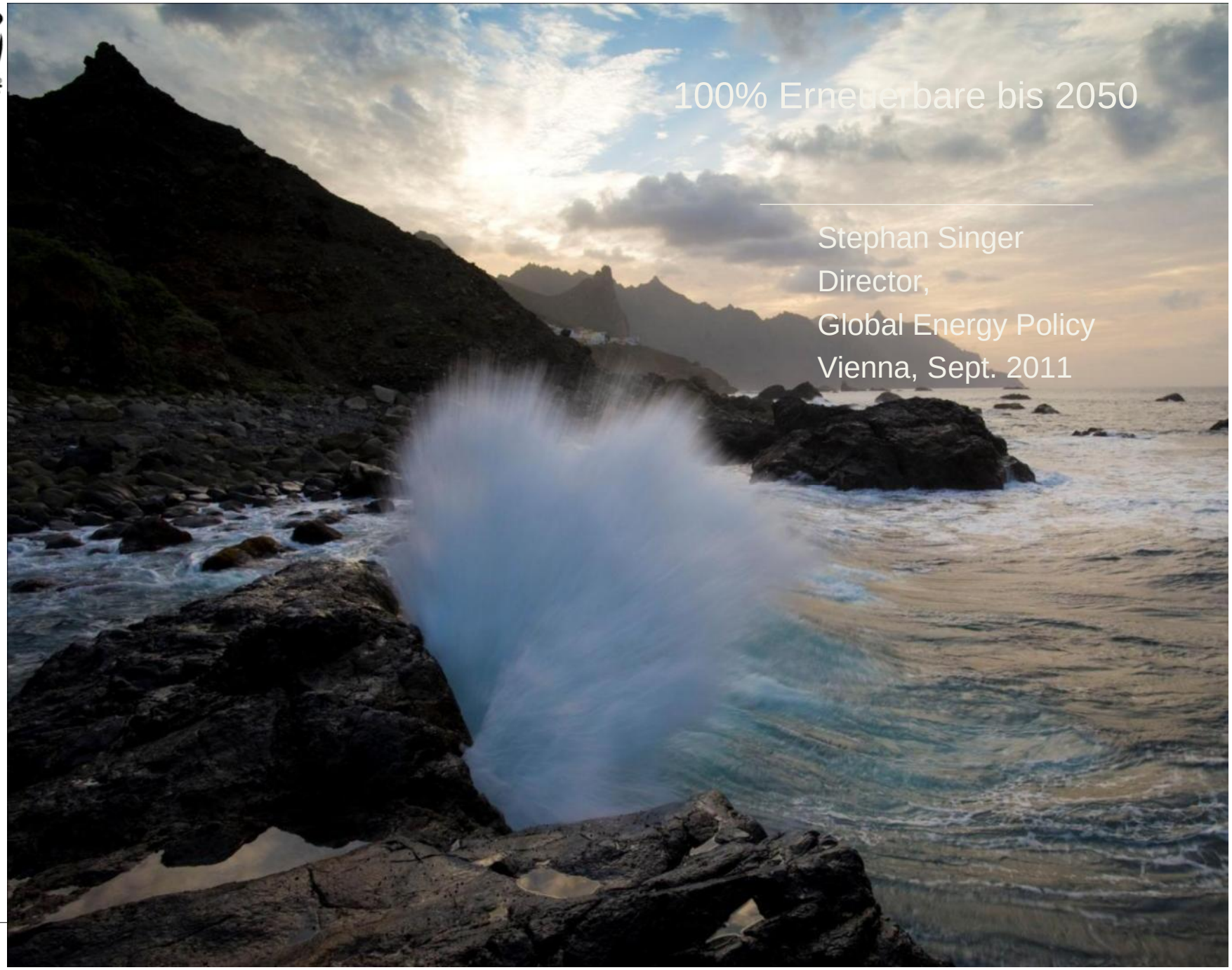


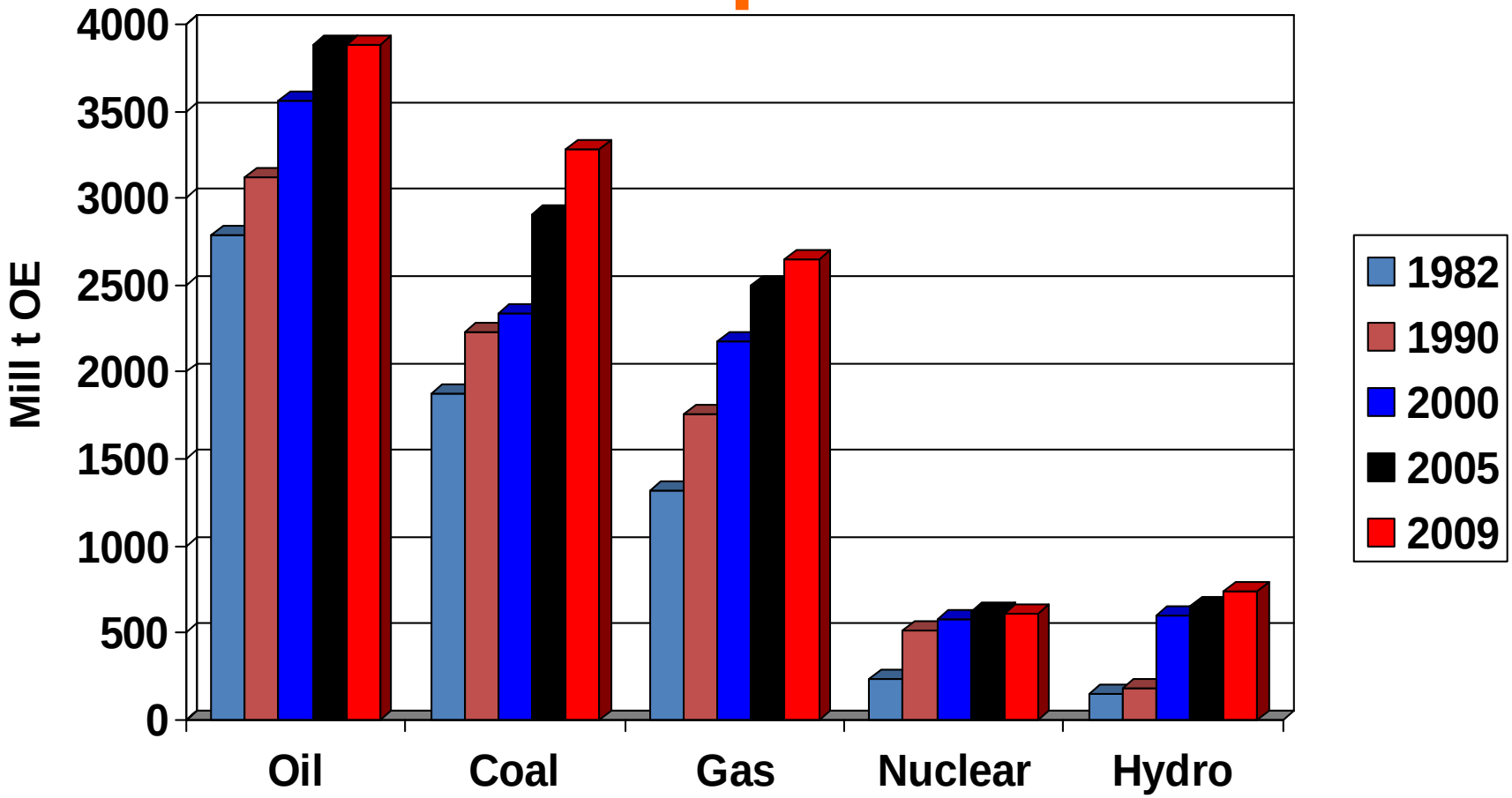
# 100% Erneuerbare bis 2050

Stephan Singer
Director,
Global Energy Policy
Vienna, Sept. 2011

# Content

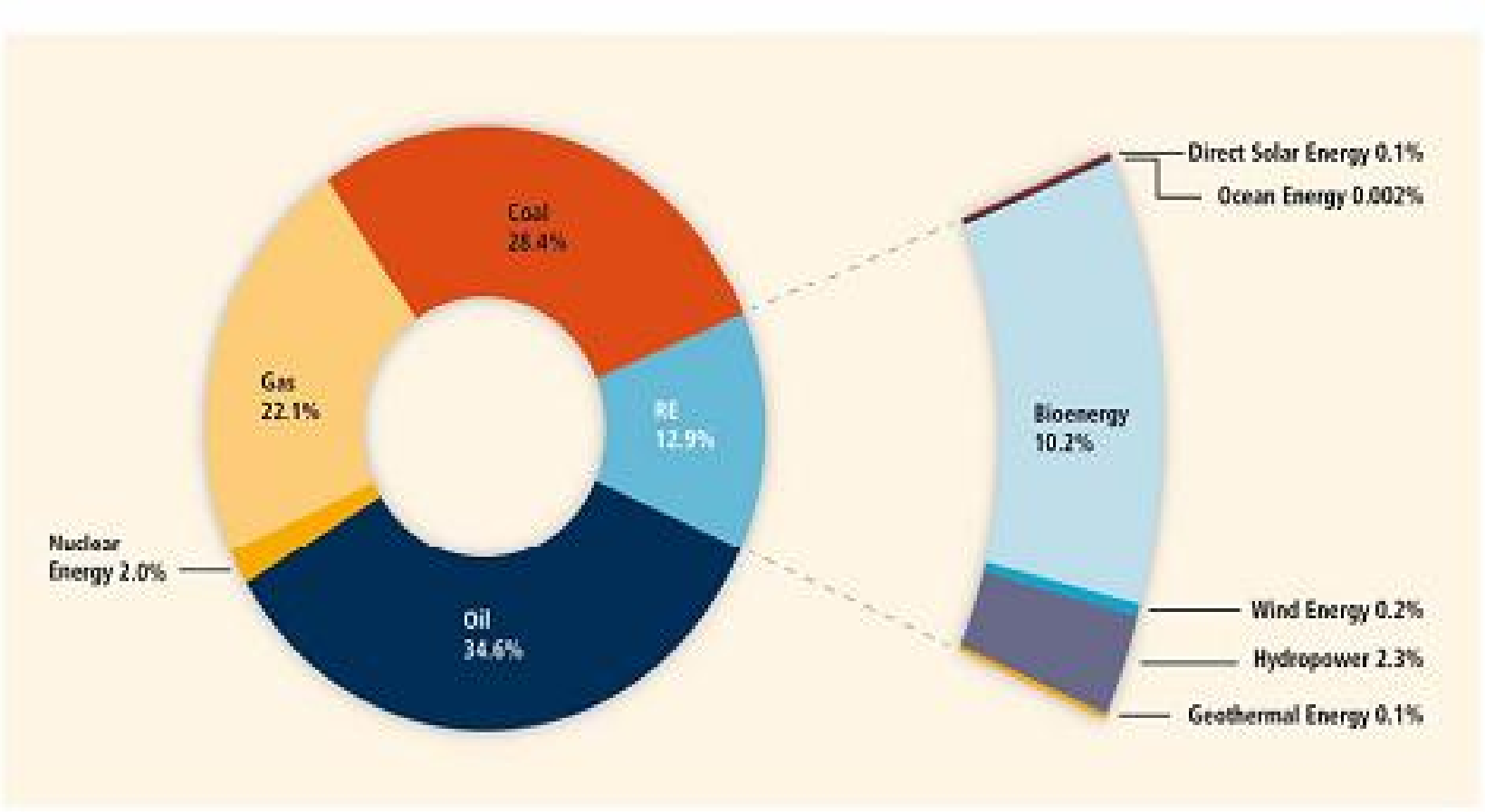
1. Global trends fossil fuels, RES
2. WWF – The Energy Report
3. Conclusions

# Global energy consumption trends



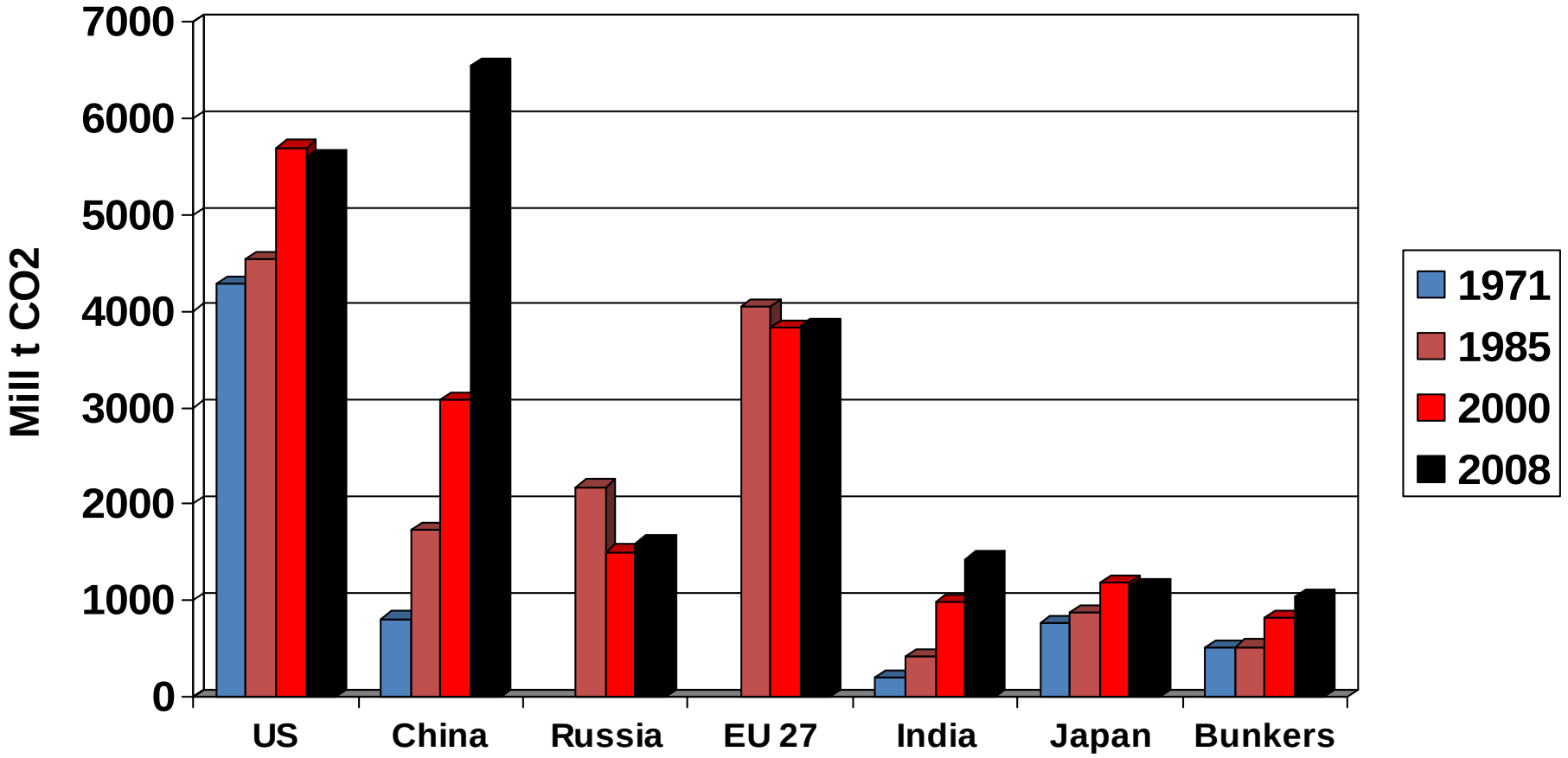

Source: BP Stat. Review 2010

# In 2009, solar, wind, geothermal provide only 0.4% of global energy



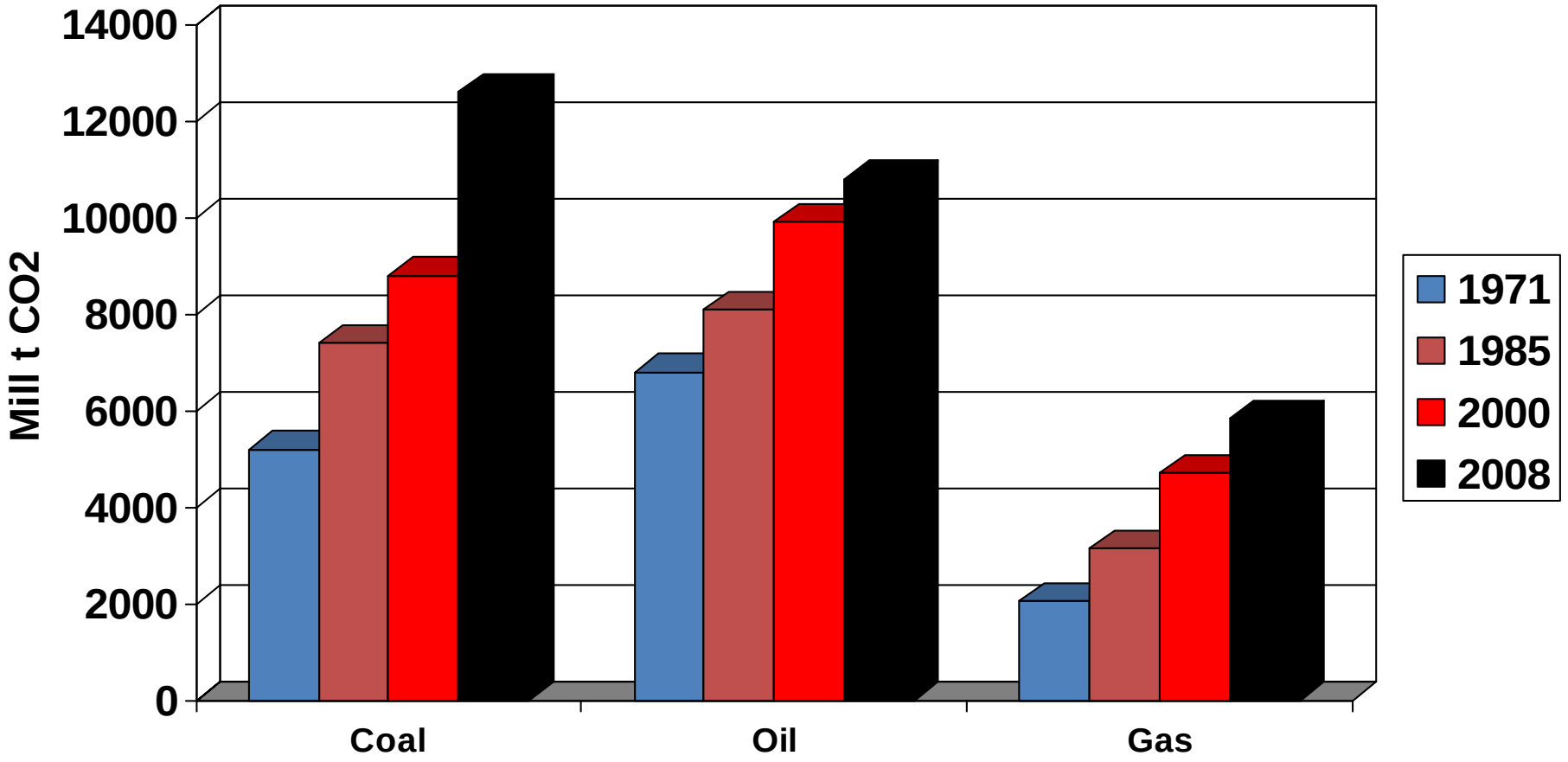

Source: IPCC 2011

# Top country energy $CO_2$ emissions



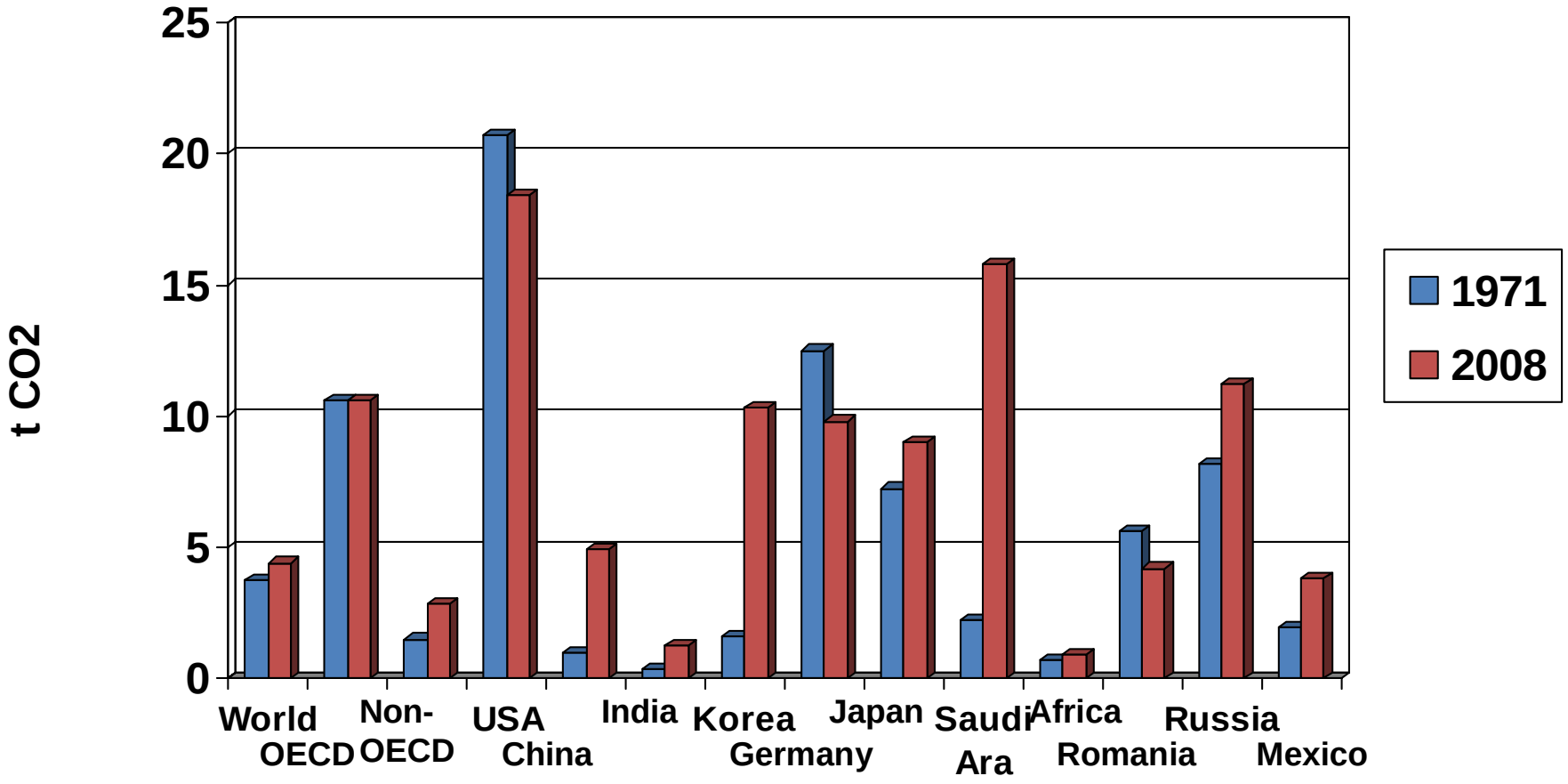

Source: IEA, CO2 emissions, 2010

# Global fuel $CO_2$ emissions



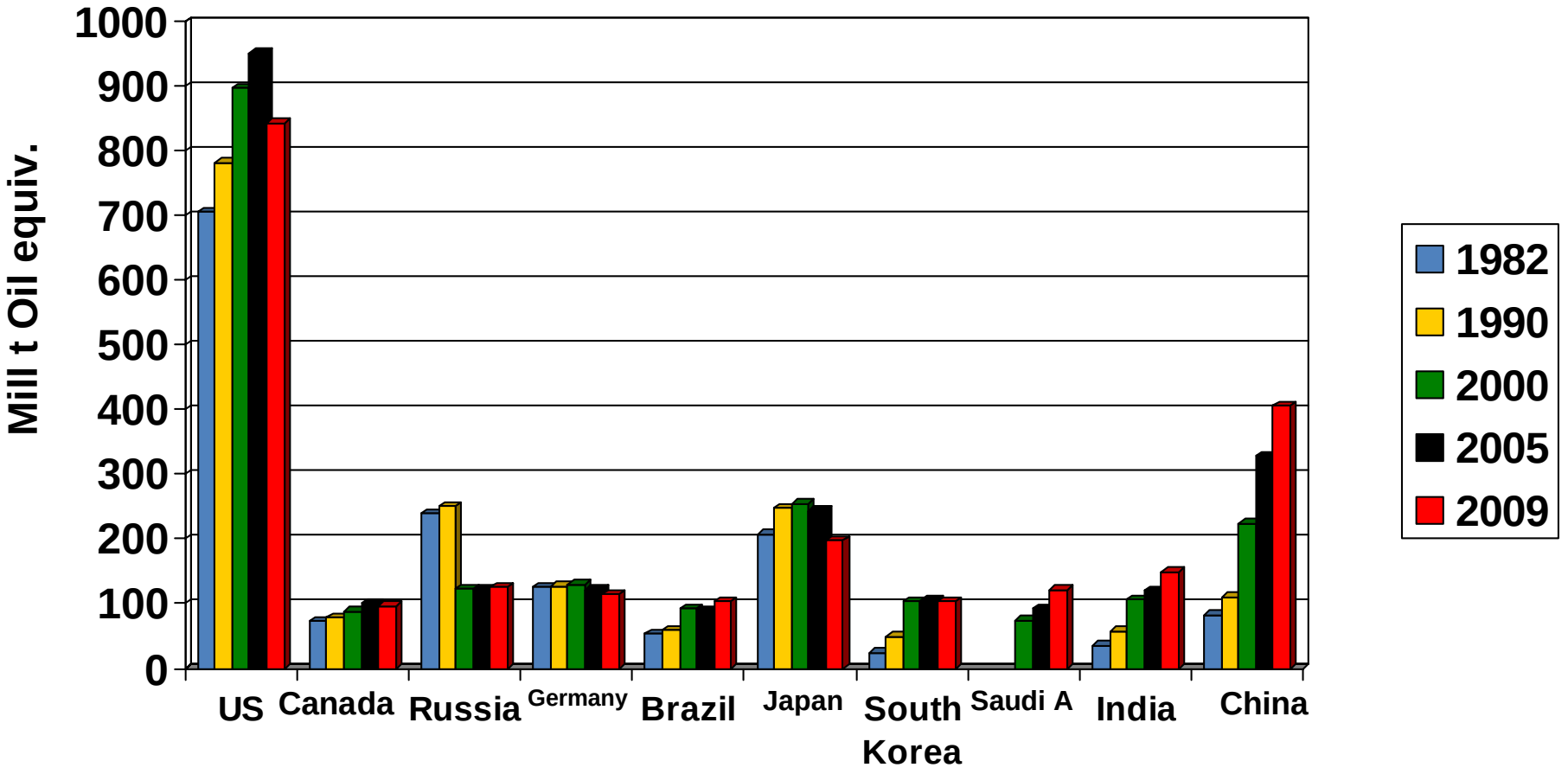

Source: IEA, CO2 emissions, 2010

# Per capita annual energy $CO_2$ emissions



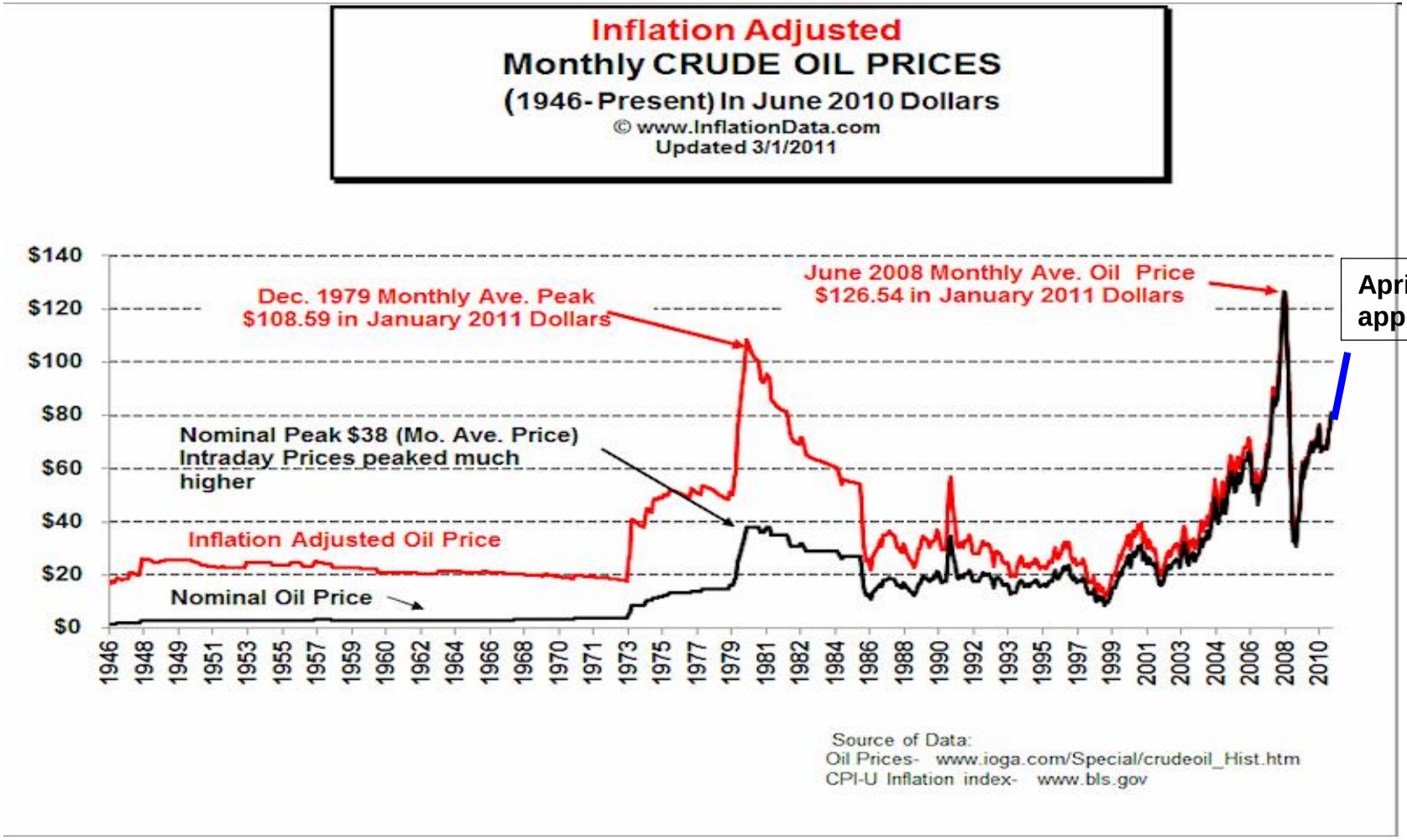

Source: IEA, CO2 emissions, 2010

# Global Oil consumption trends: USA and China consume 1/3 and 10 nations 60% in 2009




Source: BP Statistical Review 2010

# “Global oil prices will increase by 2% annually in next years” (IEA 2006)

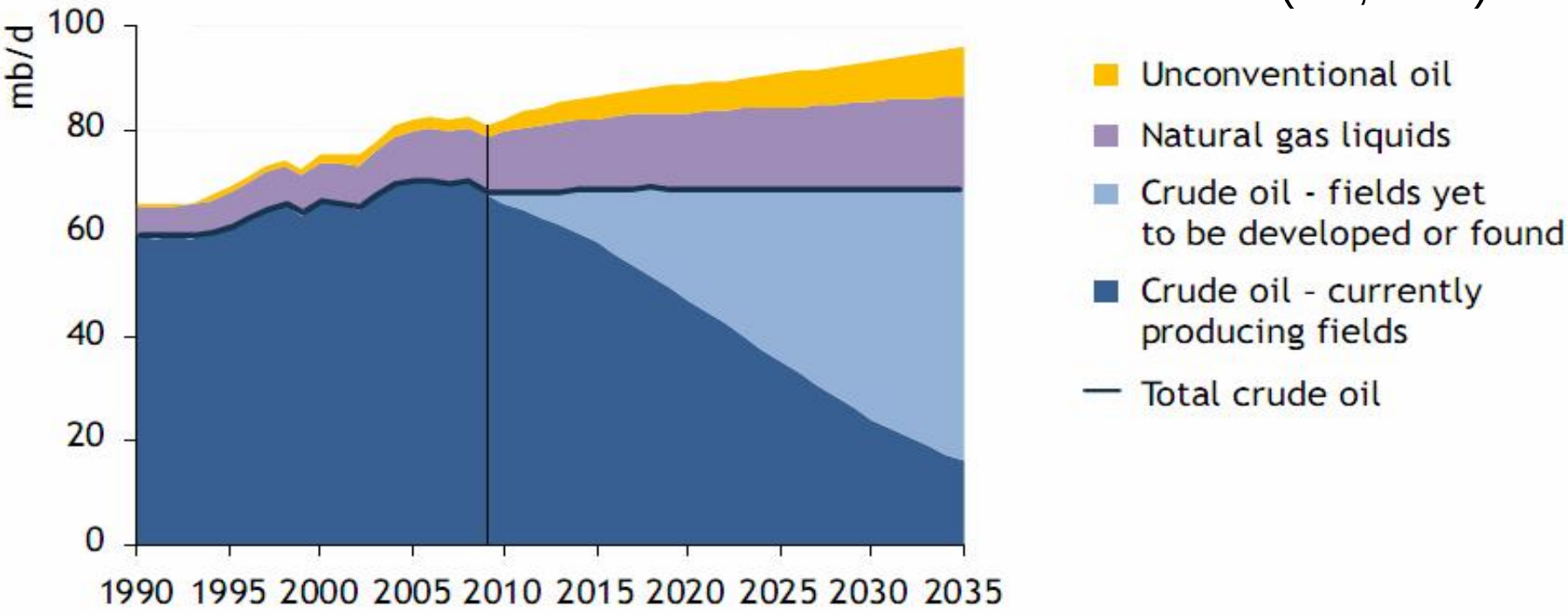



**April 2011 approx $US 105**

# We're Running Out of CHEAP Oil

**World Oil Production by Type in the New Policies Scenario**

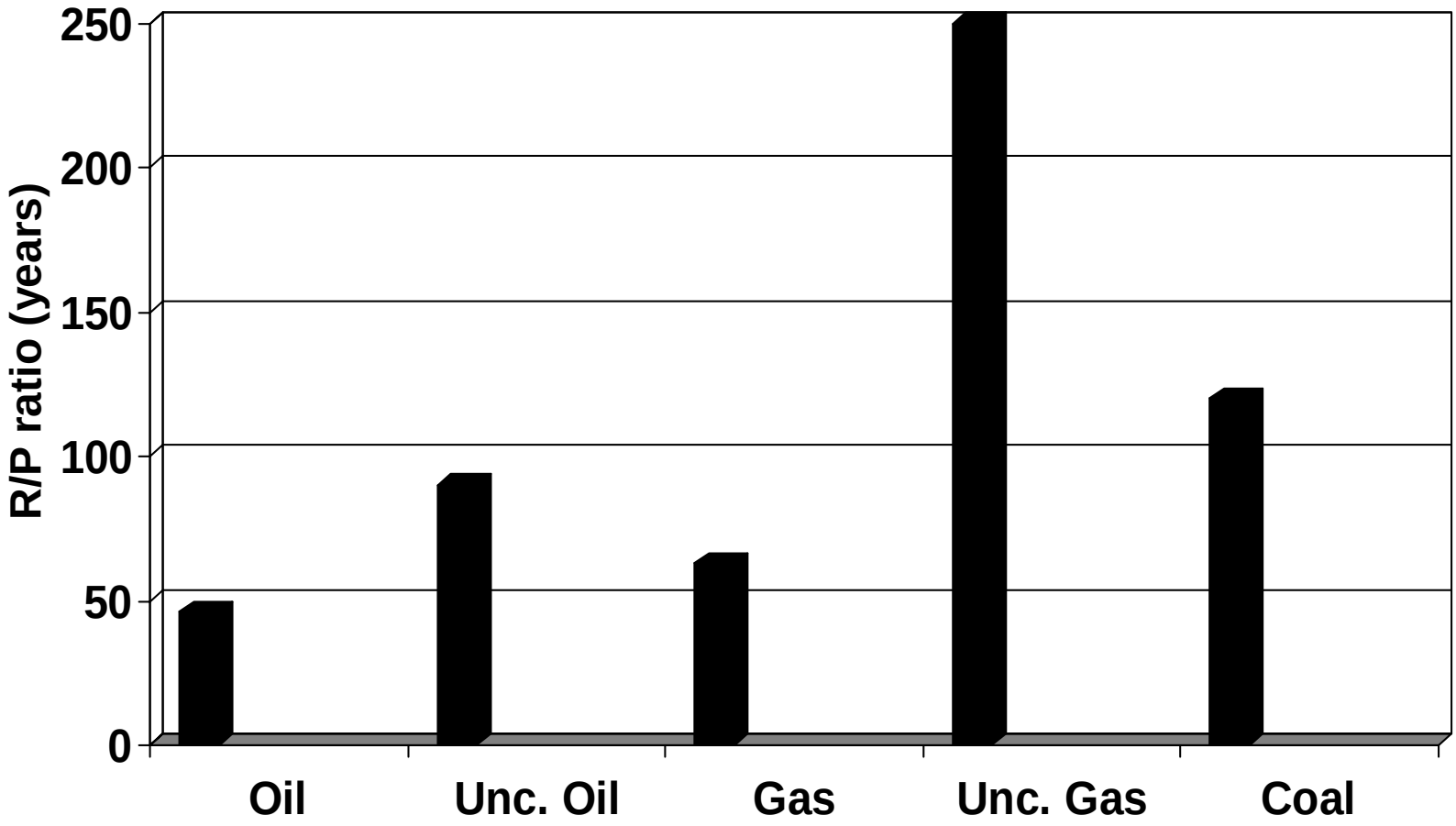
(IEA, 2010)




Global oil production reaches 96 mb/d in 2035 on the back of rising output of natural gas liquids & unconventional oil, as crude oil production stagnates

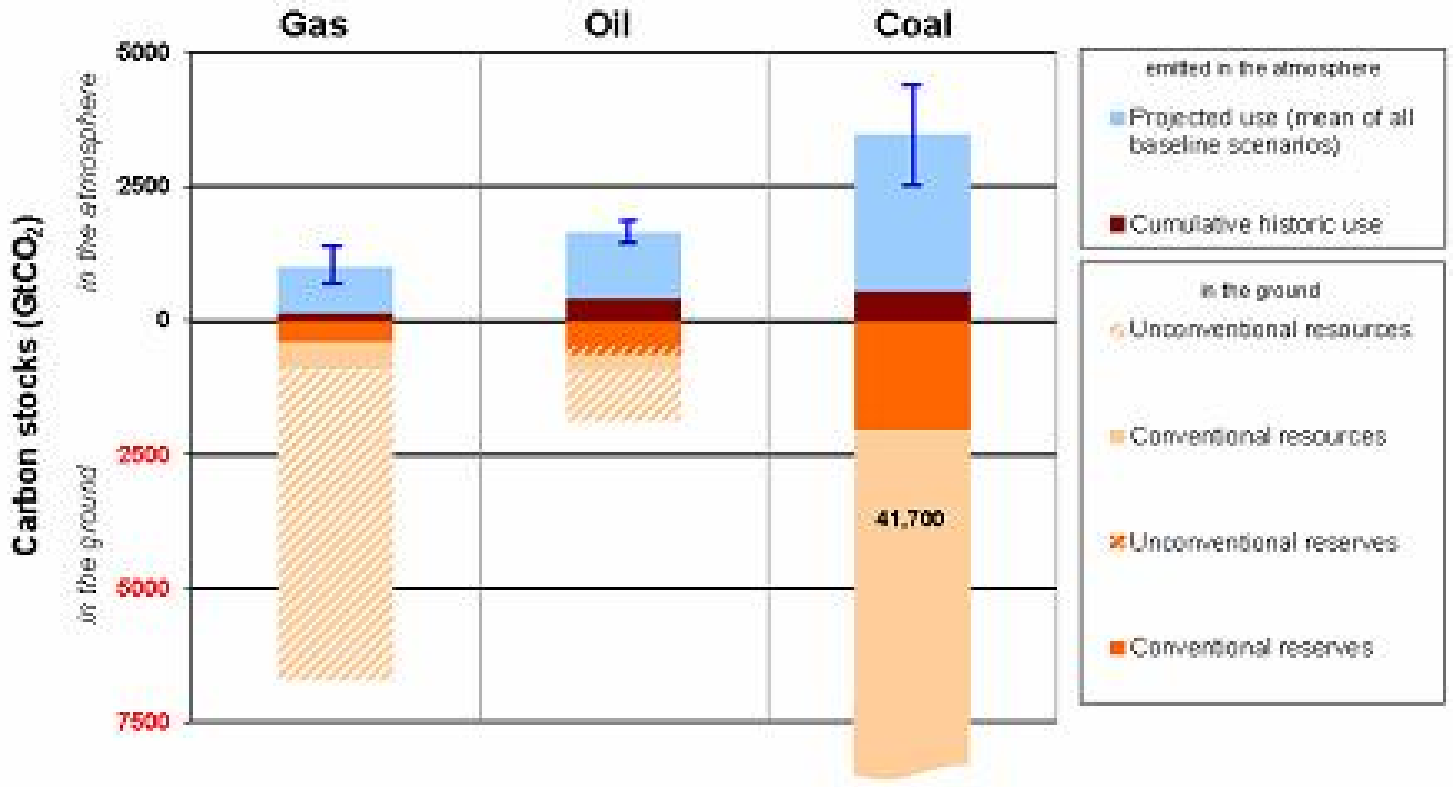
# Global Fossil Energy *Reserves*

**Fully and economically recoverable under present economic, technological and geological conditions**



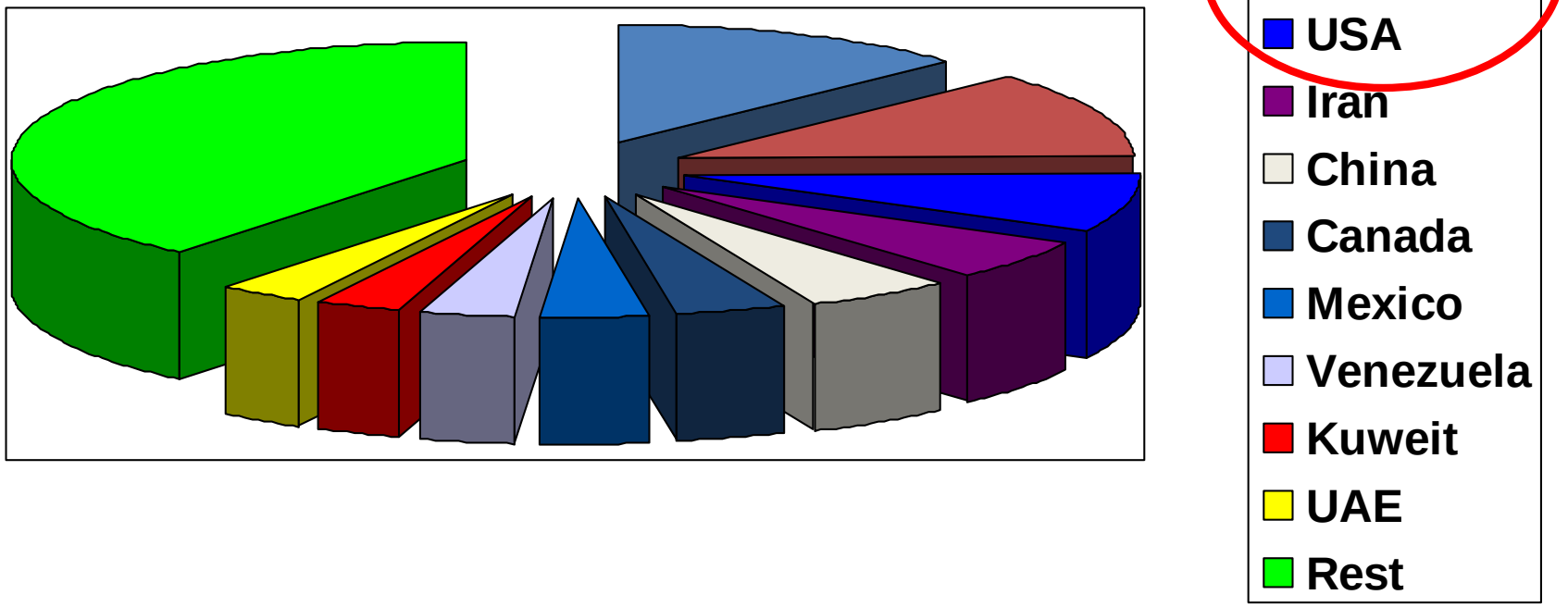

Source: BP Stat. Review 2010; IEA WEO 2009, 2010

# “Easy” oil and gas may be over – but hydrocarbons remain abundant



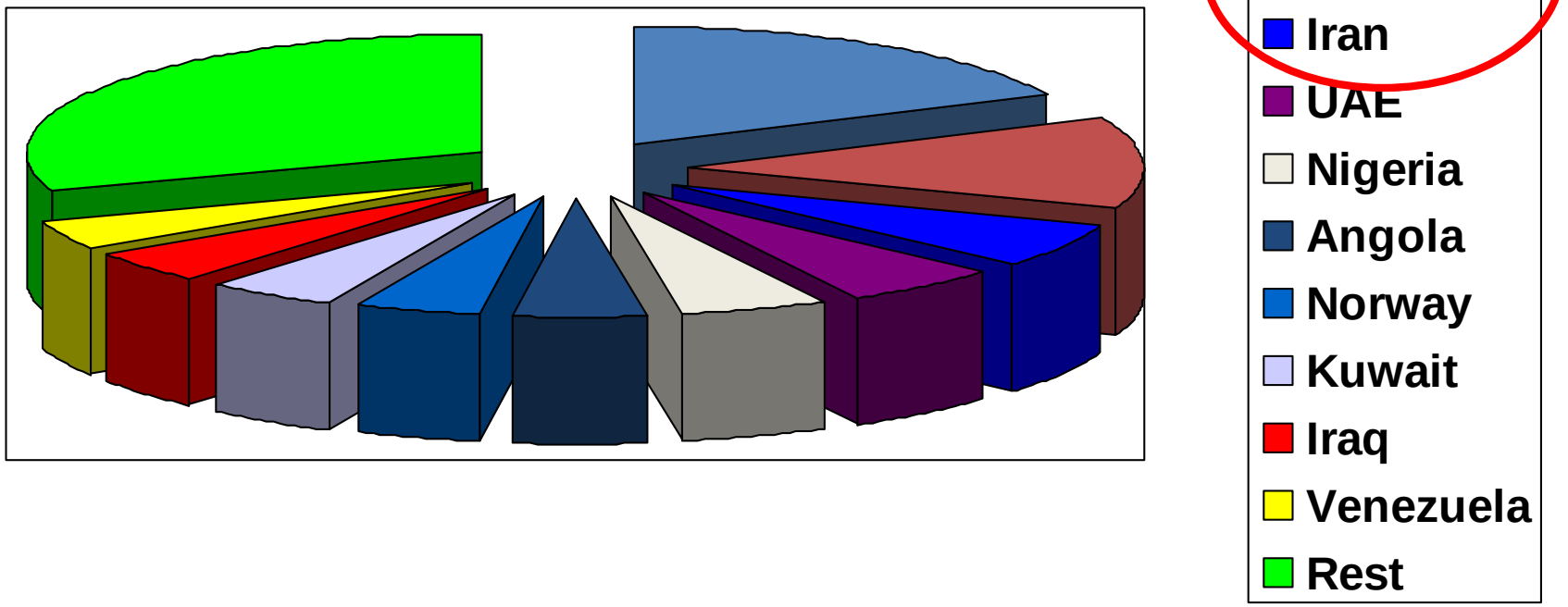

Source: IPCC 2011

# Global oil production: Three nations produce 1/3, 10 nations control 60%



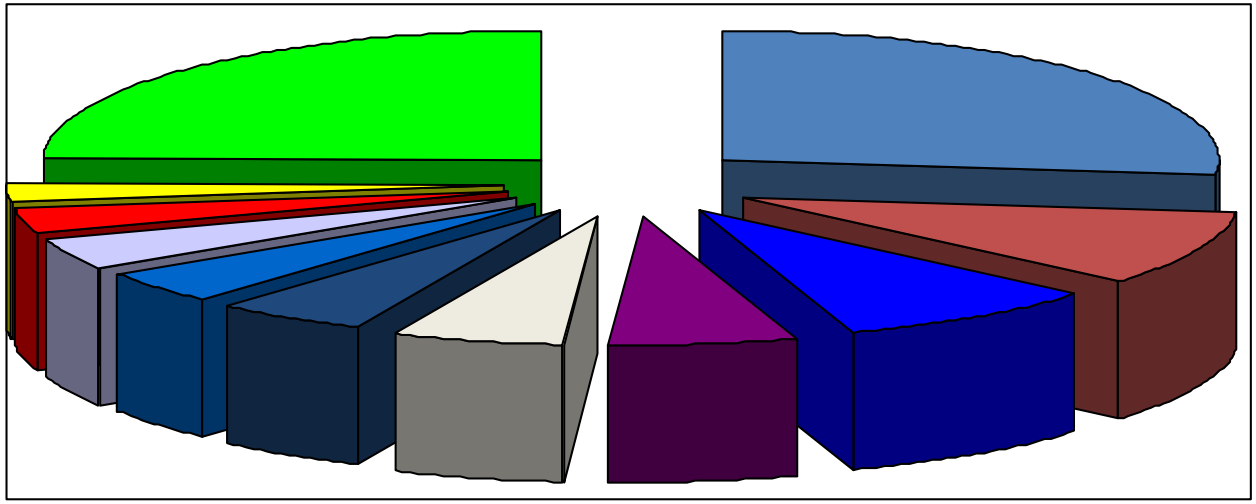

Source: IEA, database 2010

# Global oil export: Three nations run 37% of all export, 10 nations control 70%



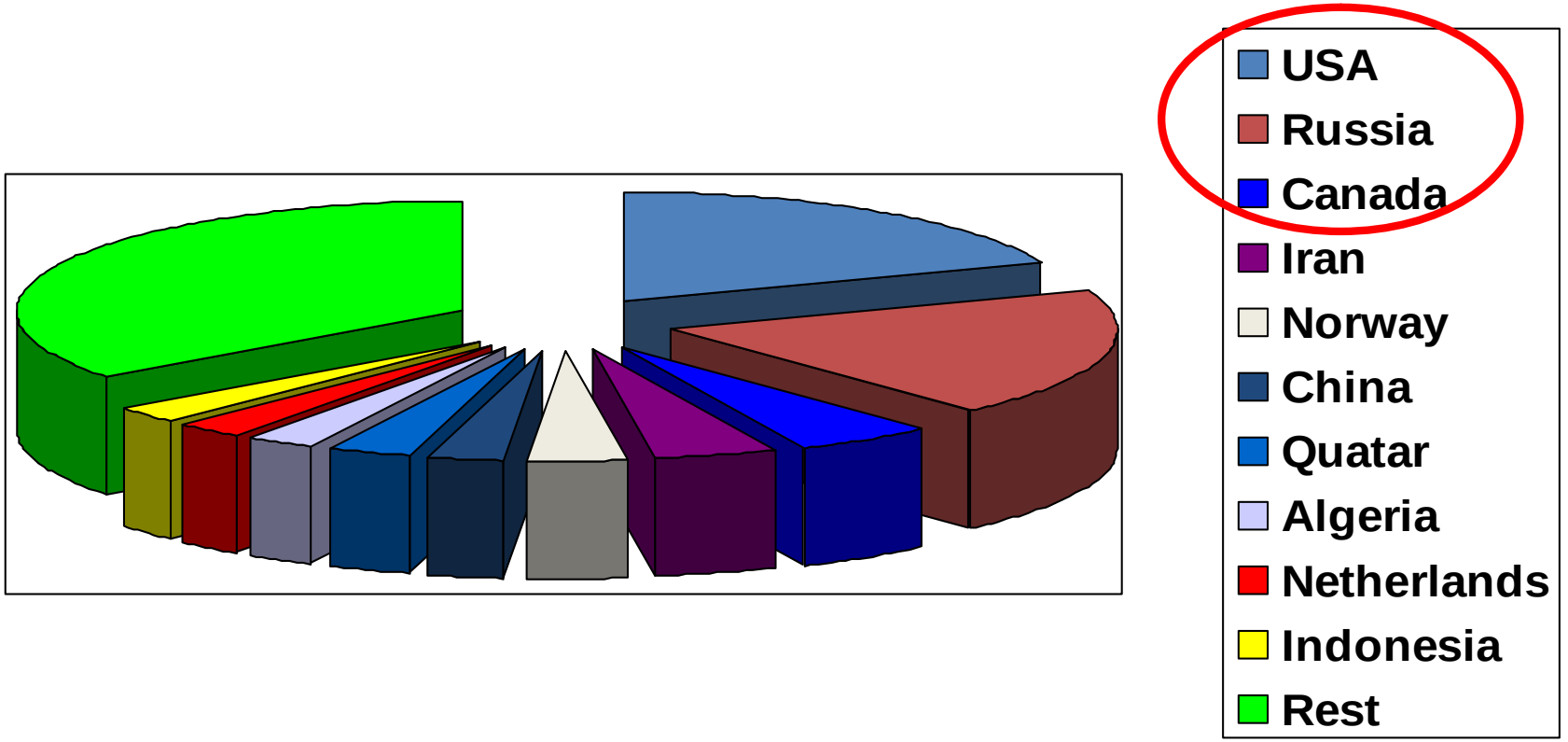

Source: IEA, database 2010

# Global oil import: Three countries import 45% of all, 10 nations import 75%.



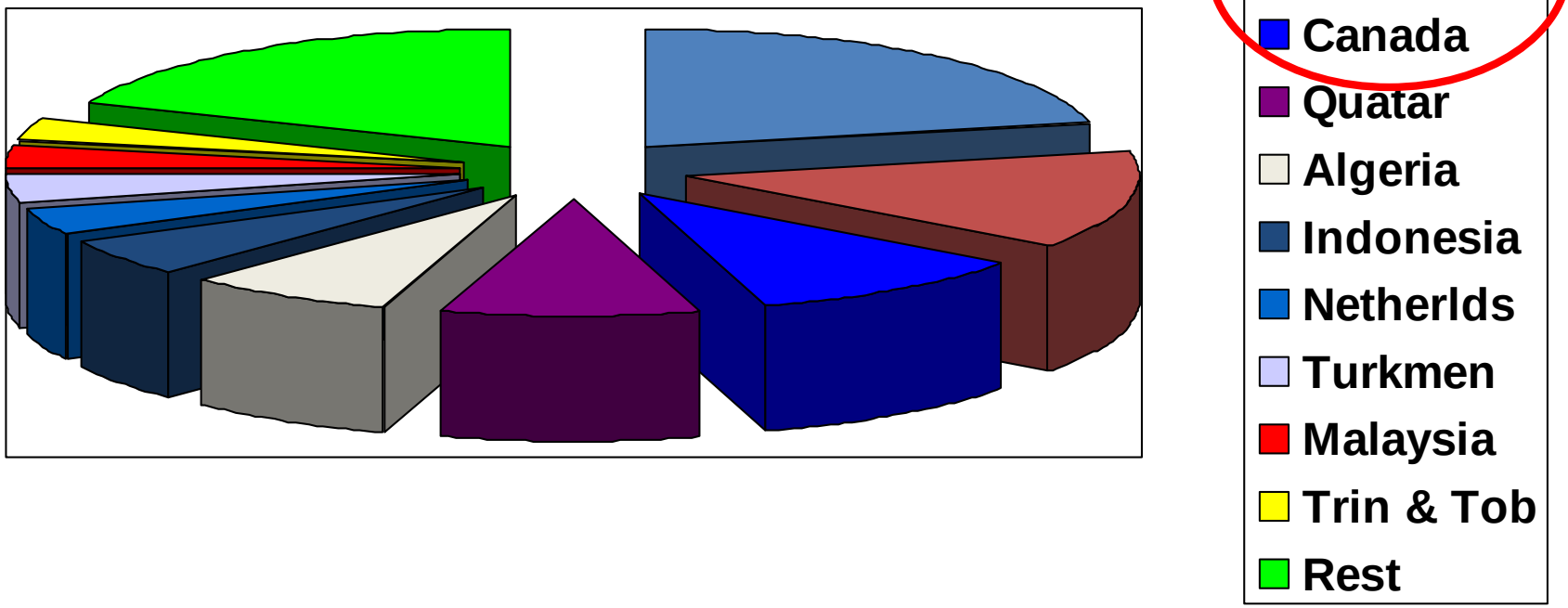

Source: IEA, database 2010

# Global gas production: Three nations produce 43%, 10 nations control 65%



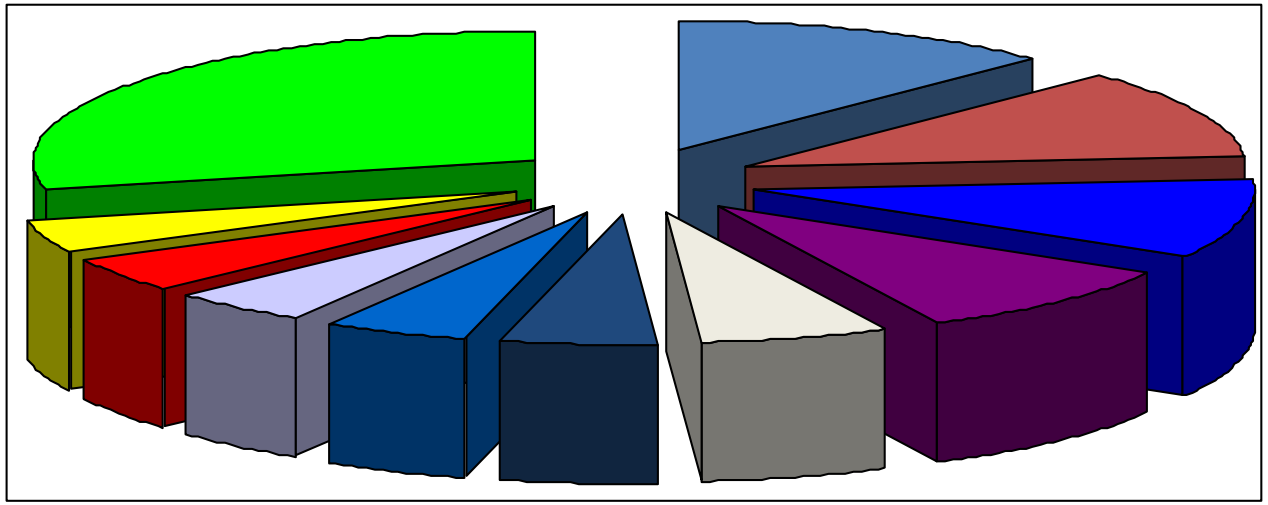

Source: IEA, database 2010

# Global gas export: Two countries export 35% of all, 10 nations export 80%.



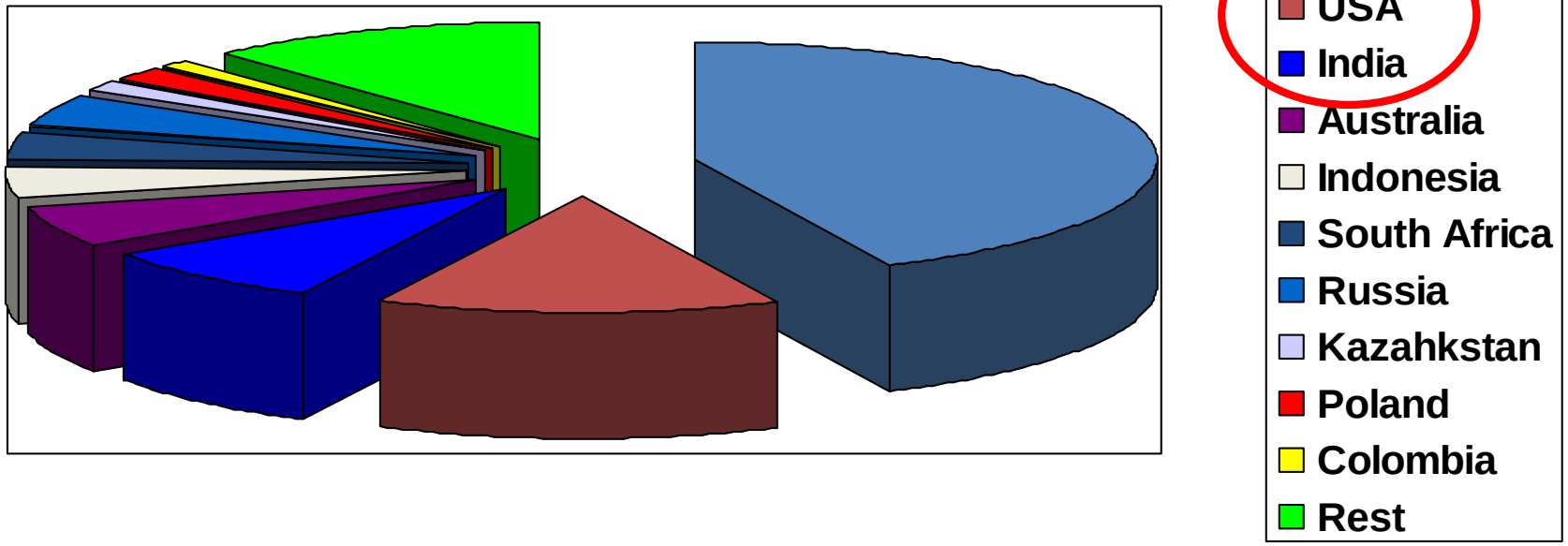

Source: IEA, database 2010

# Global gas import: Three countries import 34%, 10 nations import 72%.




Source: IEA, database 2010

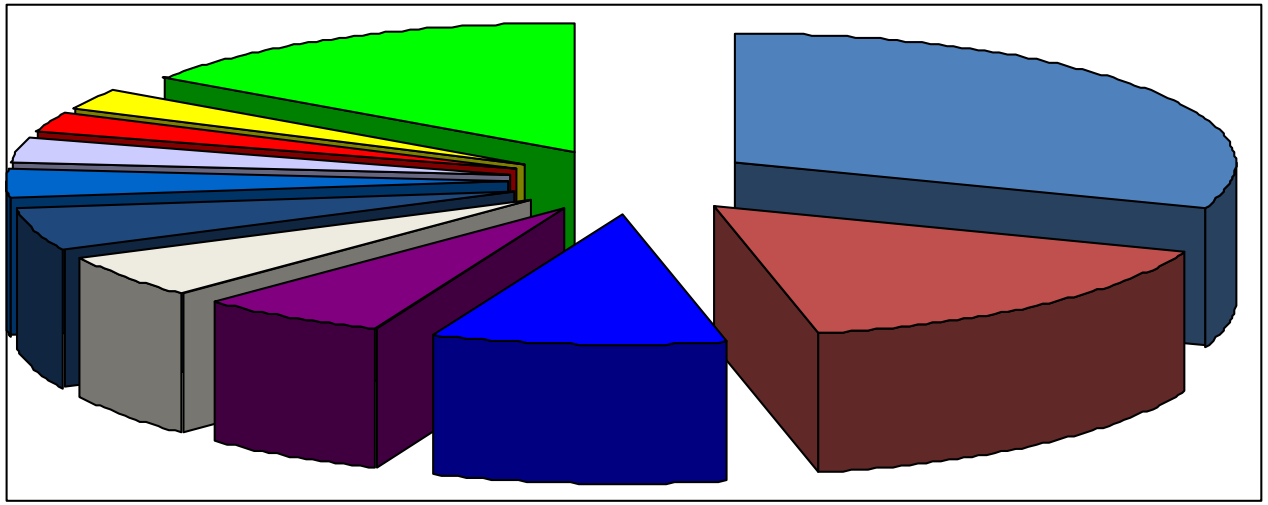
# Global coal production: Two nations produce 57%, 10 nations control 88%




April 2011

Source: IEA, database 2010

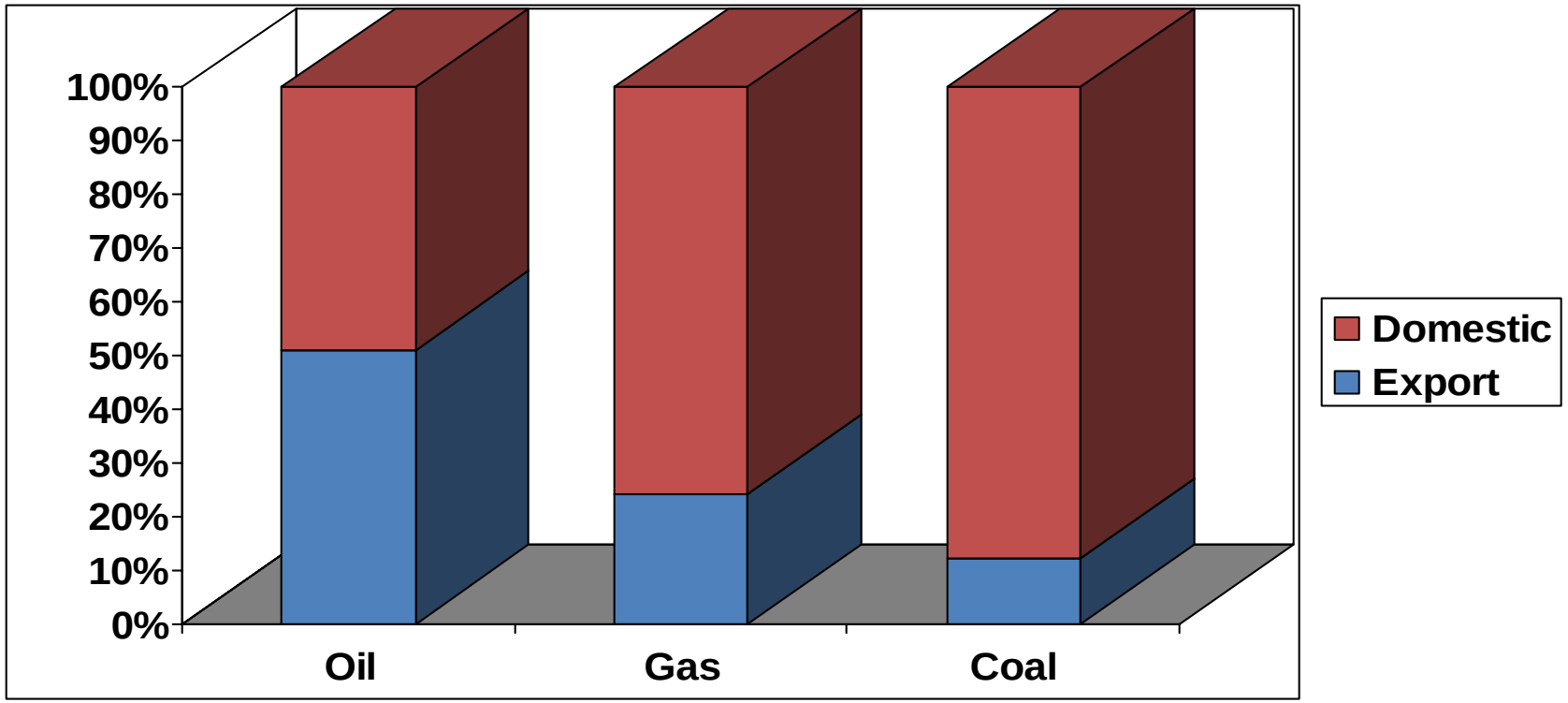
# Global nuclear production: Two countries produce 47%, 10 nations 85%.



- USA
- France
- Japan
- Russia
- S Korea
- Germany
- Canada
- Ukraine
- China
- Sweden
- Rest

Source: IEA, database 2010

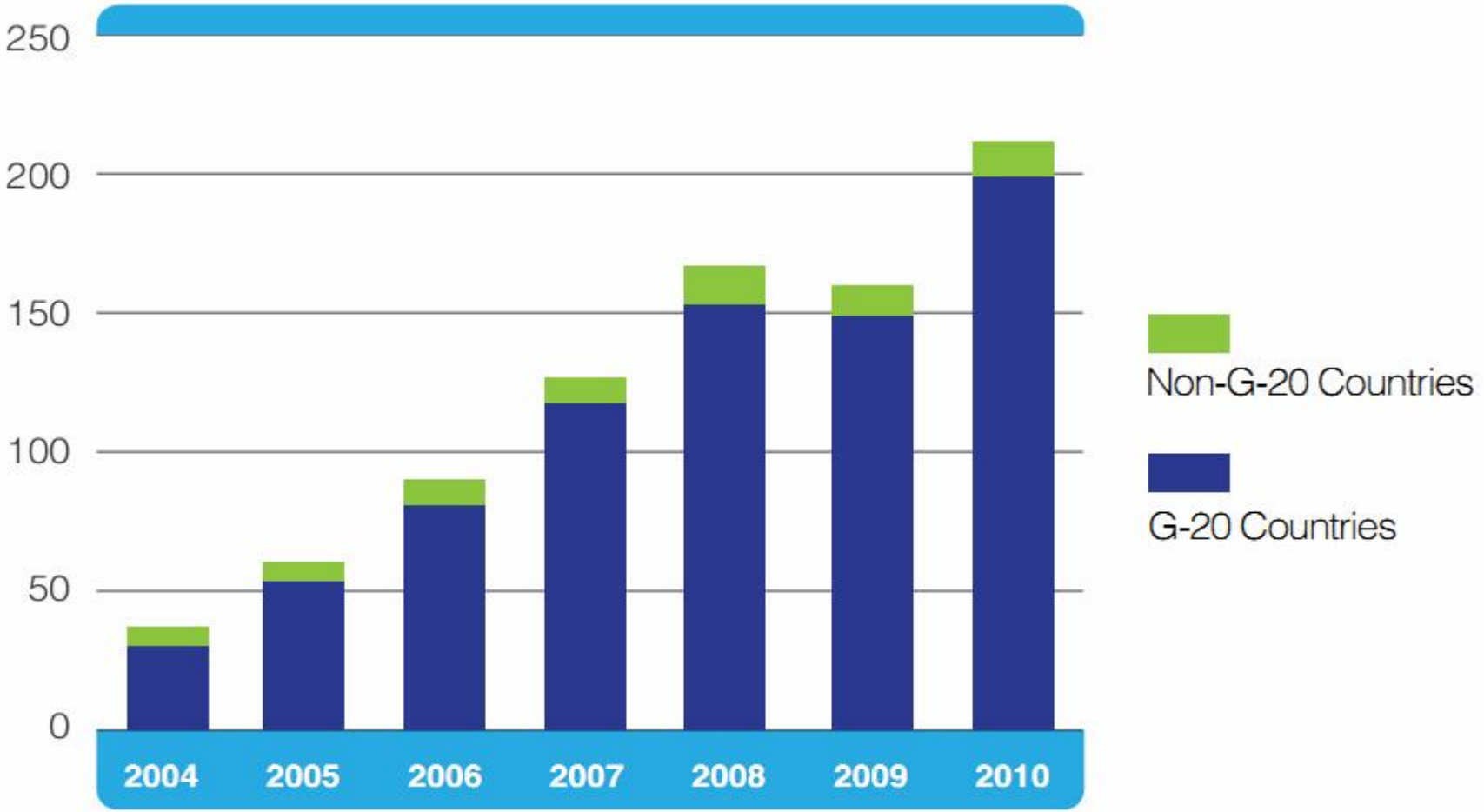
# Export quota of fossil fuels produced




April 2011

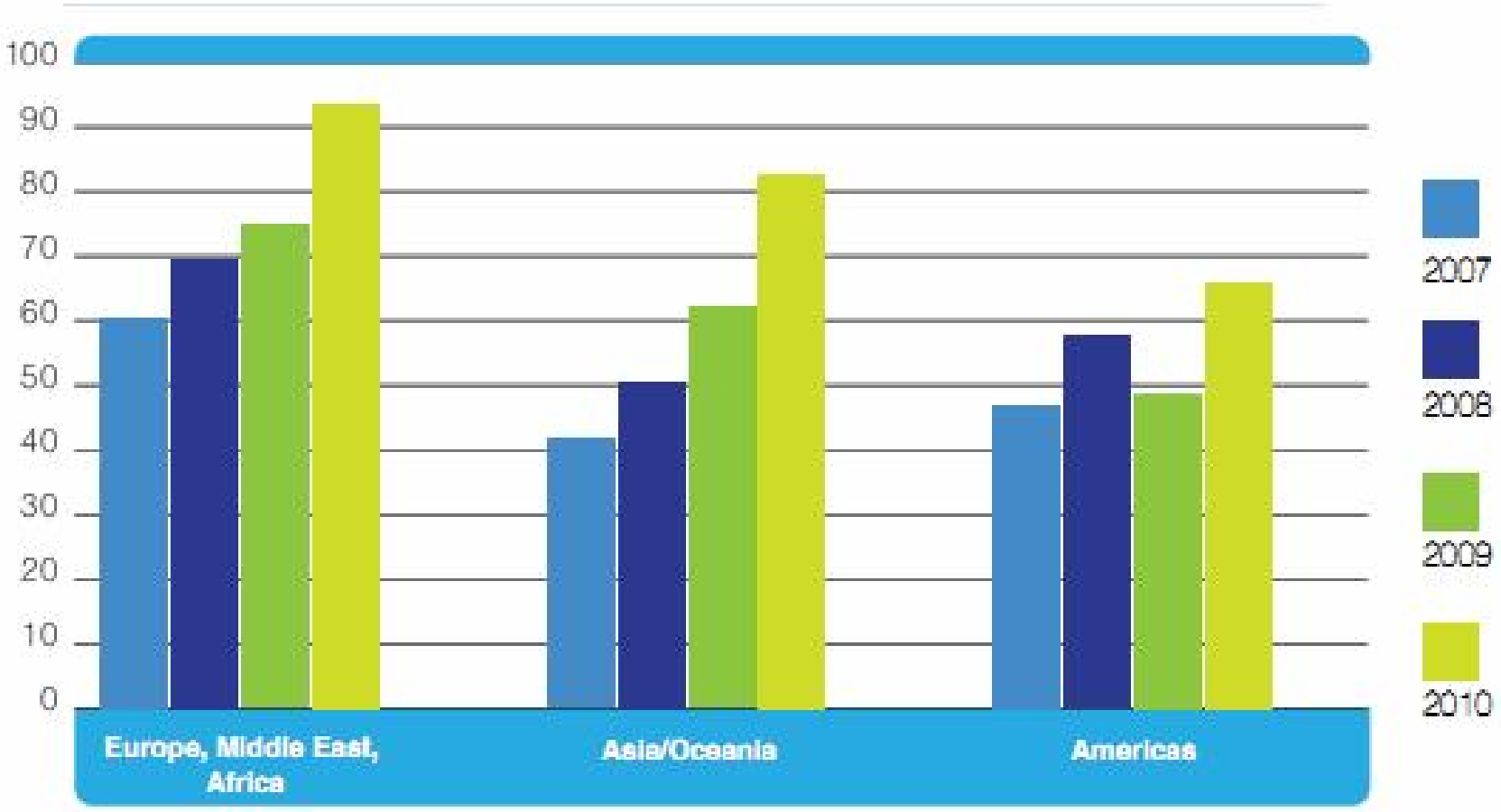
Source: IEA, database 2010

# G-20 leads in global renewable energy investments ($US bln)



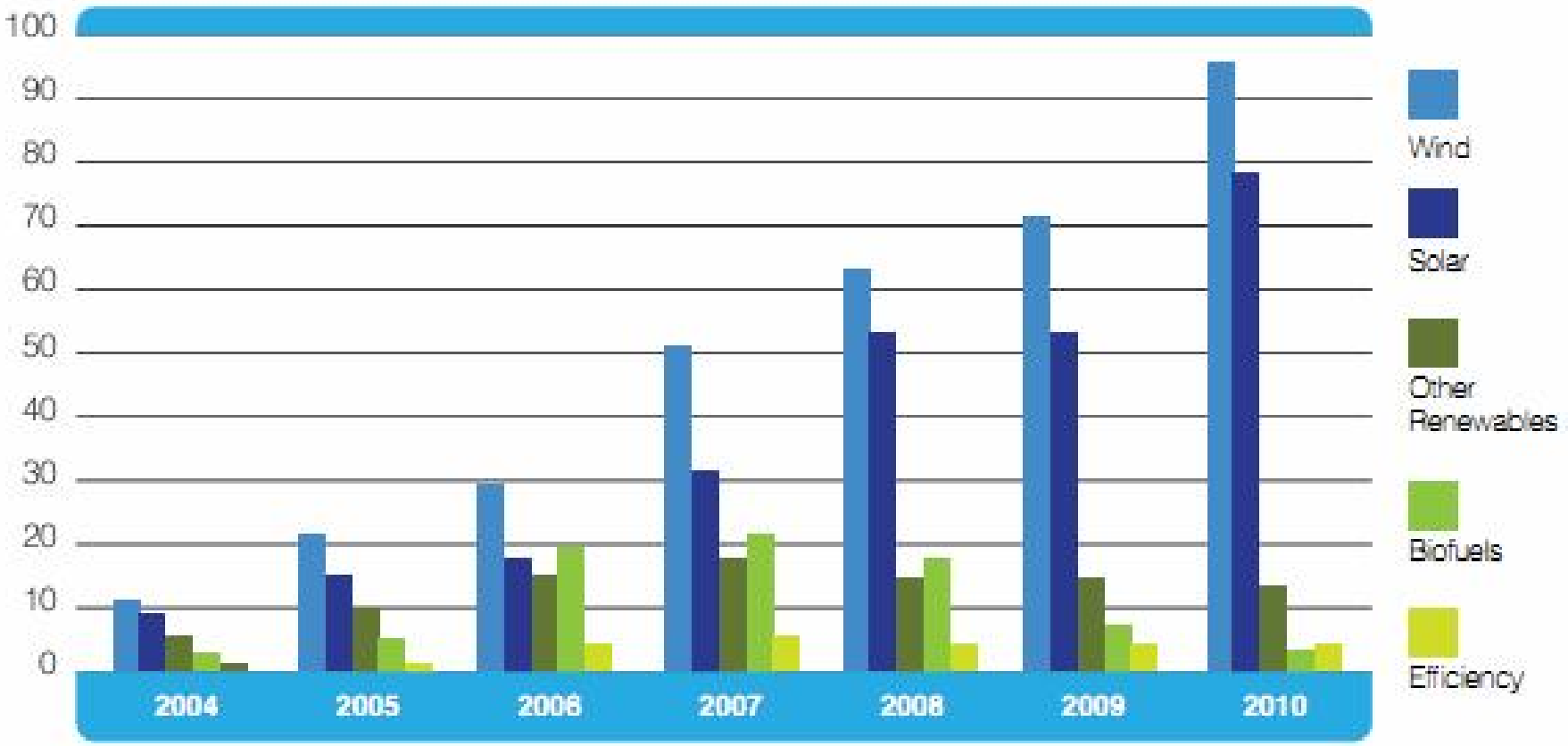

Source: PEW, BNEF; 2011

# Asia on the rise in global renewable energy investments ($US bln)



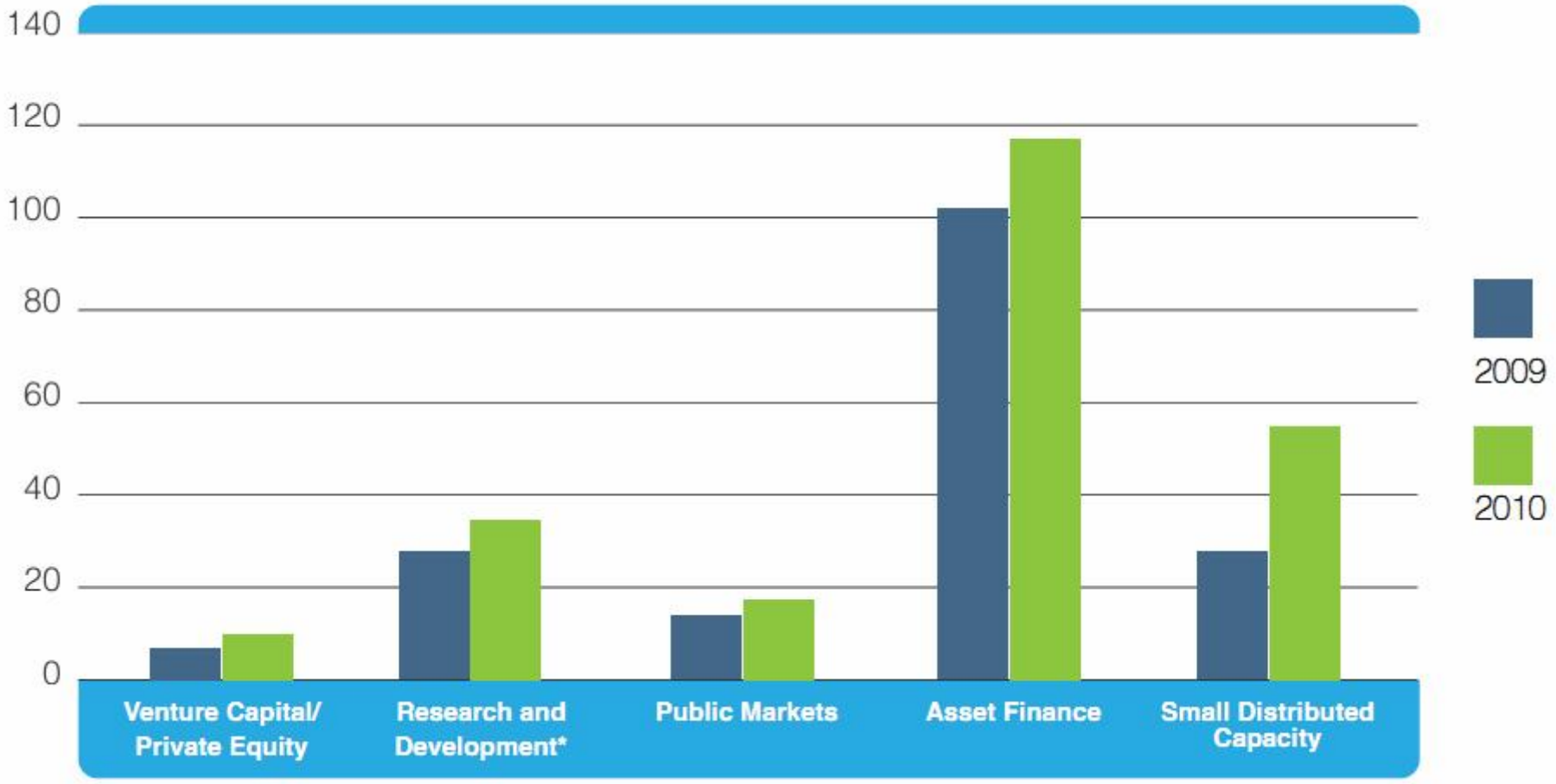

Source: PEW, BNEF; 2011

# Wind power leads global clean energy investments ($US bln)




Source: PEW, BNEF; 2011

# Most investments by Asset Finance ($US bln)




Source: PEW, BNEF; 2011

# Largest investors

| 2010 Rank | Country | 2010 Investment (billions of $) | 2009 Investment (billions of $) | 2009 Rank |
|---|---|---|---|---|
| 1 | China | 54.4 | 39.1 | 1 |
| 2 | Germany | 41.2 | 20.6 | 3 |
| 3 | United States | 34.0 | 22.5 | 2 |
| 4 | Italy | 13.9 | 6.2 | 8 |
| 5 | Rest of EU-27 | 13.4 | 13.3 | 4 |
| 6 | Brazil | 7.6 | 7.7 | 7 |
| 7 | Canada | 5.6 | 3.5 | 9 |
| 8 | Spain | 4.9 | 10.5 | 6 |
| 9 | France | 4.0 | 3.2 | 12 |
| 10 | India | 4.0 | 3.2 | 11 |

Source: PEW, BNEF; 2011

# RES growth rates in last 5 years

| Rank | Country | 5-Year Growth Rate |
|---|---|---|
| 1 | Turkey | 190% |
| 2 | Argentina | 115% |
| 3 | South Africa | 94% |
| 4 | Indonesia | 89% |
| 5 | China | 88% |
| 6 | Brazil | 81% |
| 7 | Mexico | 74% |
| 8 | Italy | 71% |
| 9 | South Korea | 62% |
| 10 | Rest of EU-27 | 62% |

Source: PEW, BNEF; 2011

# Largest RES power capacities (GW)

| Rank | Country | Capacity |
|---|---|---|
| 1 | China | 103.36 |
| 2 | United States | 57.99 |
| 3 | Germany | 48.86 |
| 4 | Rest of EU-27 | 39.80 |
| 5 | Spain | 27.78 |
| 6 | Japan | 25.96 |
| 7 | India | 18.65 |
| 8 | Italy | 16.66 |
| 9 | Brazil | 13.84 |
| 10 | France | 9.57 |

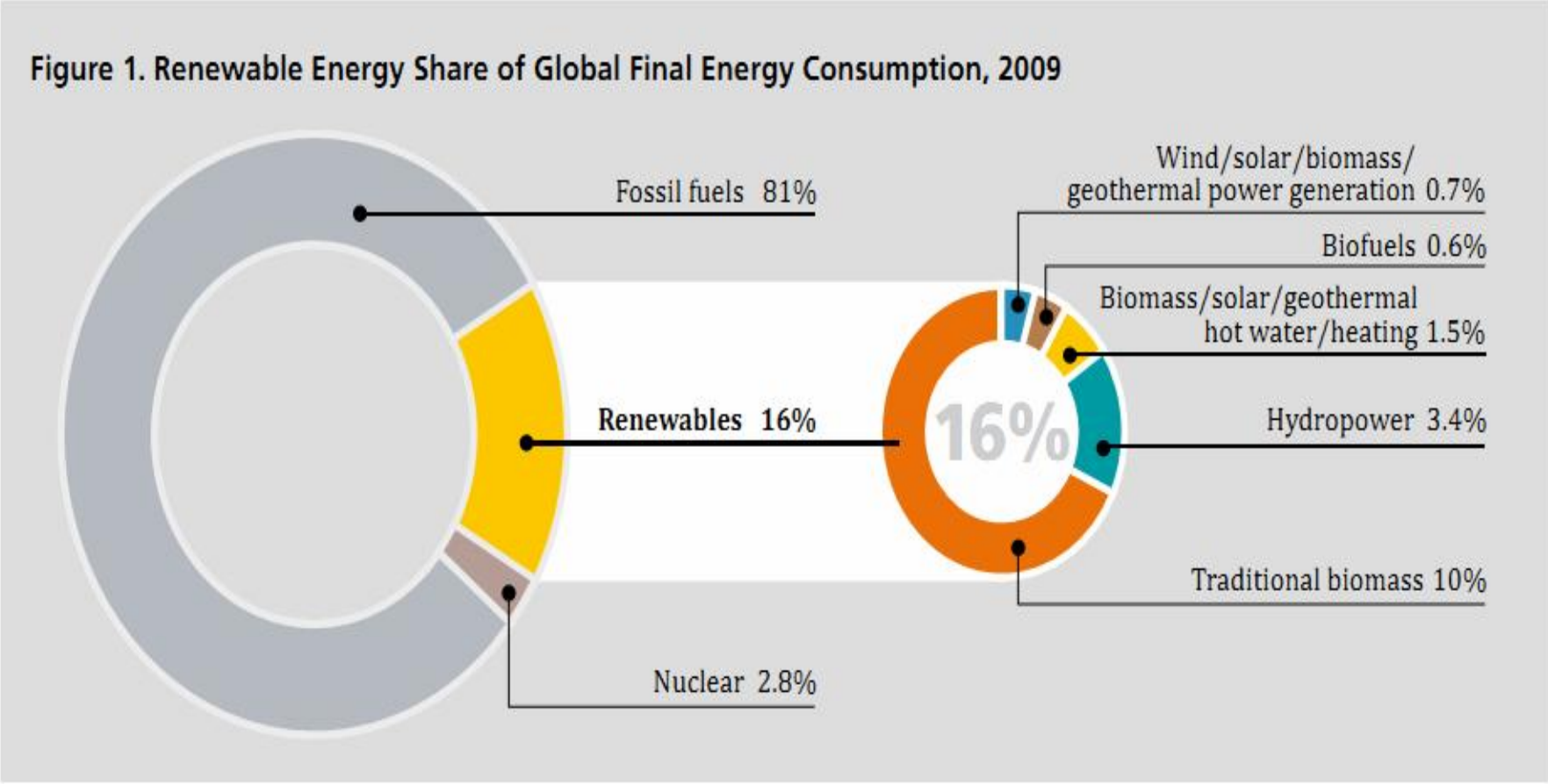
Source: PEW, BNEF; 2011

# The largest efforts (national investments in % of GDP)

| Rank | Country | Intensity |
|---|---|---|
| 1 | Germany | 1.4% |
| 2 | Italy | 0.79% |
| 3 | China | 0.55% |
| 4 | Canada | 0.42% |
| 5 | Australia | 0.37% |
| 6 | Spain | 0.36% |
| 7 | Brazil | 0.35% |
| 8 | Rest of the EU-27 | 0.30% |
| 9 | United States | 0.23% |
| 10 | France | 0.15% |

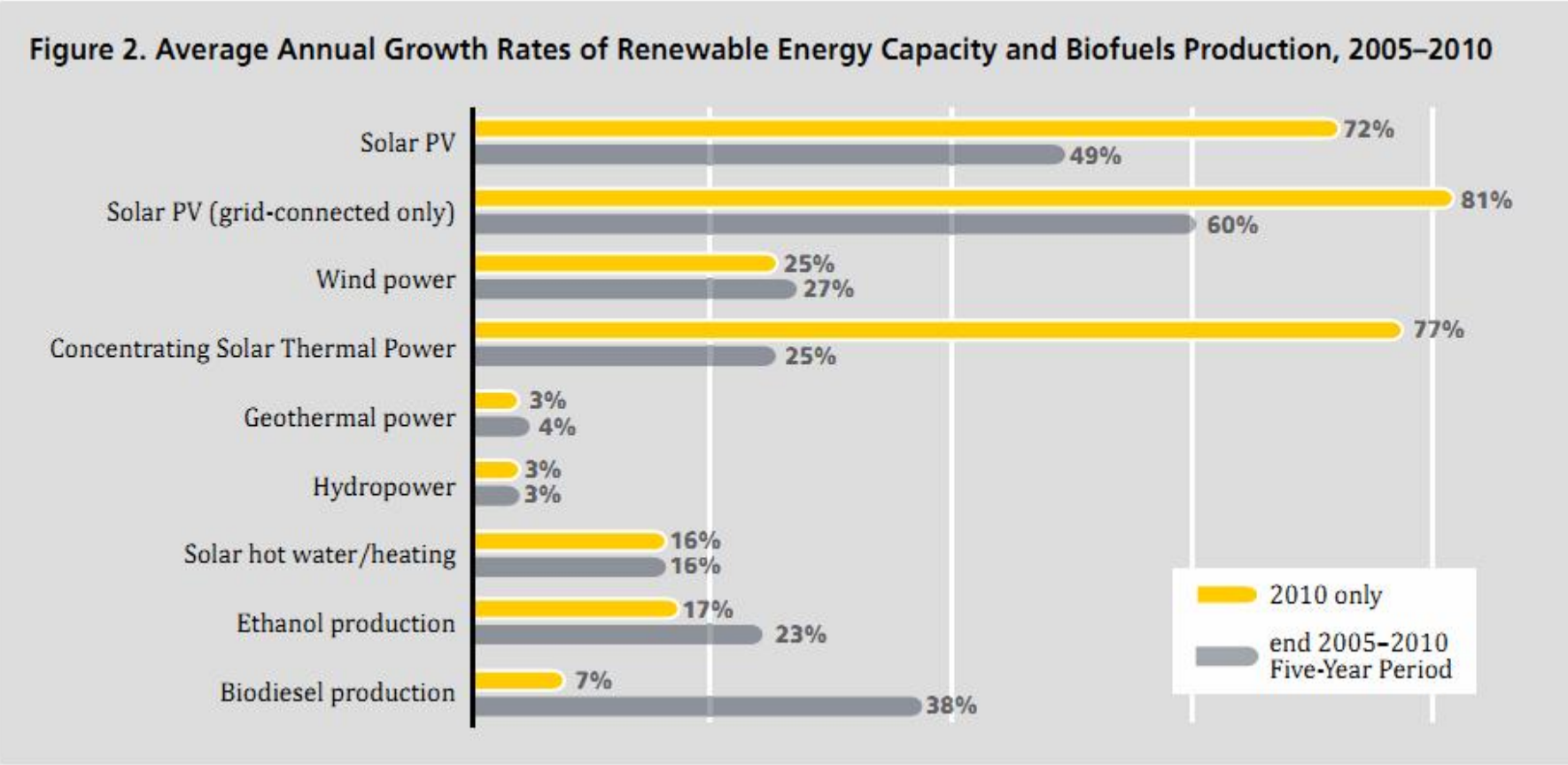
Source: PEW, BNEF; 2011

# Traditional biomass still have largest RES share



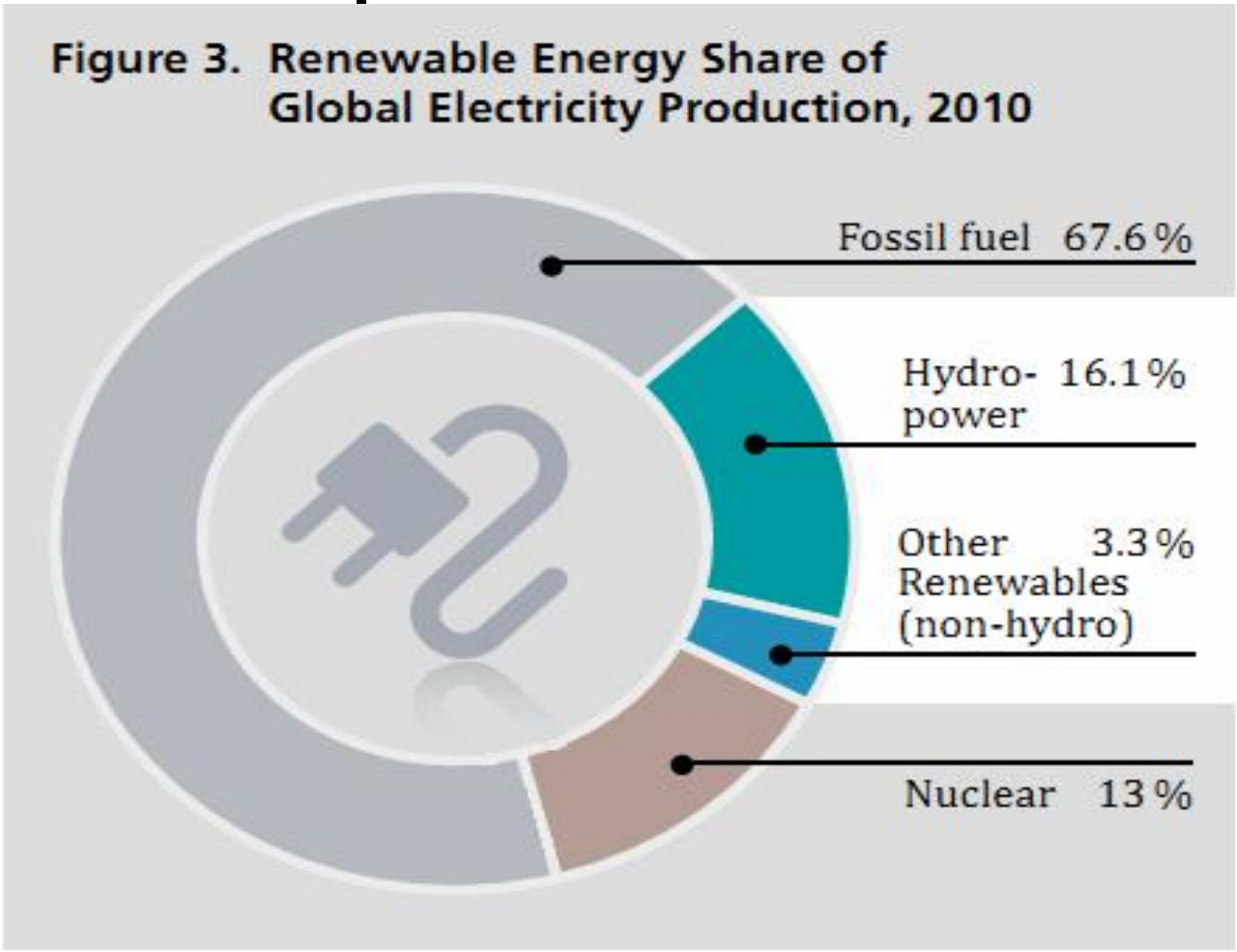

Source: REN 21, 2011

# Largest growth in solar in last year 2010



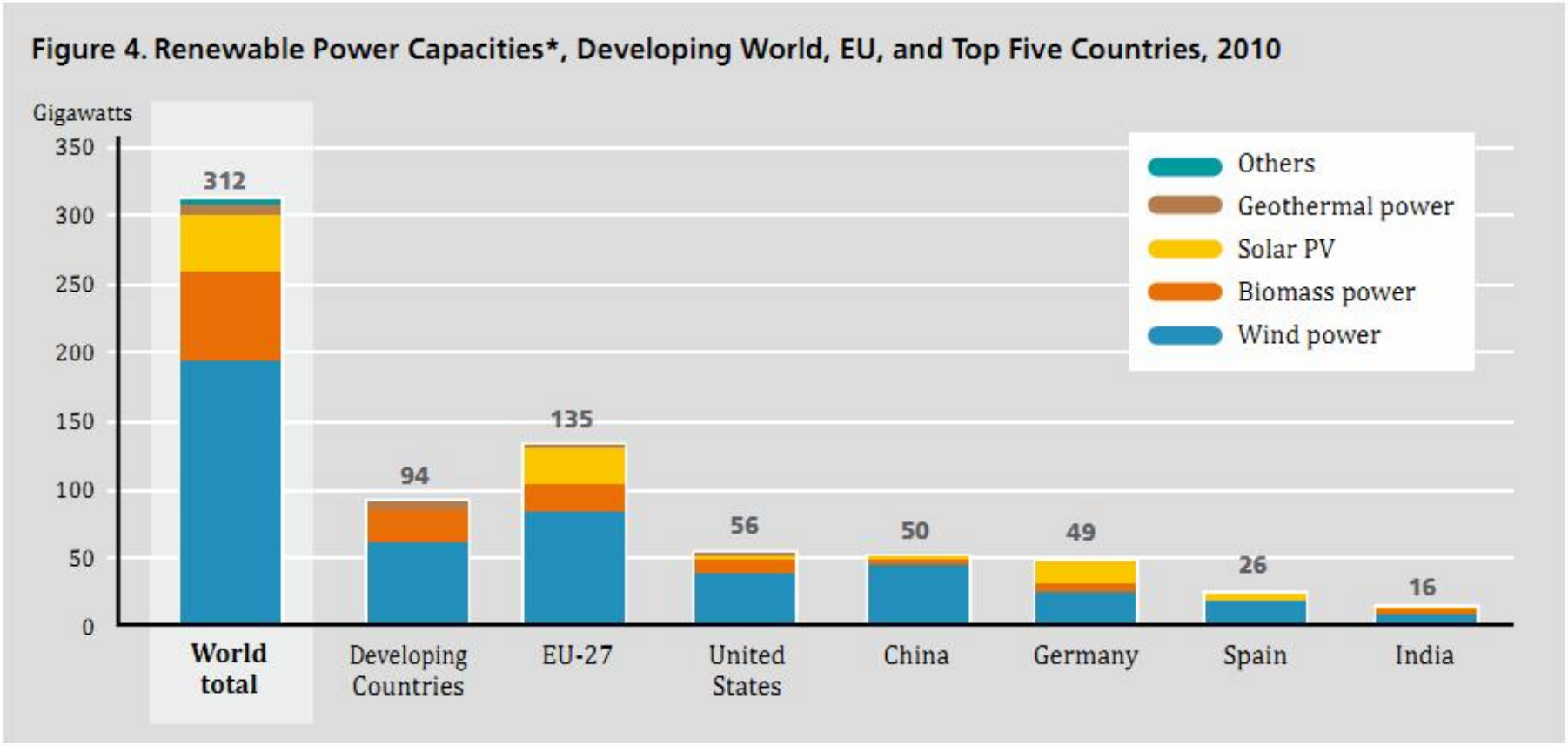

Source: REN 21, 2011

# Hydropower still largest RES power source



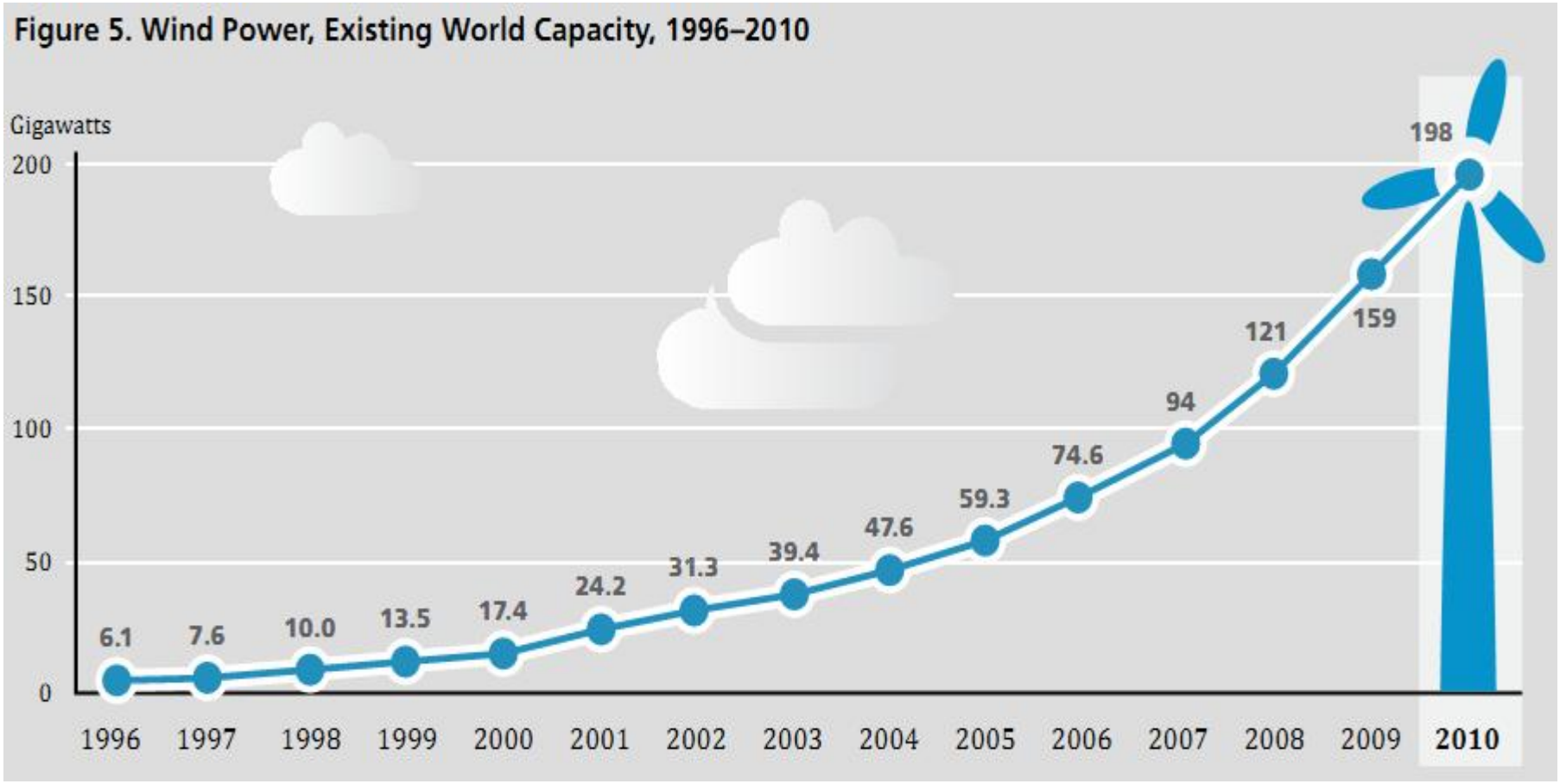

Source: REN 21, 2011

# Largest RES power capacity in EU27 (excl. large hydro)



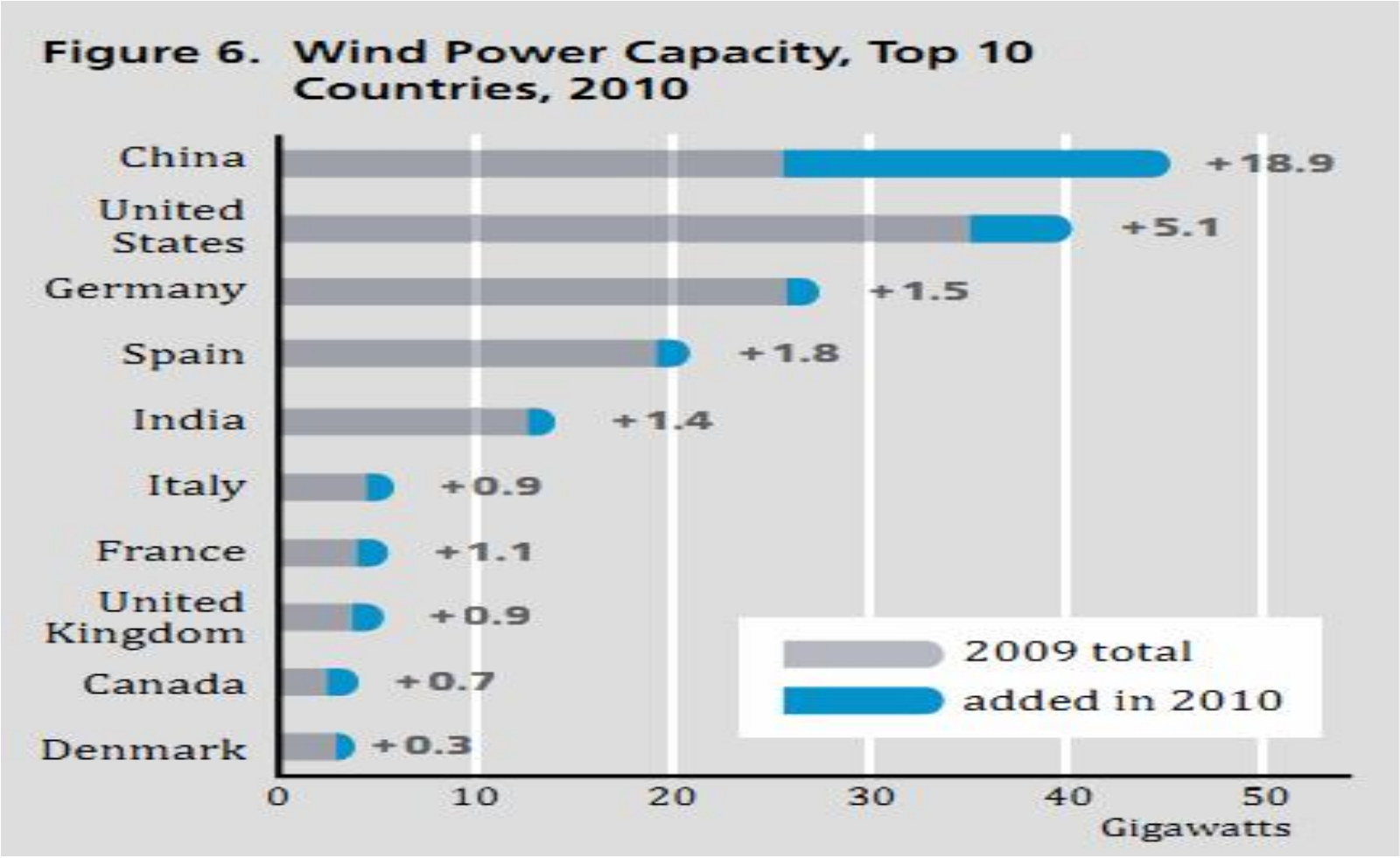

Source: REN 21, 2011

# Global wind power growth



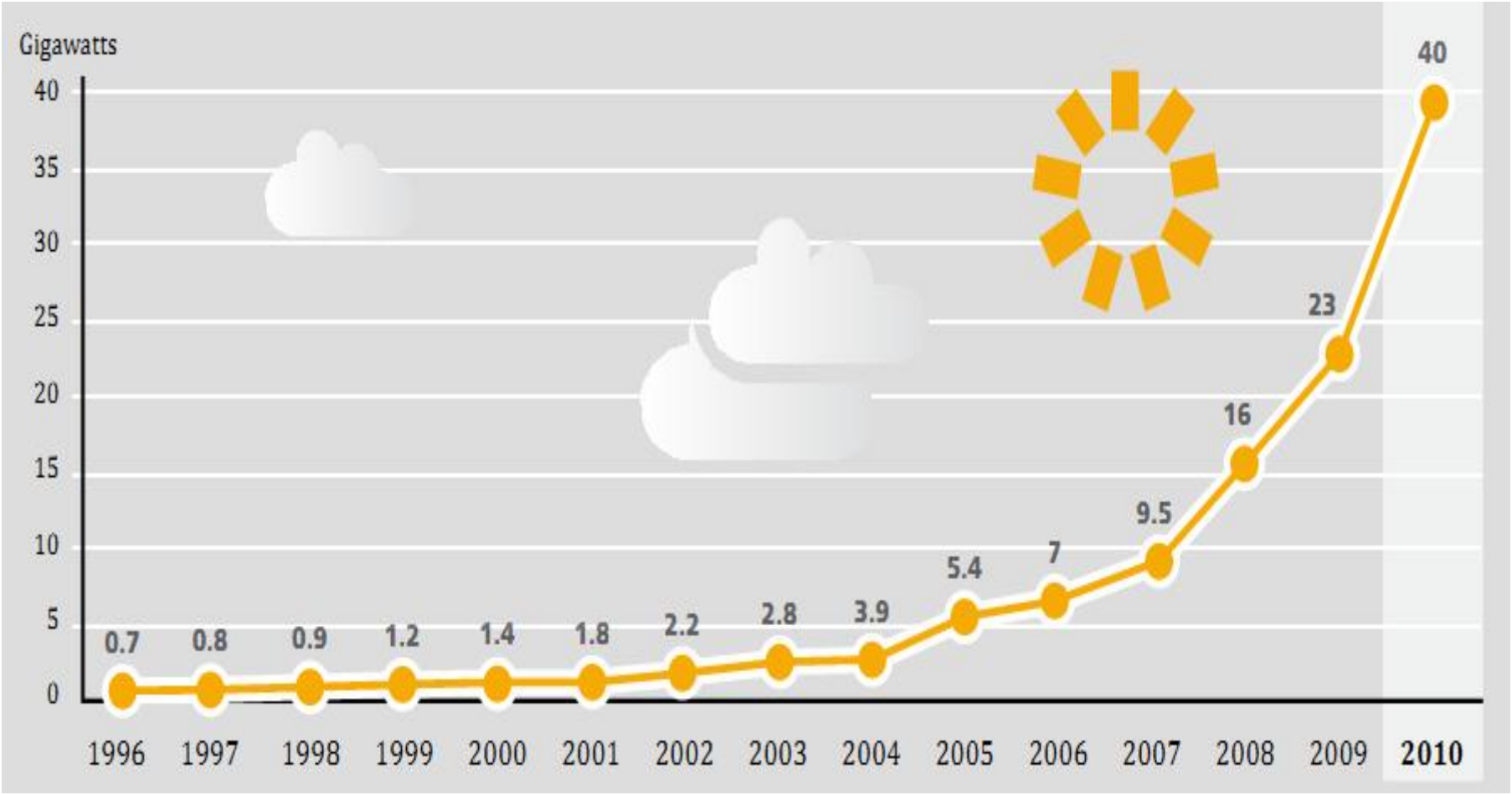

Source: REN 21, 2011

# China largest wind country



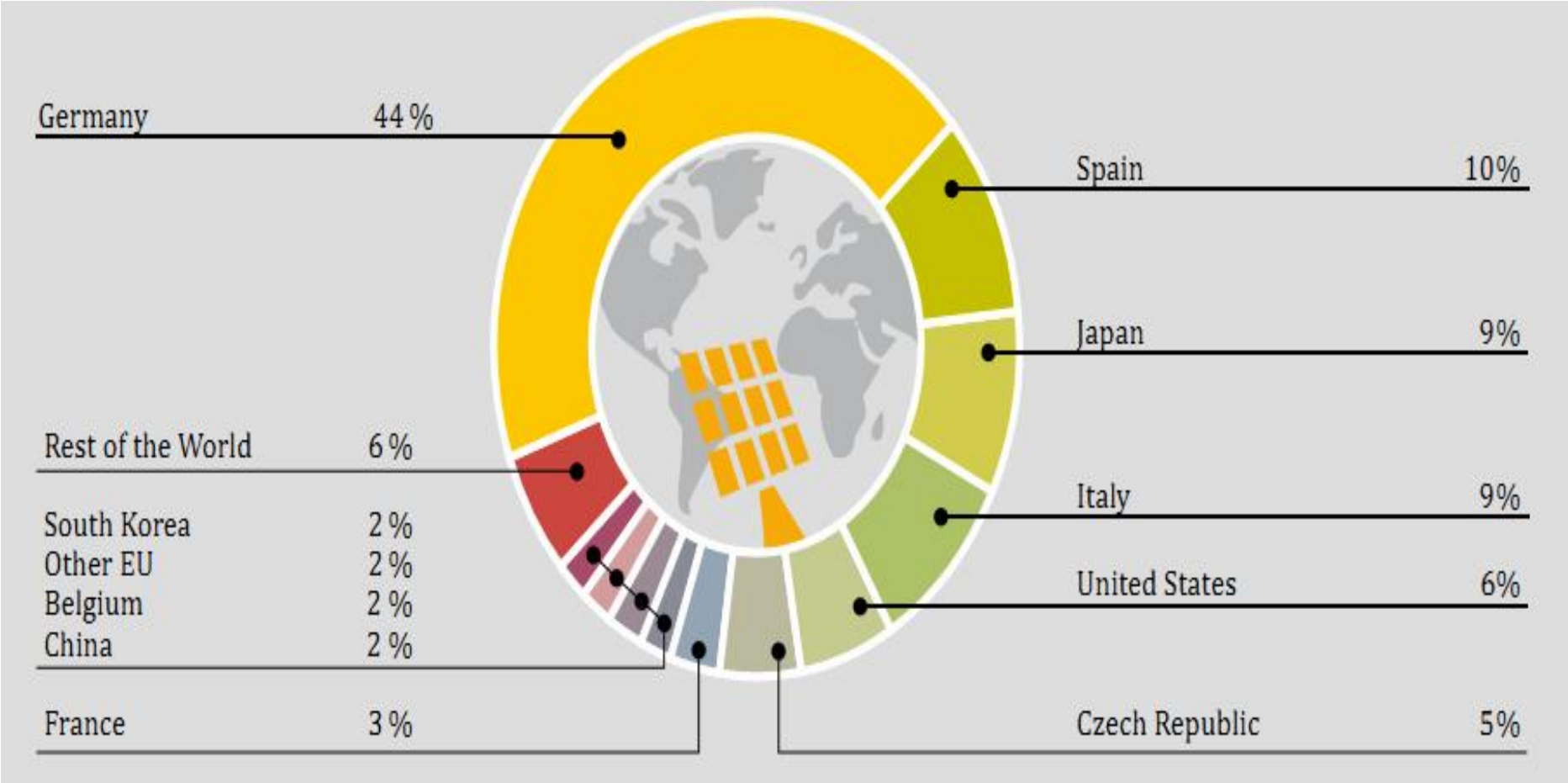

Source: REN 21, 2011

# Global PV growth



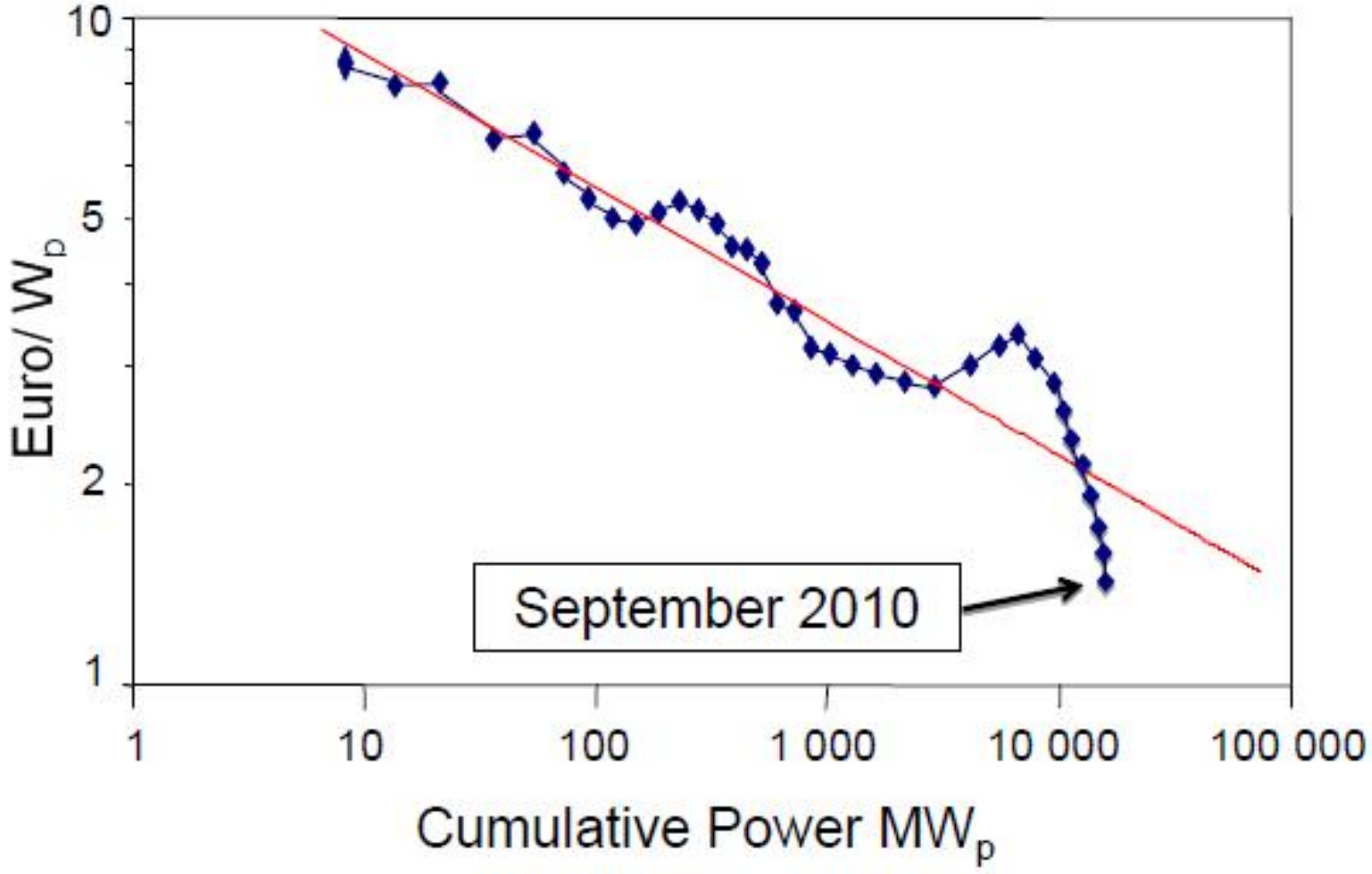

Source: REN 21, 2011

# Germany largest PV country



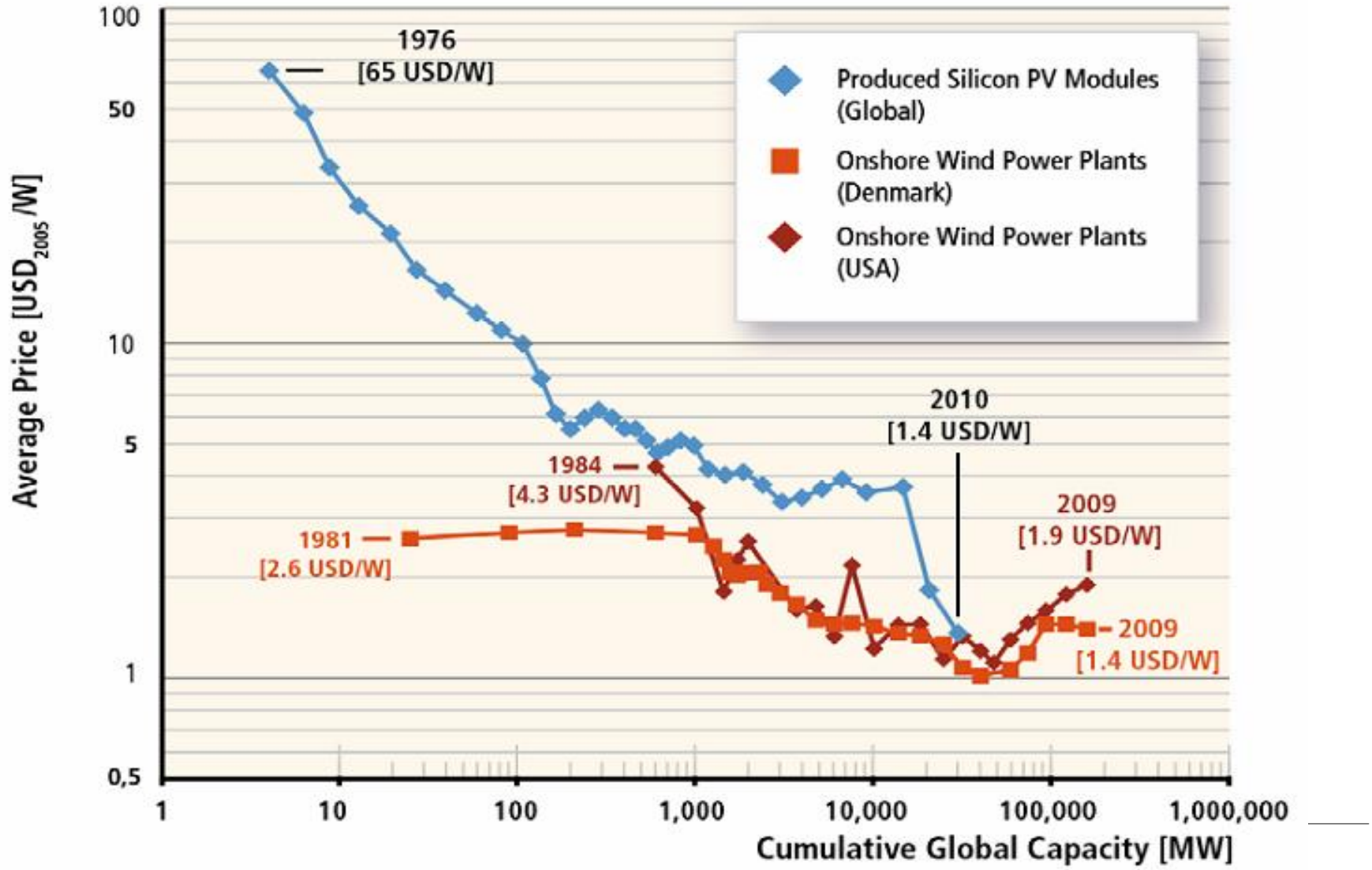

Source: REN 21, 2011

# Exponential cost decline of PV Modules

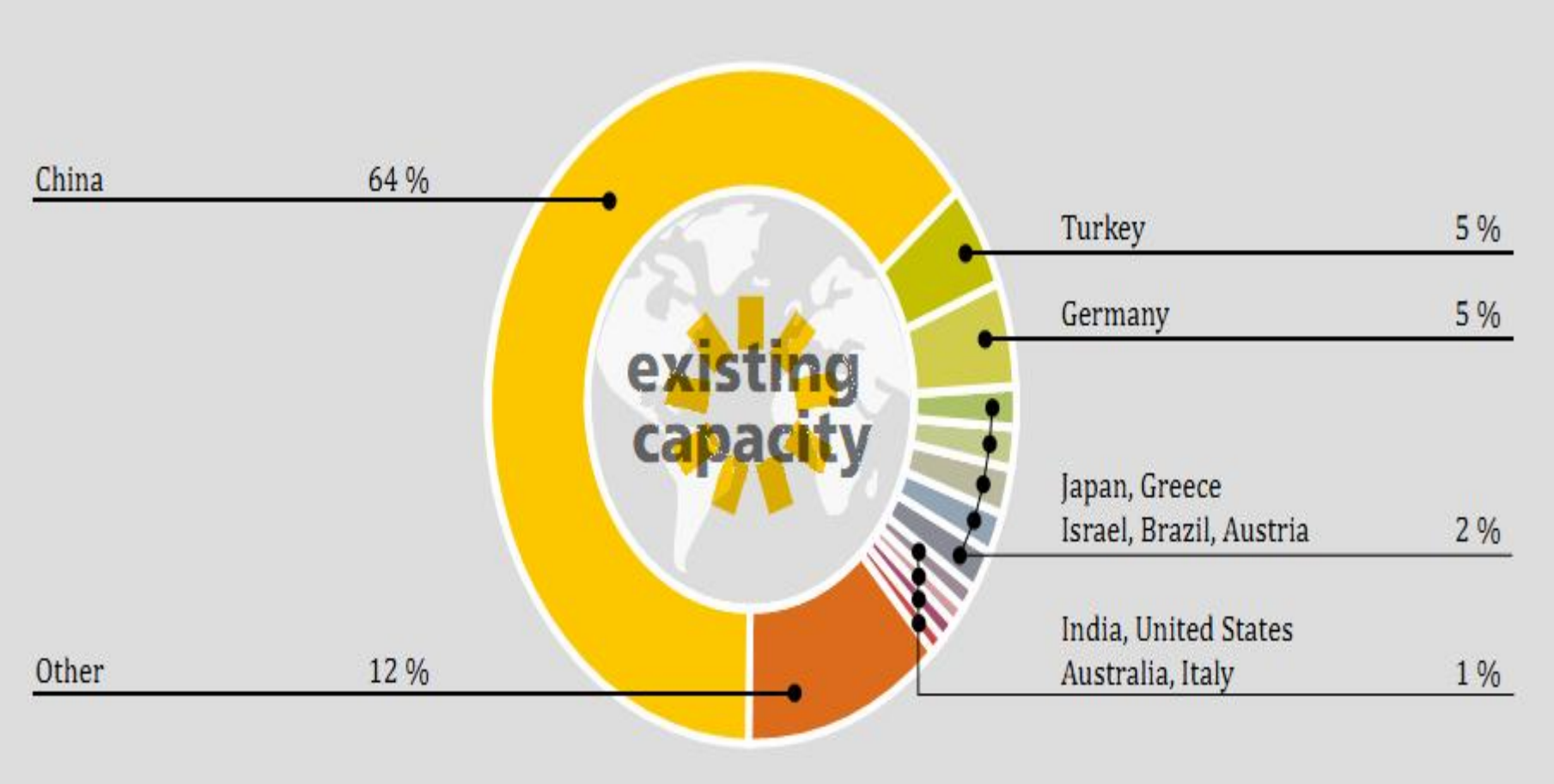



Source: Solar Generation, IEA-PVPS 2006; SERIS market research 2010

# Renewable cost developments

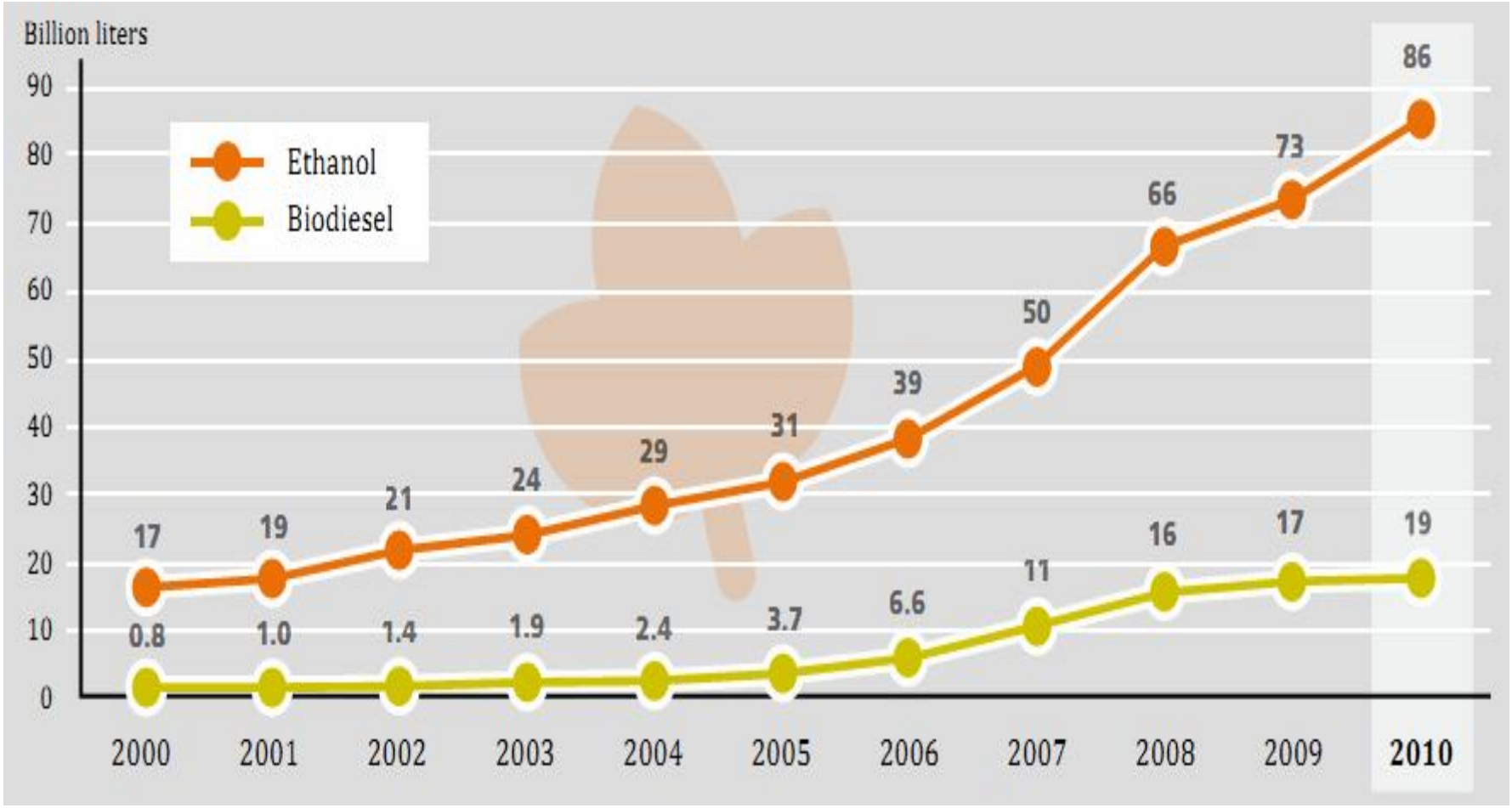


# China largest solar heating capacity



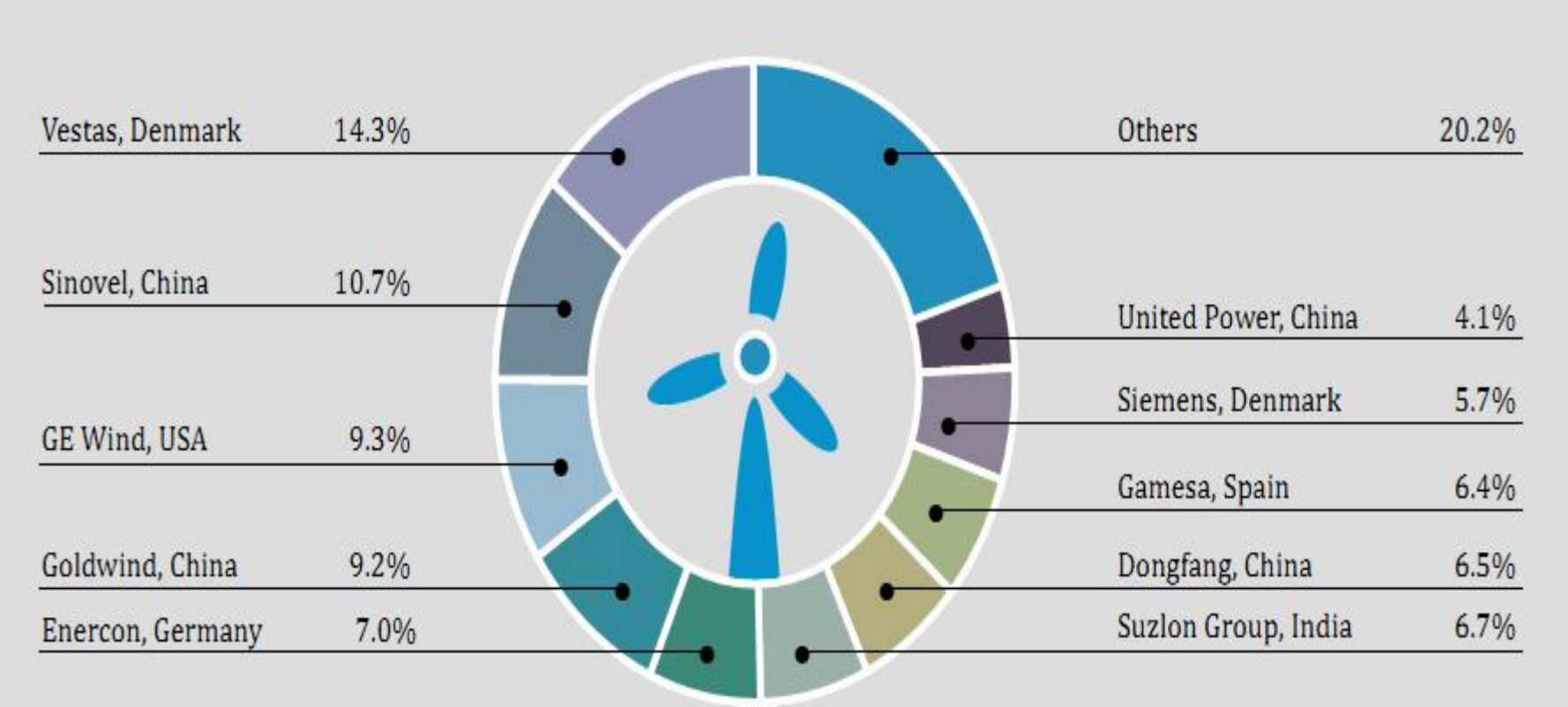

Source: REN 21, 2011

# Global biofuel production



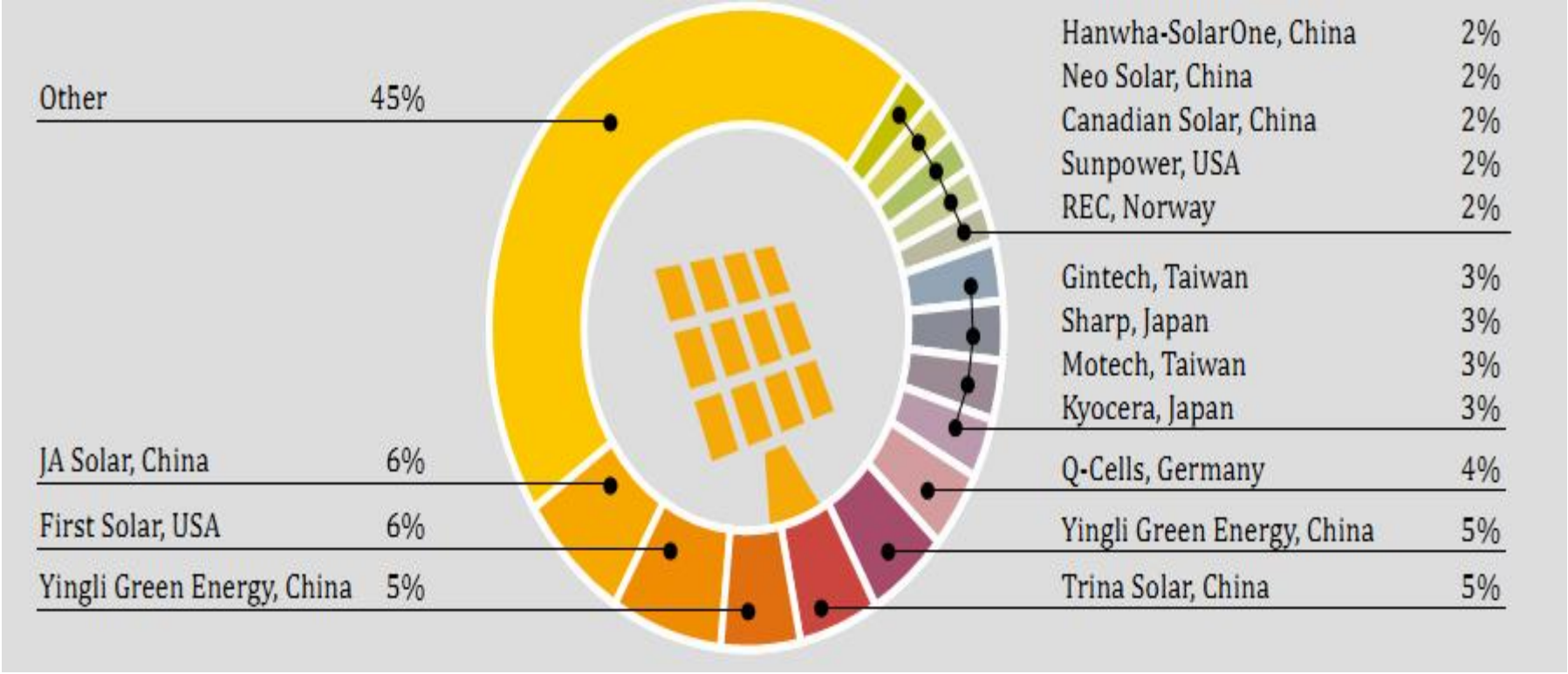

Source: REN 21, 2011

# 10 companies produce 80% of all wind turbines



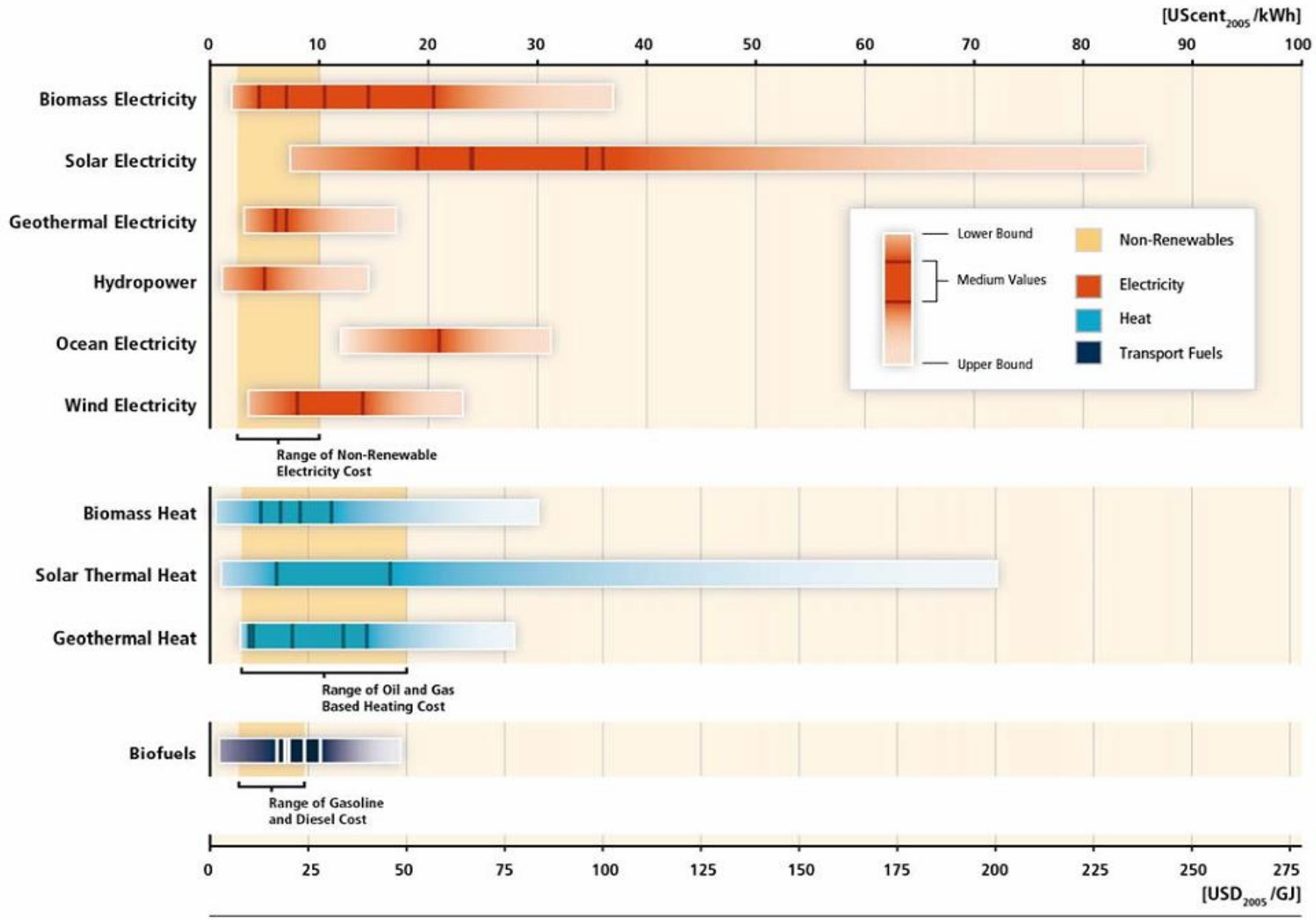

Source: REN 21, 2011

# 15 companies produce 55% of all PV plants




Source: REN 21, 2011

# Renewable costs




WWF
REPORT
2011
ECOFYS
OMA
AMO
THE ENERGY REPORT
100% RENEWABLE ENERGY BY 2050

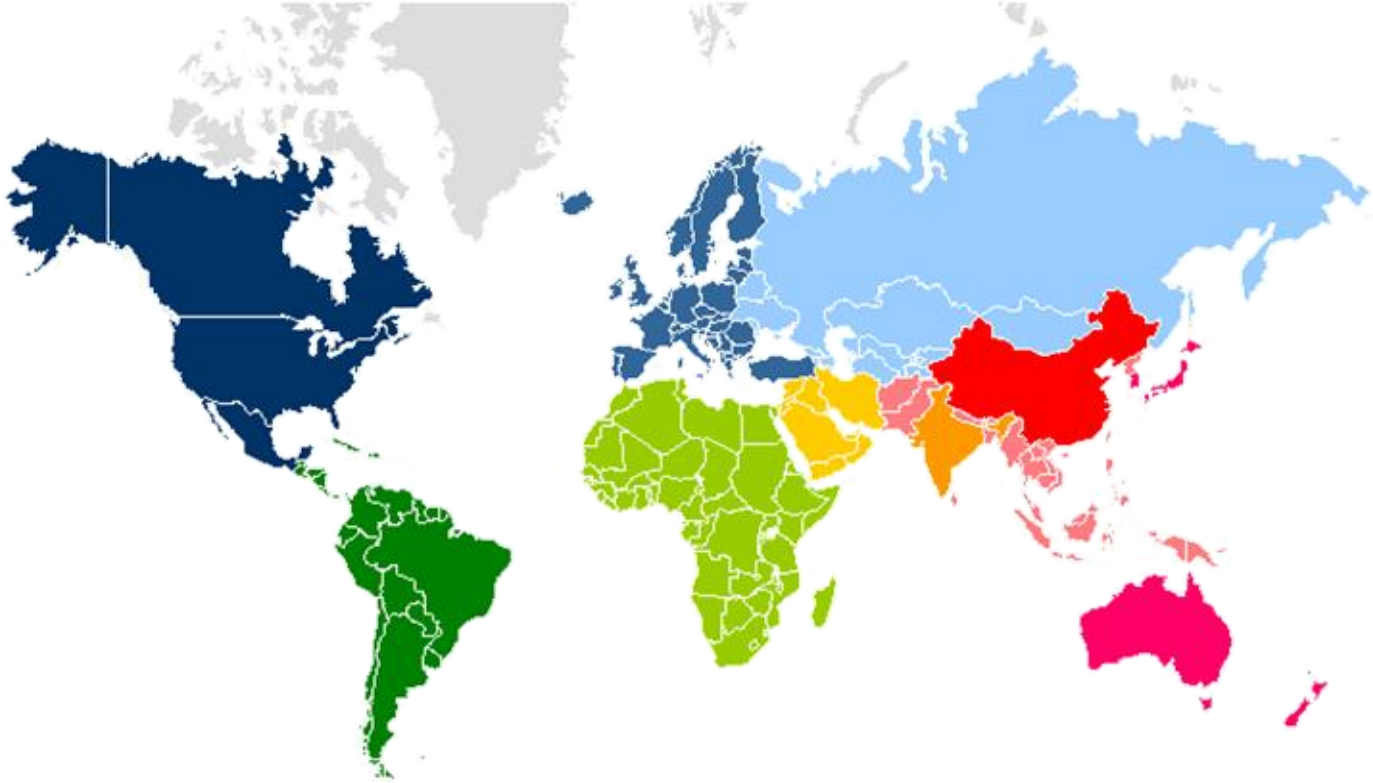
# The Scenario - Principle Assumptions

1. Conservation/efficiency – with Best Available Technology
2. Material efficiency – with Best Available Technology
3. Only materials, products "on shelf" today (2020)
4. Electricity highest priority – used as much as possible
5. Renewables growth rates below 'realisable' potential
6. Need to end energy poverty/traditional biomass
7. No nuclear, no CCS (NB: Not addressing process emissions)
8. All bioenergy must be based on sustainable practices – no cropland, forests, protected areas
9. Free technology transfer, free electricity trade
10. Accept 'BAU' for: Population growth, GDP, 'activity levels', fuel prices, limits to clean tech growth
11. Change 'BAU' for: Modal shift, diets

CCS: Carbon Capture & Storage
BAU: "Business-As-Usual"
GDP: Gross Domestic Product

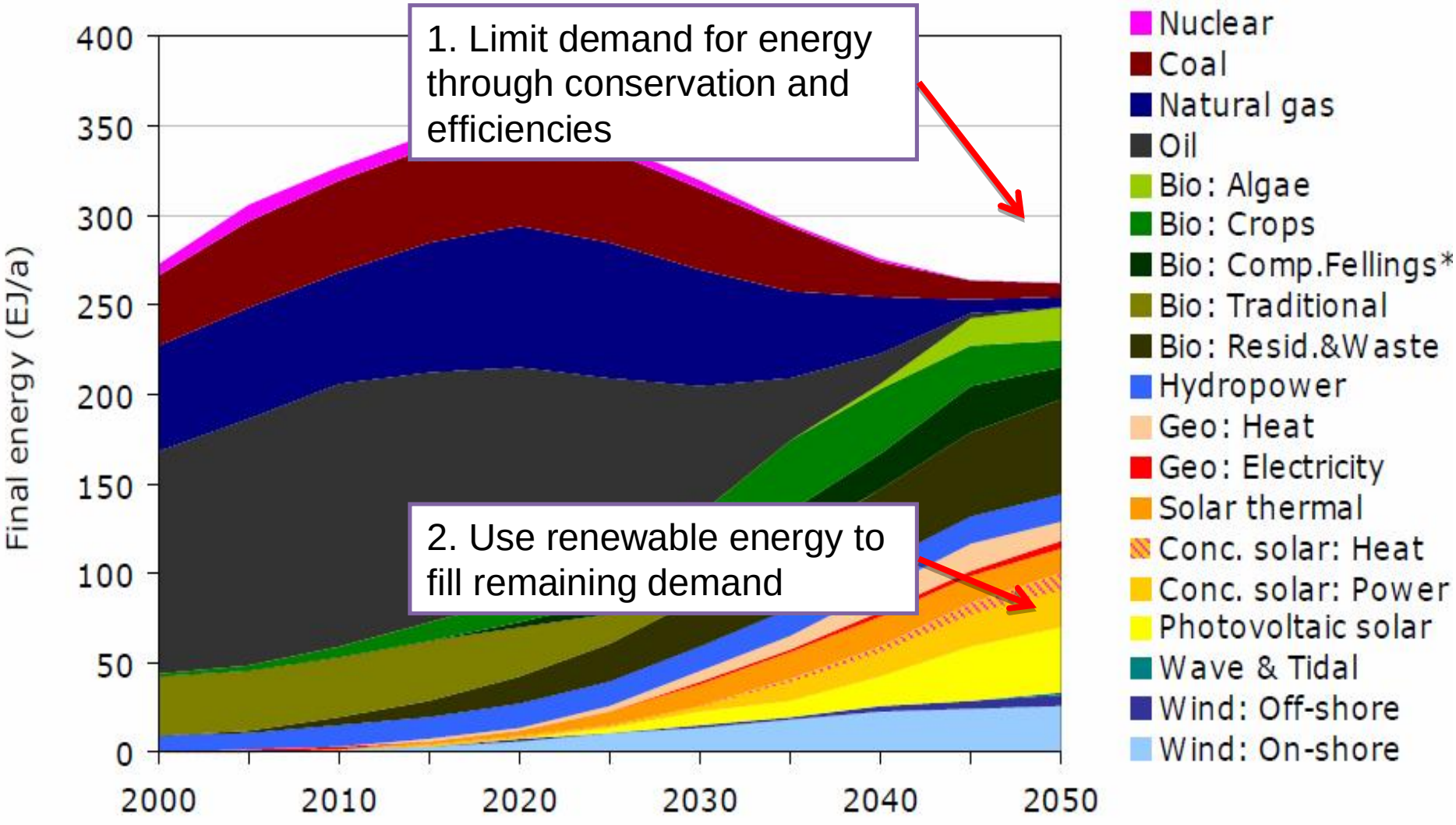
# Scope of the Scenario

Demand and supply examined in 10 world regions



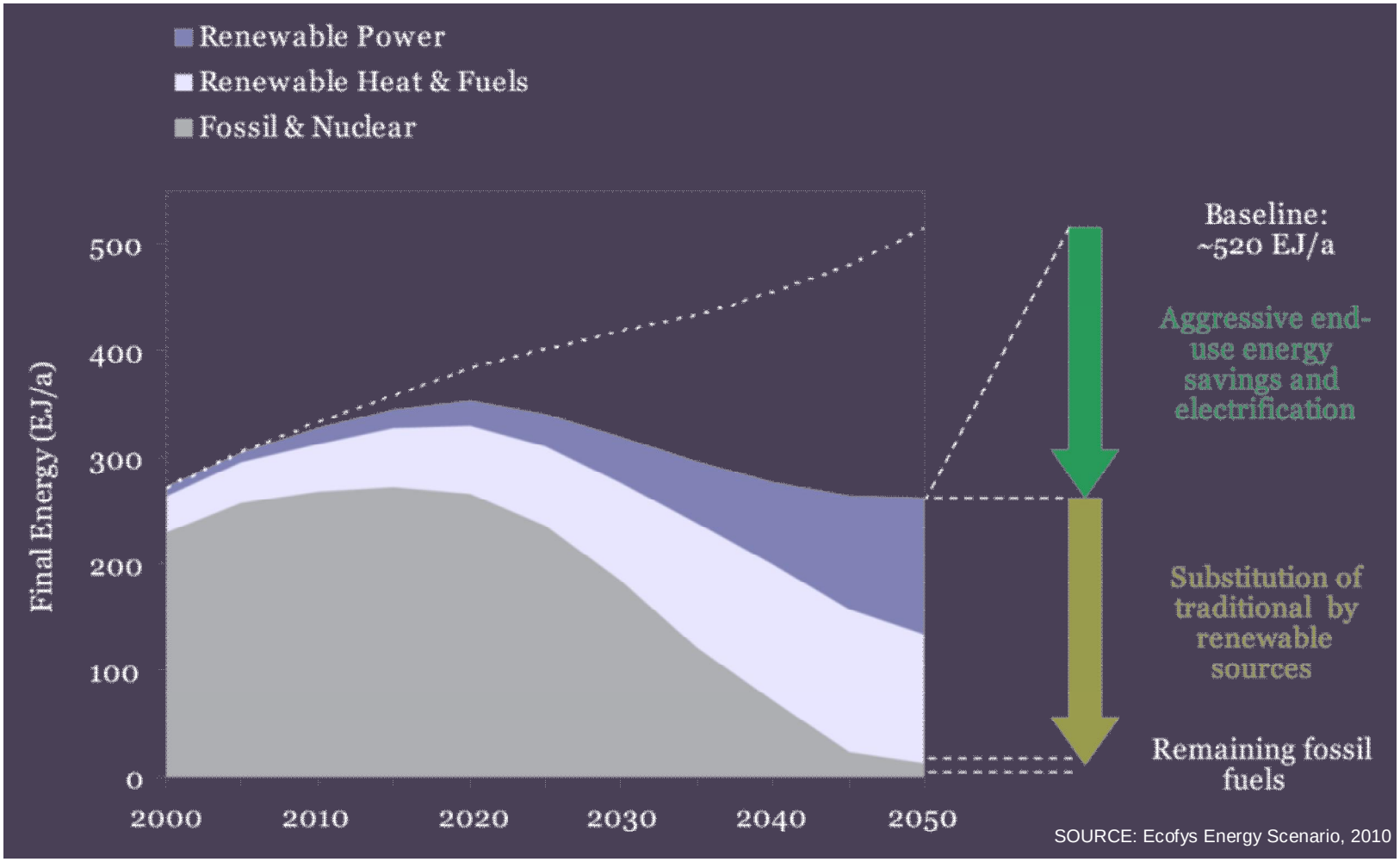
**Currently, the Scenario is only valid at the global level, but future regional studies are possible**

# The Scenario

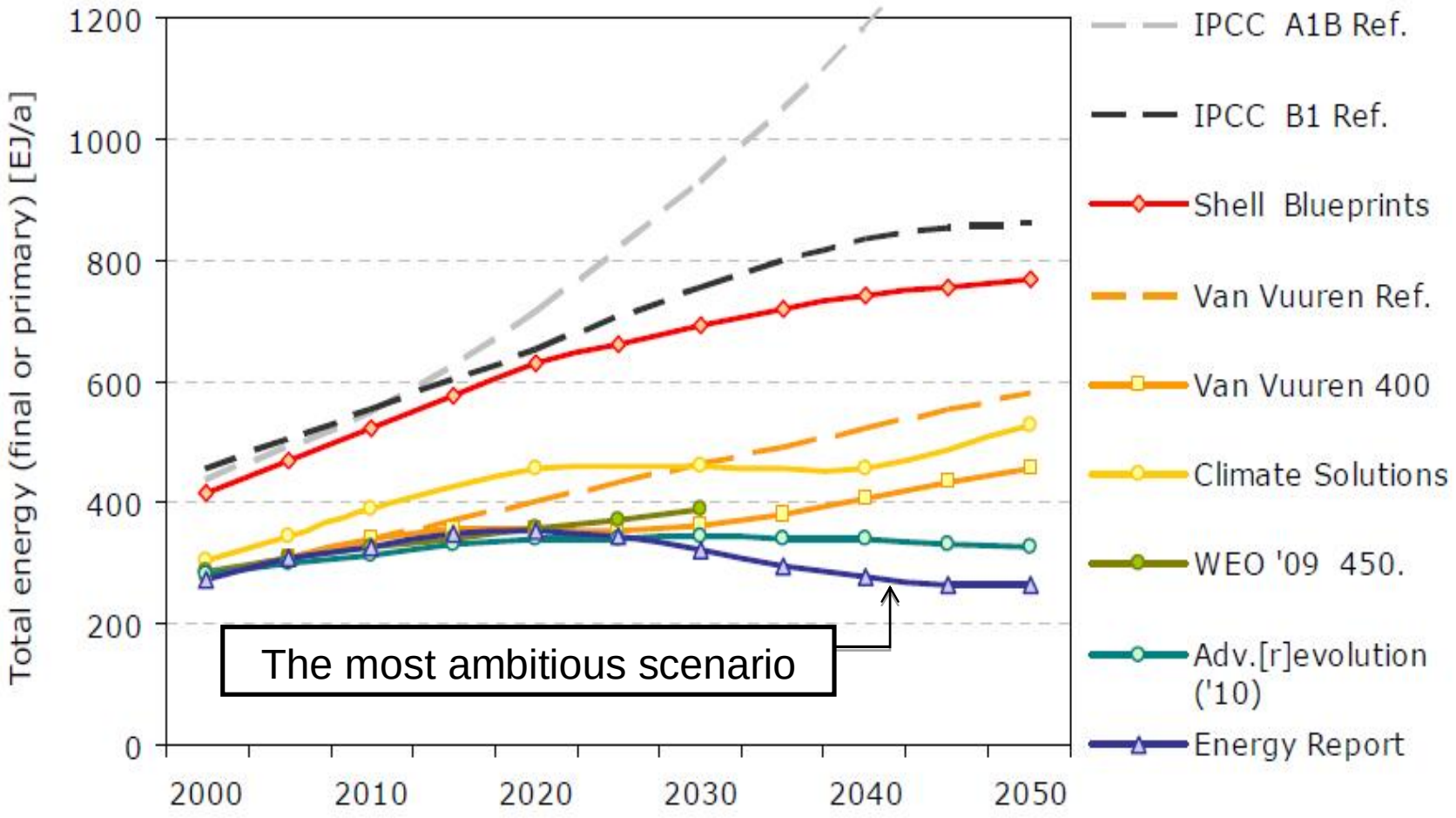



SOURCE: Ecofys Energy Scenario, 2010

# The Scenario – Key Elements

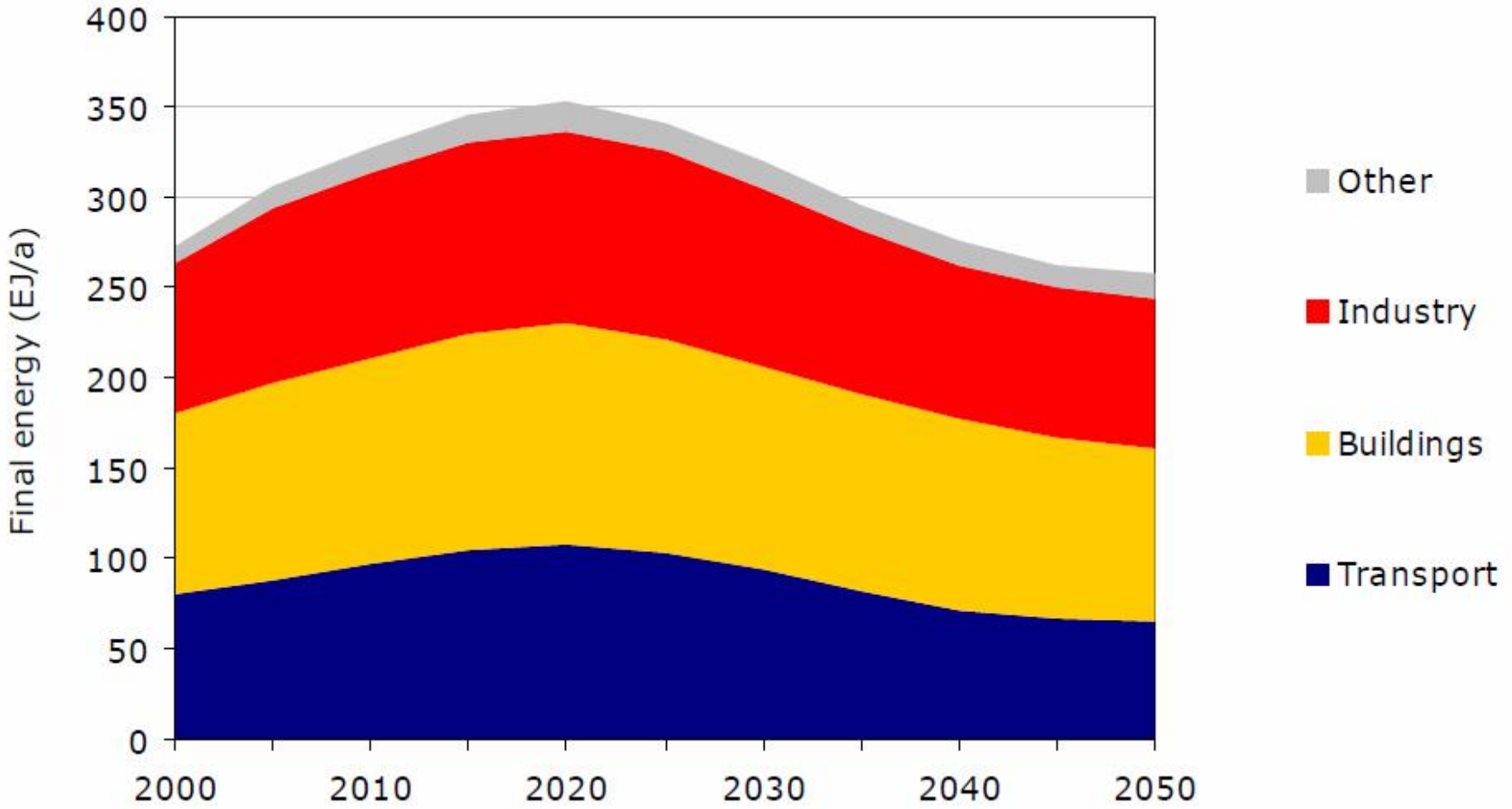


# Global Energy Demand




Global energy demand evolution in *The Energy Report* compared to other energy scenarios. Top three lines are in primary, lower six lines in final energy SOURCE: Ecofys Energy Scenario, 2010

# Sectoral World Energy Demand

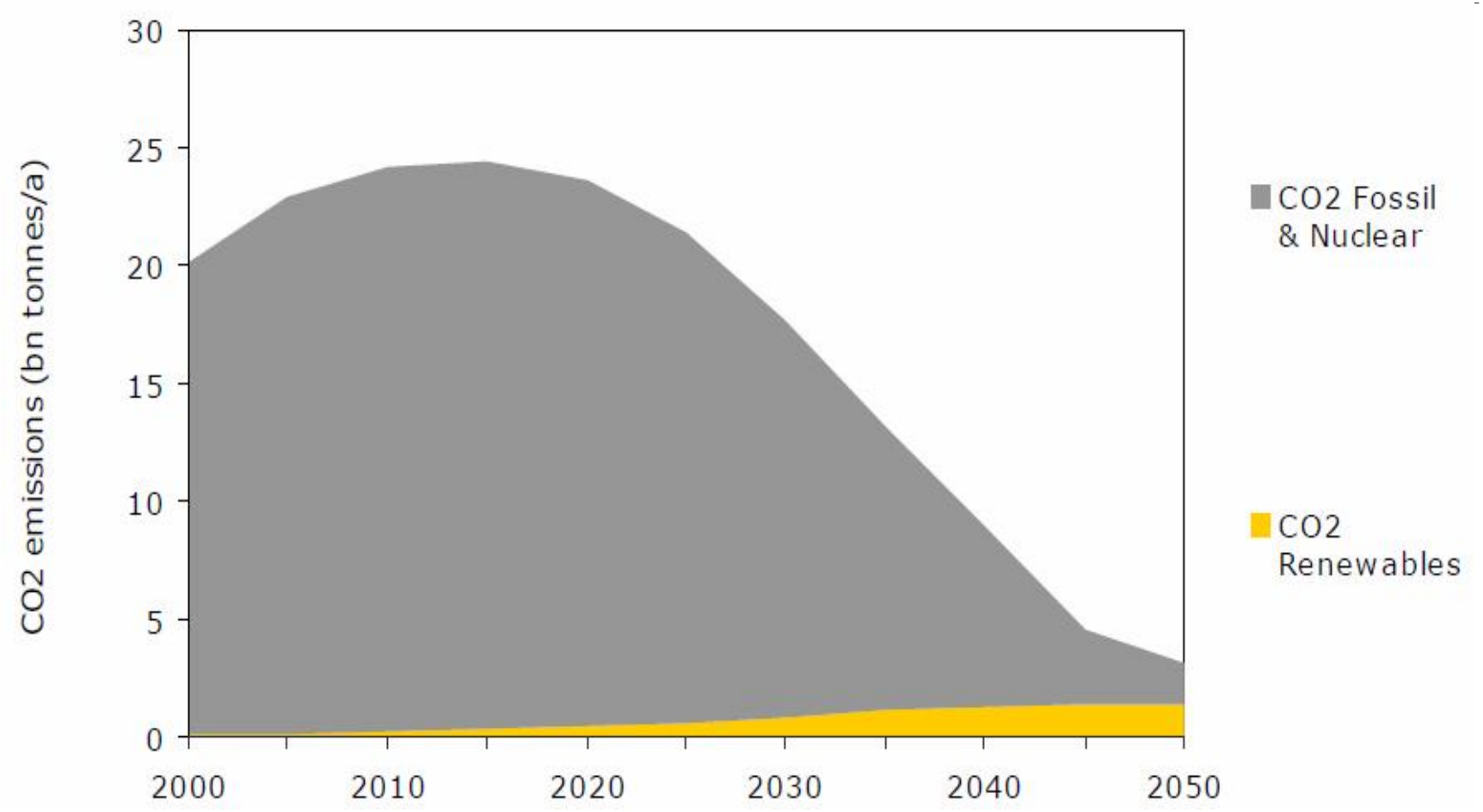



Global energy demand across all sectors, from 2000 to 2050

SOURCE: Ecofys Energy Scenario, 2010

# Reducing $CO_2$ Emissions from Energy Sector by >80%

**The Ecofys Scenario**

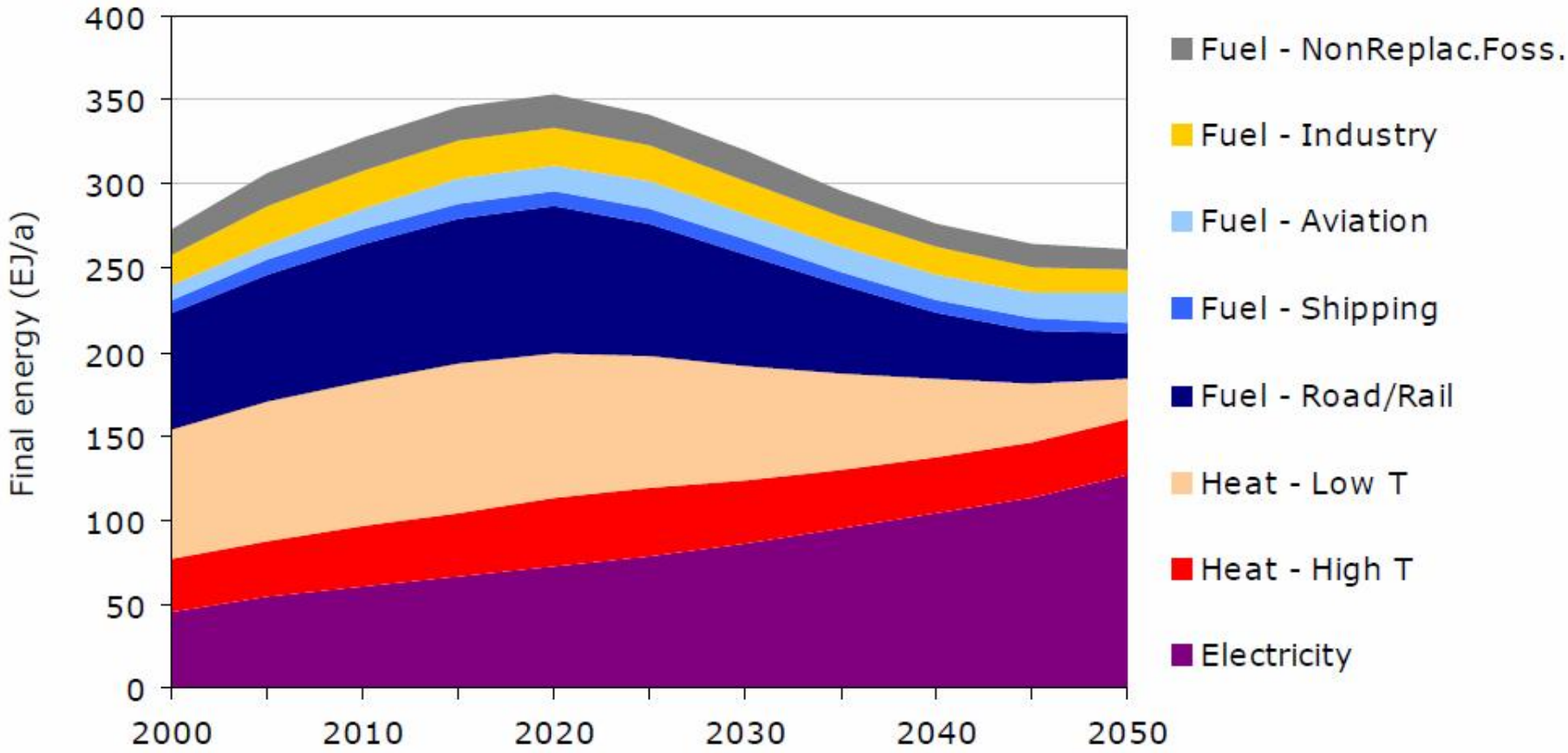



Global CO2-eq GHG emissions from the energy system in the scenario

SOURCE: Ecofys Energy Scenario, 2010

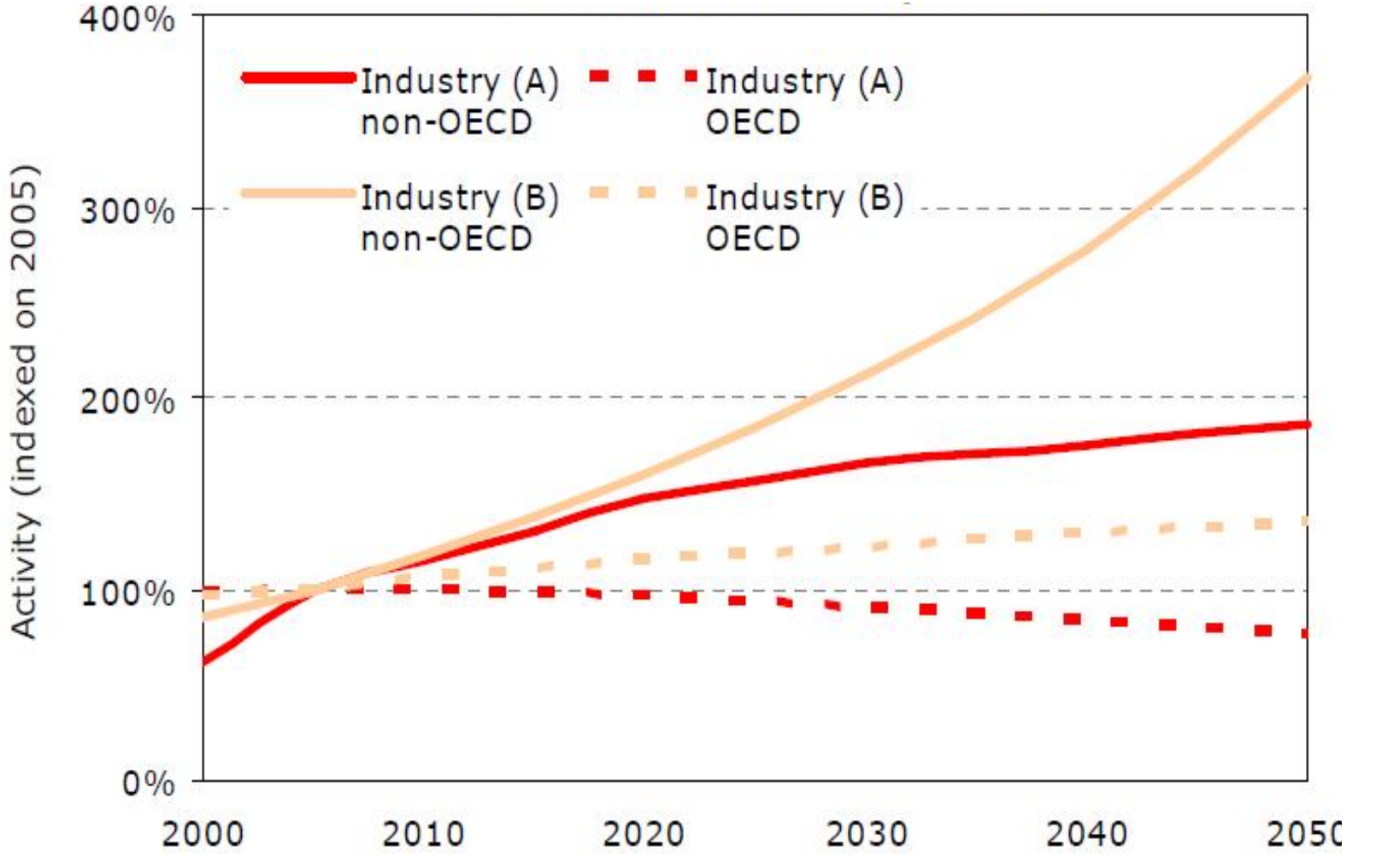
# Global Energy Demand

## Global energy demand in all sectors, split by energy carrier




SOURCE: Ecofys Energy Scenario, 2010

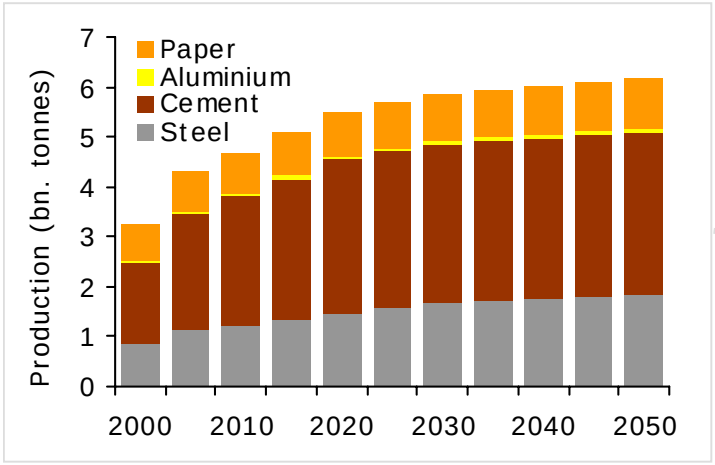
# Absolute Industry Activity Levels

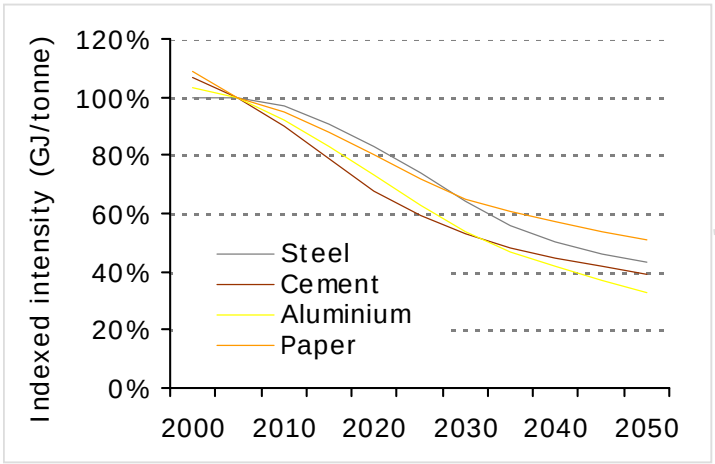


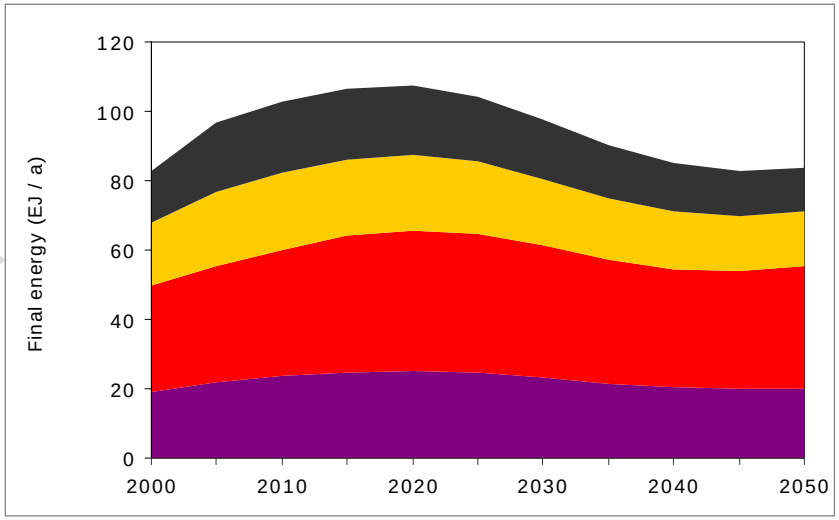

SOURCE: Ecofys Energy Scenario, 2010

# Energy Demand in Industry

Stabilisation in energy demand in industry results from ambitious efficiency improvements



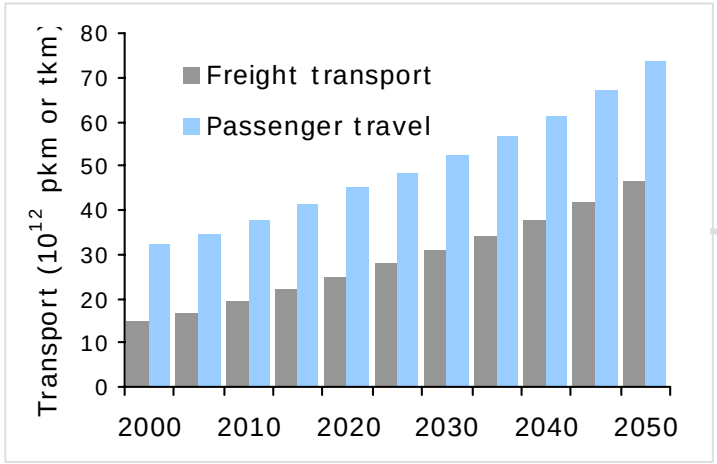



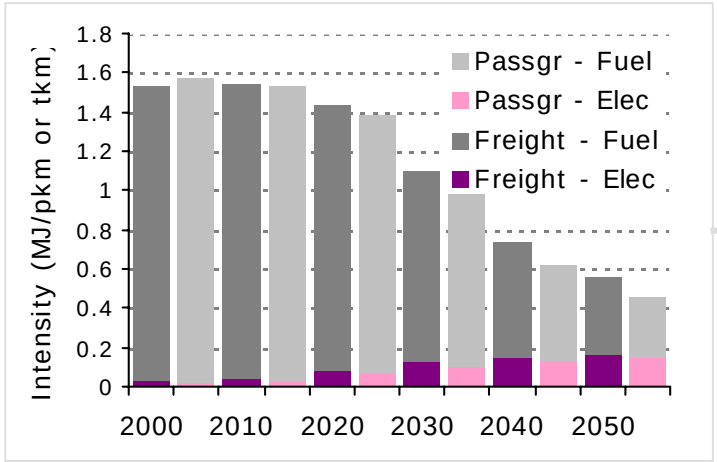




Activity and intensity graphs are only shown for Steel, Cement, Aluminium and Paper sectors for illustration. Other sectors are based on GDP growth projections

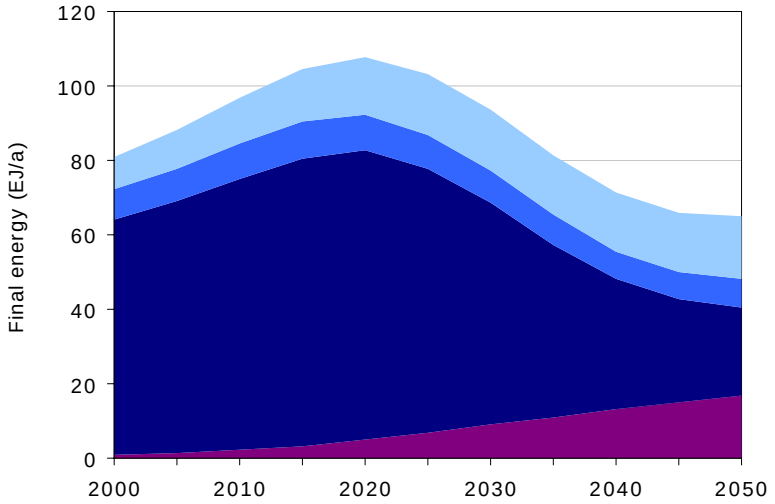
SOURCE: Ecofys Energy Scenario, 2010

# Demand in Transport Sector




The stabilisation in demand in the transport sector results from ambitious energy efficiency improvements

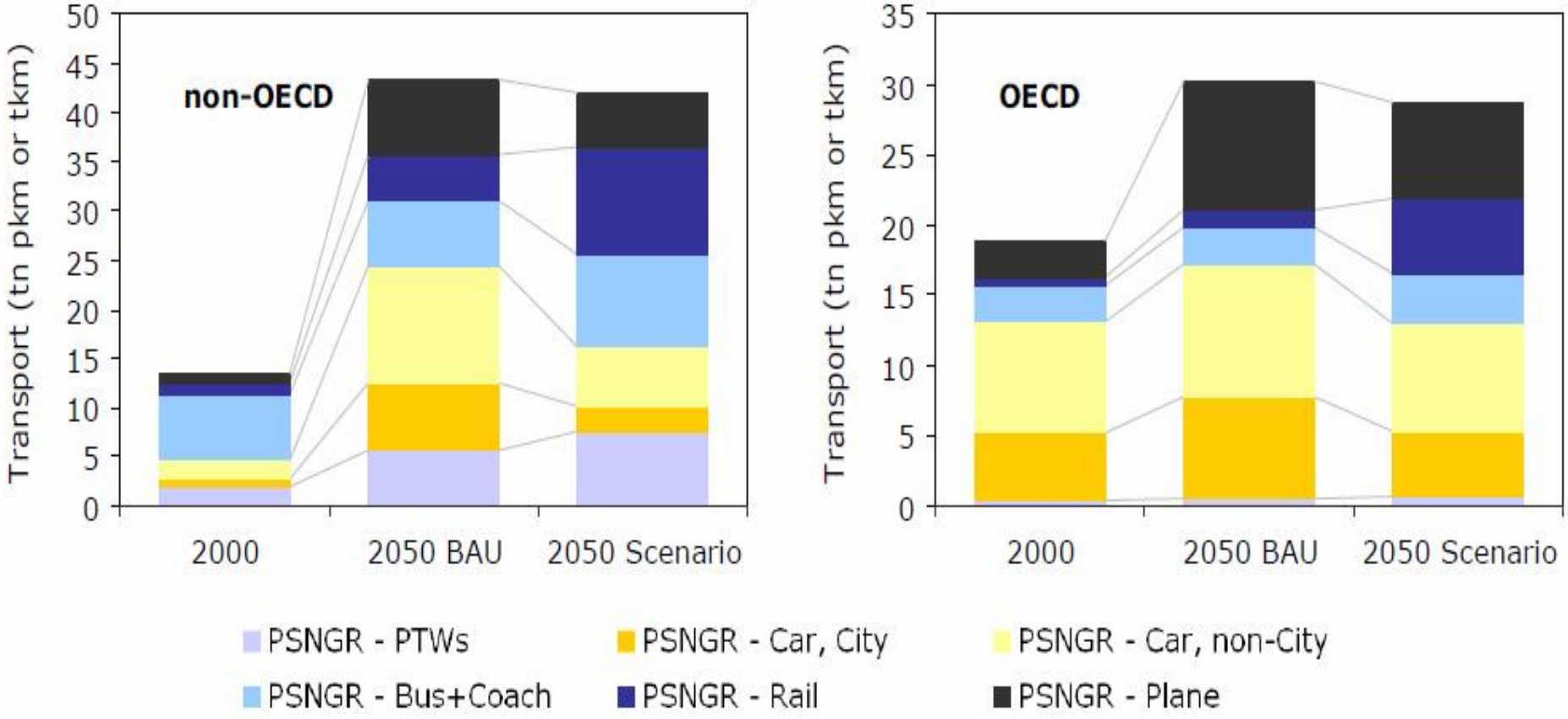



Activity graph excludes shipping. Shipping energy demand is based on GDP growth and relative efficiency savings in line with other modes.

SOURCE: Ecofys Energy Scenario, 2010

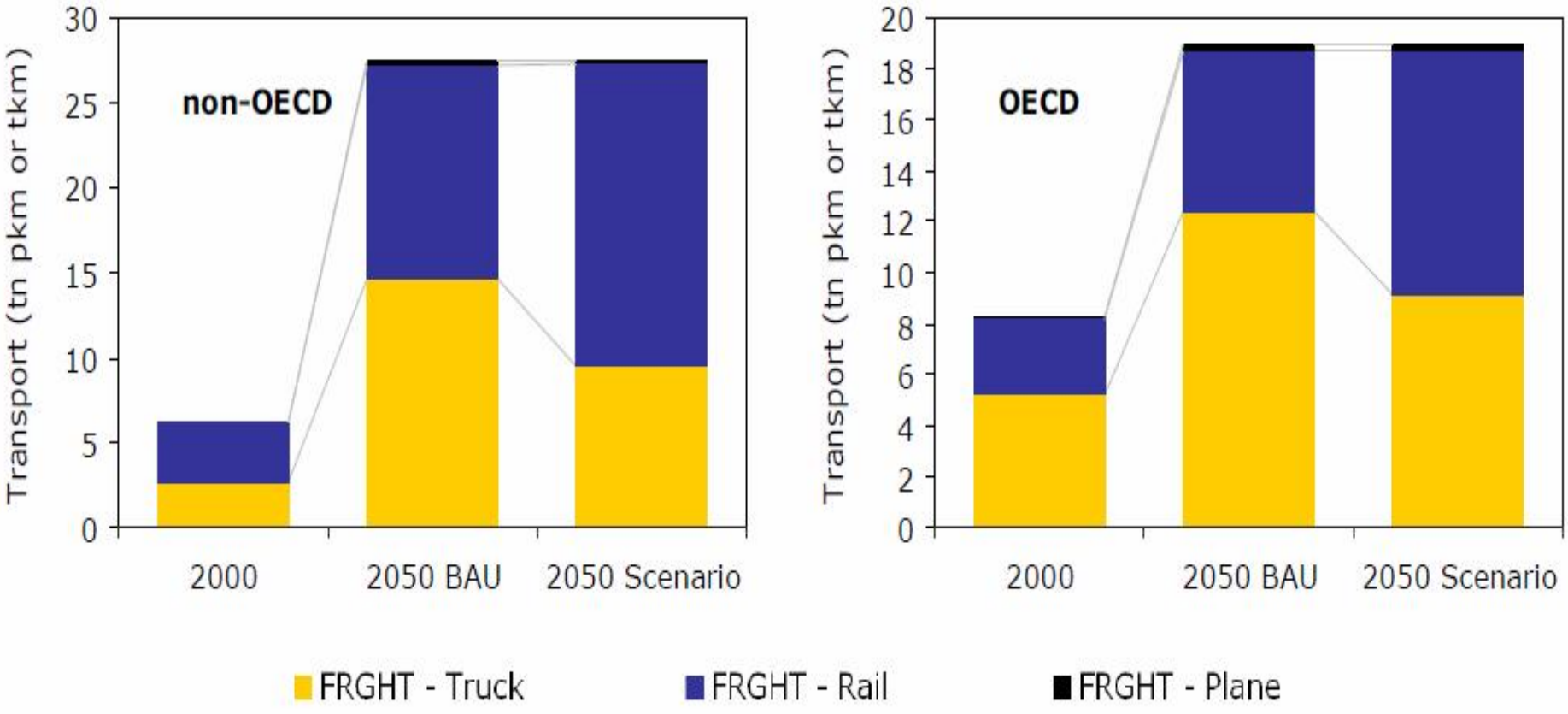
# Modal Shift for Transport 1

Substantive modal shift for passenger transport needed

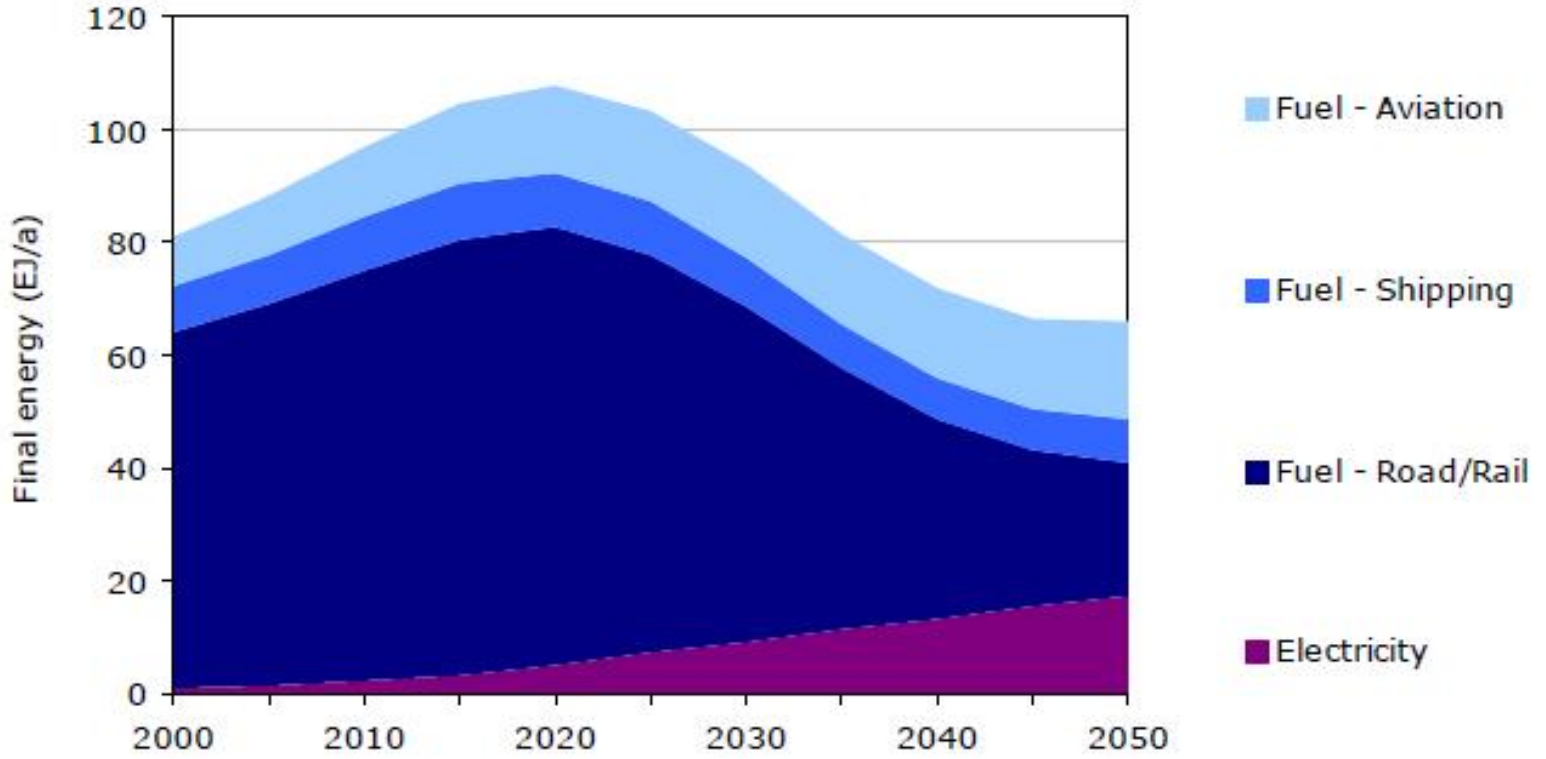


# Modal Shift for Transport 2

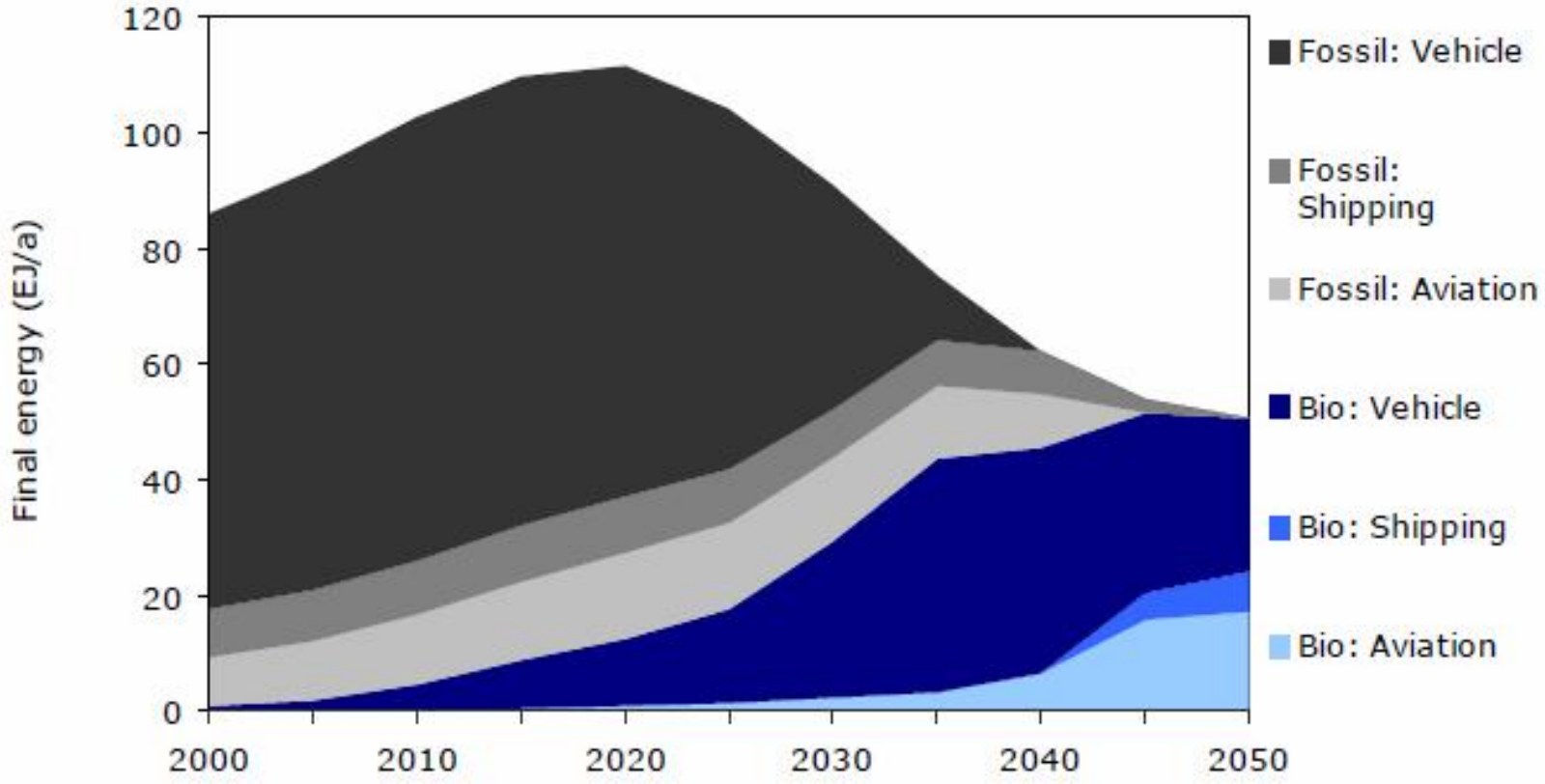
Substantive modal shift for freight transport needed



# Supply *type* in transport

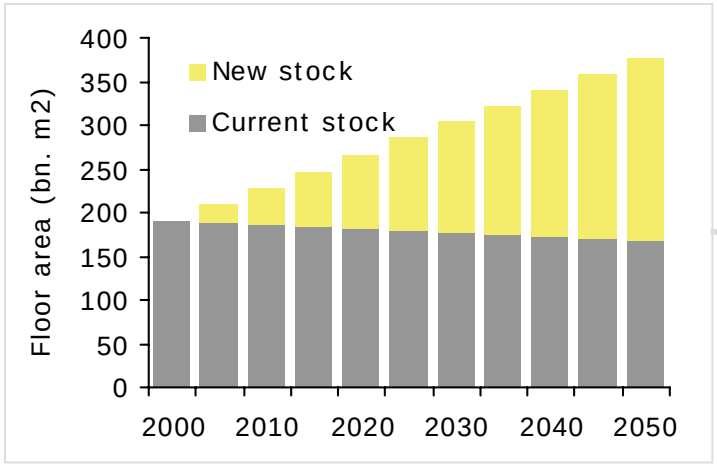


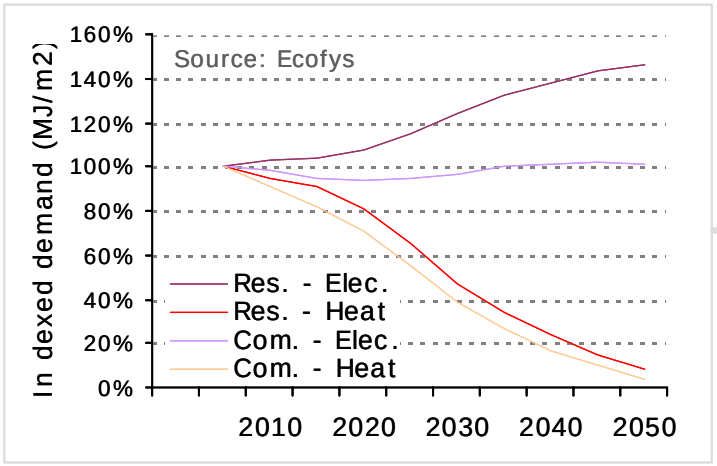
# Supply *change* in transport

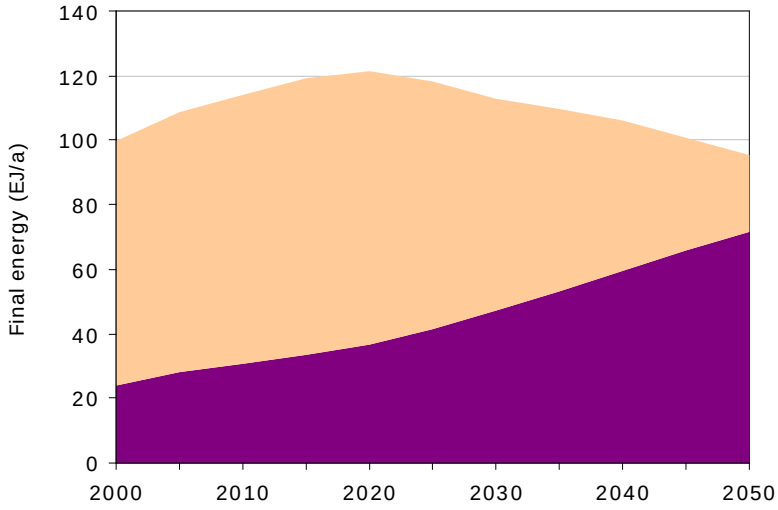


# Buildings: Ambitious Energy Efficiency

Stabilisation in demand in built environment results from ambitious energy efficiency improvements



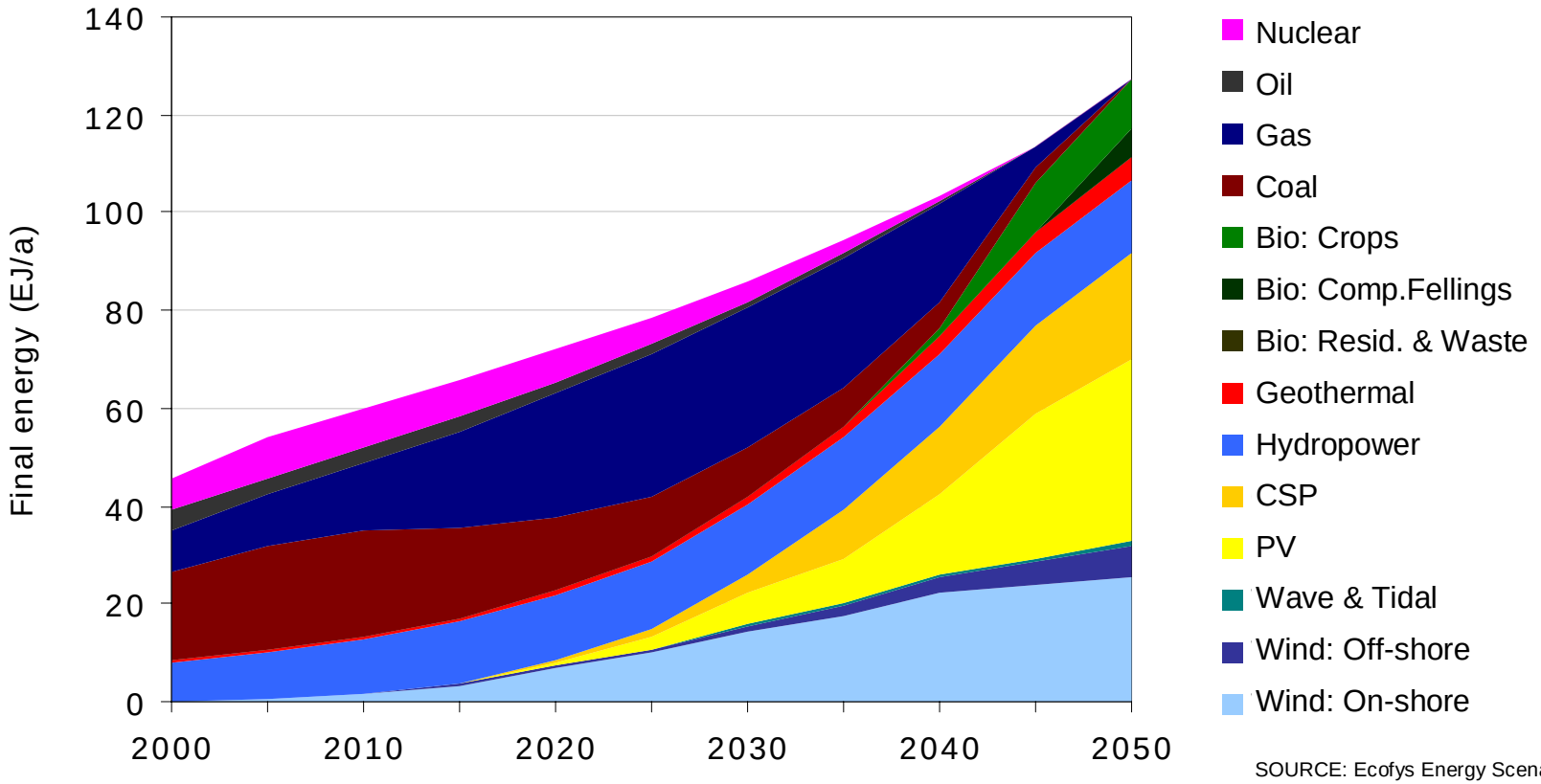




Floor area and specific energy use are shown for Residential sector only for illustrative purposes.

SOURCE: Ecofys Energy Scenario, 2010

# 100% Renewable Electricity

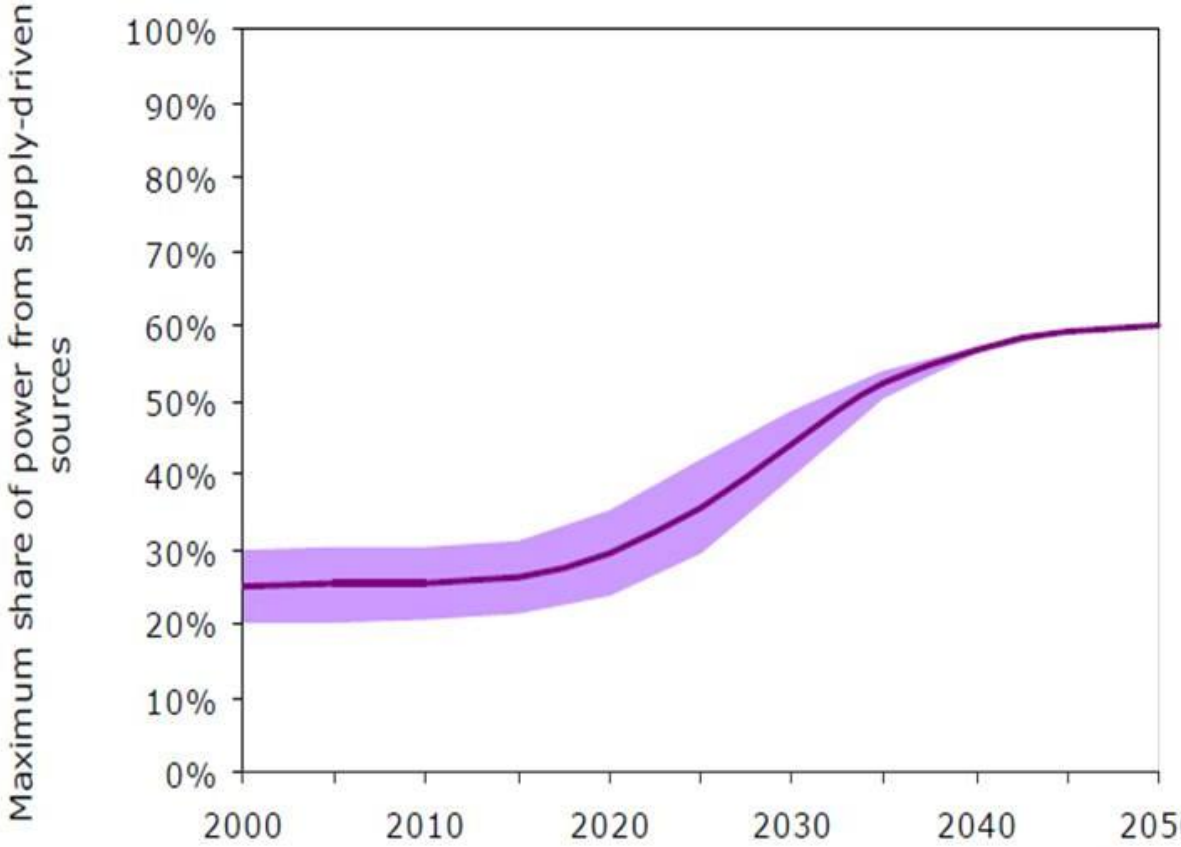
## Renewable electricity will be so abundant that options will compete against each other even before 2050




SOURCE: Ecofys Energy Scenario, 2010

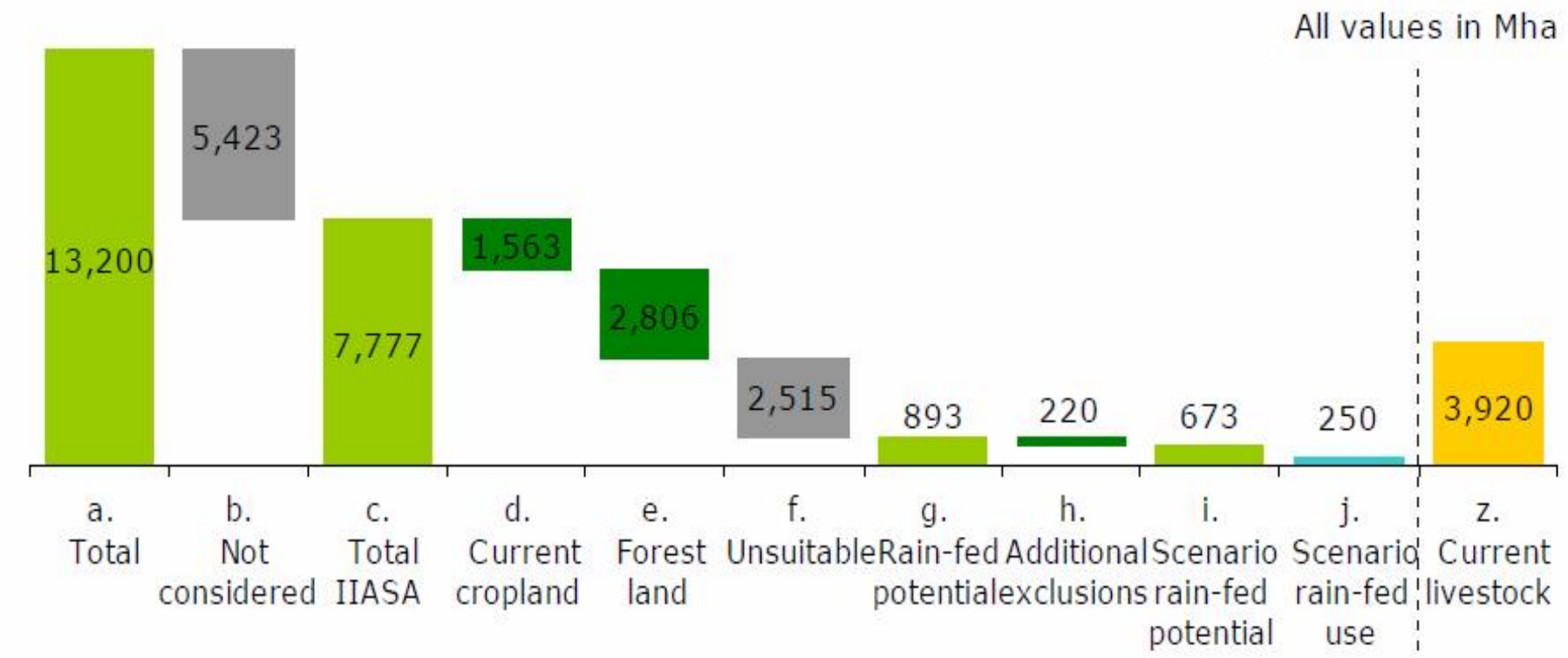
# Electricity Supply

**Constraint placed on PV and wind power due to grid limits. Range represents differences across regions**



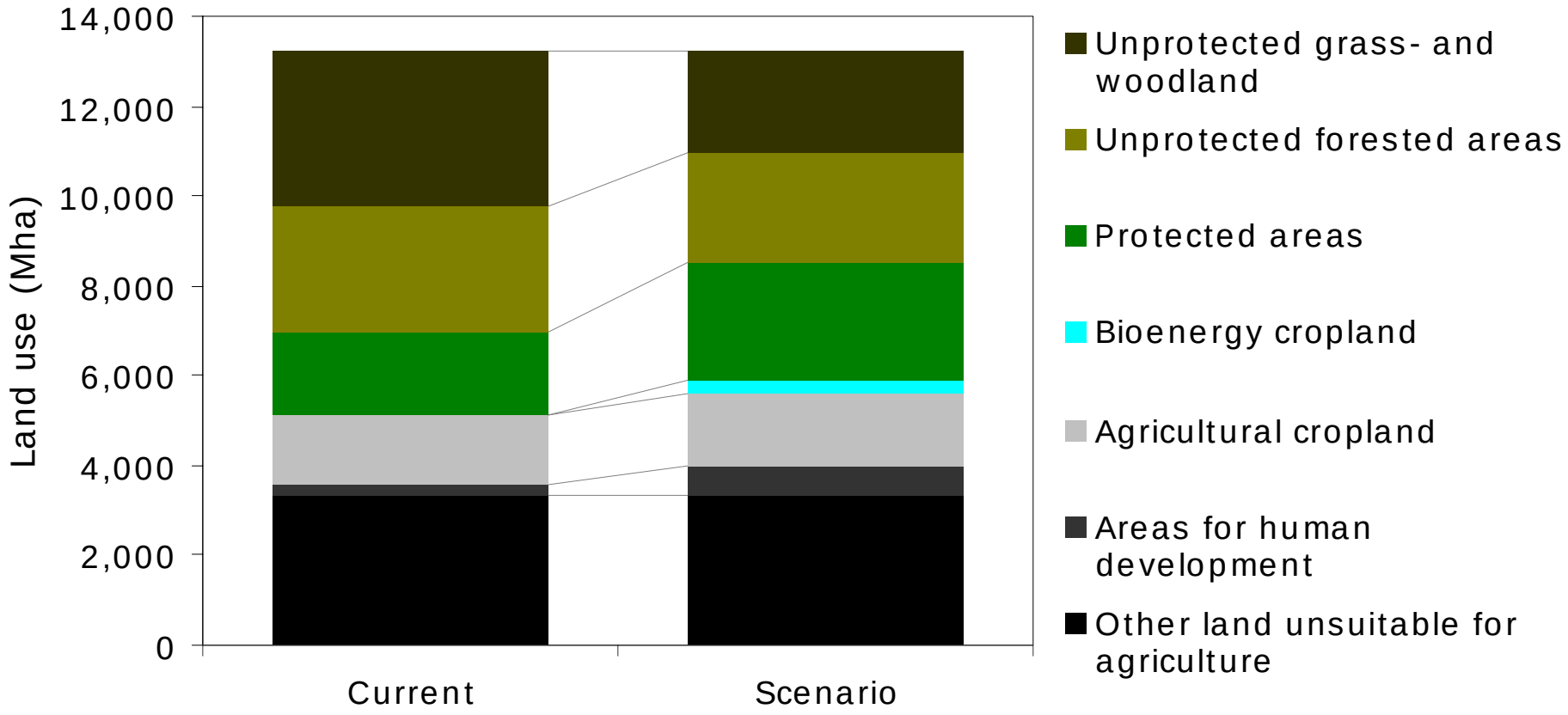

SOURCE: Ecofys Energy Scenario, 2010

# Land Distribution




SOURCE: Ecofys Energy Scenario, 2010

# Land Use Development

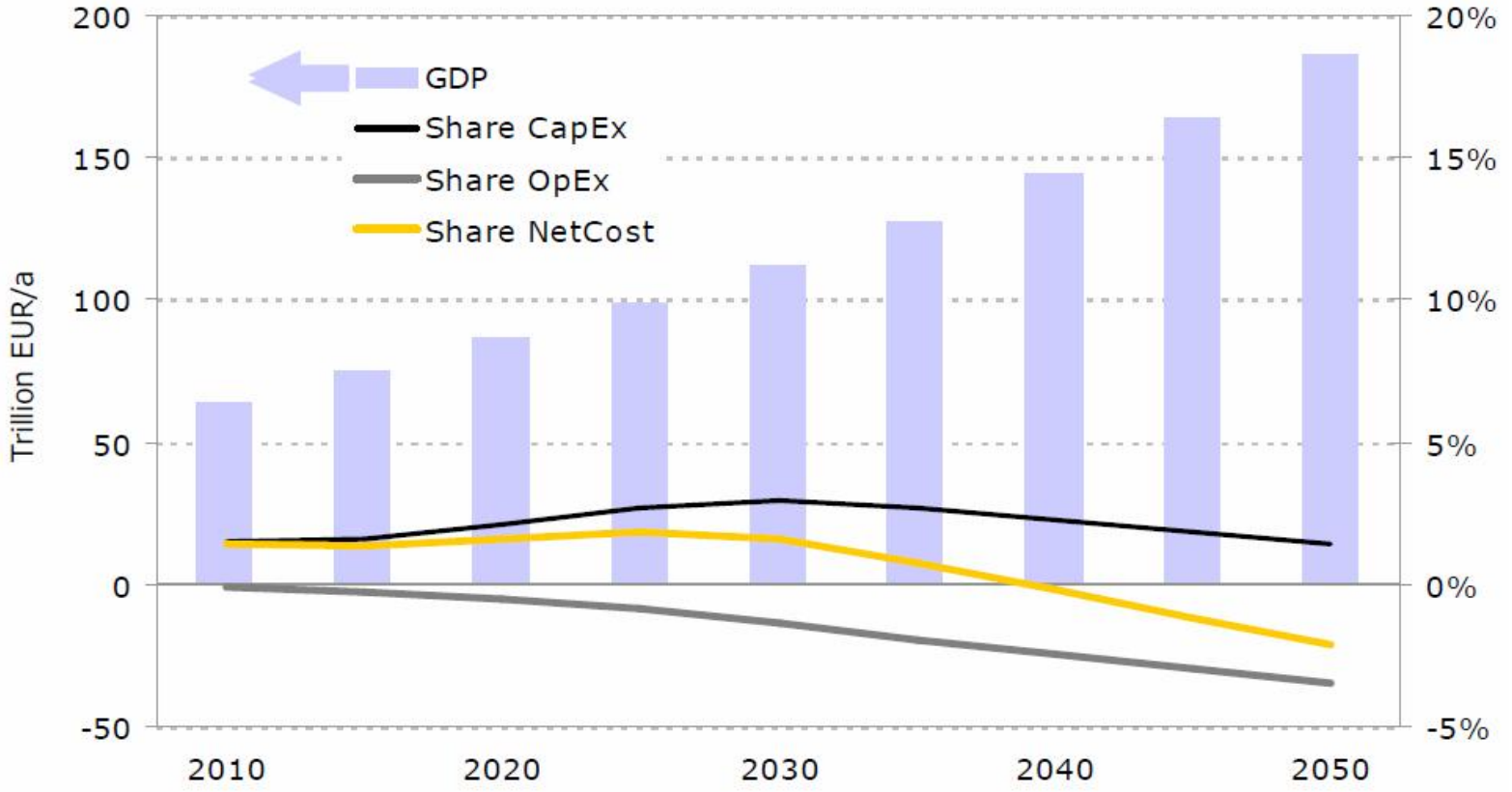



SOURCE: Ecofys Energy Scenario, 2010

# Upfront Investment

The Ecofys Scenario

## High upfront investments needed, Saving money long term

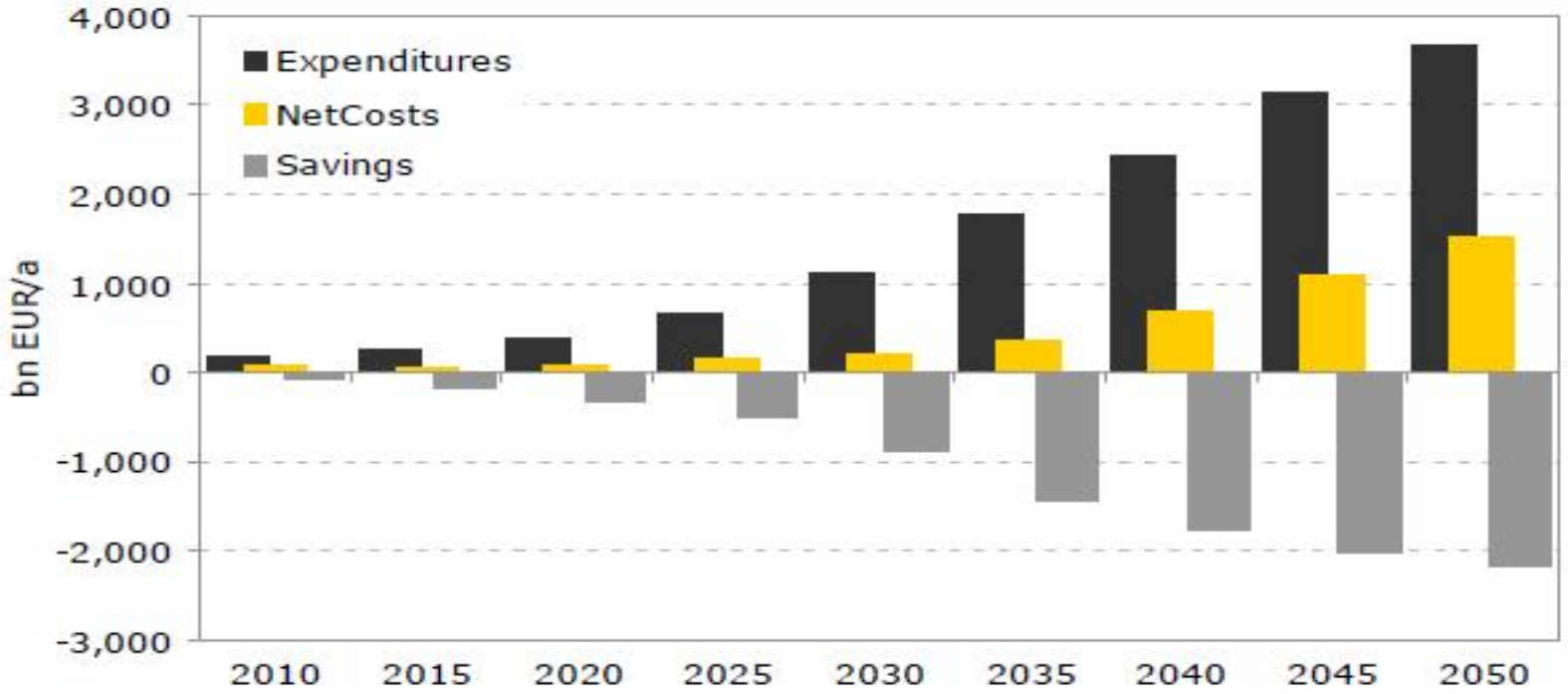



Comparison of cost results with global GDP

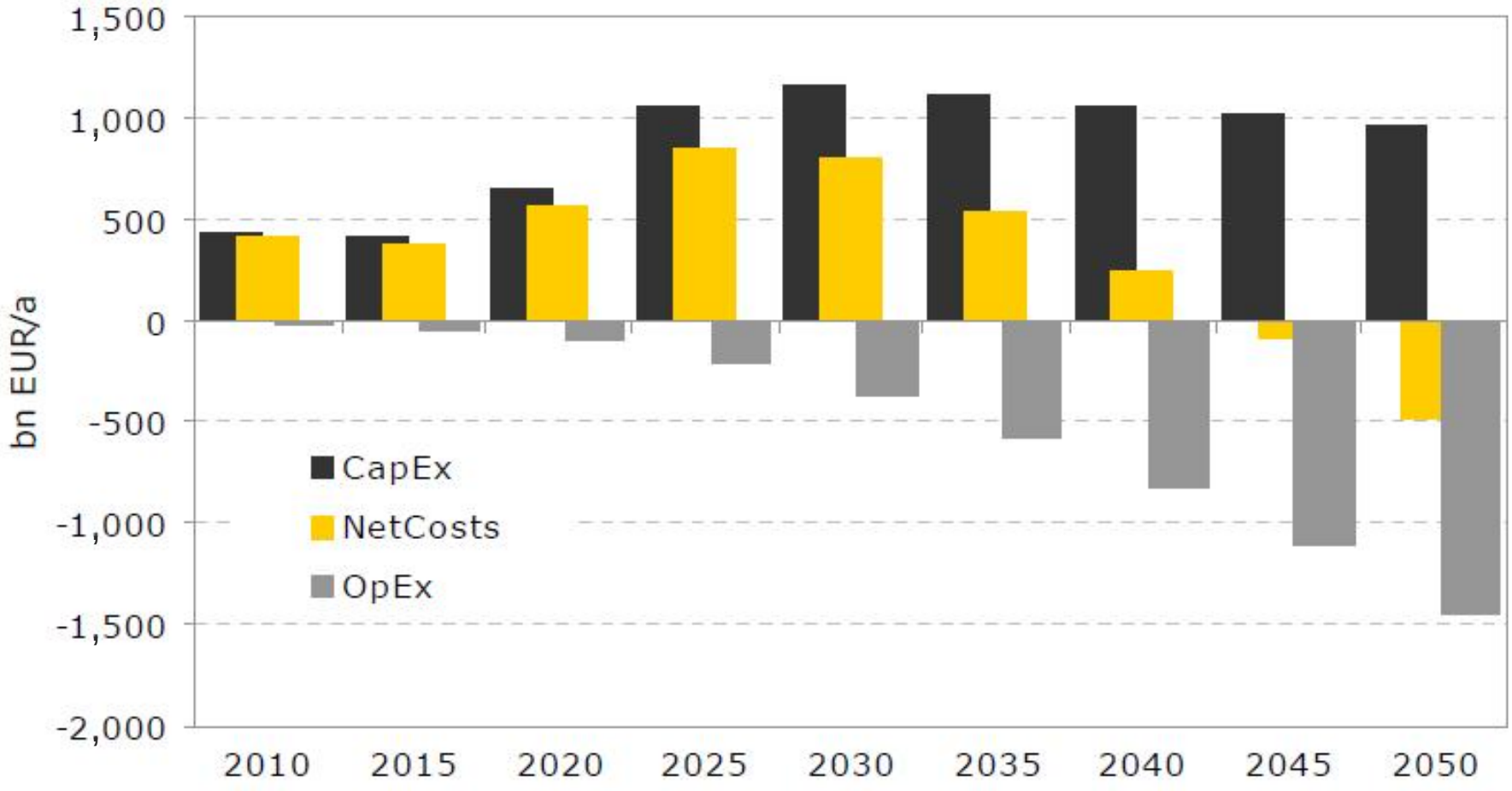
SOURCE: Ecofys Energy Scenario, 2010

NB: Cost savings do NOT include avoided damage costs from climate change, reduced health costs and other monetary environmental impacts from using fossil fuels

# Net costs of biofuels increase!

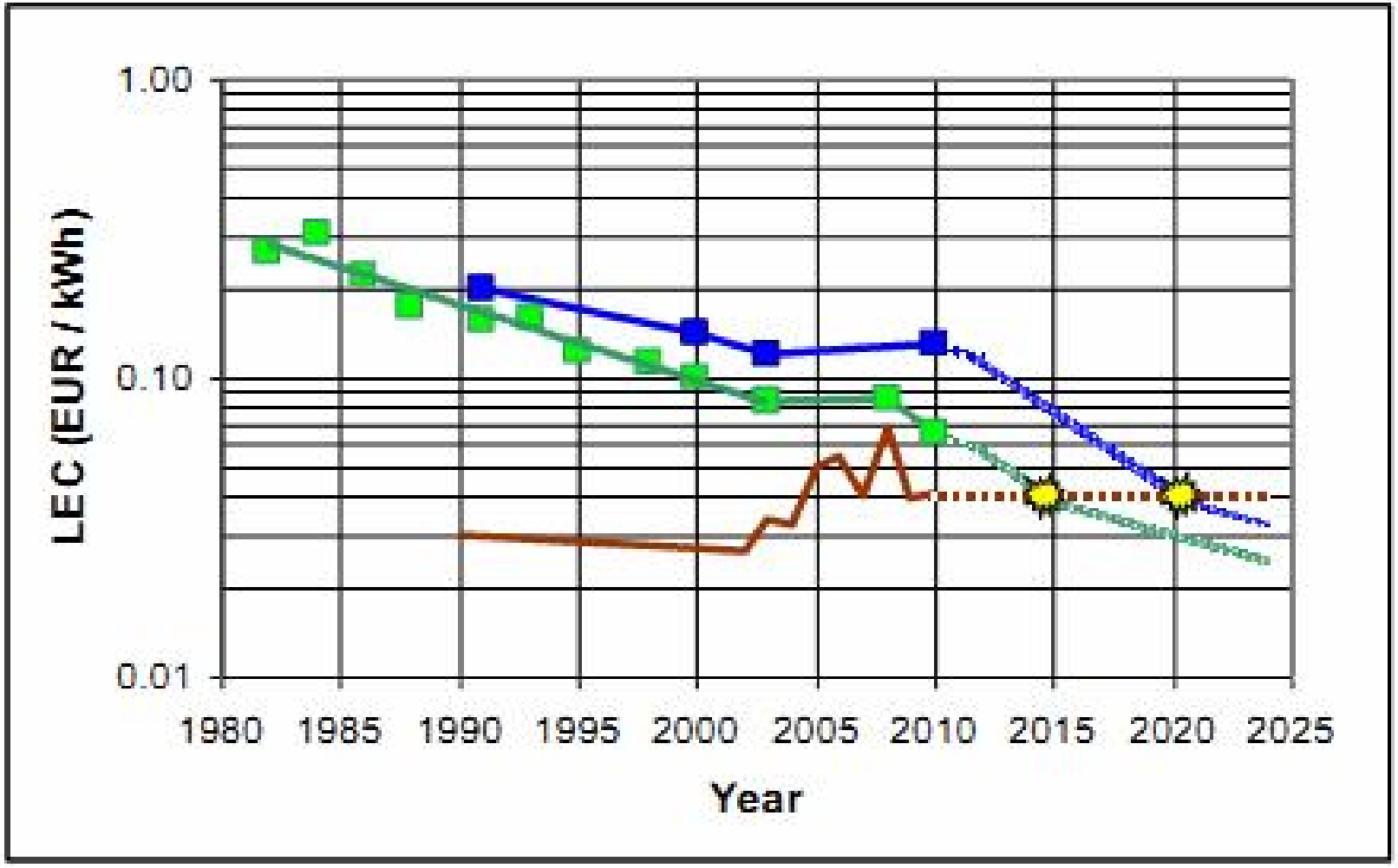


# Costs: Buildings



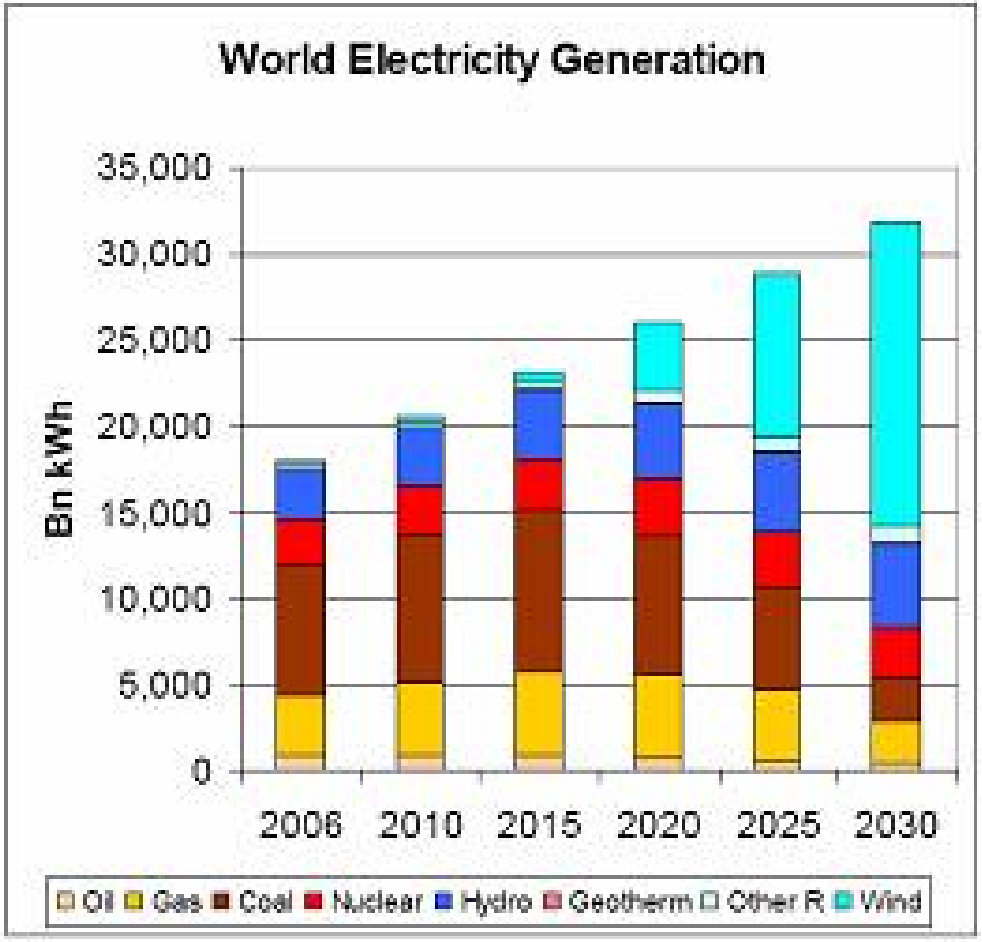

SOURCE: Ecofys Energy Scenario, 2010

# A time machine could come in handy!



# If we are successful, we may change the energy world

SIEMENS




## Comments

### The "digital" thresholds

- If wind is more expensive than other energy sources, we serve only a politically driven part of the market.
- If we become competitive with other energy sources, we will serve the whole market
- This may completely change the energy world

# The Ecofys Scenario

"imaginative, challenging, encouraging"

Key elements:

- Technically possible ("can do")
- Energy efficiency is critical
- Electrification is critical
- Grid expansion and smart grids
- Buildings – retrofit and 'minergize'
- Phase-out "old-fashioned" biofuels
- End energy poverty and inequity
- Source bioenergy sustainably
- Huge long-term financial benefits

# The Energy Report

100% Renewable Energy by 2050

## A VISION

A world powered by 100% renewable, sustainable energy by mid-century

## A SCENARIO

Extensive electrification of transport; enhanced energy conservation; smart grids; sustainable energy for all

## SOLUTIONS

In all of our hands - policy-makers, investors, corporate leaders, communities and individuals.

## BENEFITS

Stop fossil fuel pollution; save money; address climate change; improve health; no nuclear risks; new jobs; innovation; protect nature

## CHALLENGES

Conserving energy & reducing demand; electrification; equity; investment; land/water/sea-use implications; governance; lifestyle choices - behaviour changes & public attitudes; innovation and R&D

# Lessons learned

- Despite rapid growth of coal and gas, oil is still largest energy source (35%)
- Despite growth of 20-30% annually in last years, wind, solar, geothermal energy shares are still very low
- Nuclear and hydro power energy supply is stagnating
- China, US, EU remain the largest energy-CO2 emitters (56%)
- Bunker fuels now sixth largest emitter, 4% of all energy-CO2.
- Coal is largest CO2 energy source (43%) and growing most rapidly
- Per capita CO2 emissions still highest in OECD and still comparably low in China, India
- Unconventional oil and gas *reserves* three times as large as conventional ones and may last for >200 years
- Conventional coal *resources* about 100 times as large as cumulative historic coal use.

# Lessons learned

- Oil is most important energy source still and revenues this year may yield > $US 1000 billion to OPEC – or about 2.3% of global GDP - if oil prices stay >$US 100/bll
- Compared to other fuels, oil is much more internationally traded/exported and hence its price remains a strong economic factor
- There are only very few countries benefitting mostly from oil production and export, the top ones being Saudi Arabia and Russia jointly controlling 25% of both
- USA and China are largest oil importers (30% of all) and largest oil consumers

# Lessons learned

- Similar to oil, only very few countries benefit from natural gas production and exports, Canada and Russia being the largest ones
- China and USA produce (and use) almost 60% of all global coal
- Although only 10% of global coal is being traded, export is monopolised by very few countries, Australia being the largest one
- Global hydro power production is most concentrated in three countries (China, Brazil, Canada with 41% of all)
- Global nuclear is even more concentrated – almost 50% of all is being produced by USA, France, Japan

- All conventional energy resources, their consumption and trade is highly concentrated in and by a few countries. They all are undemocratic fuels by origin