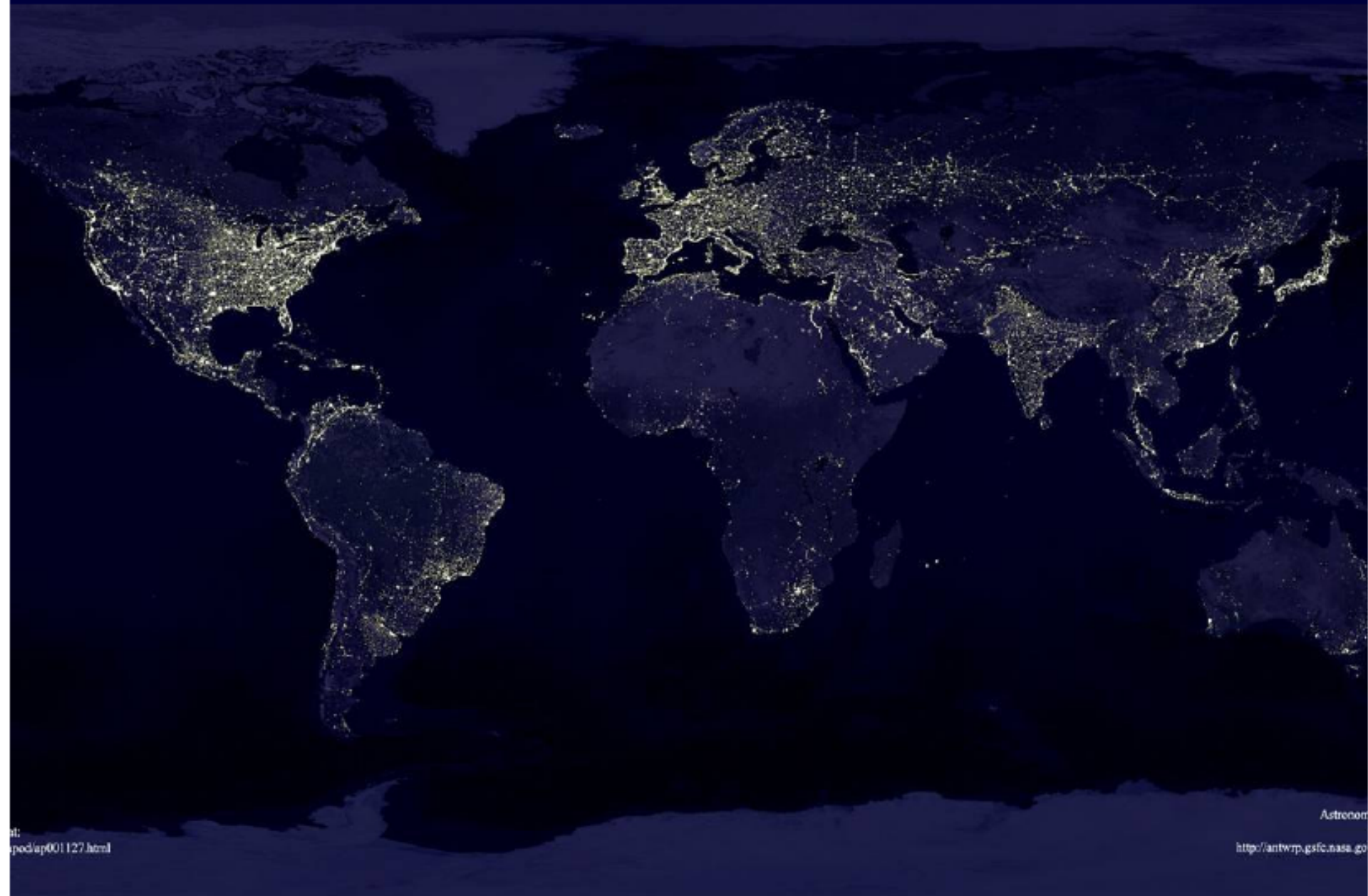


Seminar on Energy and Climate Change

Global Energy System

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Energy Demand & Prosperity

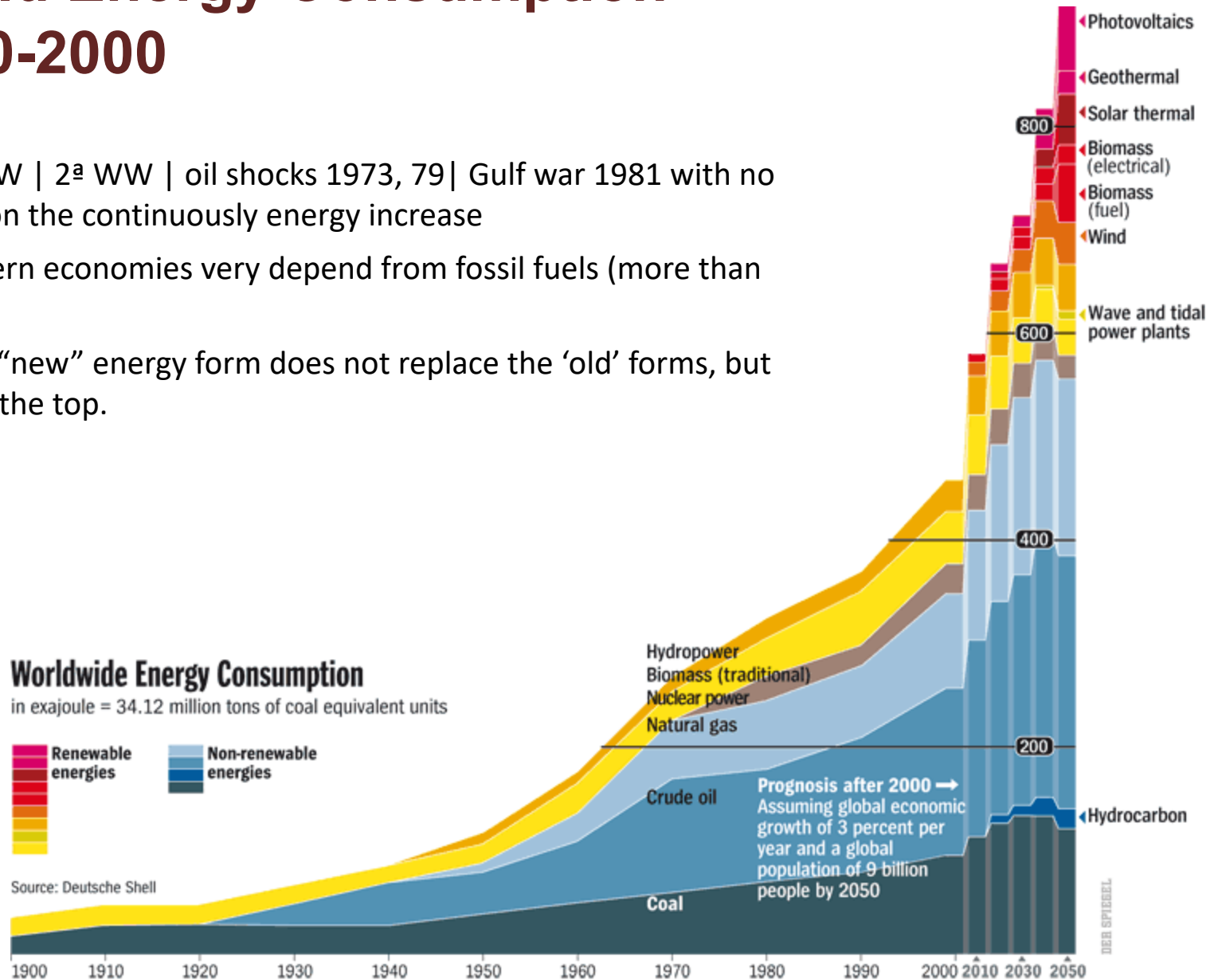


Agenda

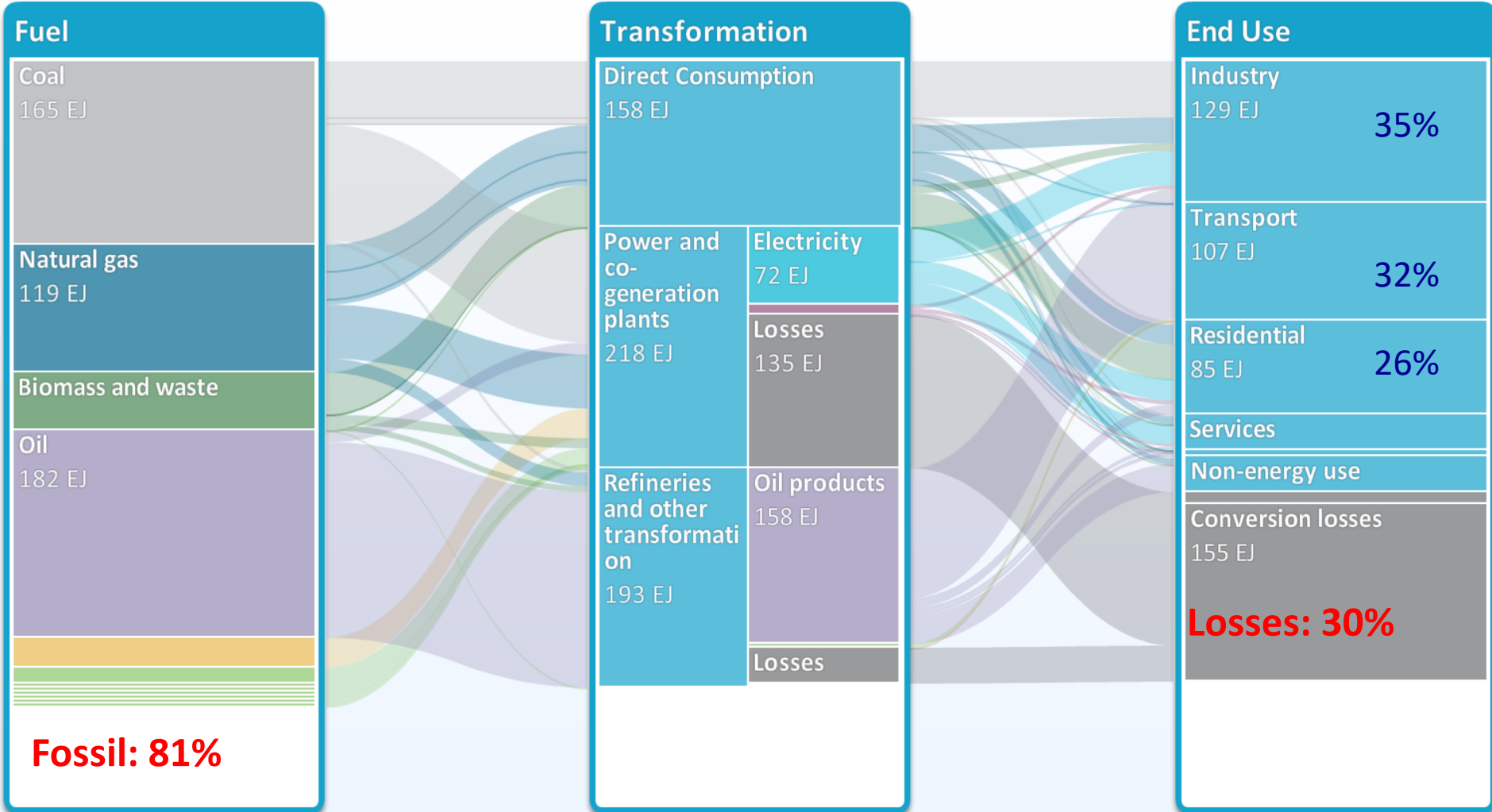
- Global and regional trends of energy consumption
- Access to clean energy
- Energy intensity indicators (energy vs. GDP)
- Questions for the future of the global energy system

World Energy Consumption 1860-2000

- 1^a WW | 2^a WW | oil shocks 1973, 79 | Gulf war 1981 with no impact on the continuously energy increase
- Modern economies very depend from fossil fuels (more than 80%).
- Each “new” energy form does not replace the ‘old’ forms, but adds on the top.

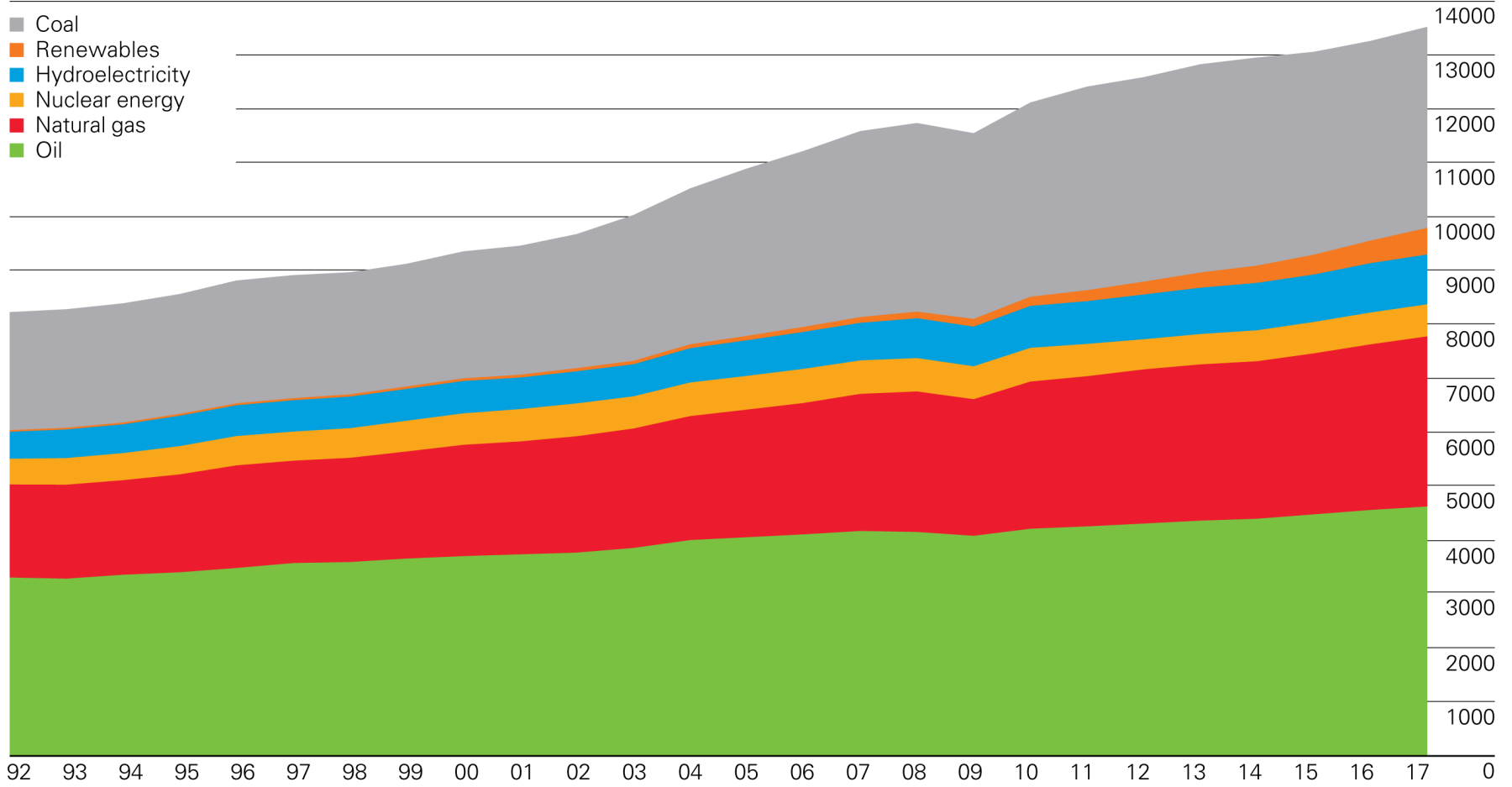


World Energy Balance - 2014



Primary energy world consumption

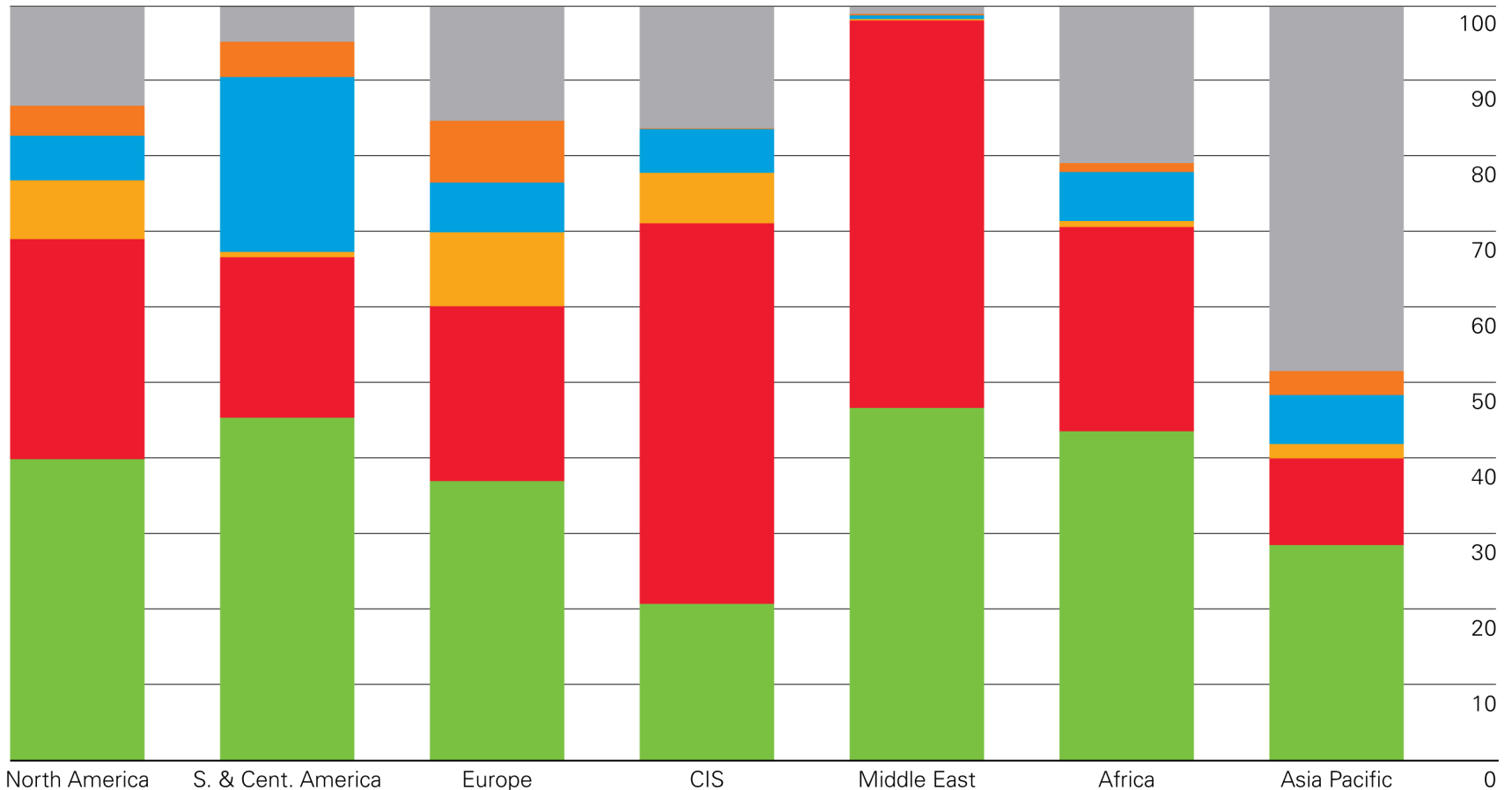
Million tonnes oil equivalent



Primary energy regional consumption by fuel 2017

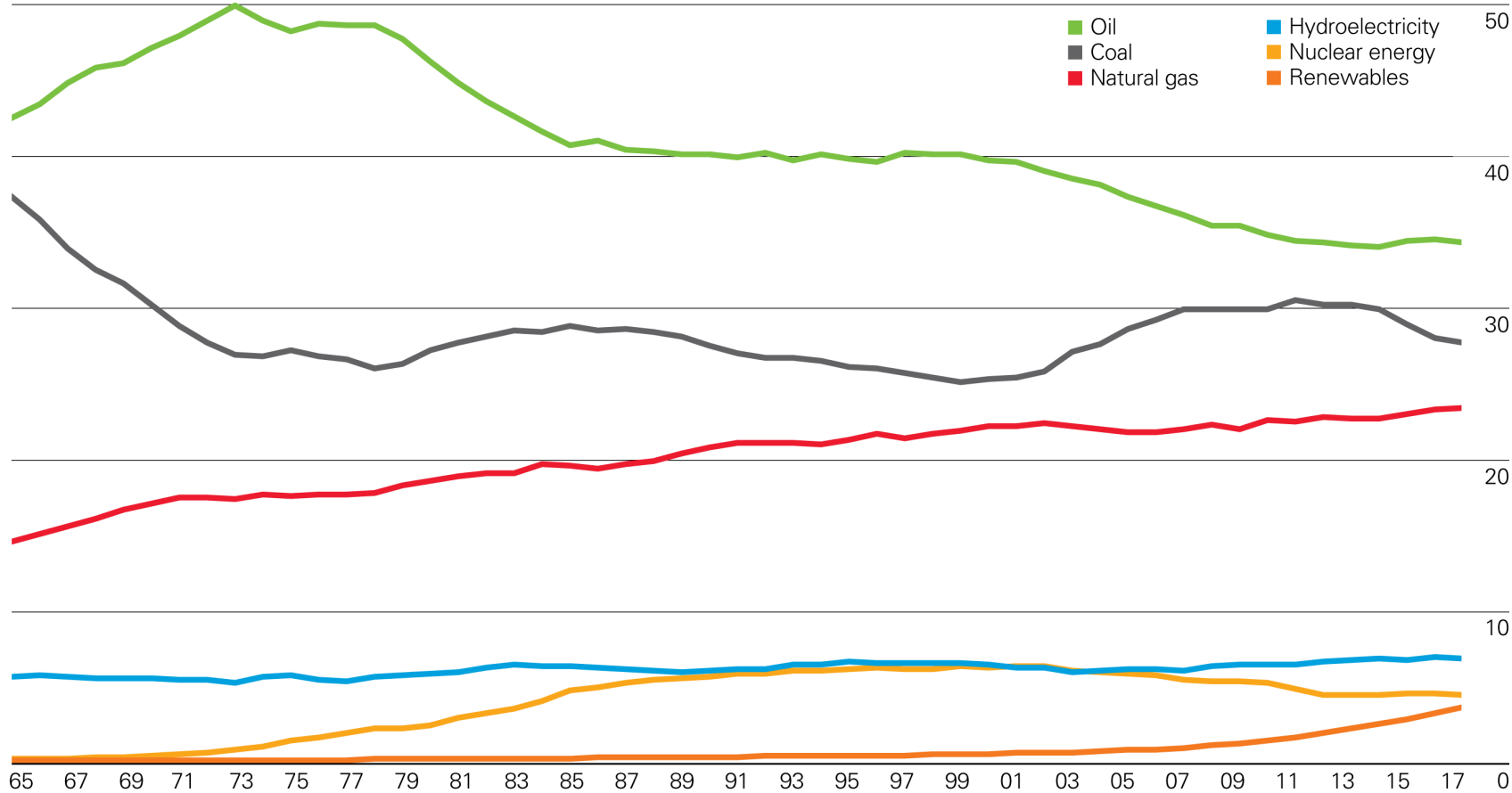
Percentage

- Coal
- Renewables
- Hydroelectricity
- Nuclear energy
- Natural gas
- Oil



Shares of global primary energy consumption

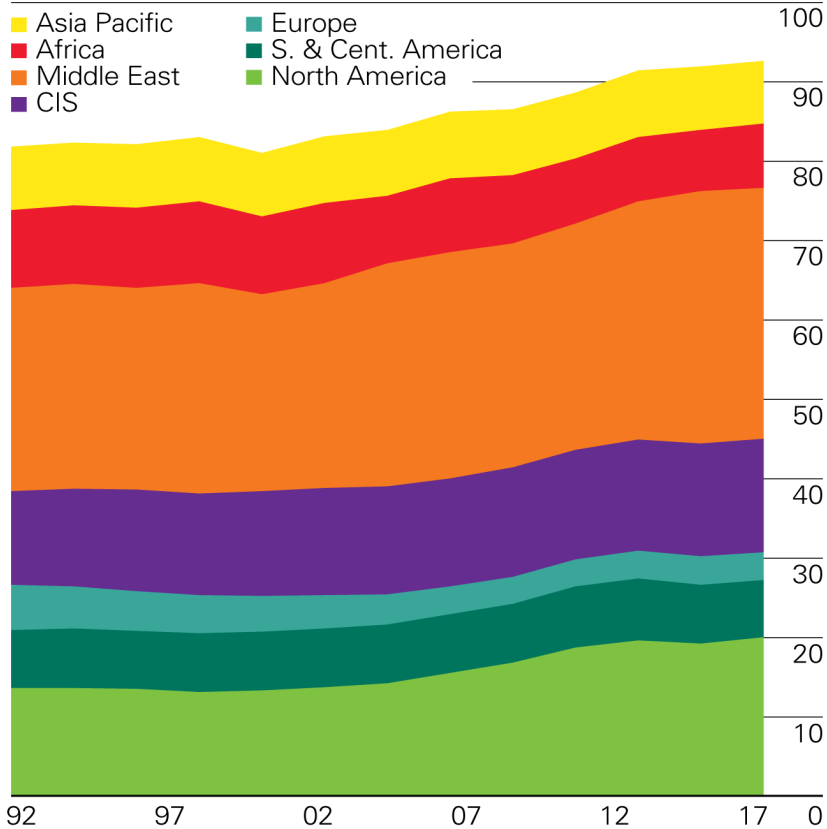
Percentage



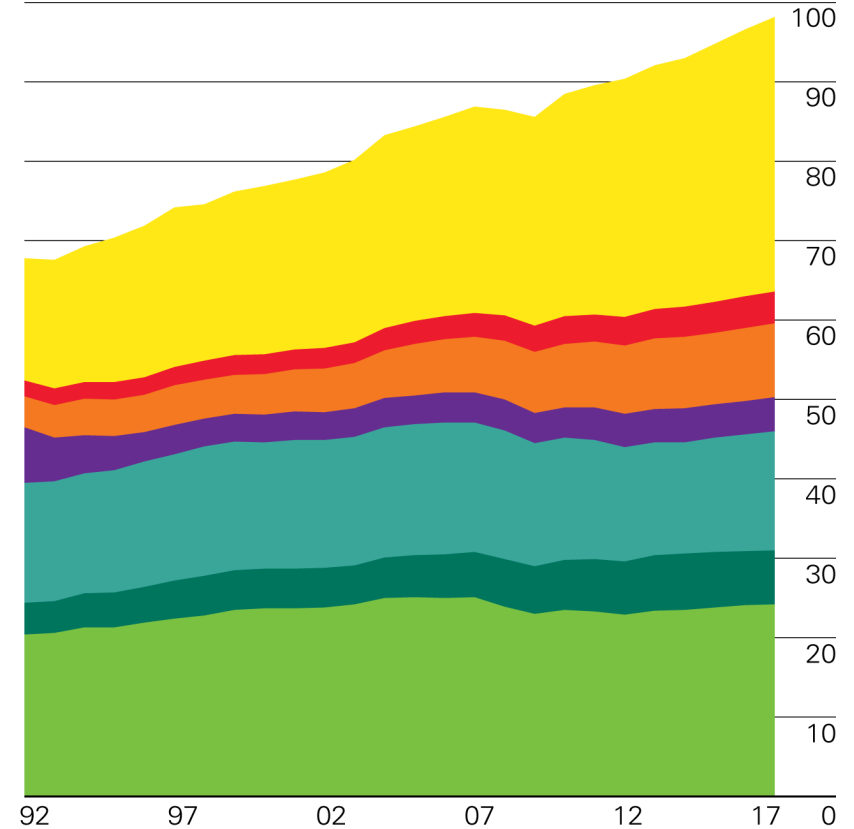
Oil production/consumption by region

Million barrels daily

Production by region



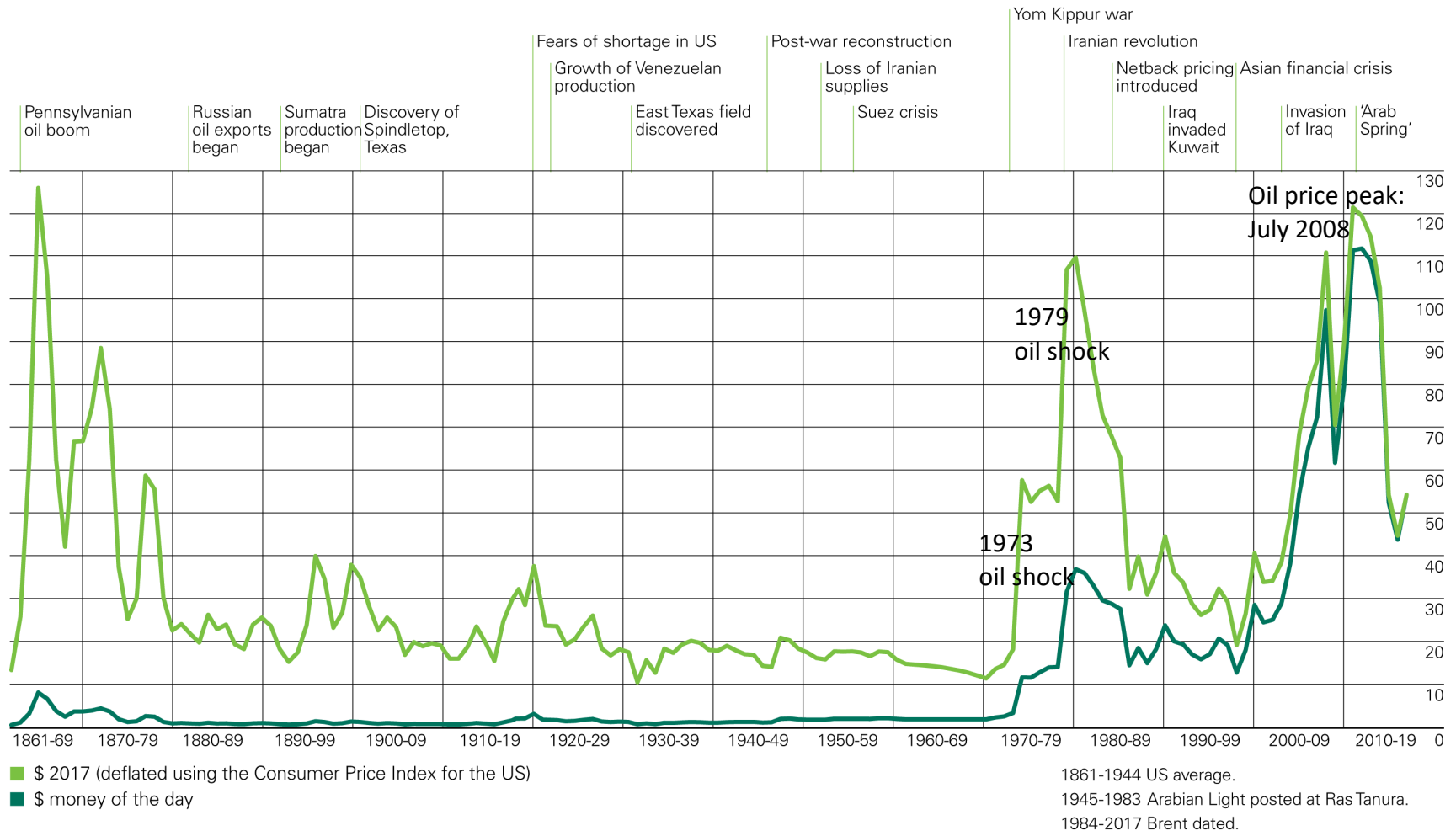
Consumption by region



CIS: Commonwealth of Independent States (10 post-Soviet republics in Eurasia)

Crude oil prices 1861-2017

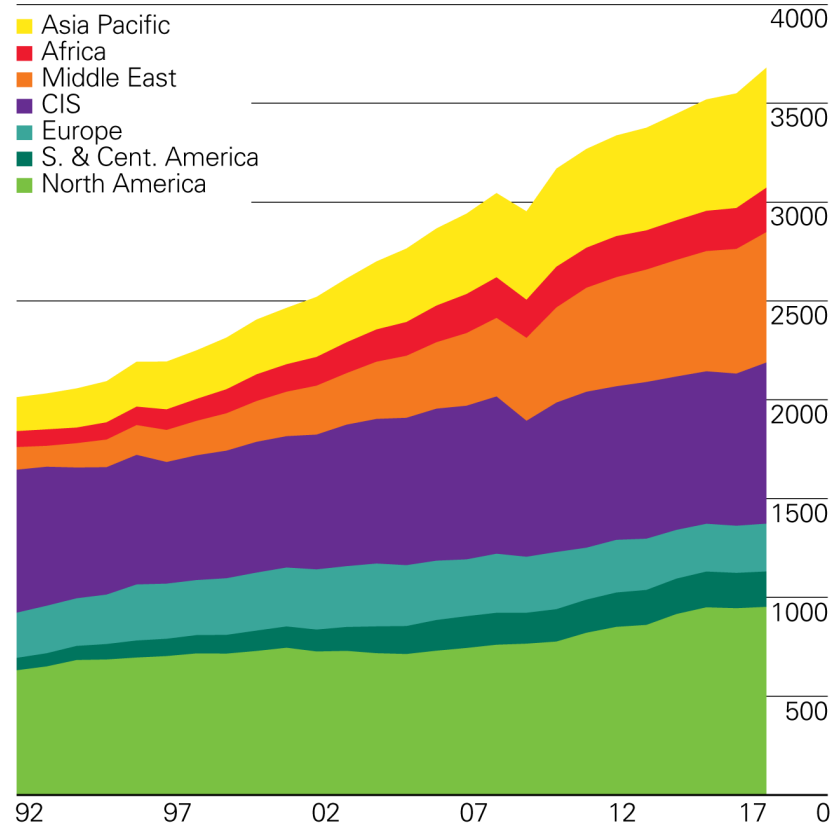
US dollars per barrel, world events



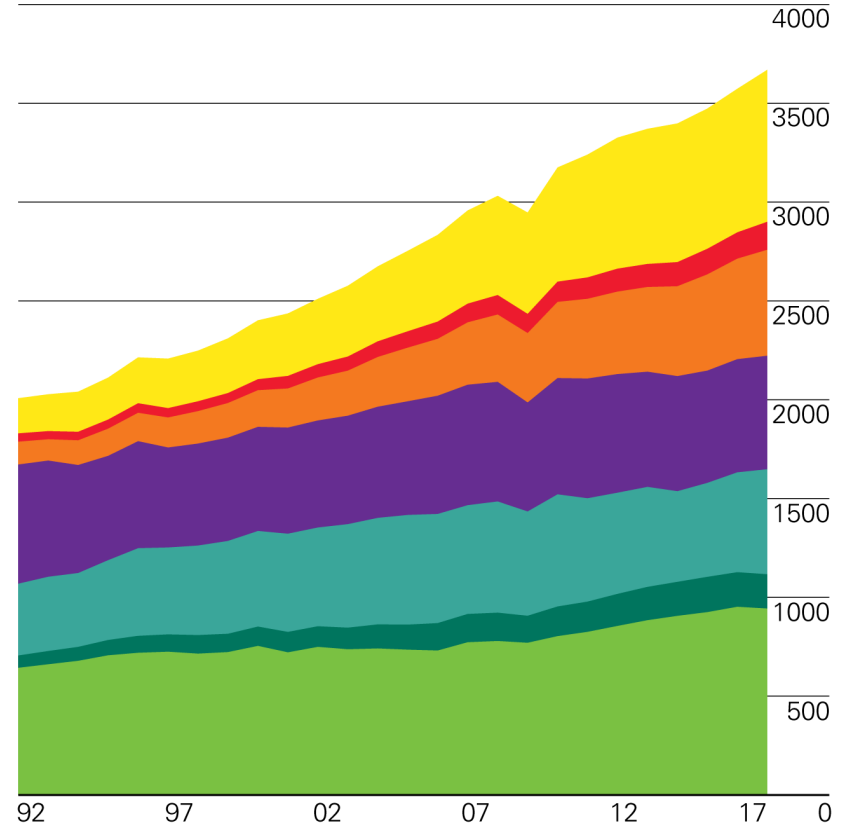
Gas production/consumption by region

Billion cubic metres

Production by region



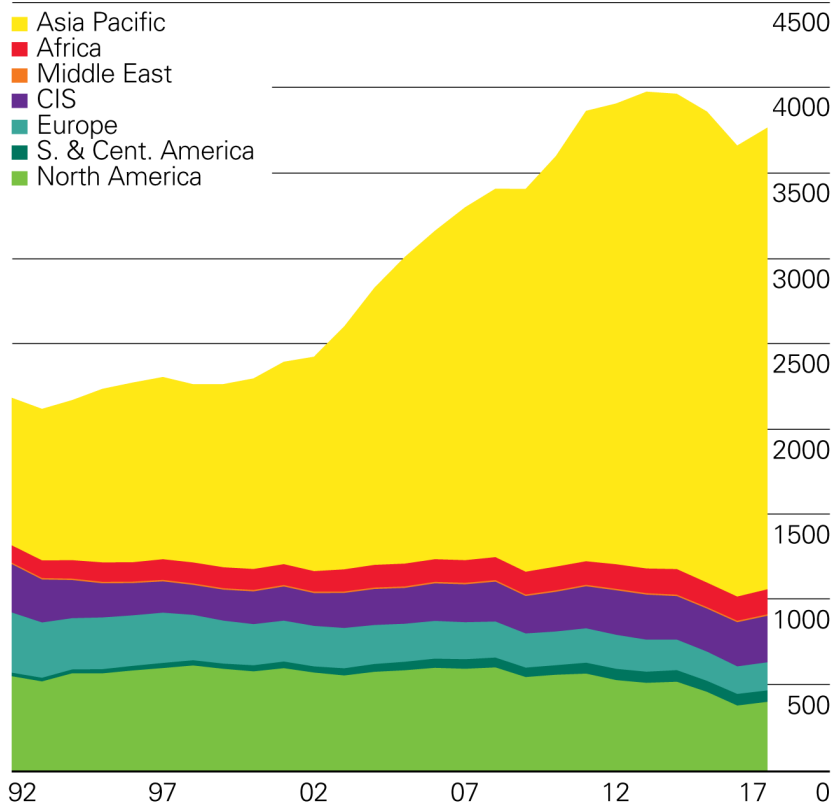
Consumption by region



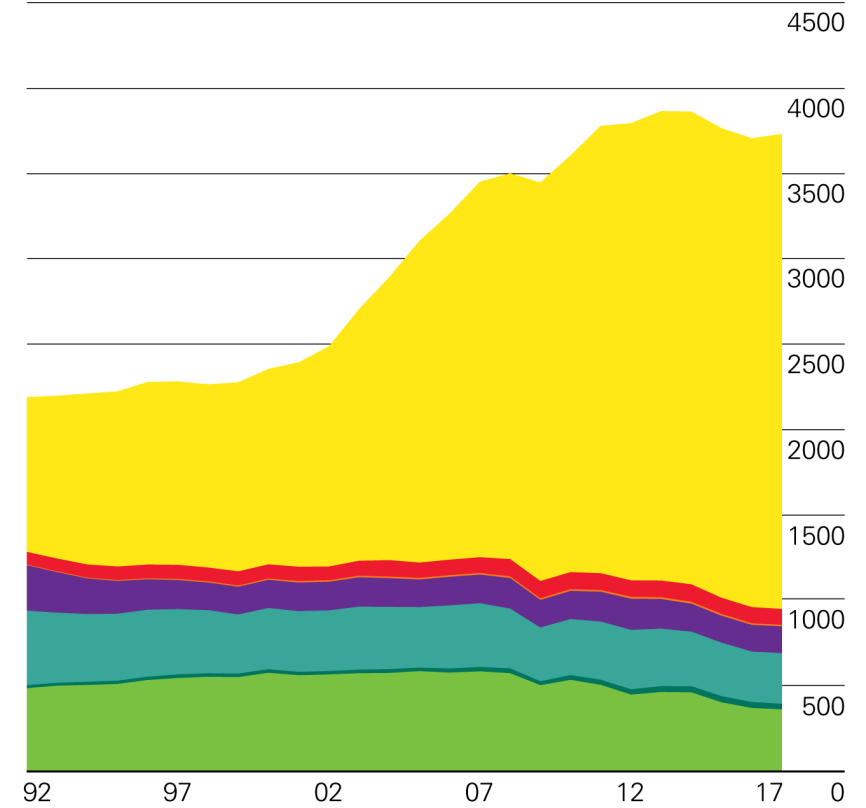
Coal production/consumption by region

Million tonnes oil equivalent

Production by region

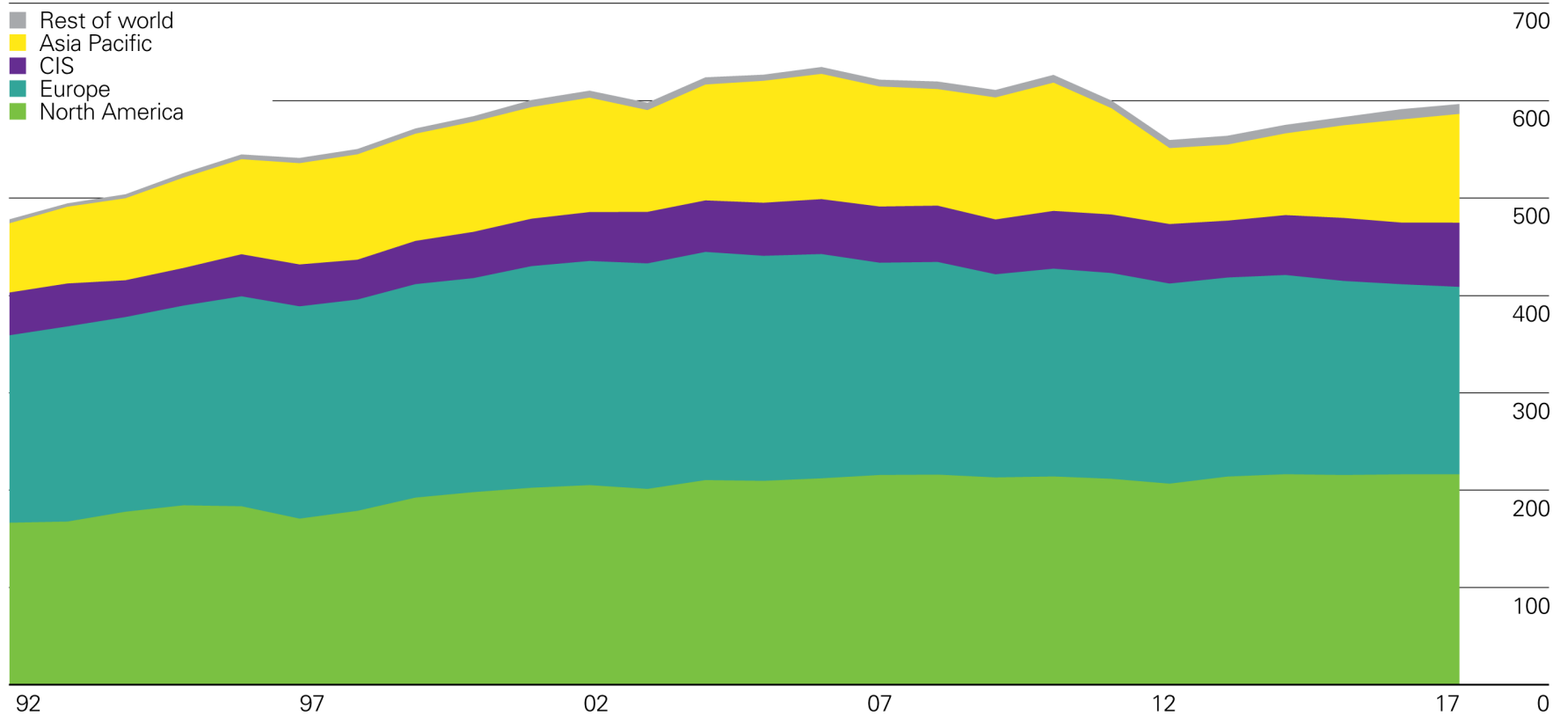


Consumption by region



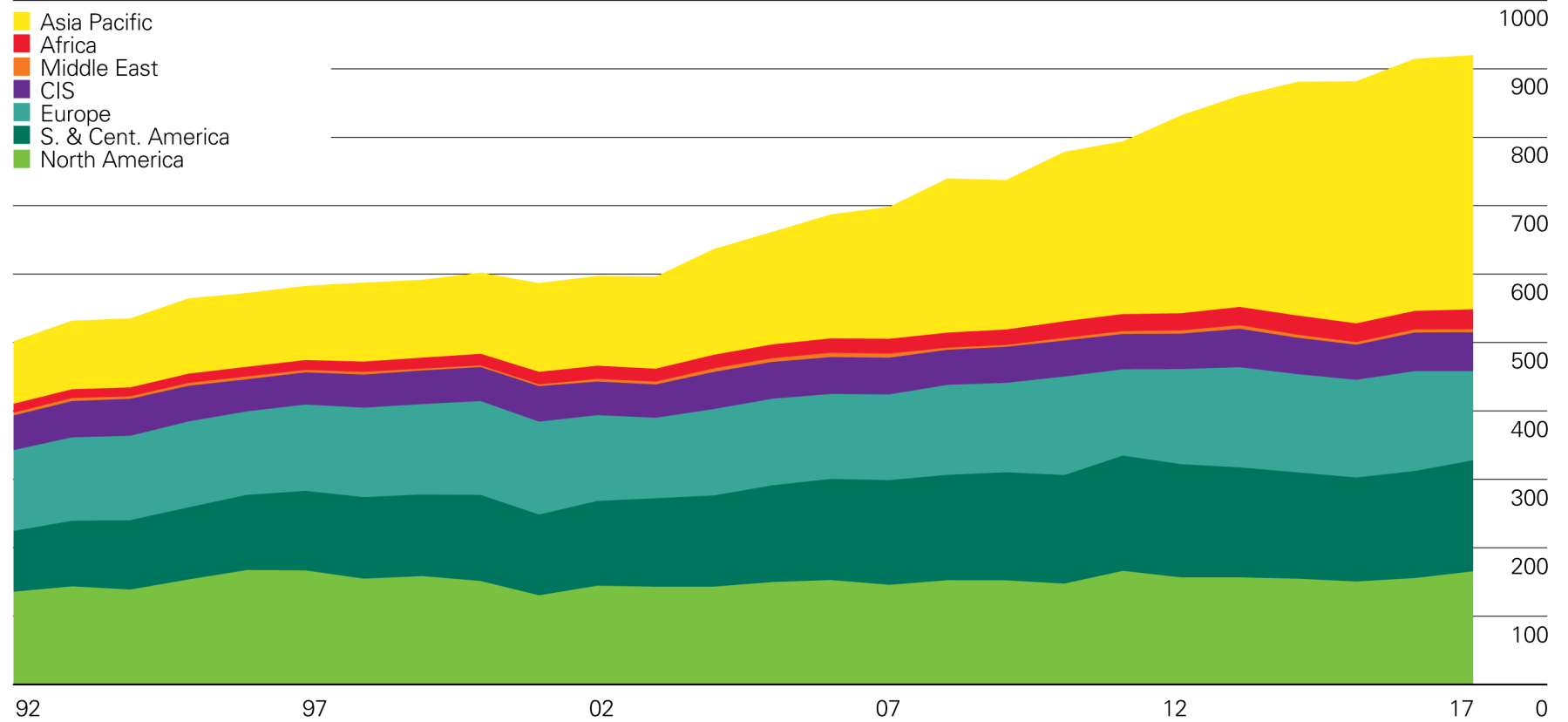
Nuclear energy consumption by region

Million tonnes oil equivalent



Hydroelectricity consumption by region

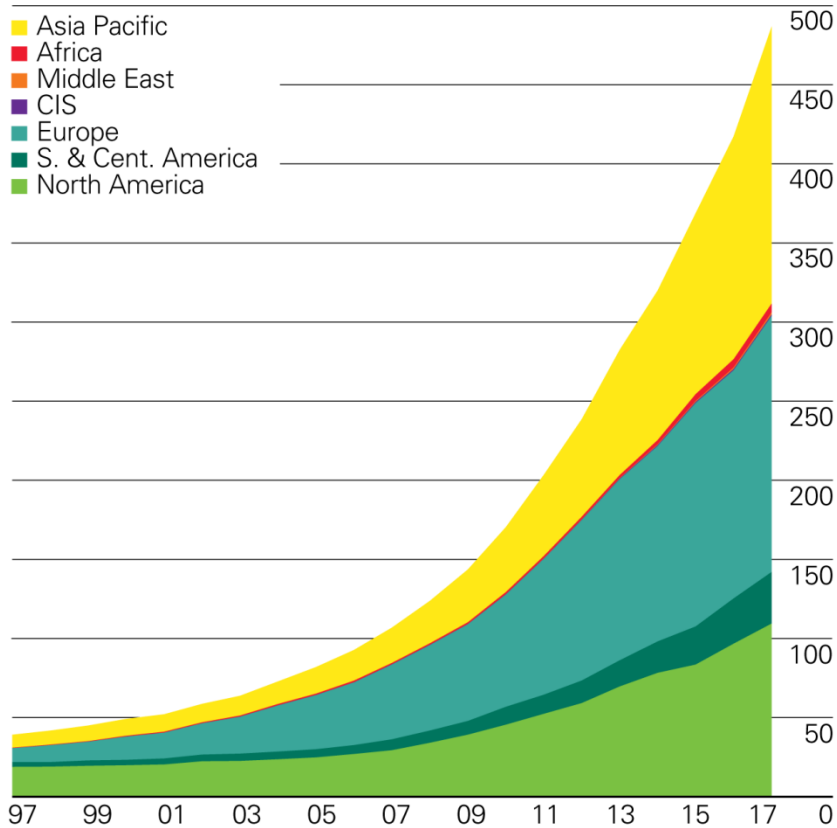
Million tonnes oil equivalent



Renewable energy consumption/share of power by region

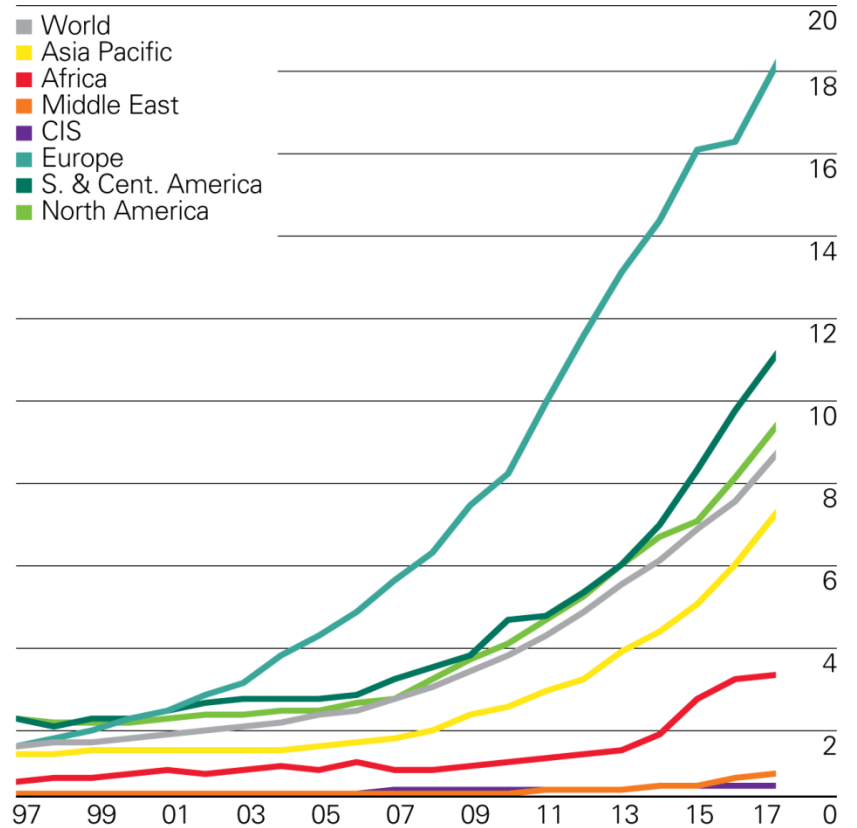
Other renewables consumption by region

Million tonnes oil equivalent



Other renewables share of power generation by region

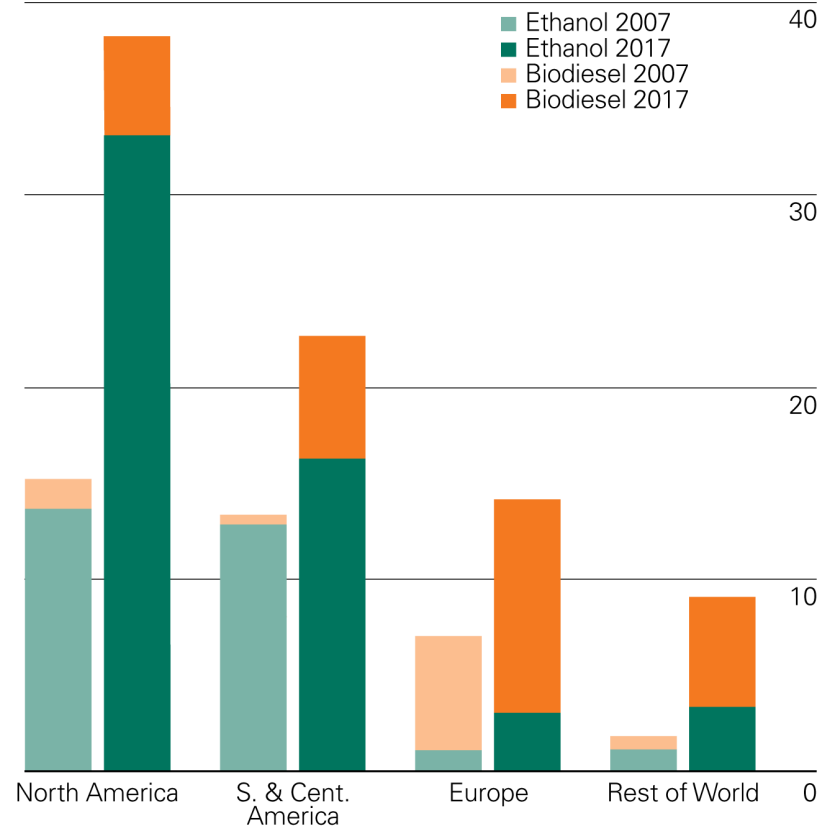
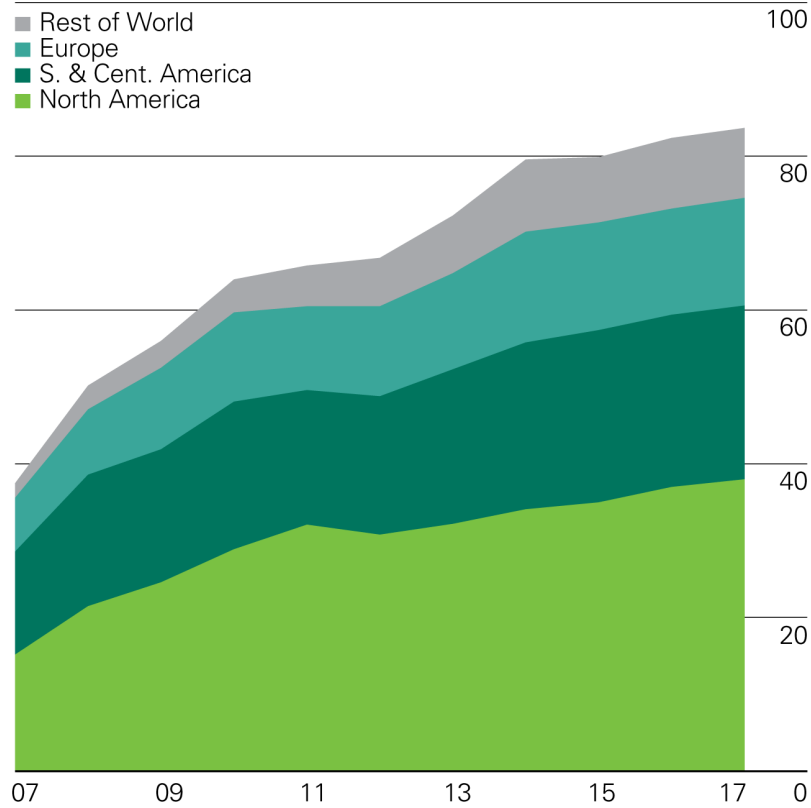
Percentage



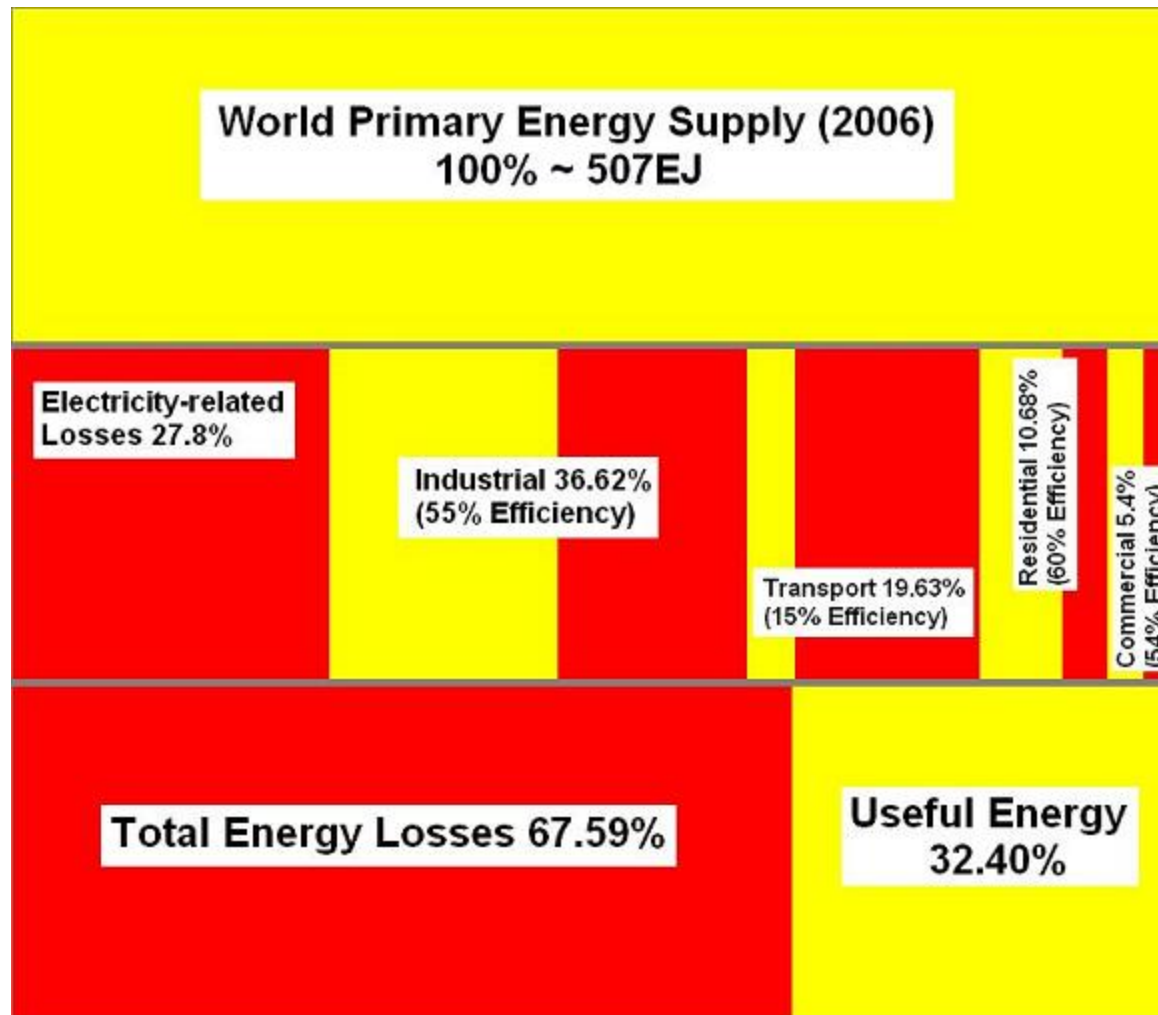
Biofuels production by region

Million tonnes oil equivalent

World biofuels production



Energy transformation and losses



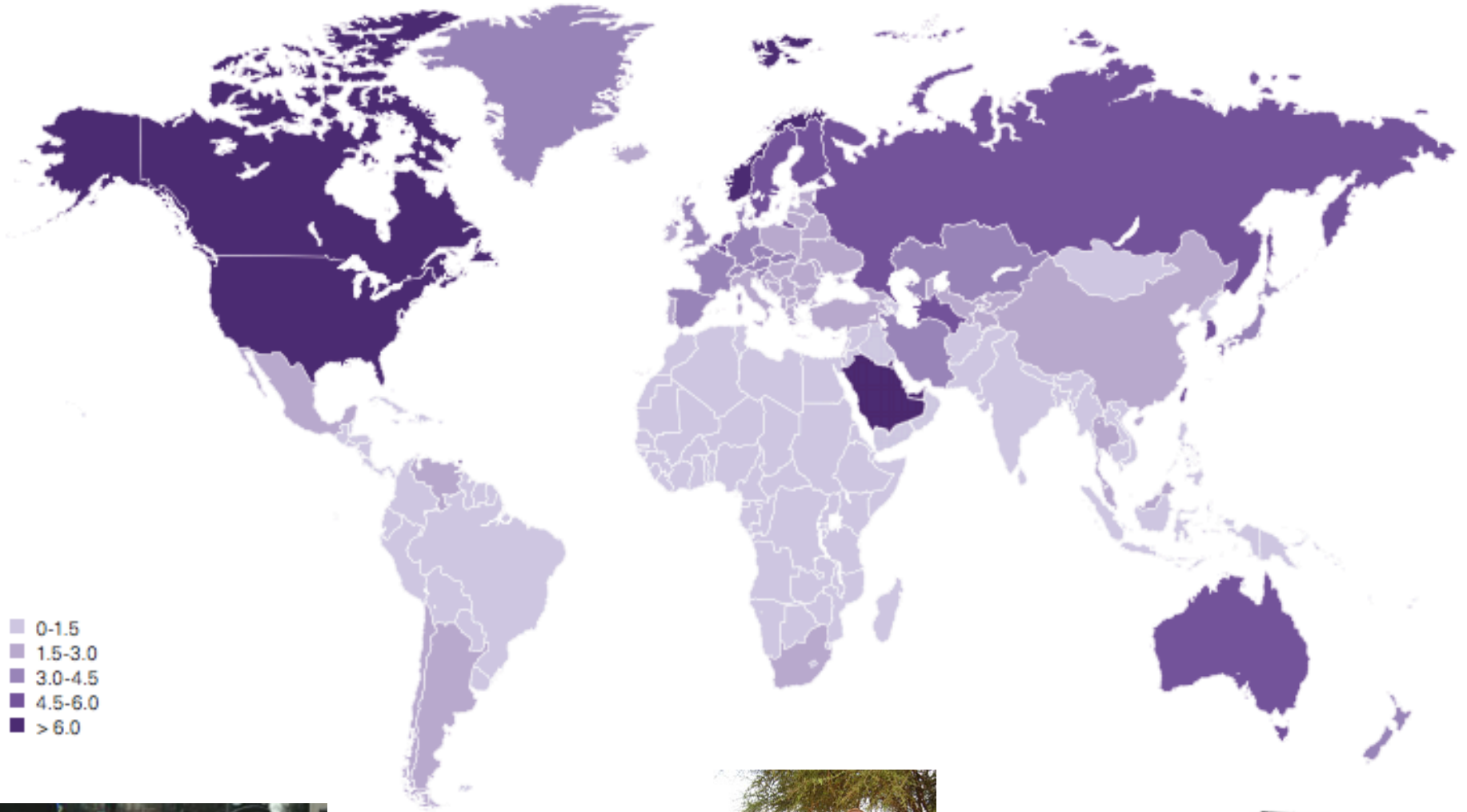
Challenge 21st century

How can we provide the benefits of energy to the population of the globe without damaging the environment, negatively affecting social stability, or threatening the well-being of future generations?

in Sustainable Energy, MIT 2005

Consumption per capita 2012

Tonnes oil equivalent



OECD countries



Darfur region of Sudan, 2004



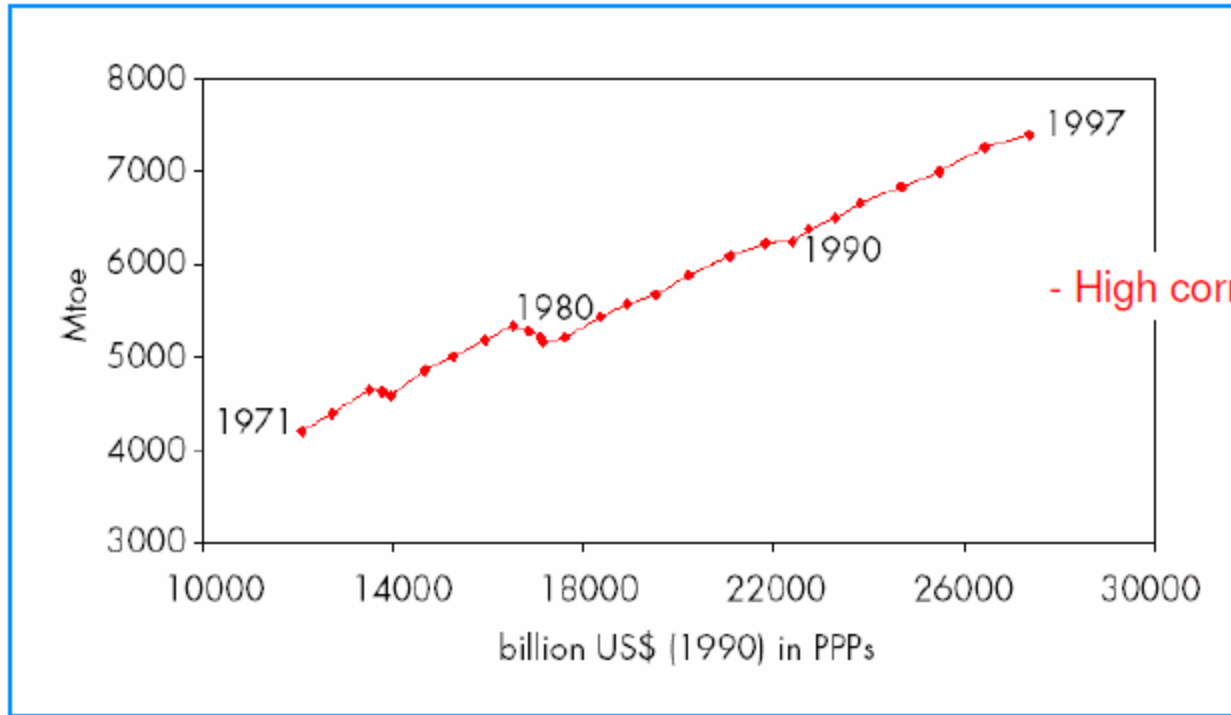
Somewhere in central Europe



Somewhere in Southern Europe

Primary Energy and GDP

Total Primary Energy Supply vs. GDP 1971-1997 (IEA)



Note: Transition economies are excluded.

Purchasing Power Parity (PPP)

¹TPES, Total Primary Energy Supply

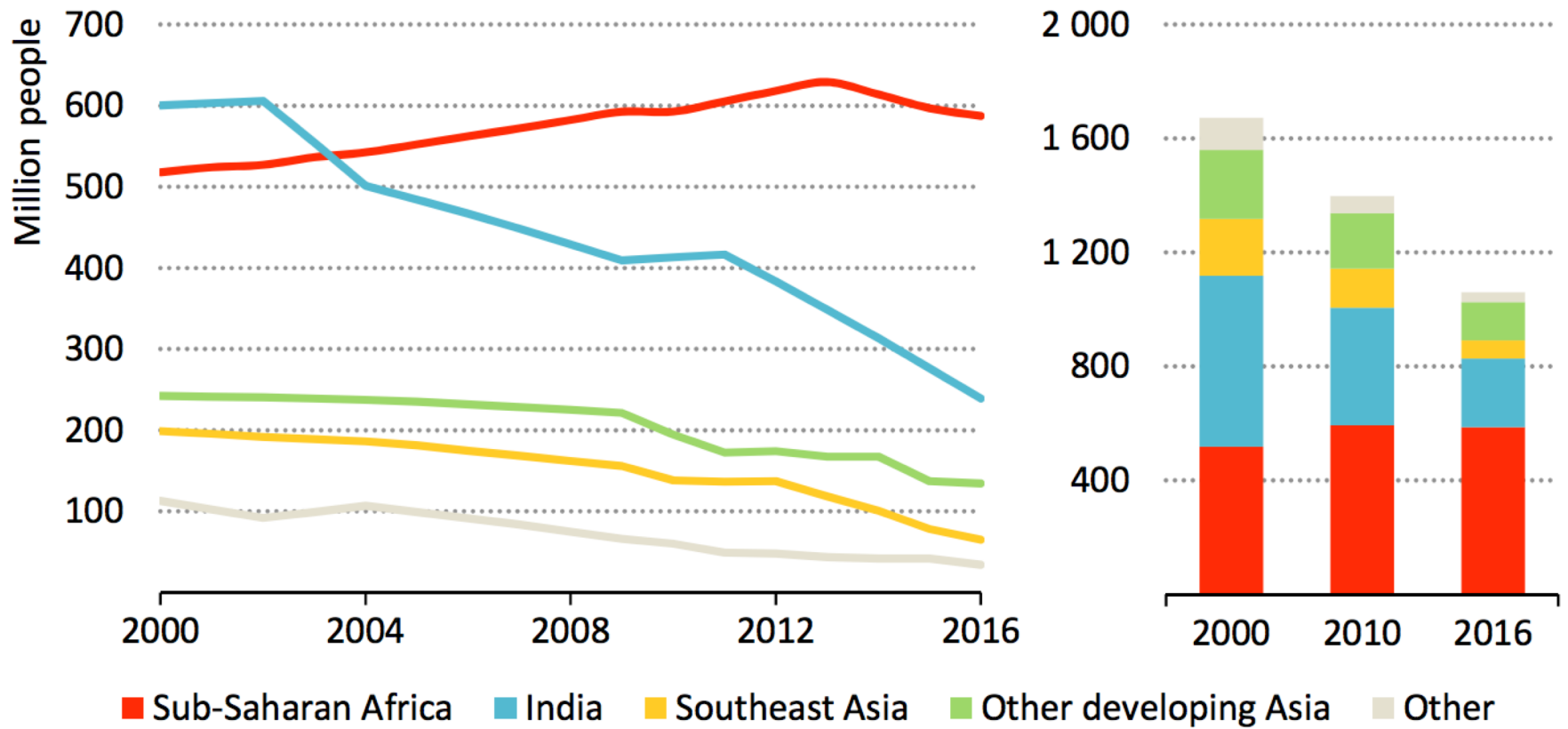
Is prosperity possible without increasing energy consumption?

Energy Services demand

Drivers for Energy services demand (e.g. food, comfort, health, culture):

- Population and family size (#households)
- Wealth
- Consumption patterns: what to use, how to use energy

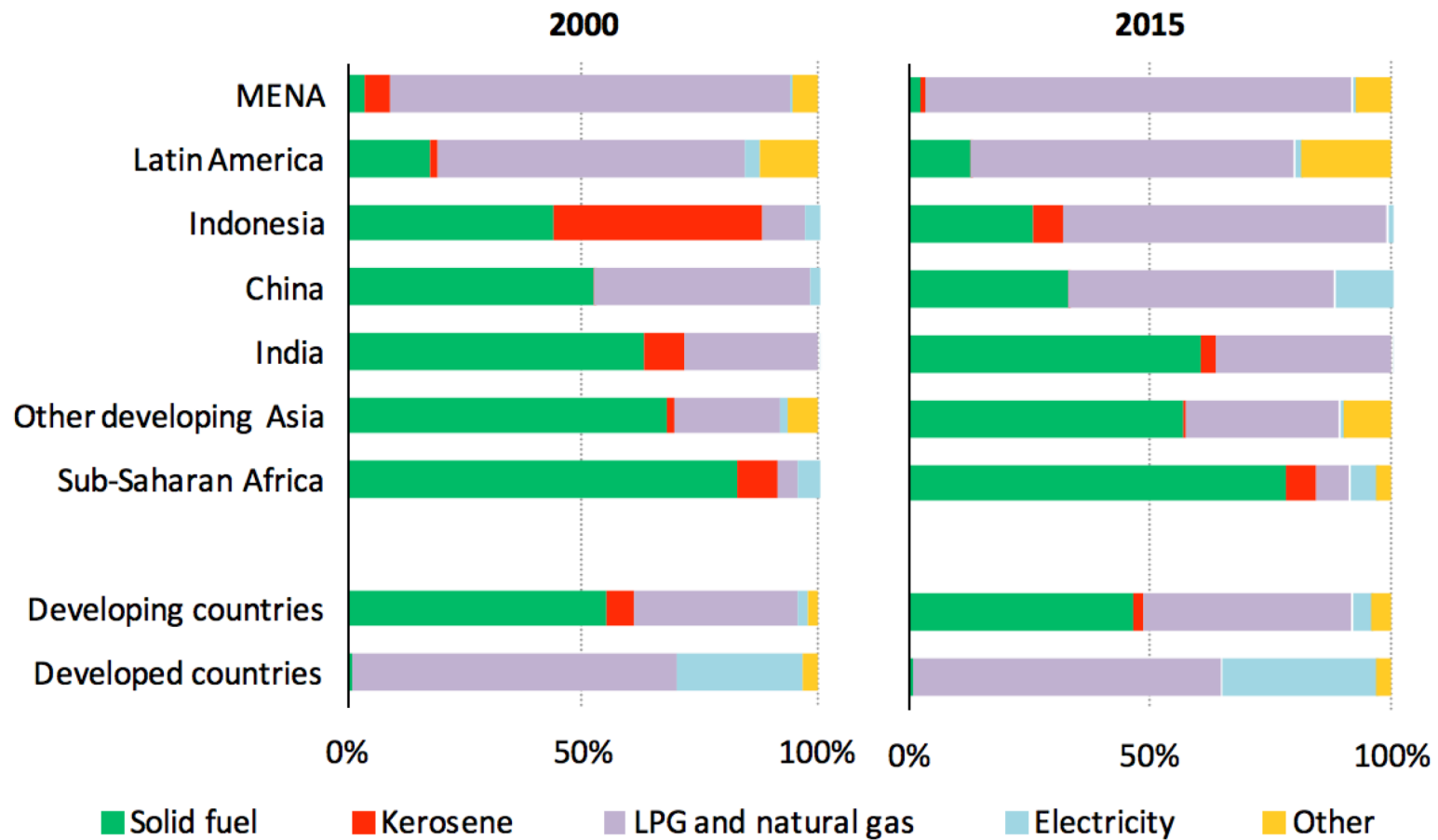
Figure 2.1 ▶ **Population without access to electricity by region**



Progress on electricity access is being made in all parts of the world, led by developing countries in Asia, in particular India

Note: Other includes Middle East, North Africa and Latin America.

Figure 3.1 ▶ Share of population with primary reliance on various cooking fuels by region

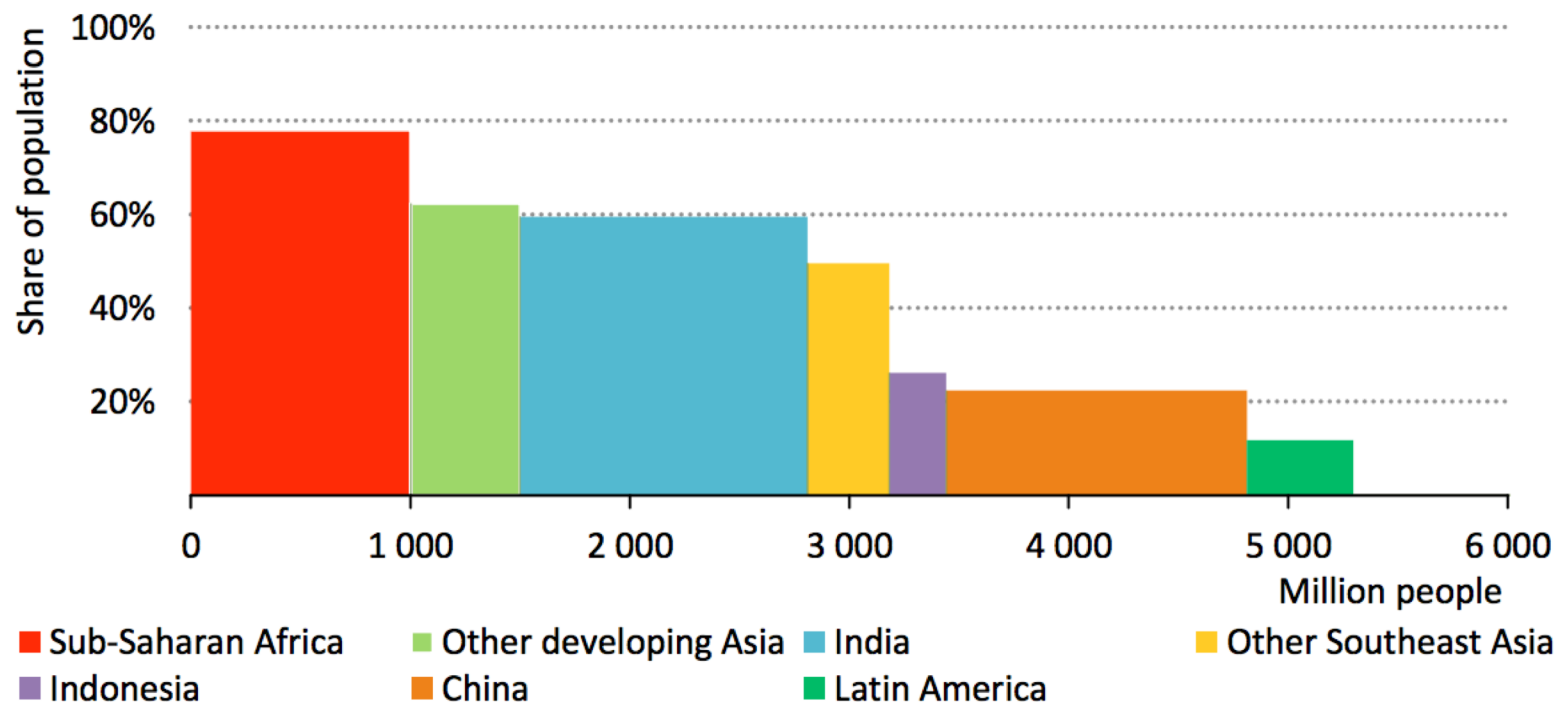


Progress has been limited on clean cooking access in many regions

the share of the population with access to clean cooking has risen from 35% in 2000 to 51% 2015, the number of people using LPG, gas and electricity has risen by 70% to almost 2 billion people.

Sources: IEA analysis; World Health Organization (WHO) Household Energy Database, (2016).

Figure 3.2 ▶ Share of population and number of people relying on biomass for cooking by region, 2015



Many parts of sub-Saharan Africa and Asia rely heavily on biomass for cooking

Sources: IEA analysis; WHO Household Energy Database.

Around 3 billion people cook using polluting open fires or simple stoves fuelled by kerosene, biomass (wood, animal dung and crop waste) and coal. Each year, close to 4 million people die prematurely from illness attributable to household air pollution from inefficient cooking practices using polluting stoves paired with solid fuels and kerosene.

Energy intensity and carbon intensity concepts

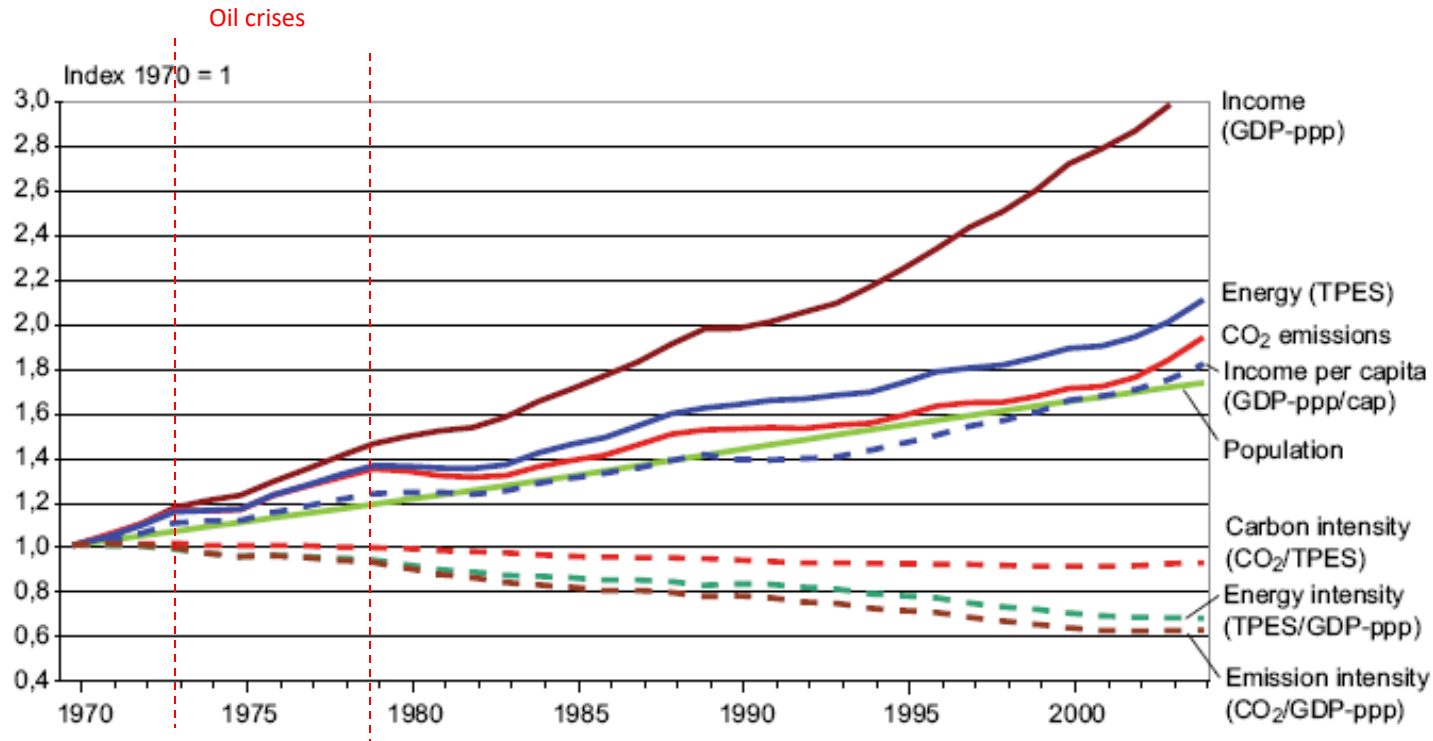
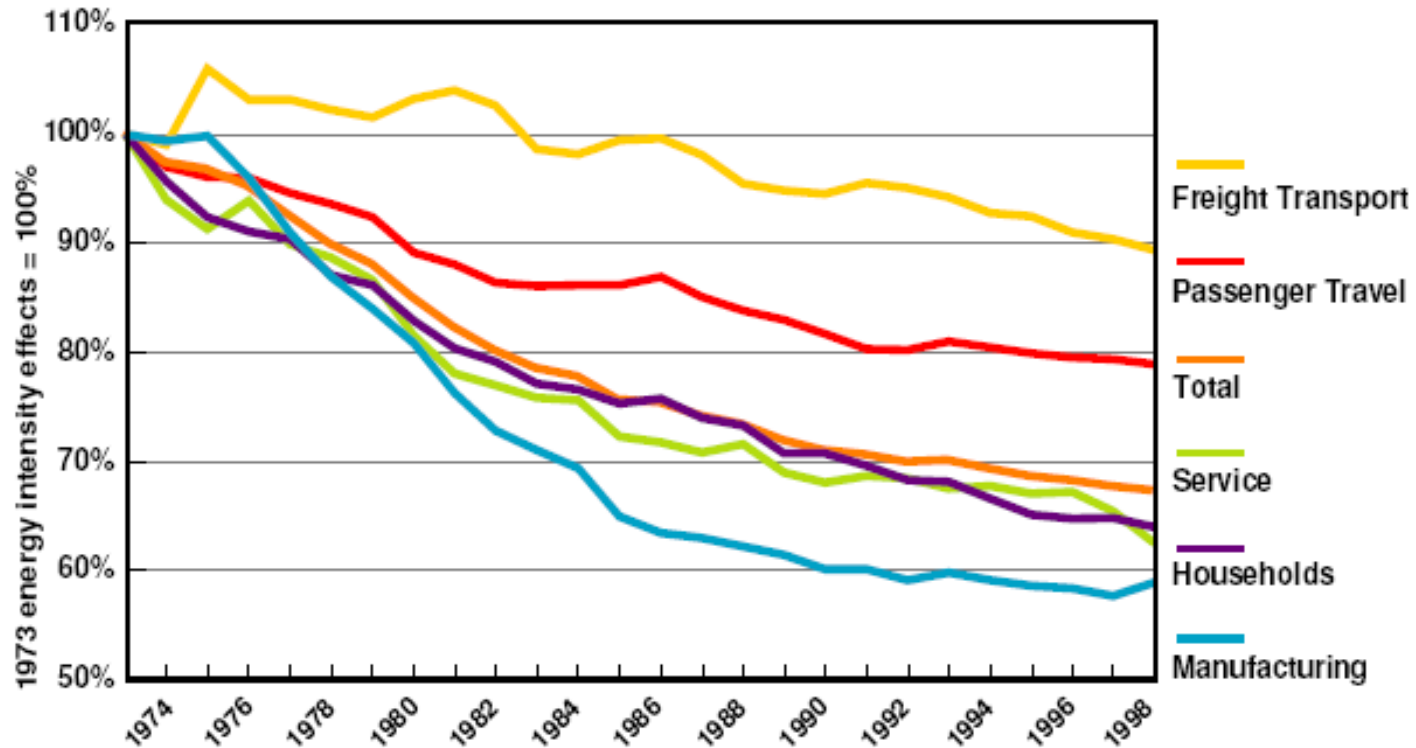


Figure SPM.2: Relative global development of Gross Domestic Product measured in PPP (GDPppp), Total Primary Energy Supply (TPES), CO2 emissions (from fossil fuel burning, gas flaring and cement manufacturing) and Population (Pop). In addition, in dotted lines, the figure shows Income per capita (GDPppp/Pop), Energy Intensity (TPES/GDPppp), Carbon Intensity of energy supply (CO2/TPES), and Emission Intensity of the economic production process (CO2/GDPppp) for the period 1970-2004. [Figure 1.5]

Energy intensity and carbon intensity concepts

Developed countries:

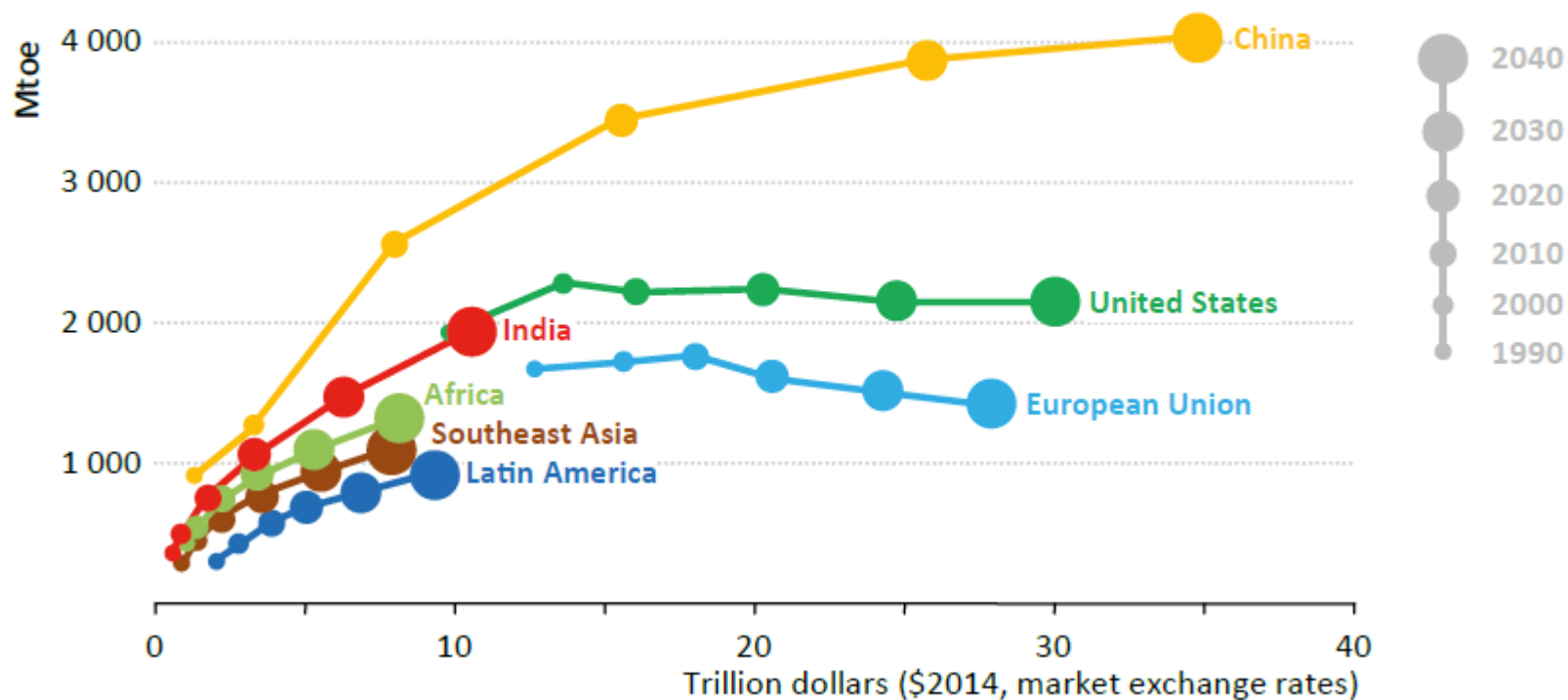


Energy intensity declines have slowed in all sectors since the late 1980s

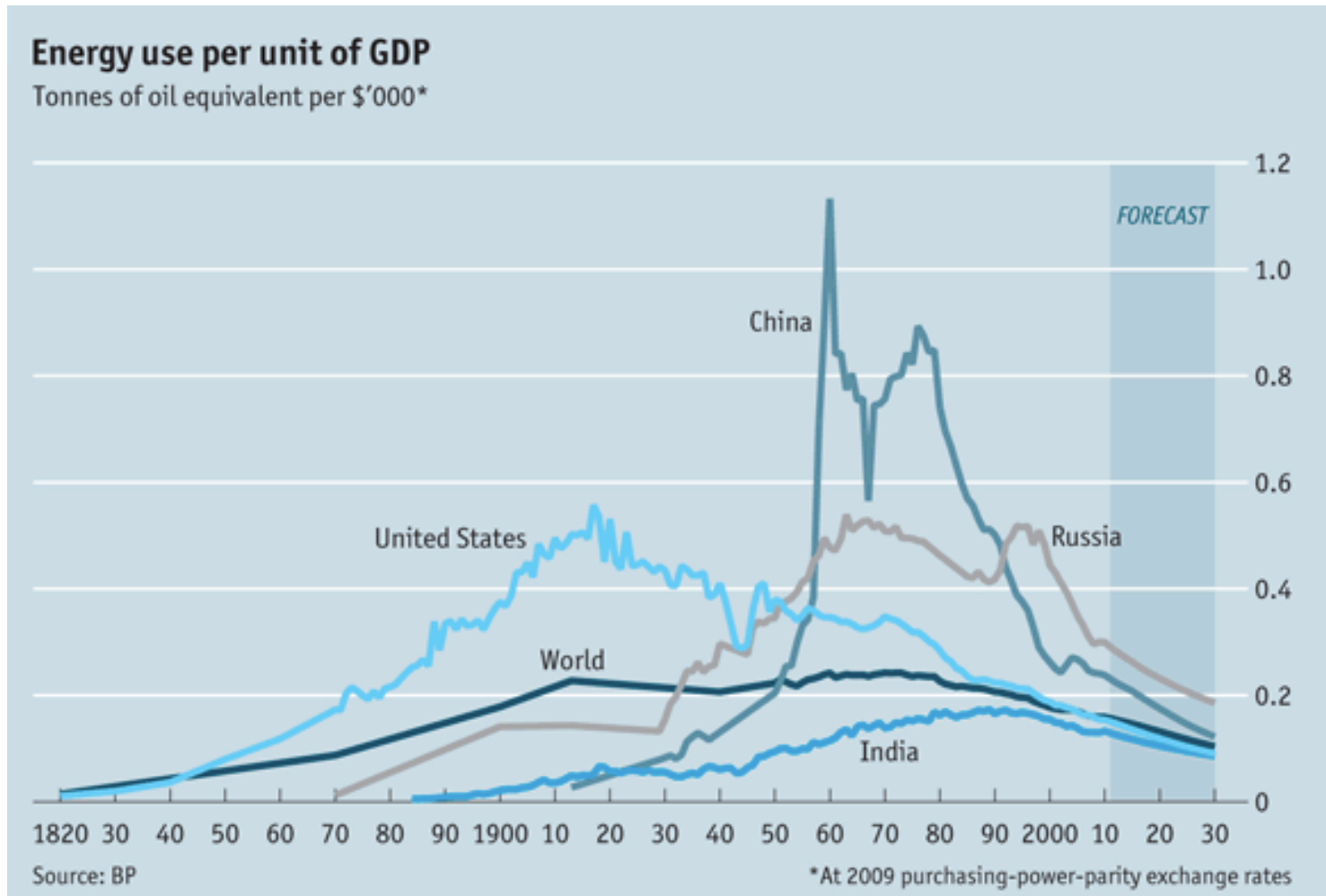
*Note: Data for IEA-11 (Australia, Denmark, Finland, France, Germany, Italy, Japan, Norway, Sweden, the United Kingdom and the United States)

Developing countries

Figure 2.4 ▶ Primary energy demand and GDP by selected region in the New Policies Scenario, 1990-2040



Energy intensity: optimistic vision



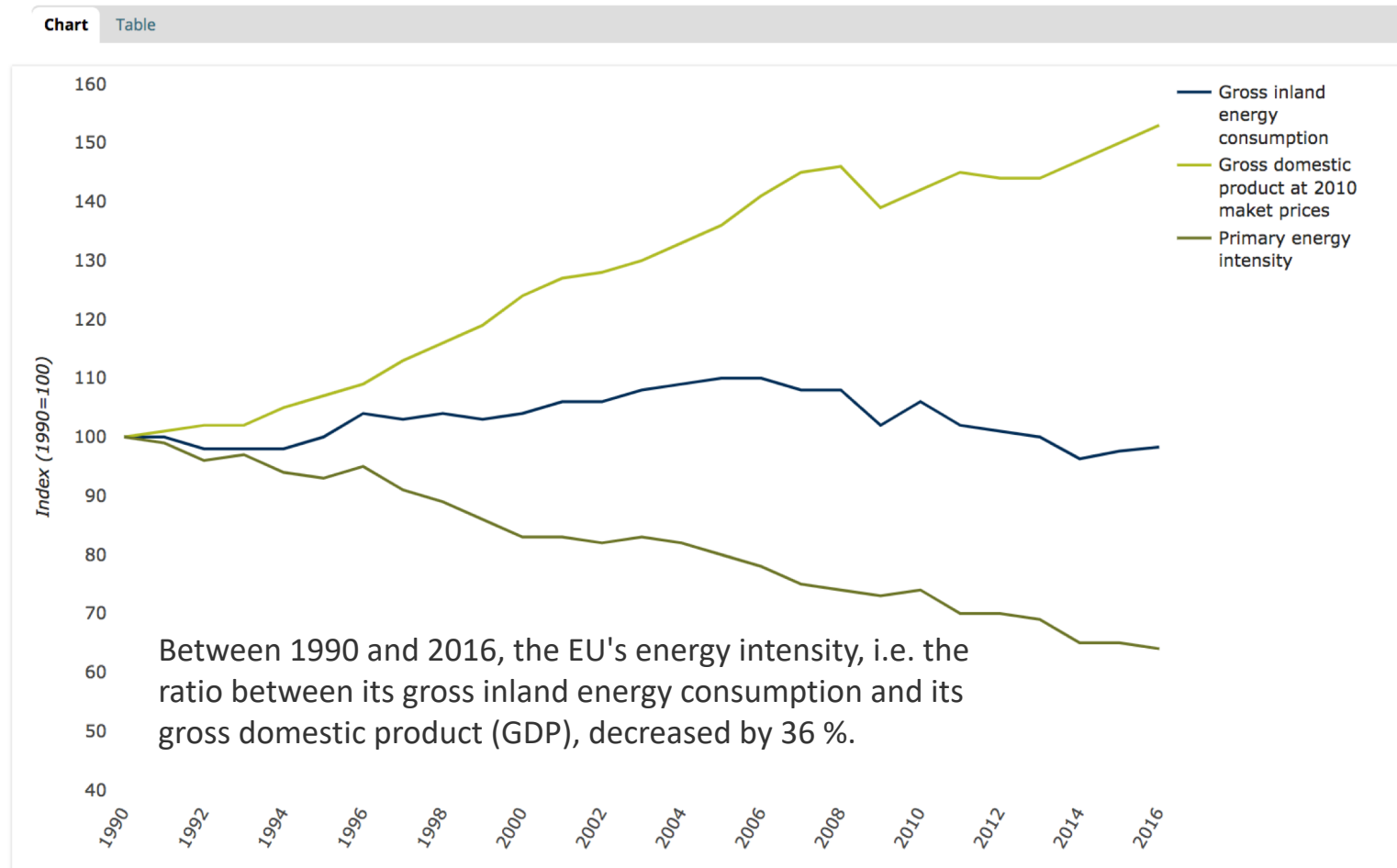
→ Decreasing from the oil shocks

→ Almost stable from first decade of the 20th century,

Energy Intensity in the UE

What means *decoupling* economic growth from energy consumption?

Fig. 1: Trends in energy intensity, gross domestic product and gross inland energy consumption



Source: EEA

In all member countries of the European Environment Agency (EEA), energy intensity decreased between 2005 and 2016. The largest decreases were observed in central and eastern European countries (e.g. Lithuania, Romania and Slovakia) because of changes in their economic structure, and in Malta.

Energy challenges

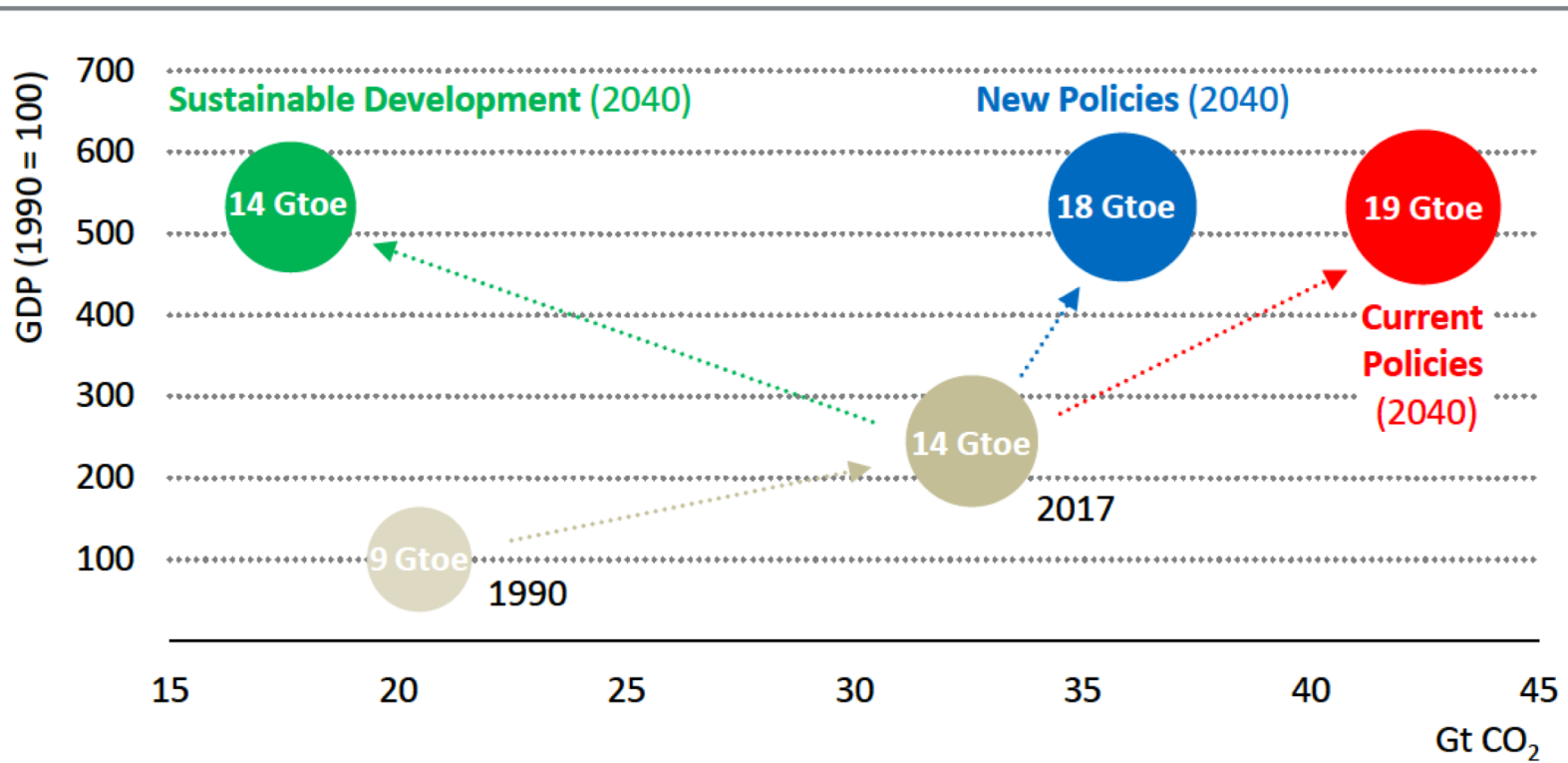
- ✓ Increased levels of energy consumption
- ✓ Lack of access to energy
- ✓ Environmental risks
- ✓ Climate change
- ✓ Air pollution
- ✓ Energy security
- ✓ Adopt a long-term approach for investment

Energy challenges: 10 ... or more questions

- ✓ Has the world broken the link between rising economic activity, energy demand and energy-related CO2 emissions?
- ✓ Which fuels and technologies are poised to do well in the new energy order?
- ✓ Are there limits to growth for renewable energy?
- ✓ Staying below the 2 C climate change limit: what would be required in the energy system?
- ✓ What can the energy sector do to reduce air pollution?
- ✓ Energy investment – is capital heading where it is needed?
- ✓ How might the main risks to energy security evolve over the coming decades?
- ✓ Are we on the path to achieving universal access to energy?
- ✓ Changing places: is global spending on energy subsidies shifting from fossil fuels and in favor of renewable energy sources?

- ✓ Does energy reform point a new way forward for Mexico?

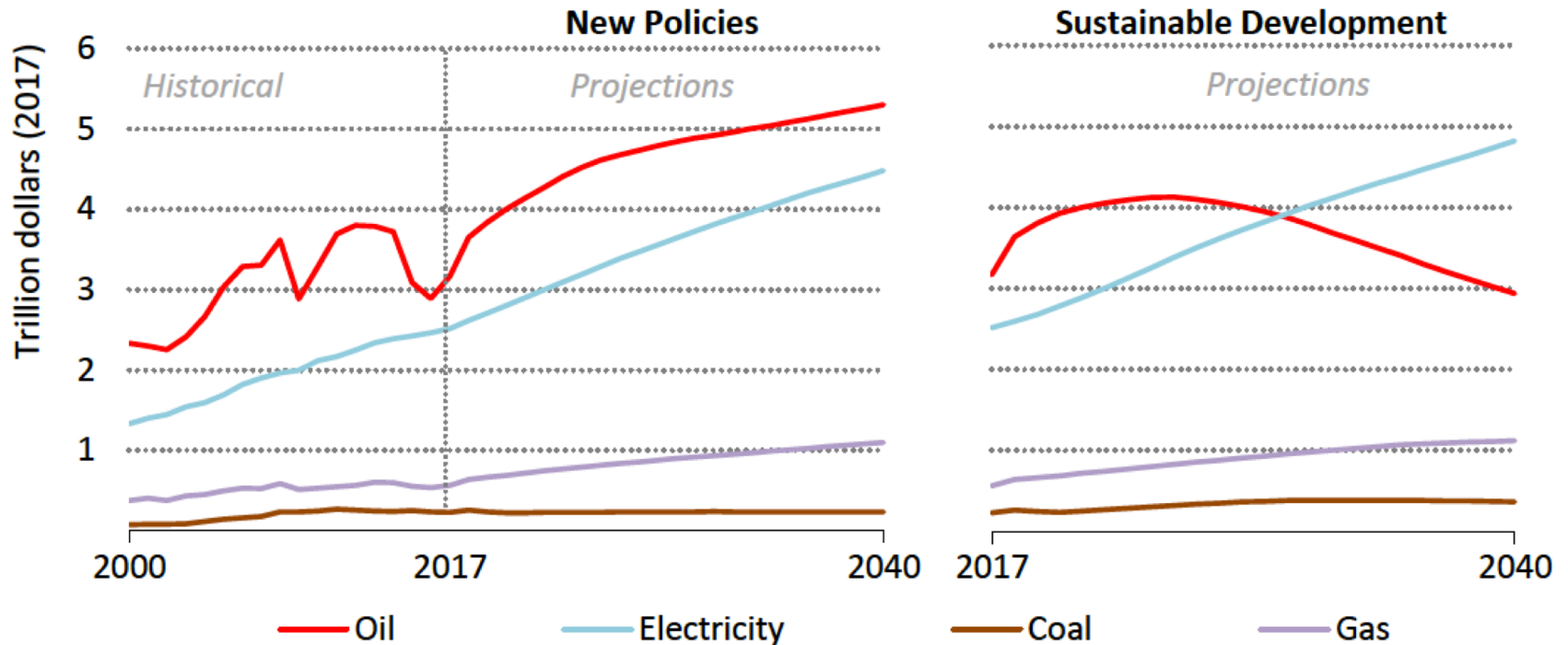
Figure 1.2 ▷ World primary energy demand and energy-related CO₂ emissions by scenario



Achieving sustainable development goals requires a complete reversal of the historic relationship between economic growth, energy demand and emissions

Notes: Bubble size and numbers represent total primary energy demand. Gtoe = gigatonnes of oil equivalent or 1 000 Mtoe; Gt CO₂ = gigatonnes of CO₂.

Figure 1.13 ▷ Global end-user energy spending by fuel and scenario



In the Sustainable Development Scenario, electricity takes over from oil as the main element of consumer spending on energy

World Energy Balance - 2050

