Seminar on Energy and Climate Change

Global Energy System

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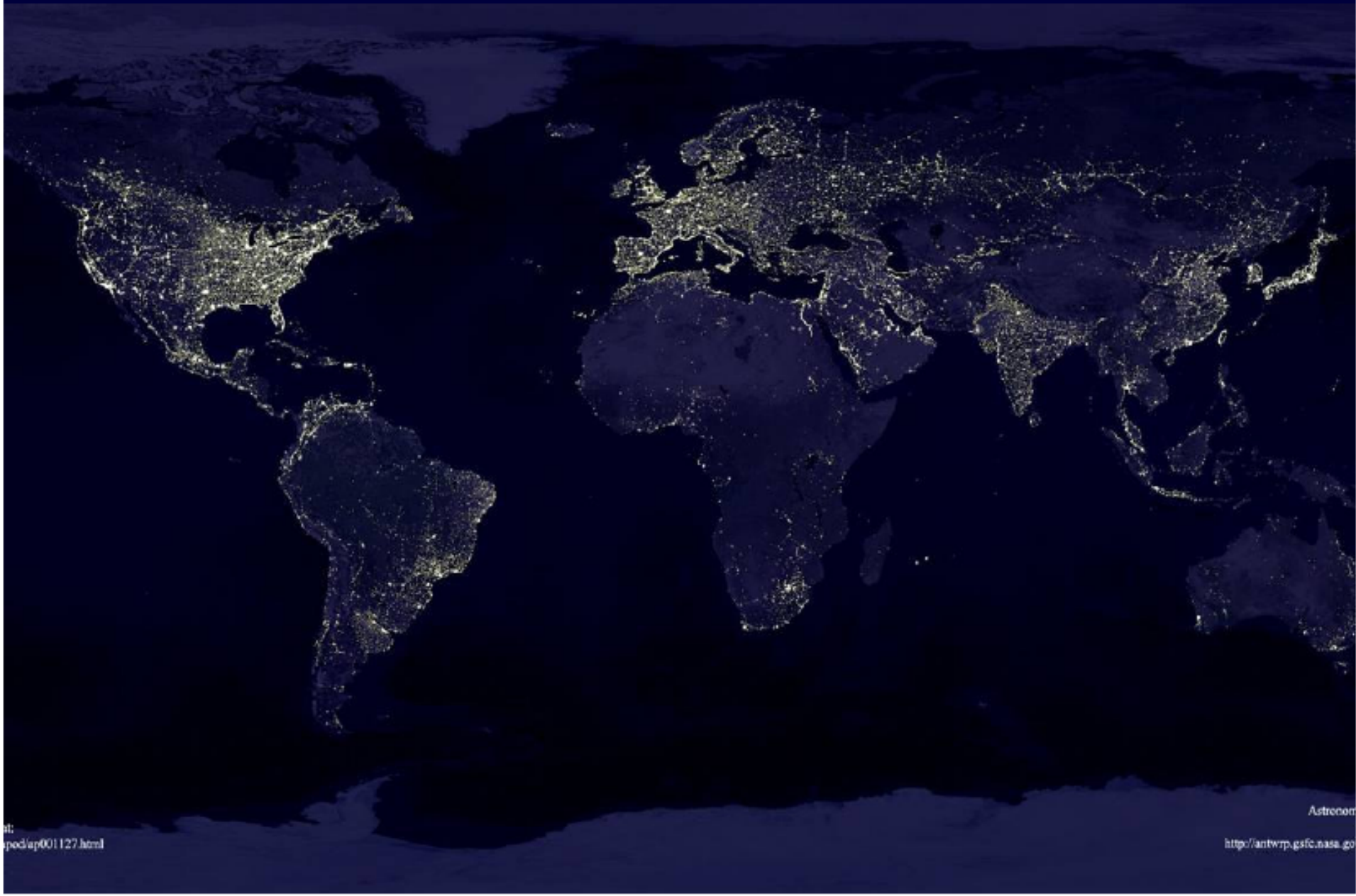
Energy Demand & Prosperity



Agenda

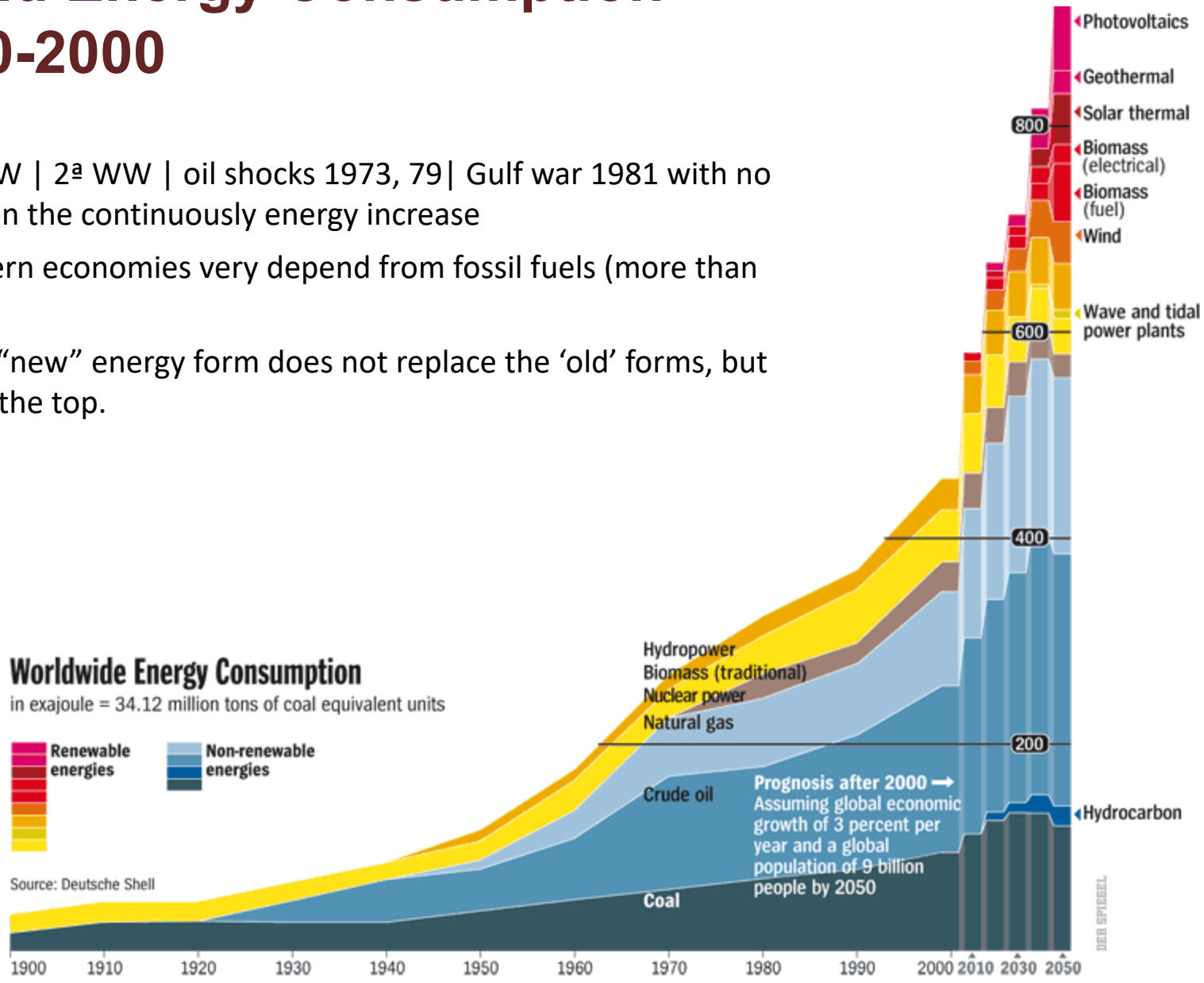
- Global and regional trends of energy consumption
- Access to clean energy
- Energy intensity indicators (energy vs. GDP)
- Questions for the future of the global energy system

World Energy Consumption 1860-2000

→ 1ª WW | 2ª WW | oil shocks 1973, 79| Gulf war 1981 with no impact on the continuously energy increase

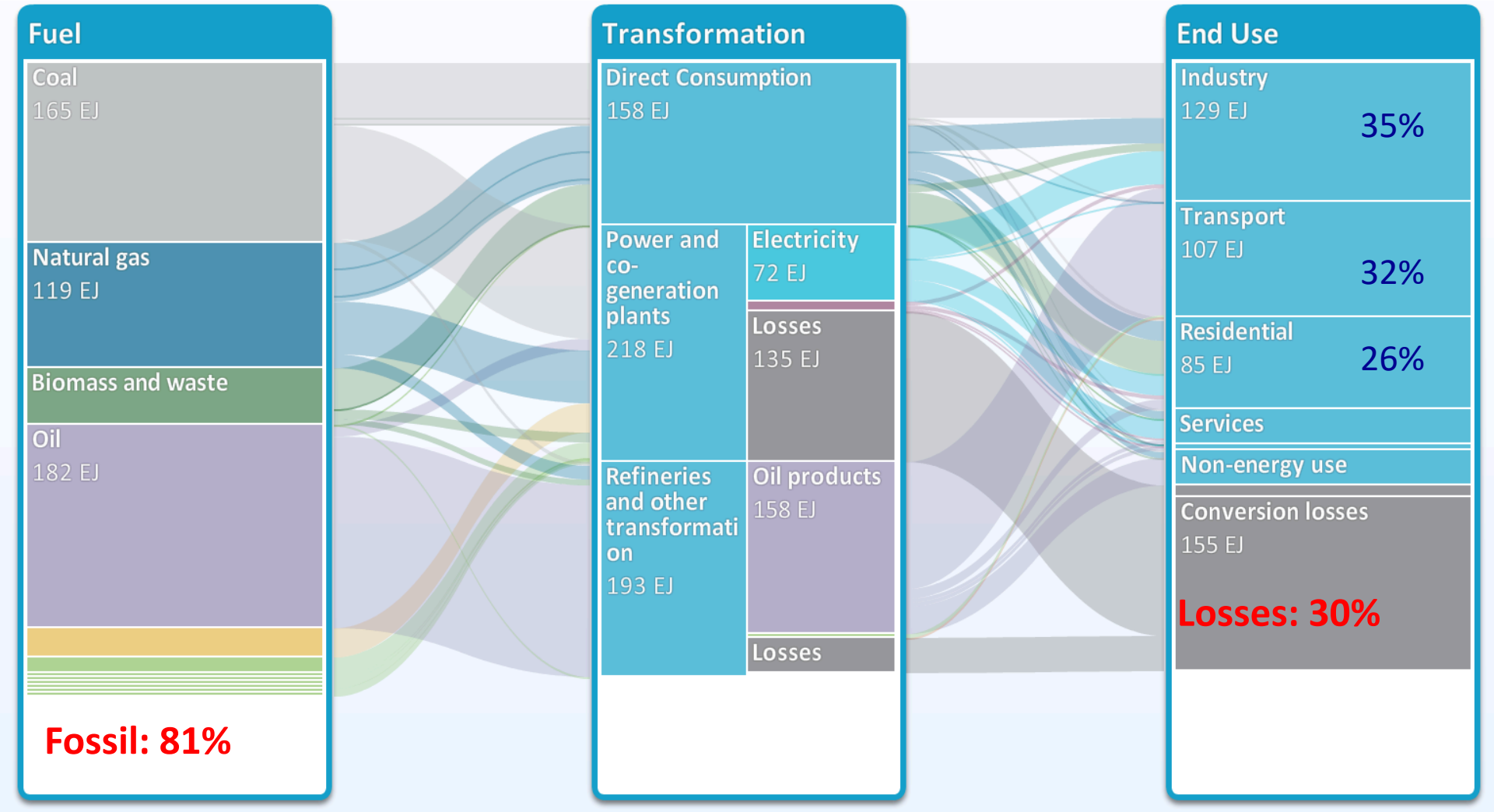
→ Modern economies very depend from fossil fuels (more than 80%).

→ Each “new” energy form does not replace the ‘old’ forms, but adds on the top.



Fonte: Deutsche Shell

World Energy Balance - 2014

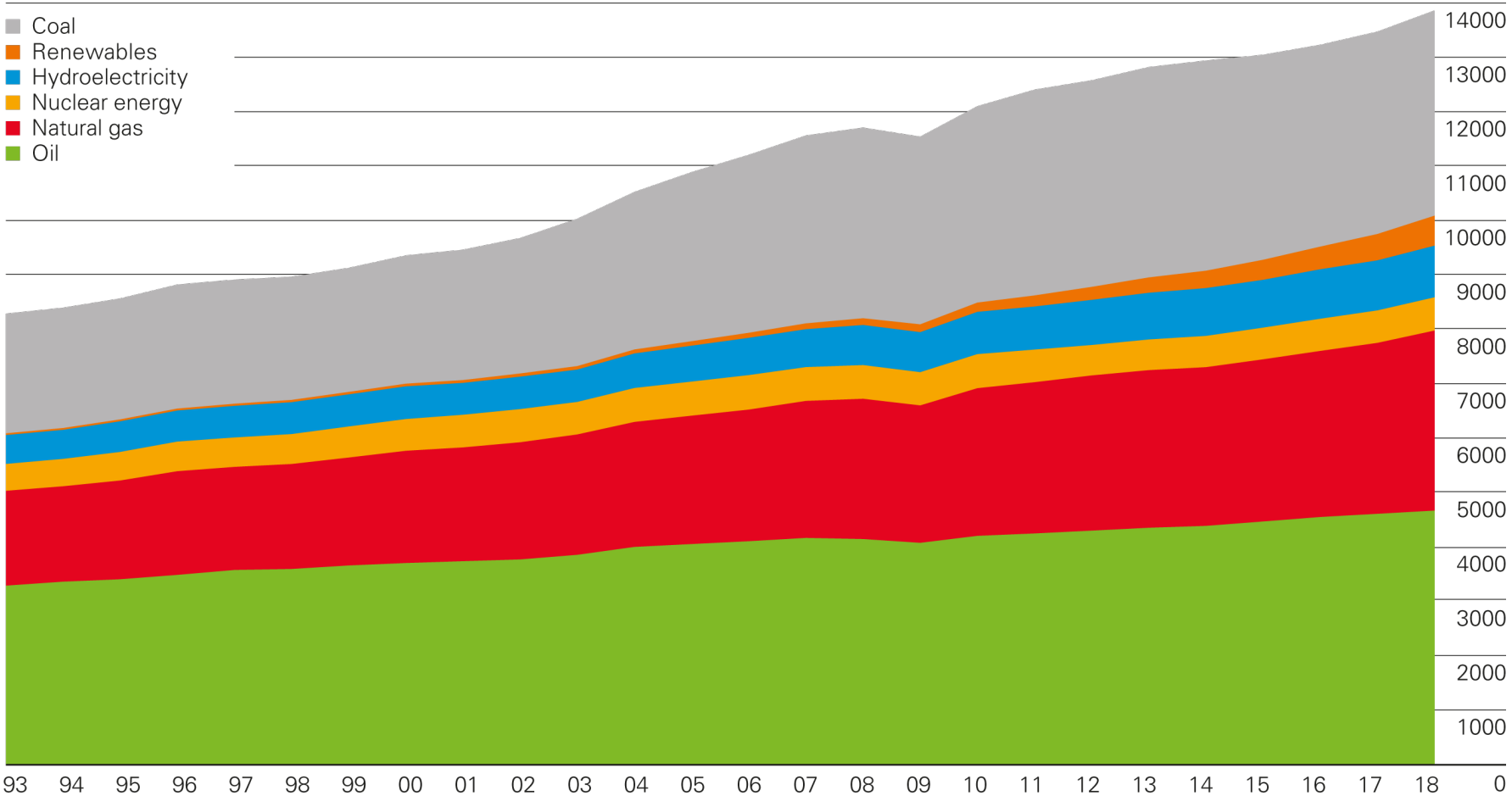


http://www.iea.org/etp/explore/ | DATA - try by yourself!

Source: IEA, ETP 2017

Primary energy world consumption

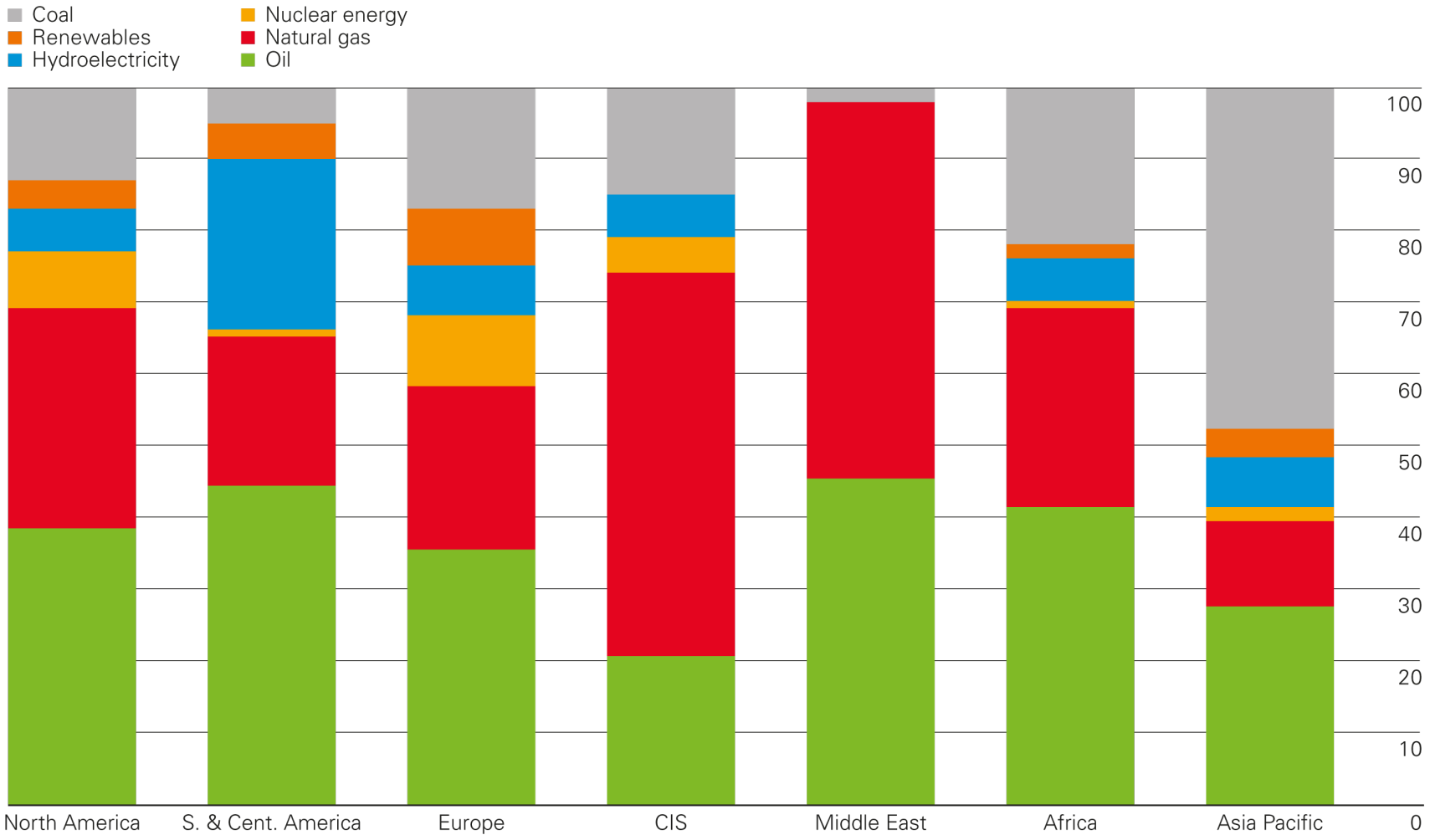
Million tonnes oil equivalent



BP Statistical Review of World Energy 2019

Primary energy regional consumption by fuel 2018

Percentage



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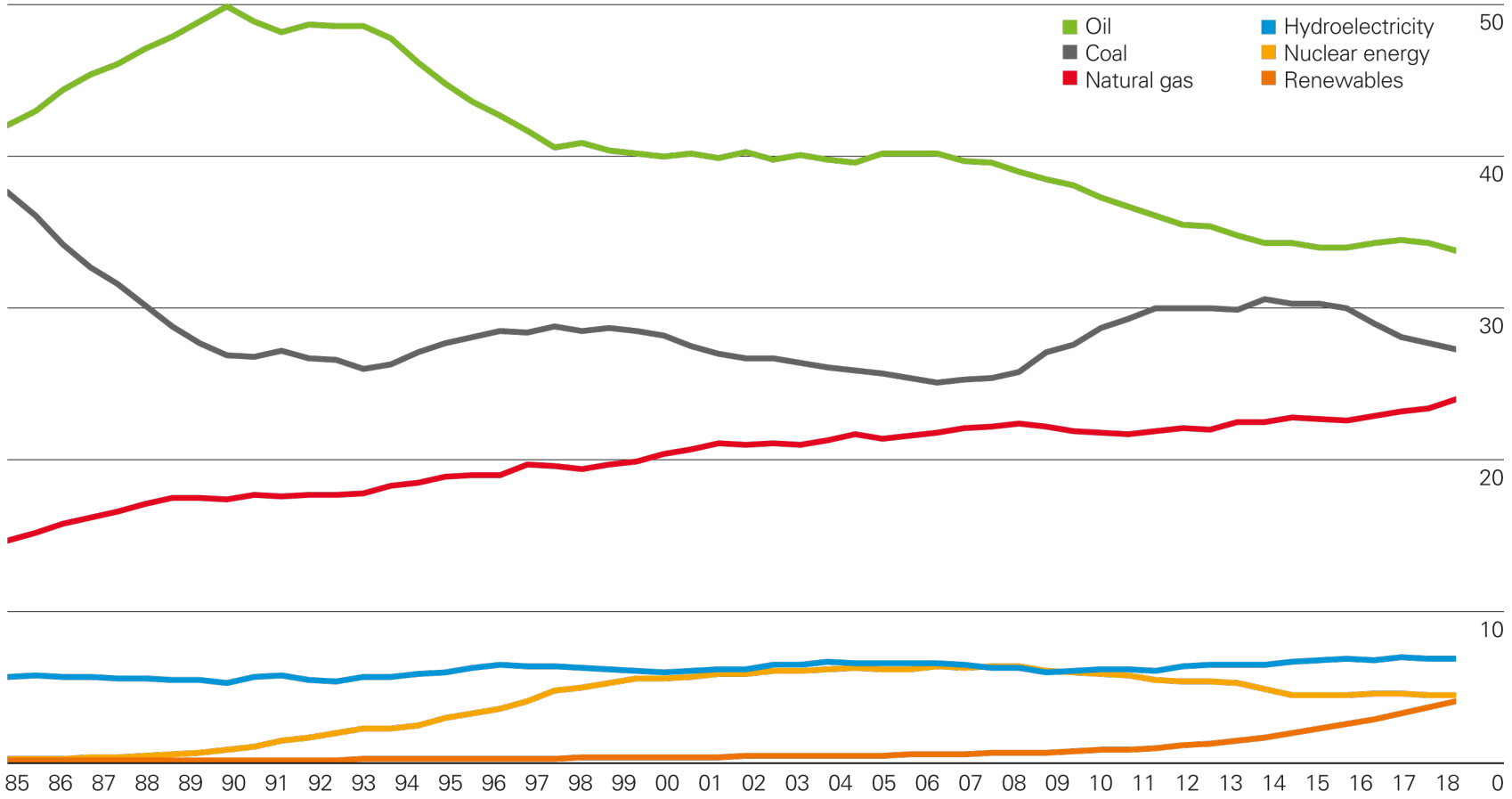
Shares of global primary energy consumption

Percentage



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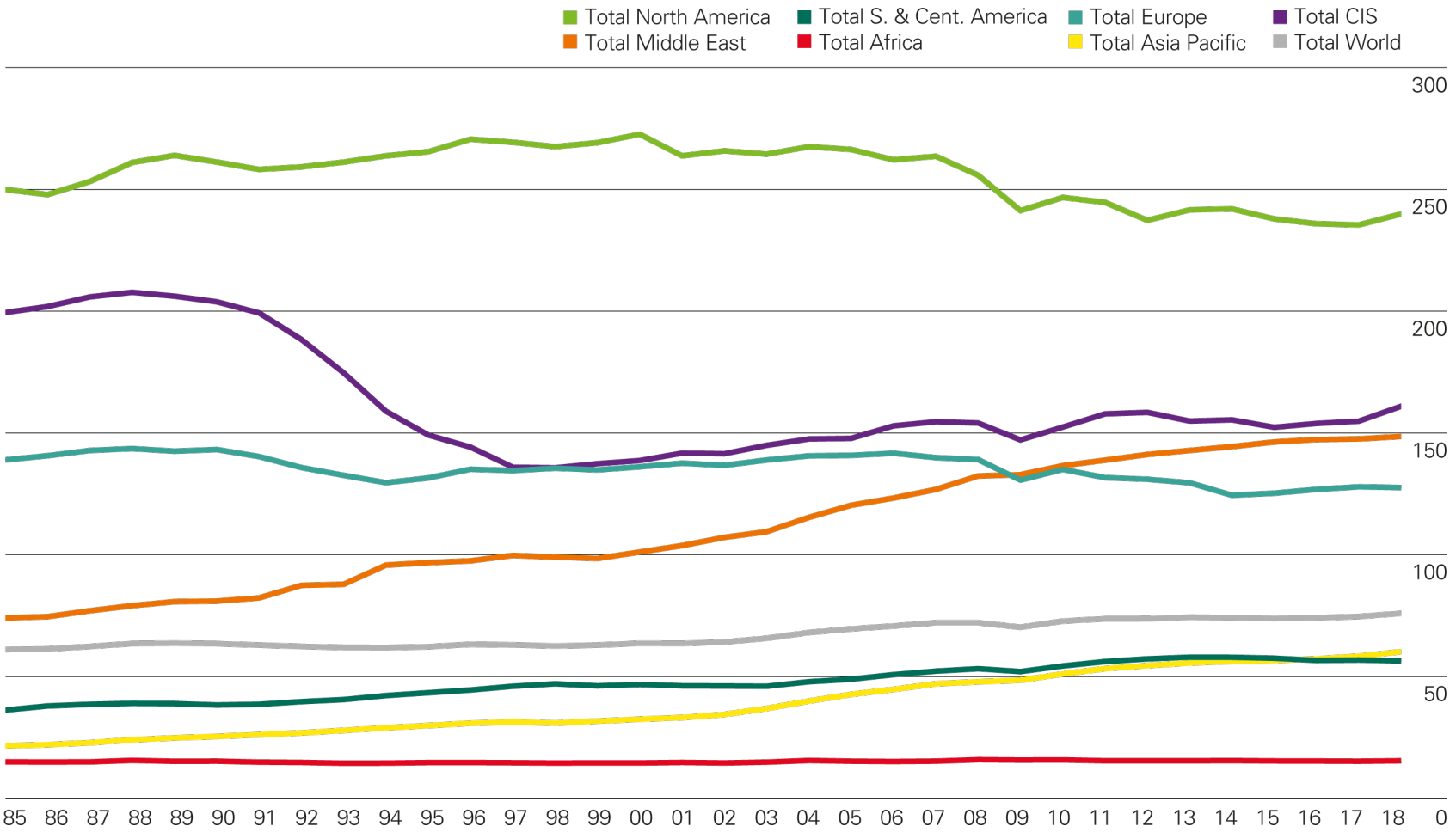
Energy per capita by region

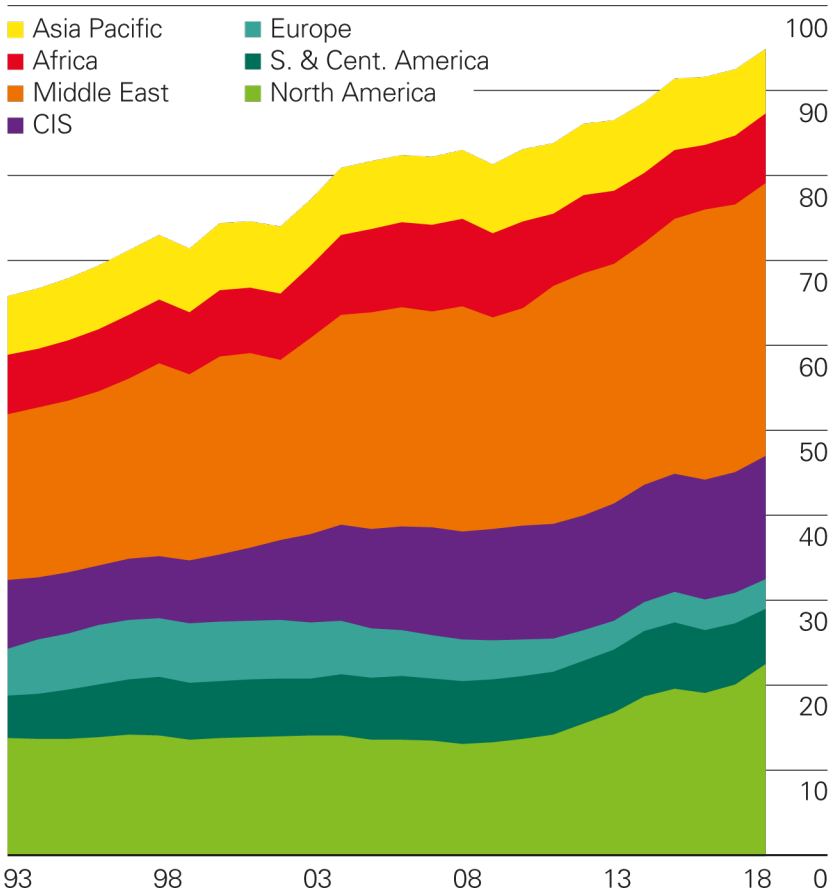
Gigajoules per head



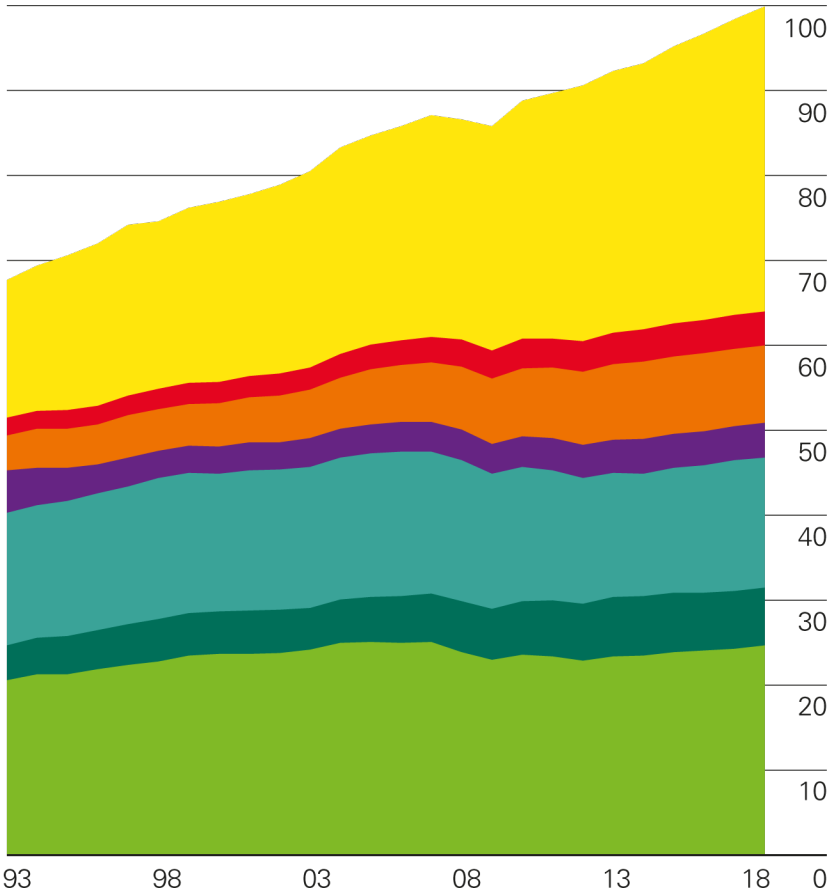
Oil production/consumption by region

Million barrels daily

Production by region

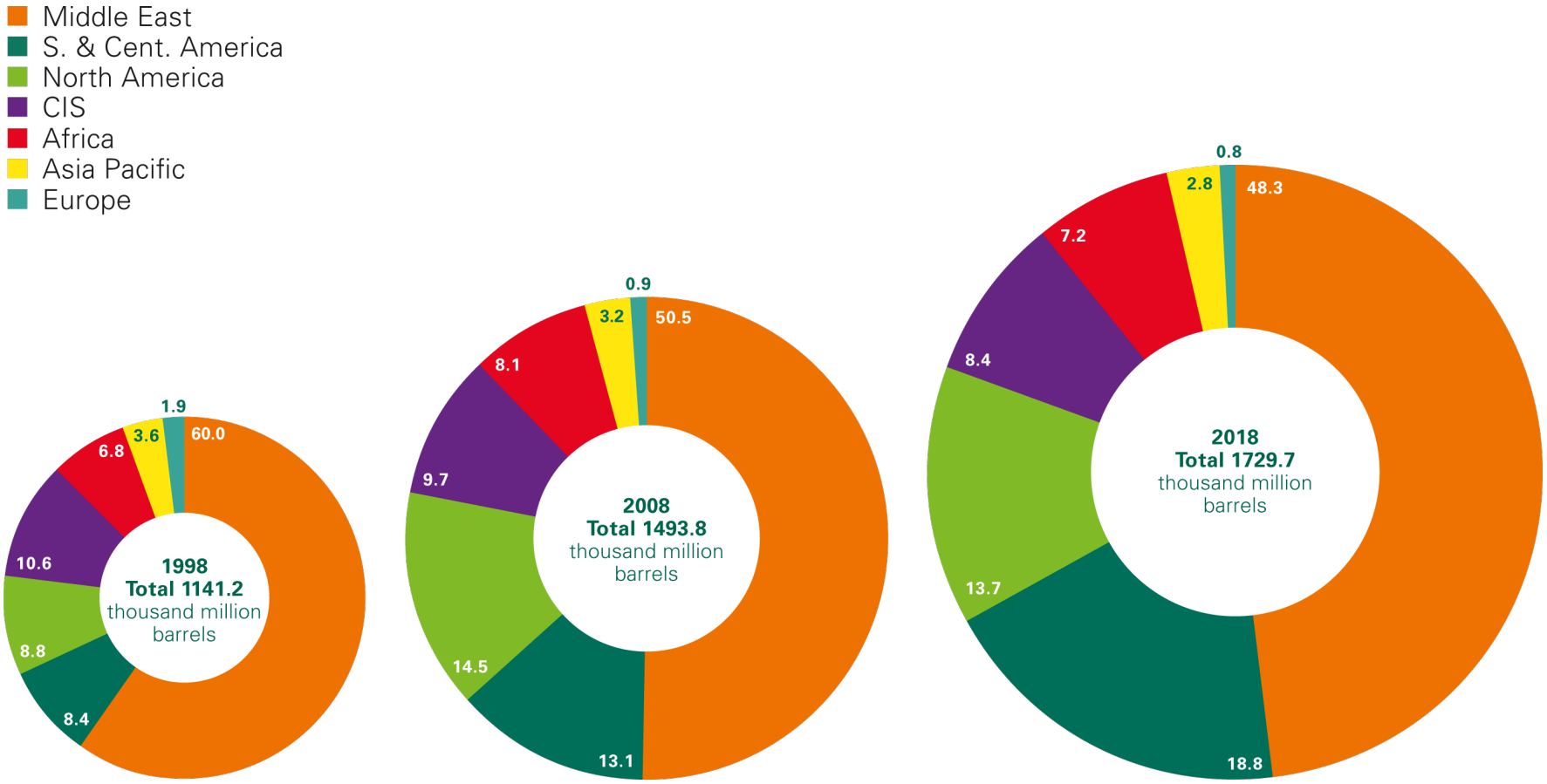


Consumption by region



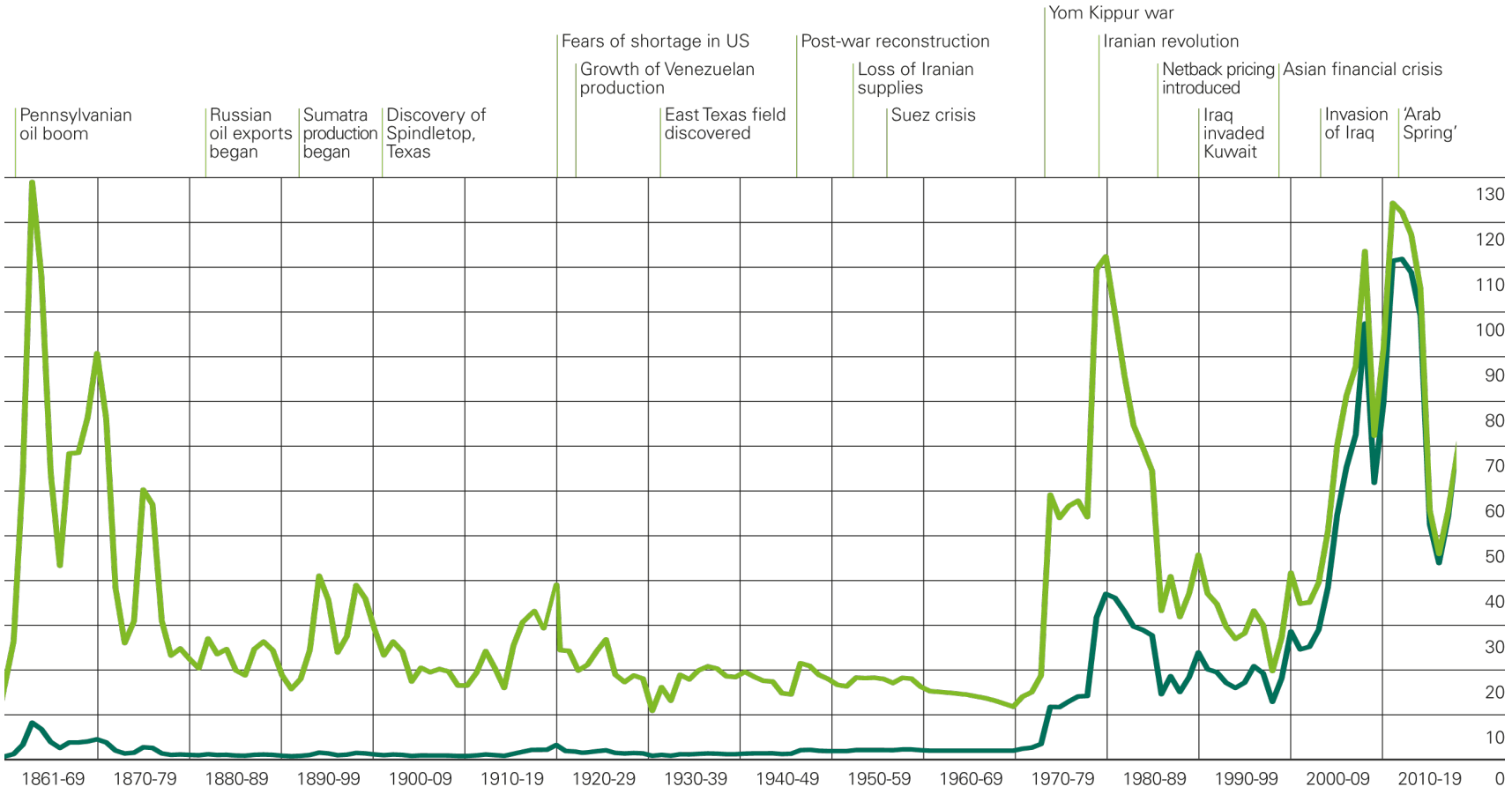
Distribution of proved oil reserves: 1997, 2007 and 2018

Percentage



Crude oil prices 1861-2018

US dollars per barrel, world events

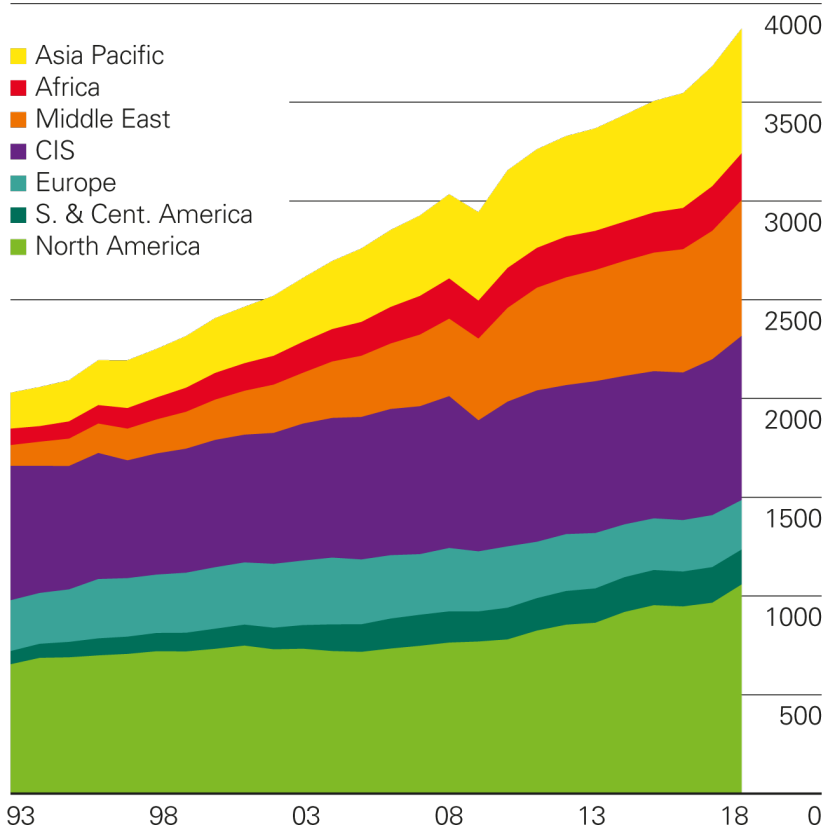


1861-1944 US average.
1945-1983 Arabian Light posted at Ras Tanura.
1984-2018 Brent dated.

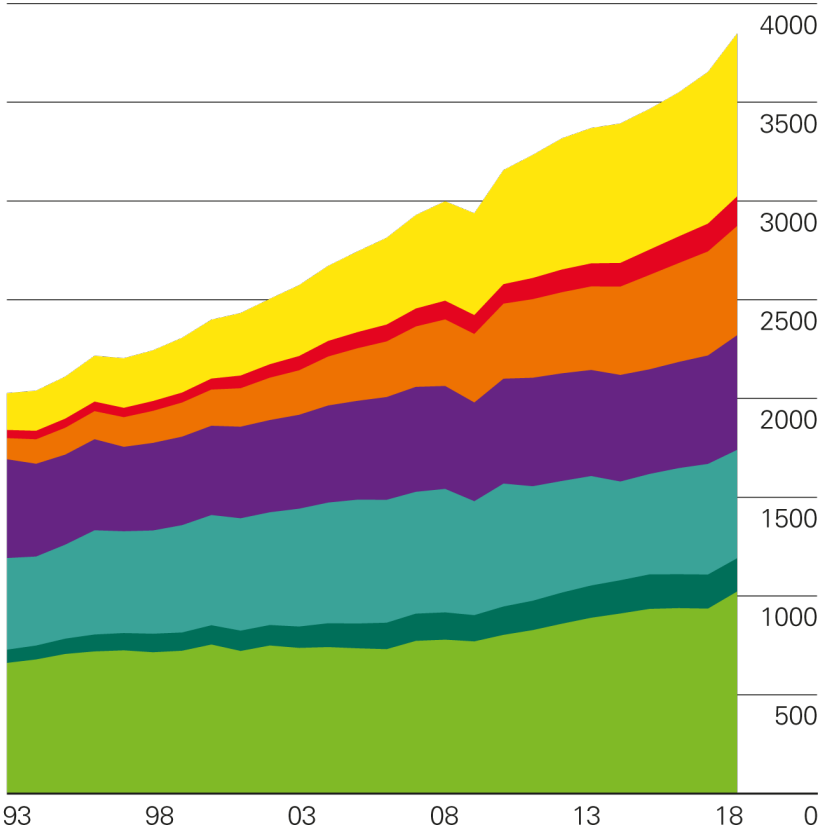
Gas production/consumption by region

Billion cubic metres

Production by region

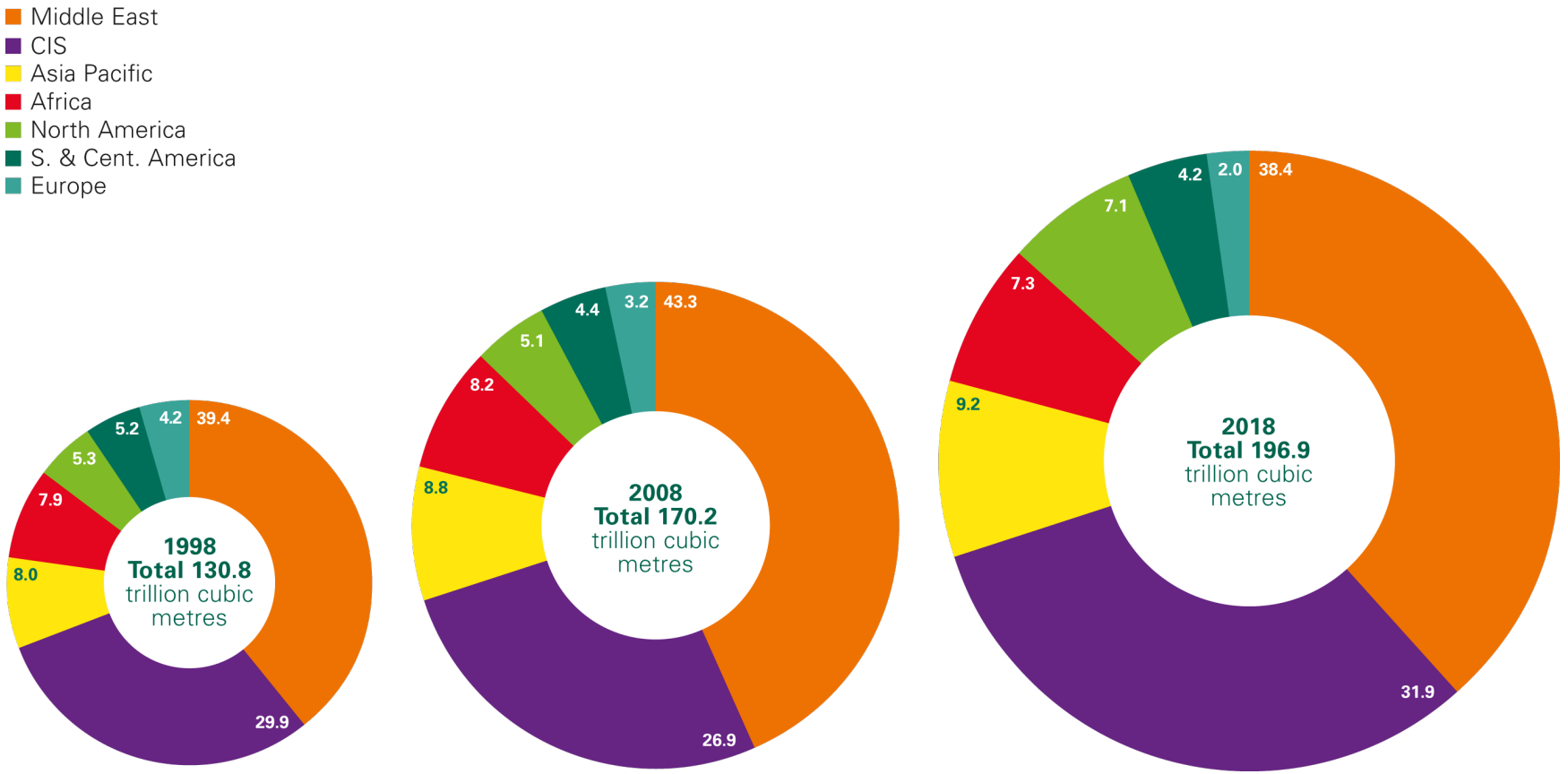


Consumption by region



Distribution of proved gas reserves: 1998, 2008 and 2018

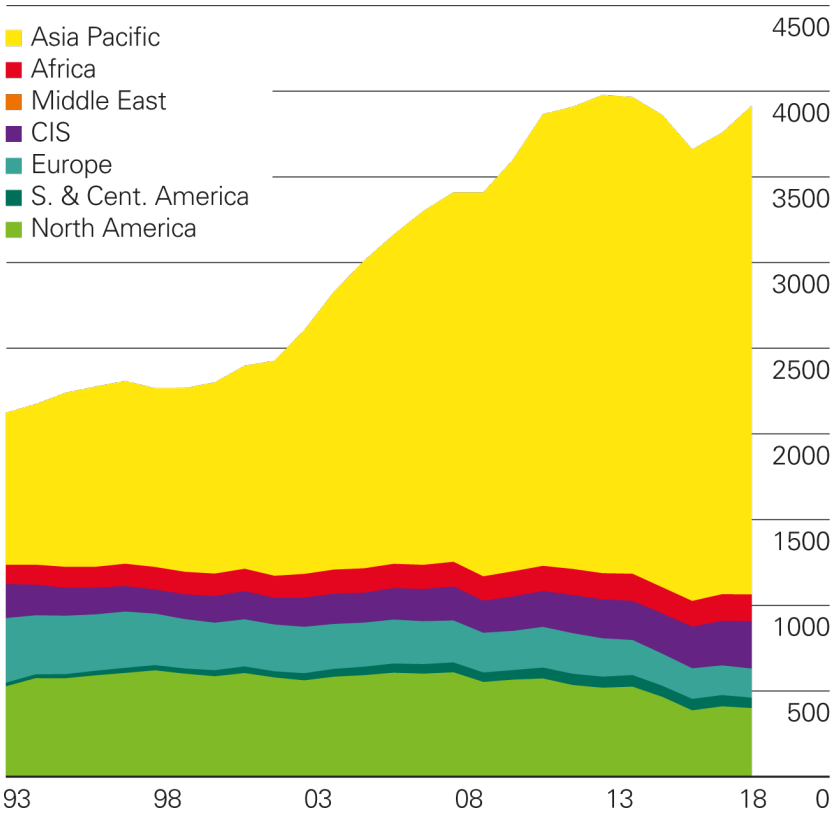
Percentage



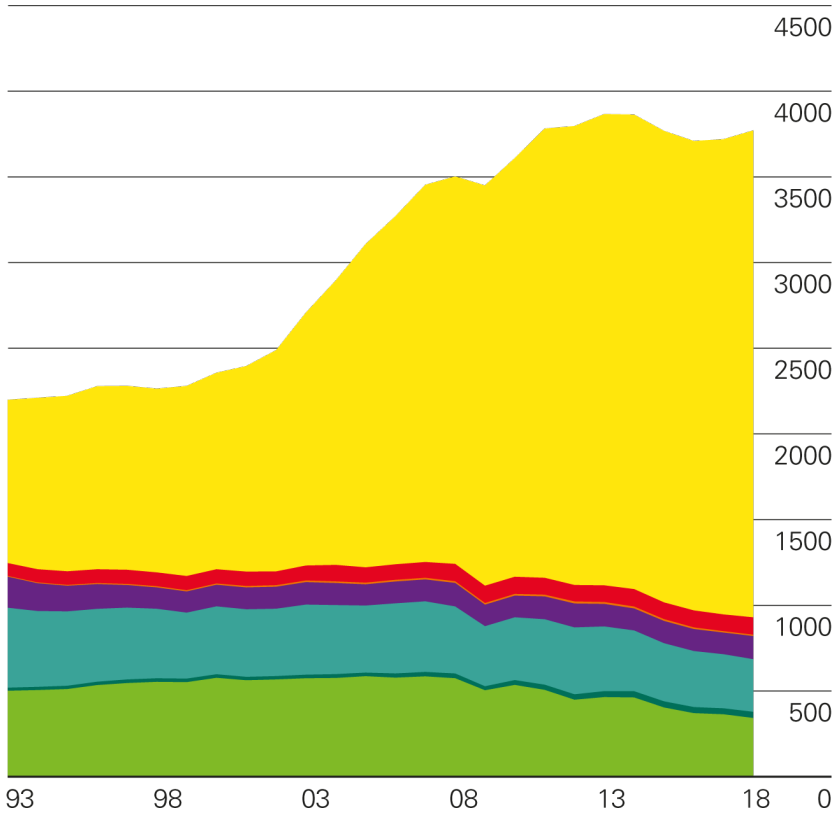
Coal production/consumption by region

Million tonnes oil equivalent

Production by region

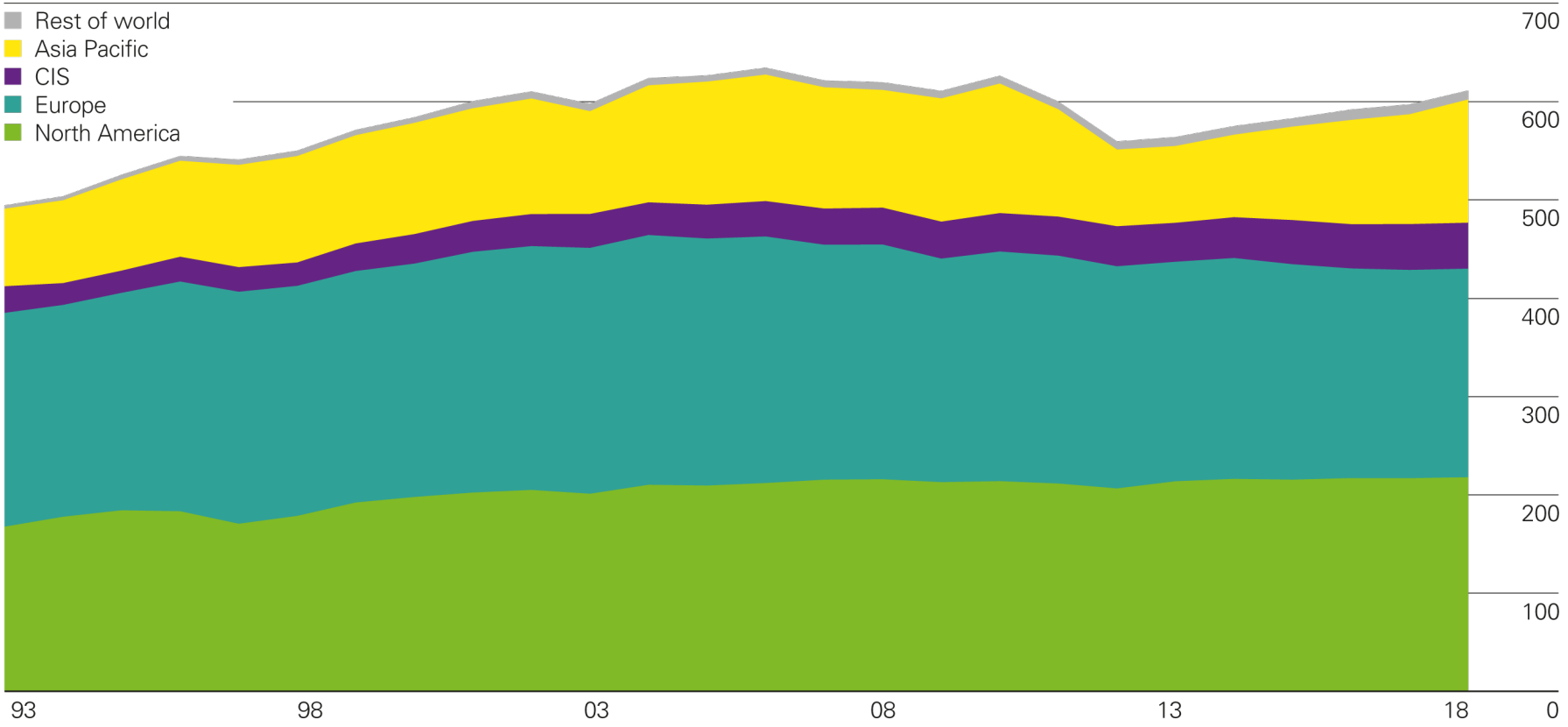


Consumption by region



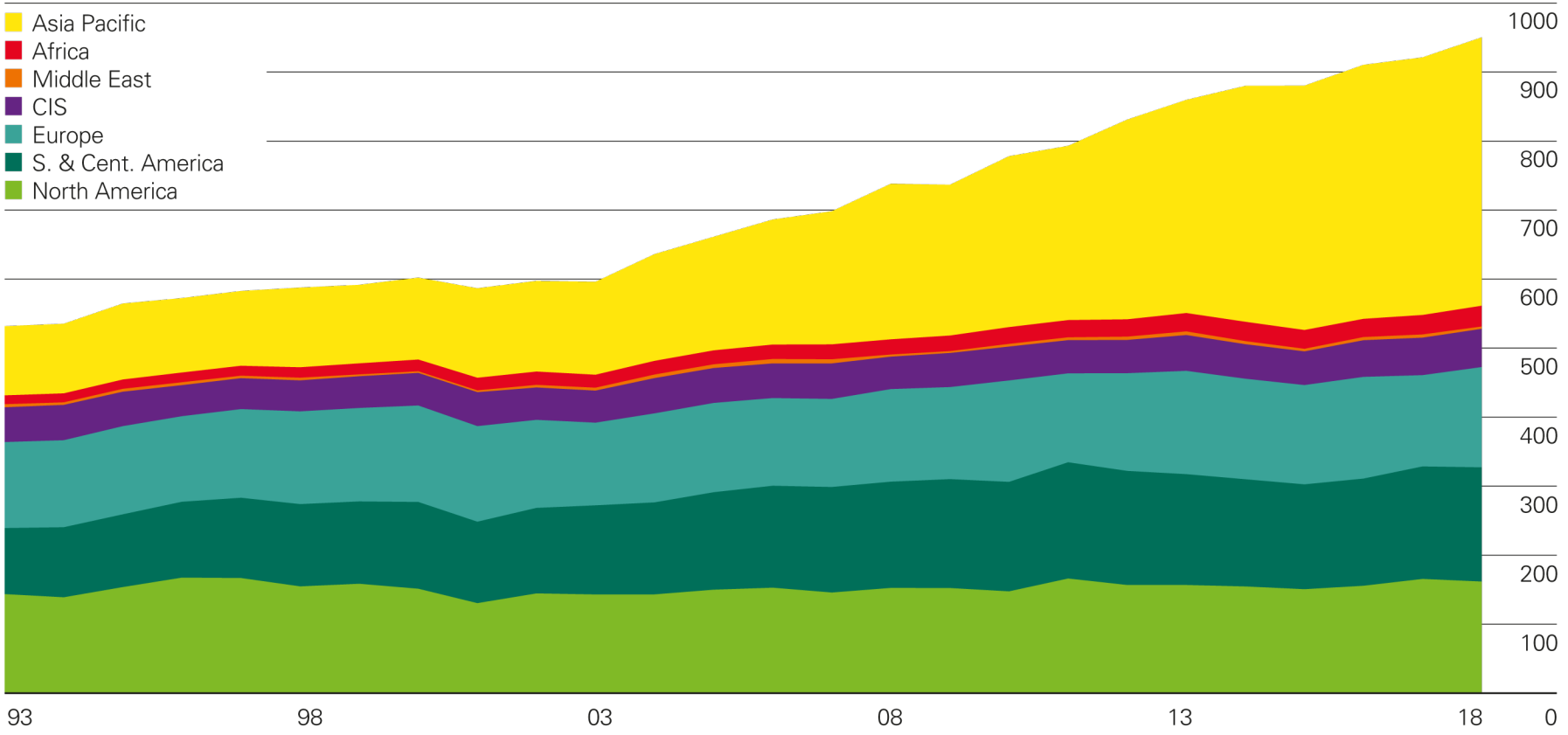
Nuclear energy consumption by region

Million tonnes oil equivalent



Hydroelectricity consumption by region

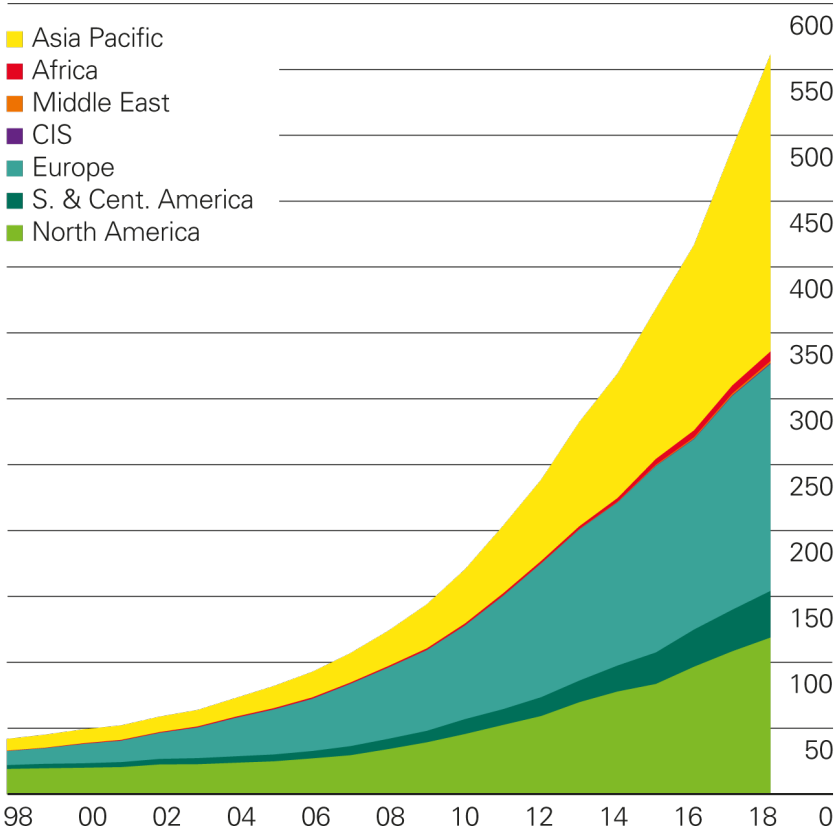
Million tonnes oil equivalent



Renewable energy consumption by region/ generation by source

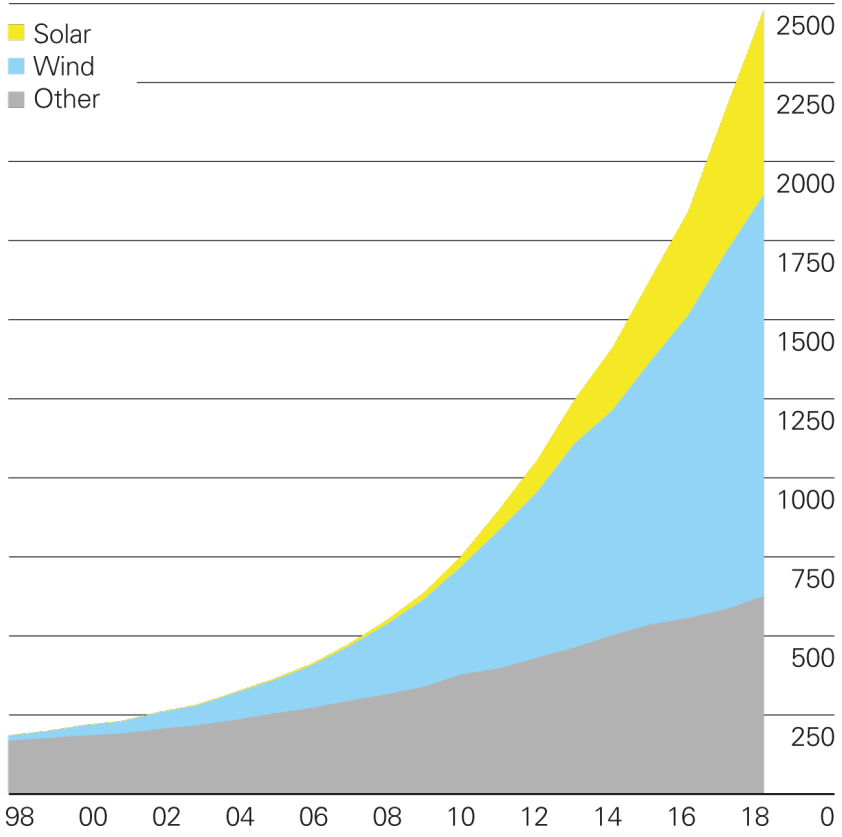
Renewables consumption by region

Million tonnes oil equivalent



Renewables generation by source

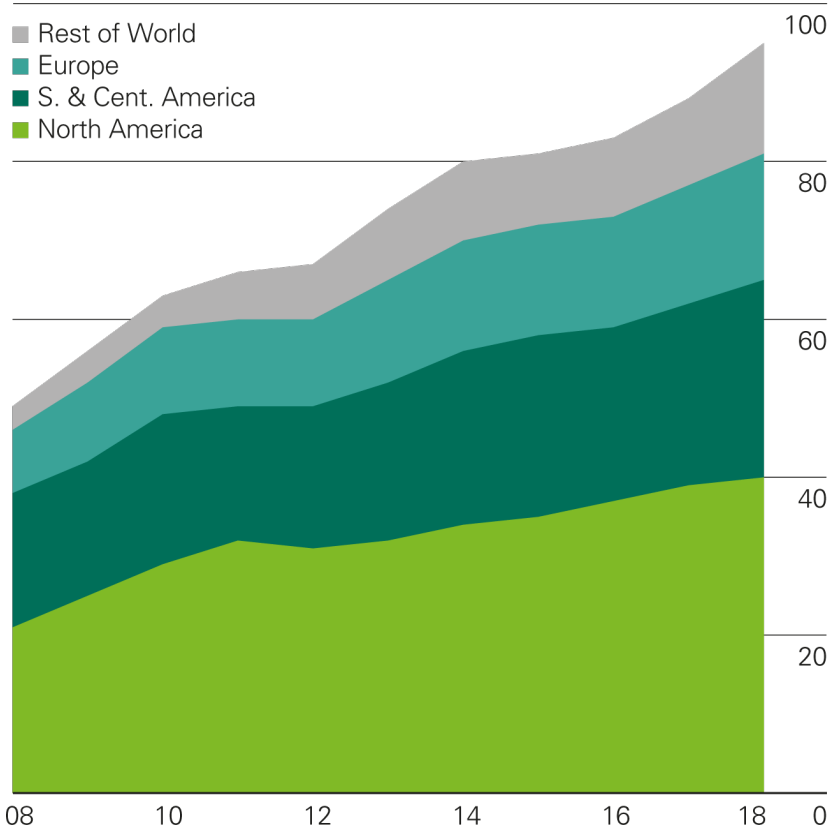
Terawatt-hours

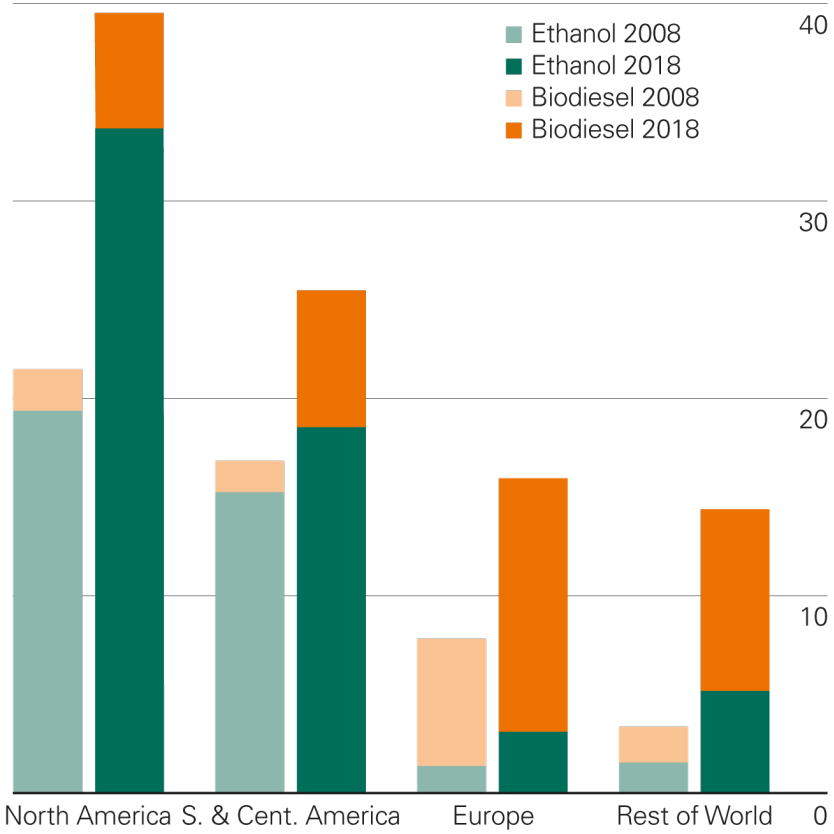


Biofuels production by region

Million tonnes oil equivalent

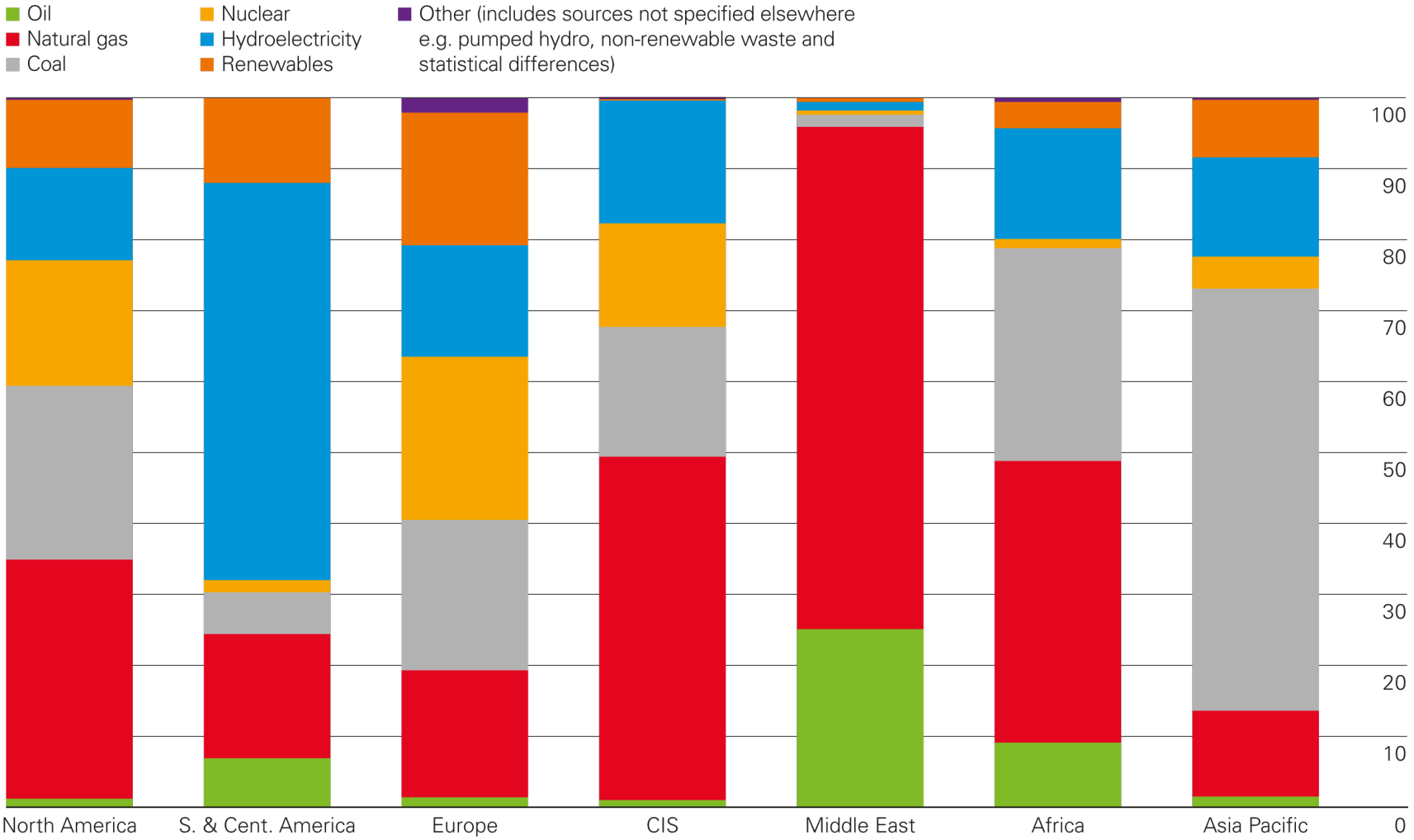
World biofuels production





Regional electricity generation by fuel 2018

Percentage



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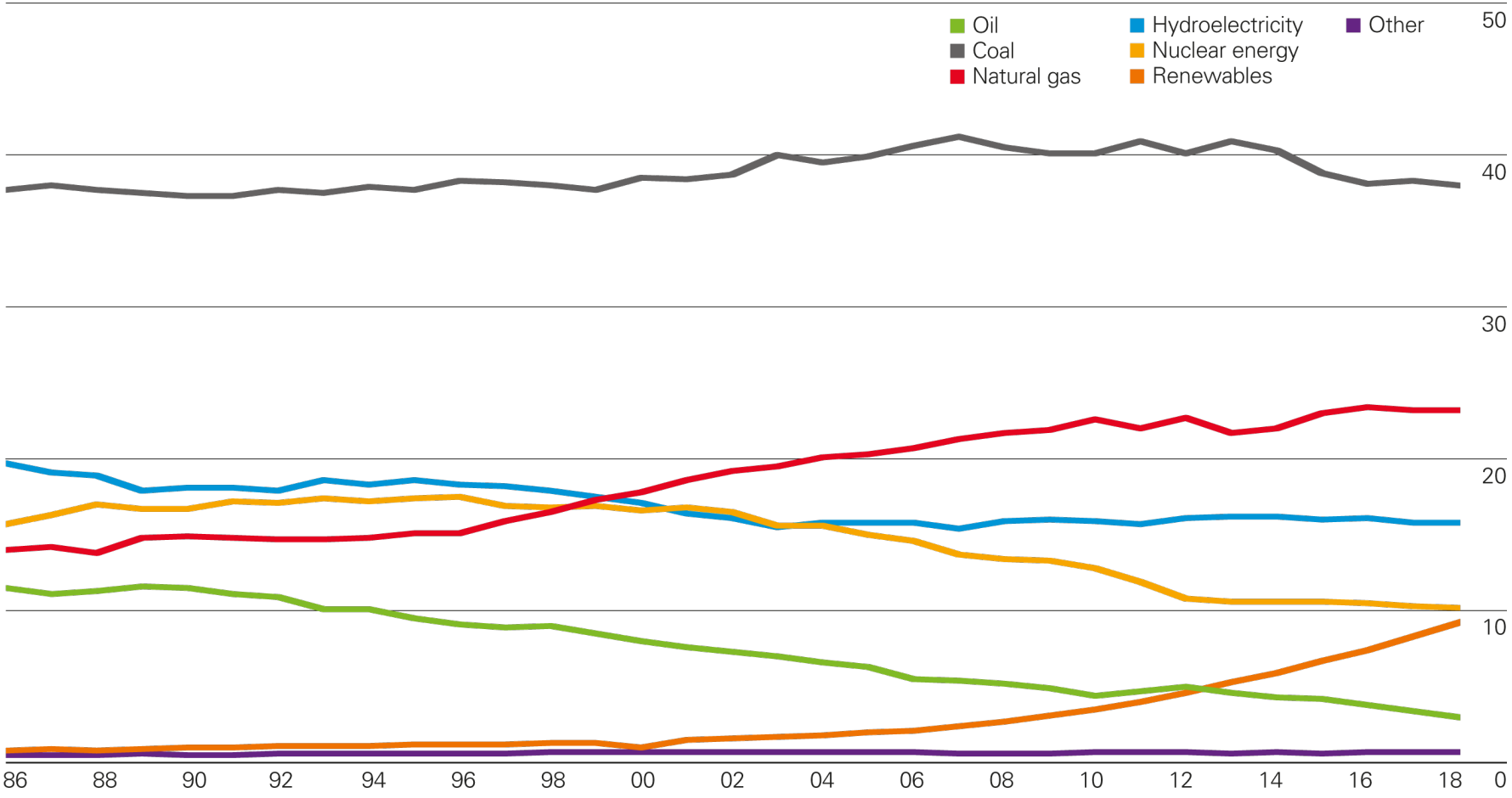
Share of global electricity generation by fuel

Percentage



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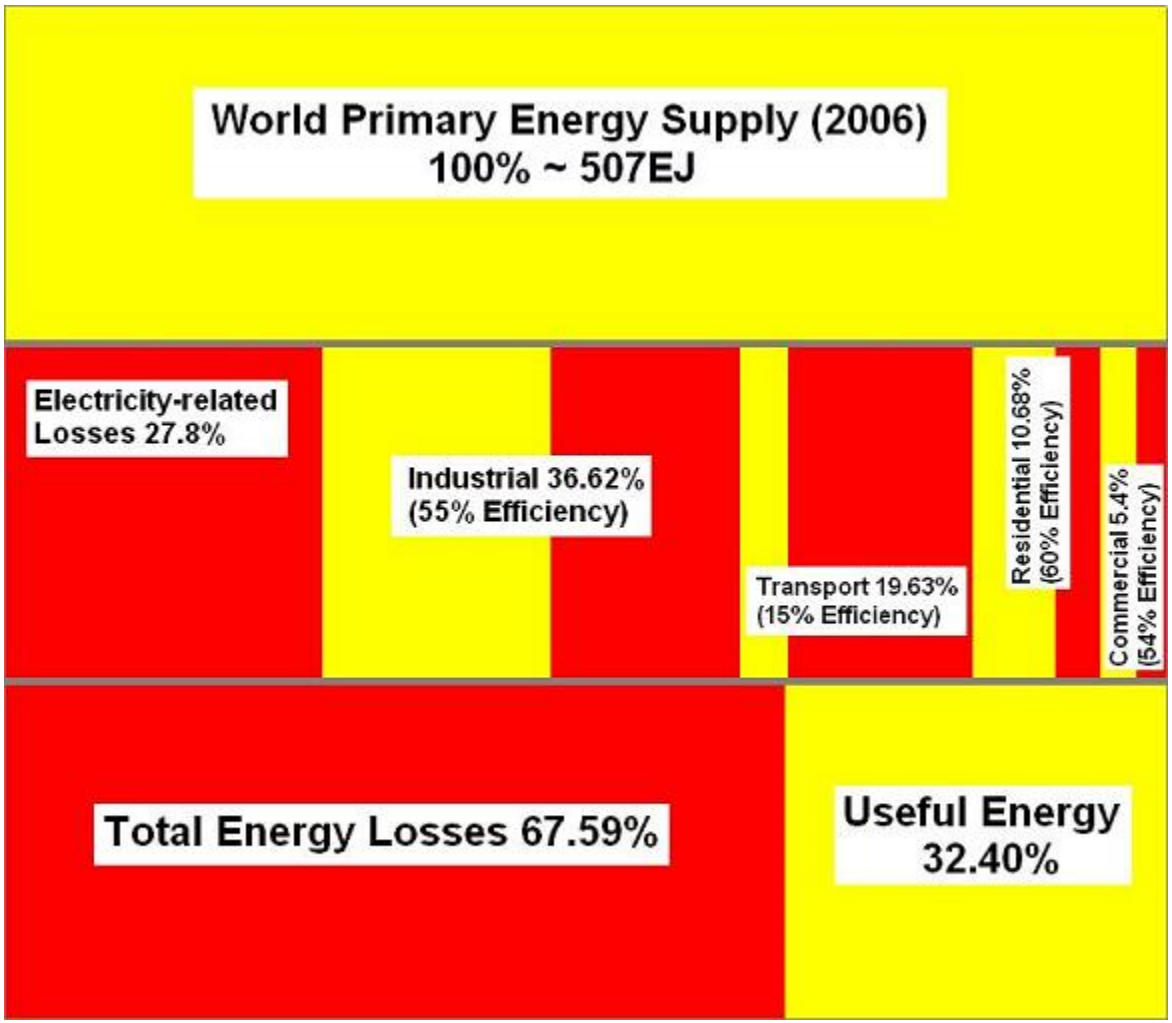
Energy transformation and losses



EFFICIENCY | INNOVATION

Energy transformation and losses

ENERGY EFFICIENCY

In general terms, energy efficiency refers to the amount of output that can be produced with a given input of energy.

Energy efficiency is measured as the amount of energy output for a given energy input and listed as a percentage between 0% and 100%.

- the amount of mechanical energy that an electric motor produces for a given input of electrical energy

'energy efficiency' means the ratio of output of performance, service, goods or energy, to input of energy:

- thermal comfort in a building is an example of performance;
- transport of persons or of information is a service;
- a smartphone is a good

ENERGY SAVINGS (energy conservation)

Energy savings are the reduction of energy use, without reference to output produced. It may be achieved through:

- Improved energy efficiency (same technology)
- Rational use of energy (behaviour)
- New products (new technology)
- New energy services (new consumption model)

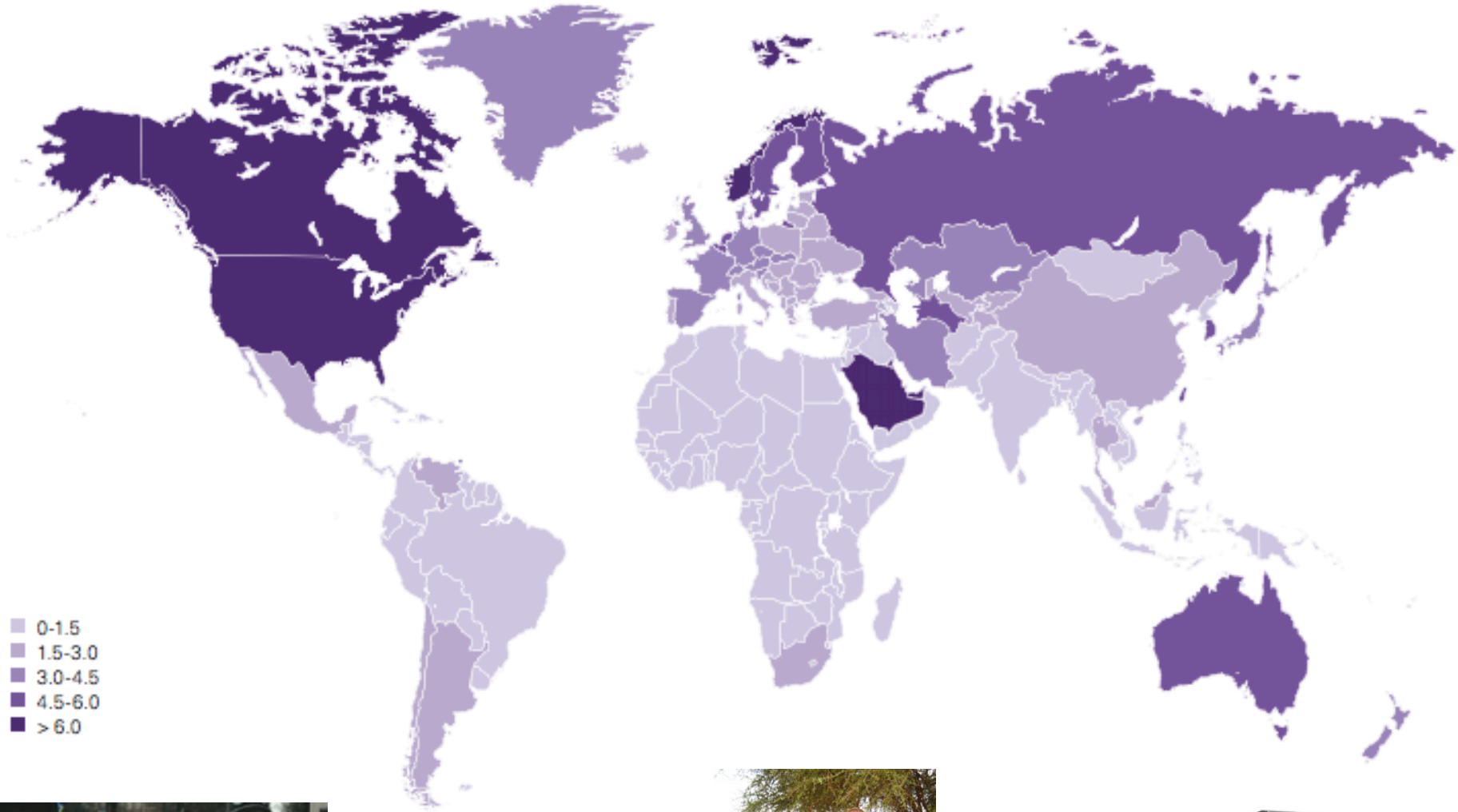
Challenge 21st century

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

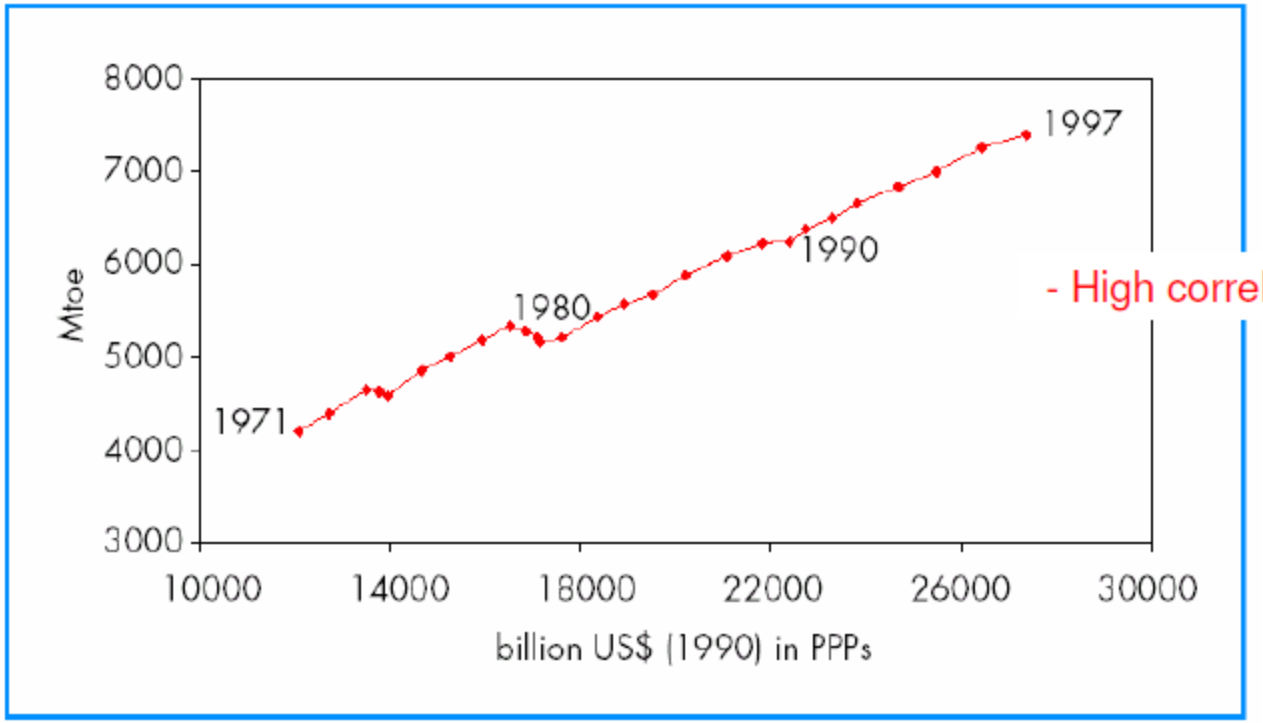
Darfur region of Sudan, 2004

Somewhere in central Europe

Somewhere in Southern Europe

Primary Energy and GDP

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



- High correlation -

Note: Transition economies are excluded.
Purchasing Power Parity (PPP)
[1] TPES, Total Primary Energy Supply

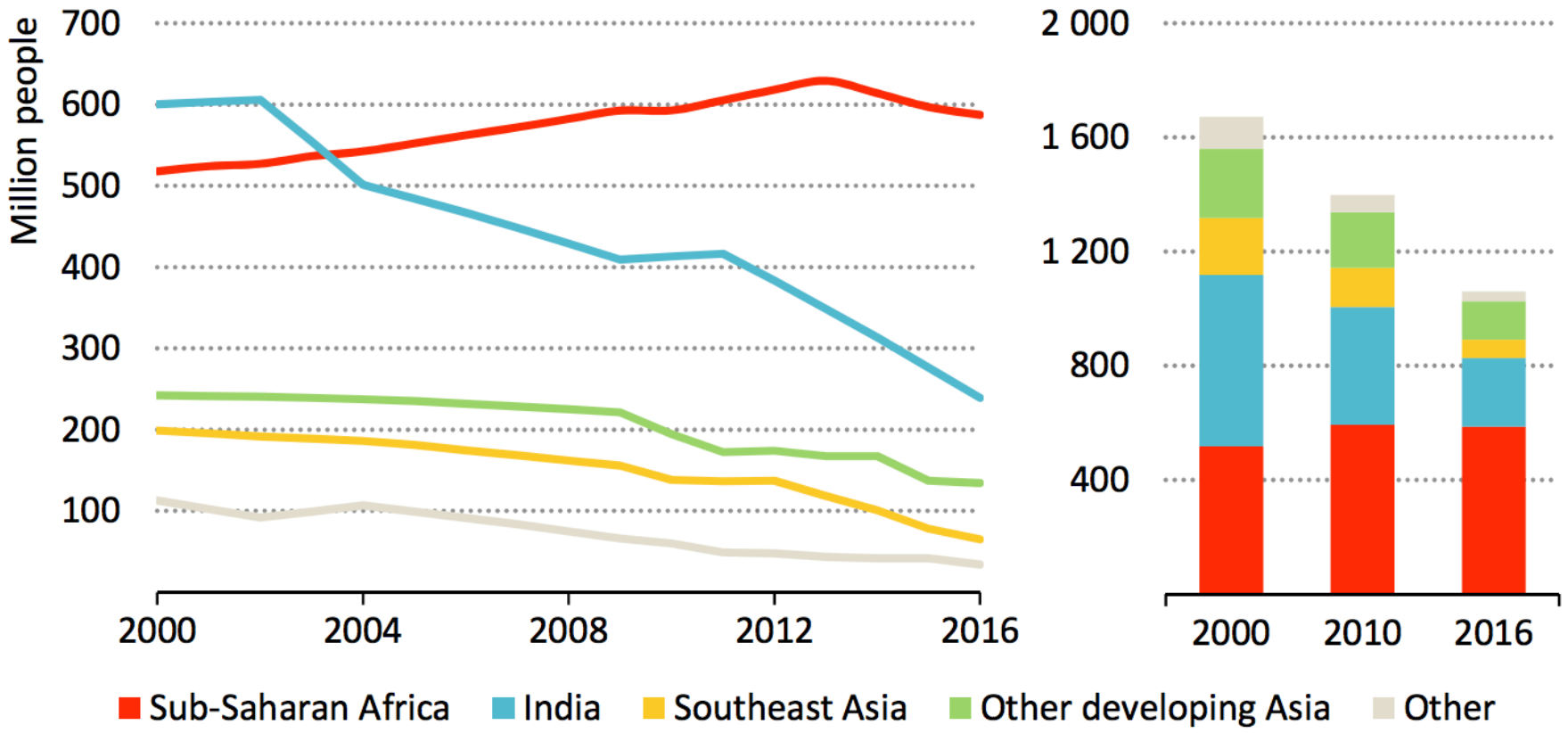
Is prosperity possible without increasing energy consumption?

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**

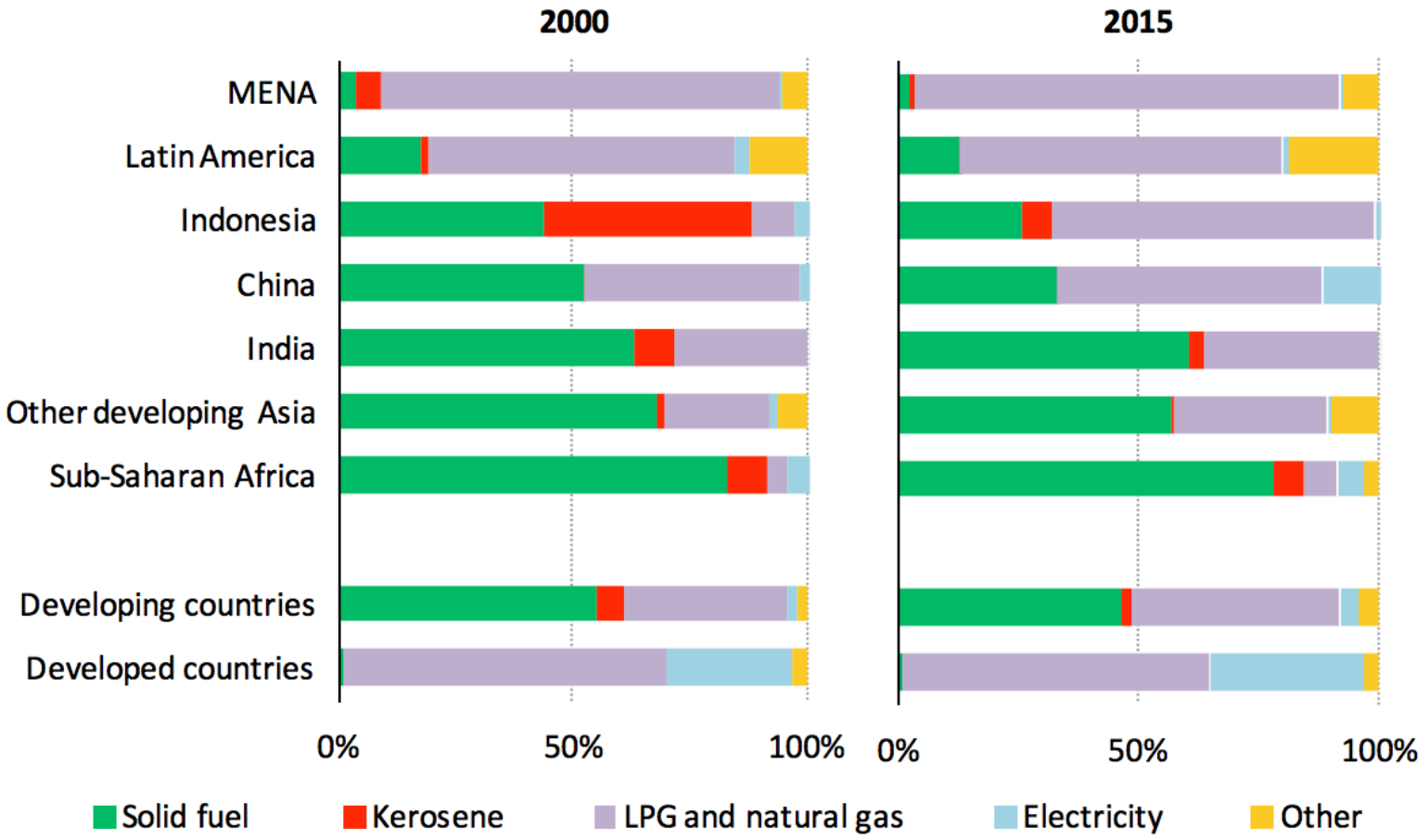


Progress on electricity access is being made in all parts of the world, led by developing countries in Asia, in particular India

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

Source: Energy Access Outlook 2017, International Energy Agency (2017): https://www.iea.org/publications/freepublications/publication/weo2017specialreport_energyaccessoutlook.pdf

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

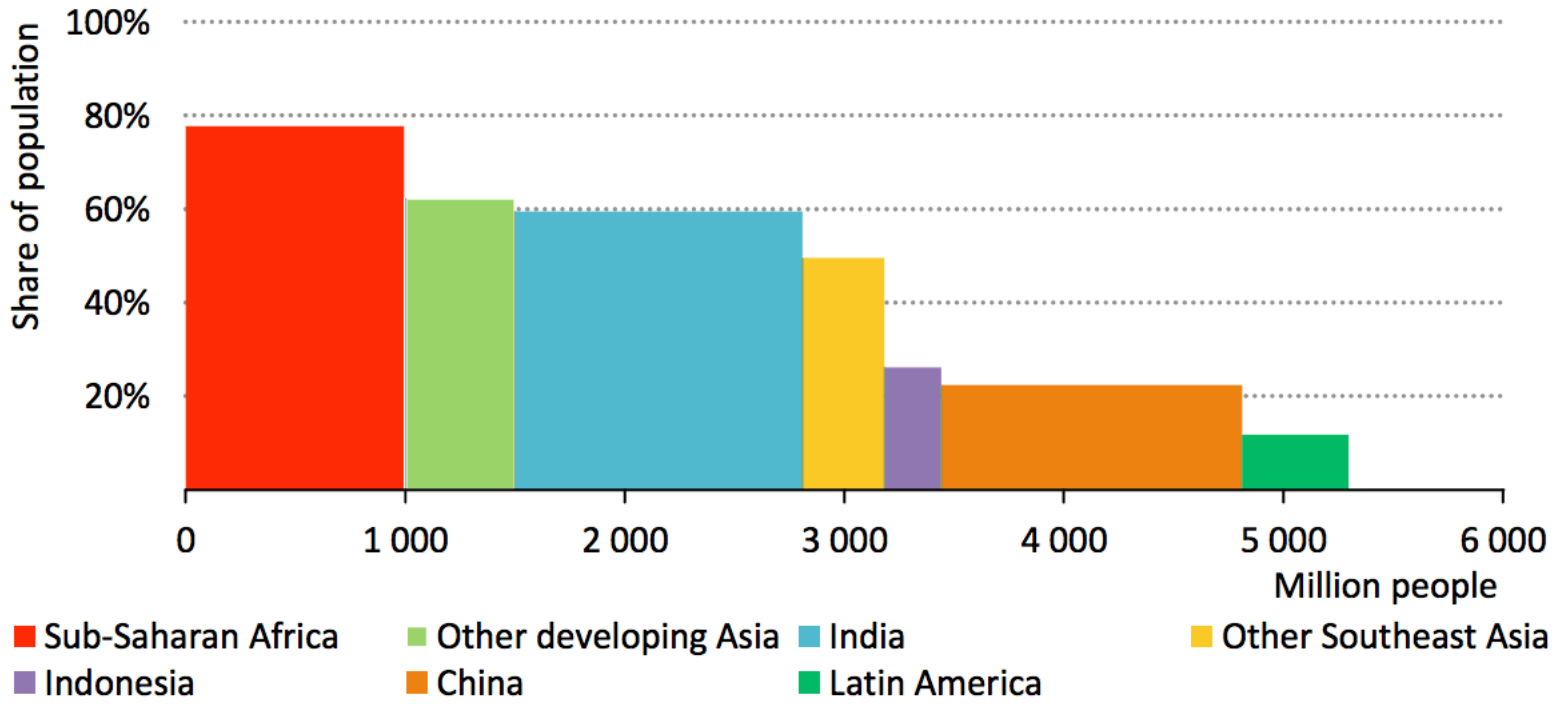


Progress has been limited on clean cooking access in many regions

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

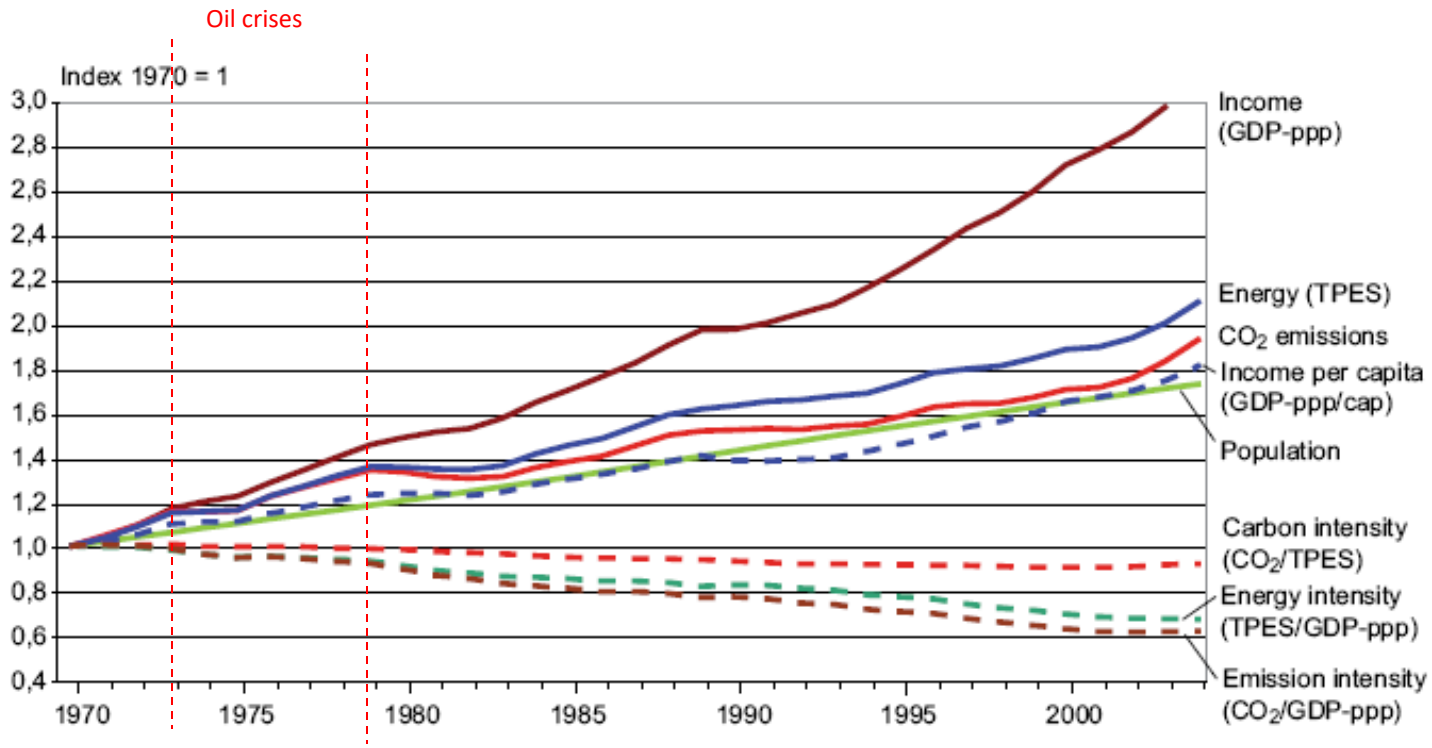
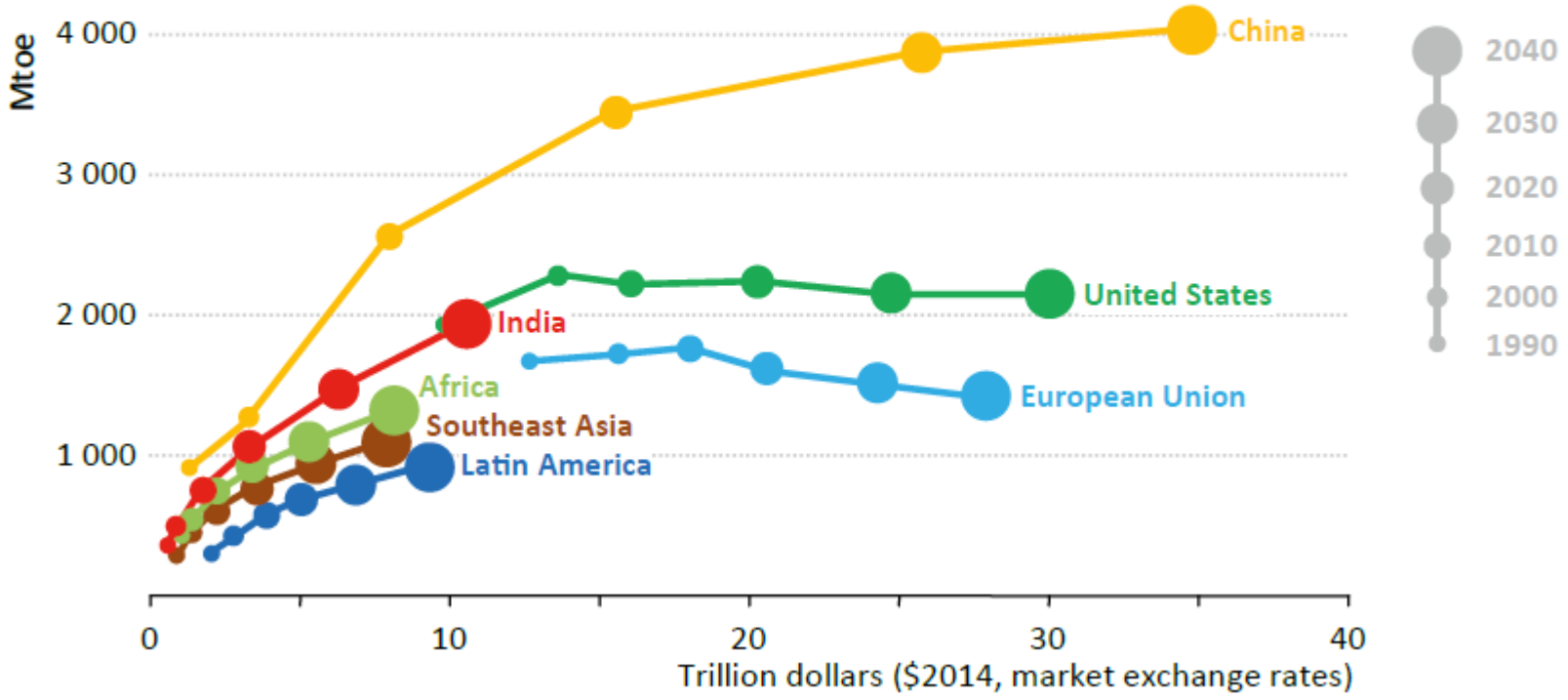


Figure SPM.2: *Relative global development of Gross Domestic Product measured in PPP (GDPppp), Total Primary Energy Supply (TPES), CO2 emissions (from fossil fuel burning, gas flaring and cement manufacturing) and Population (Pop). In addition, in dotted lines, the figure shows Income per capita (GDPppp/Pop), 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]*

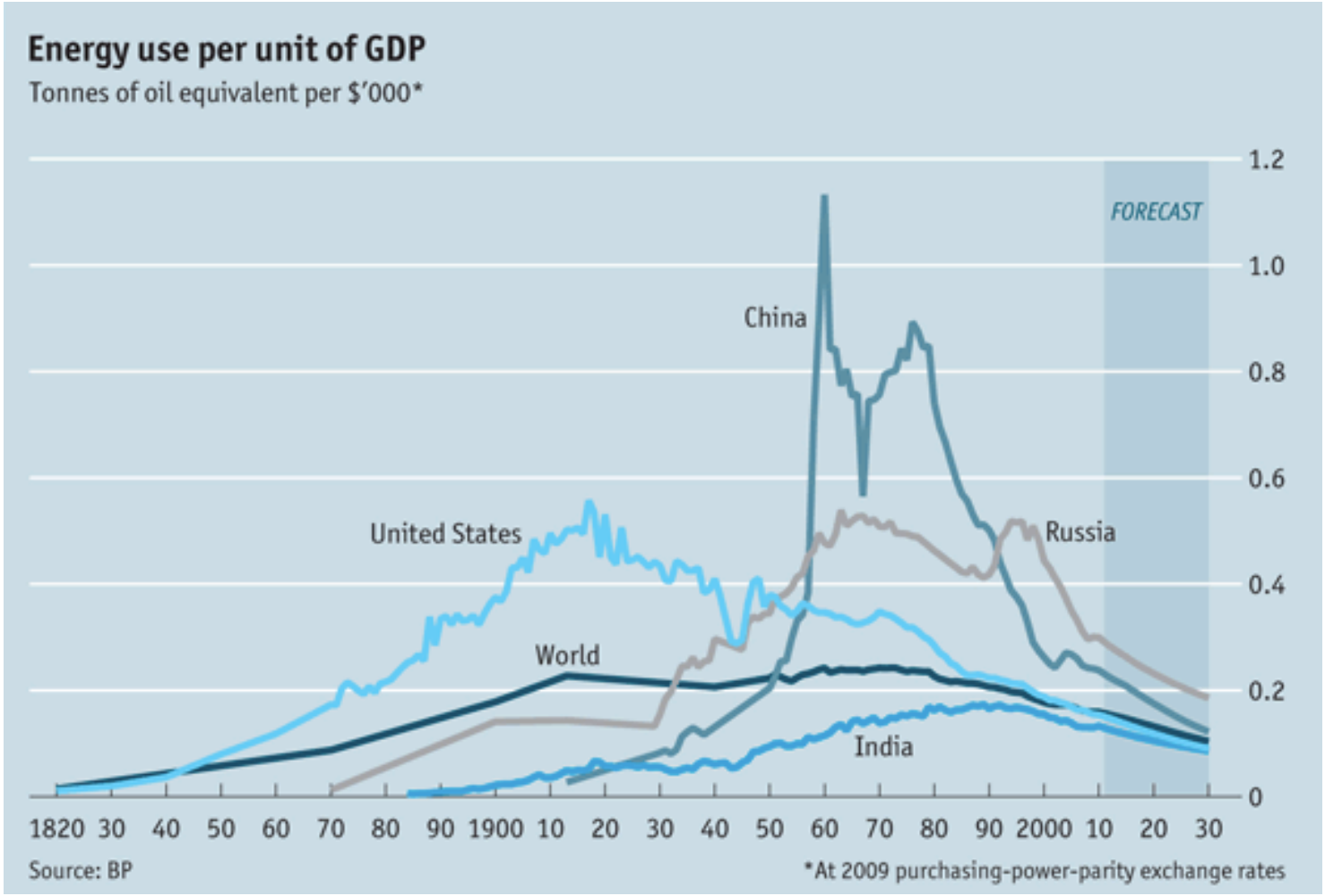
IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: **Mitigation.** Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Developing countries

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



Energy intensity: optimistic vision

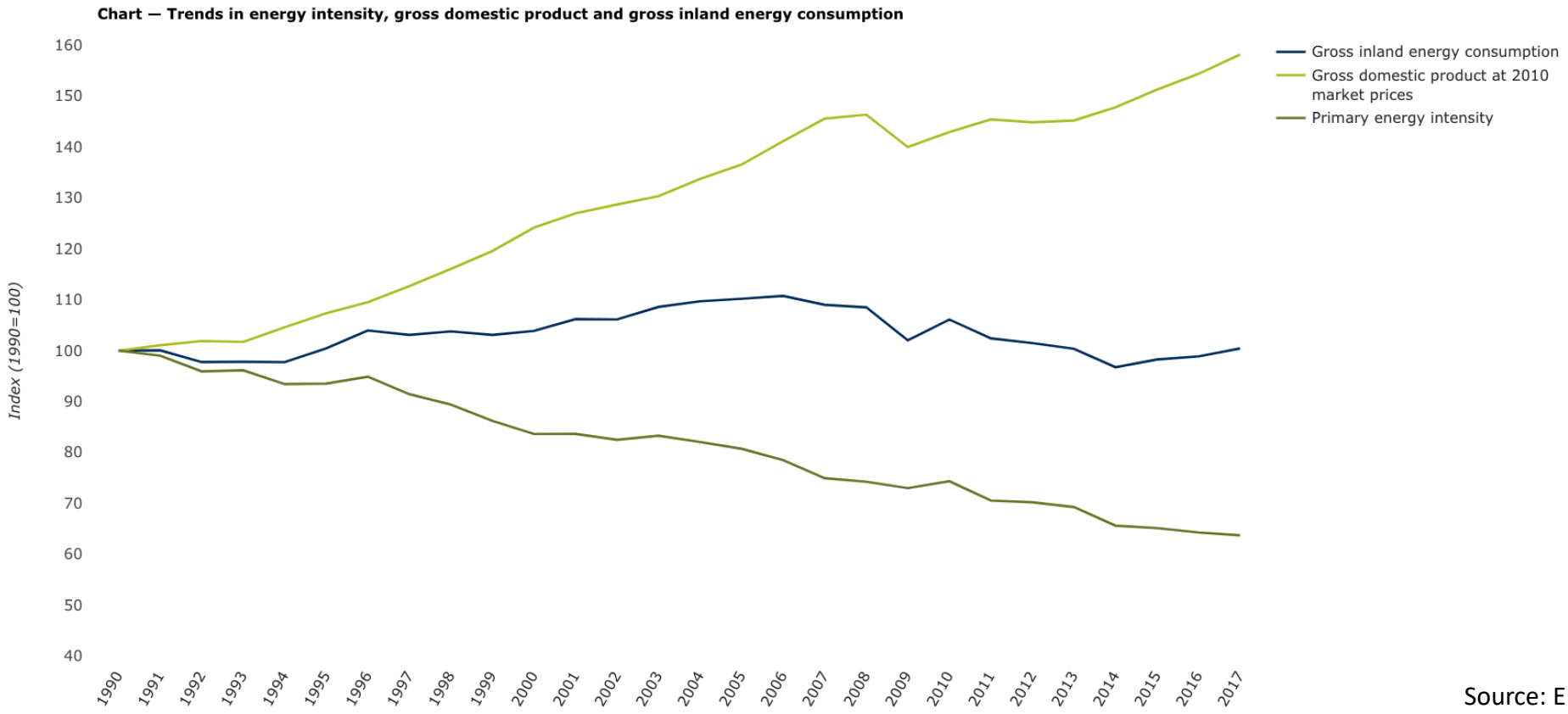


→ Decreasing from the oil shocks

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

Energy Intensity in the UE

What does it mean *decoupling* economic growth from energy consumption?



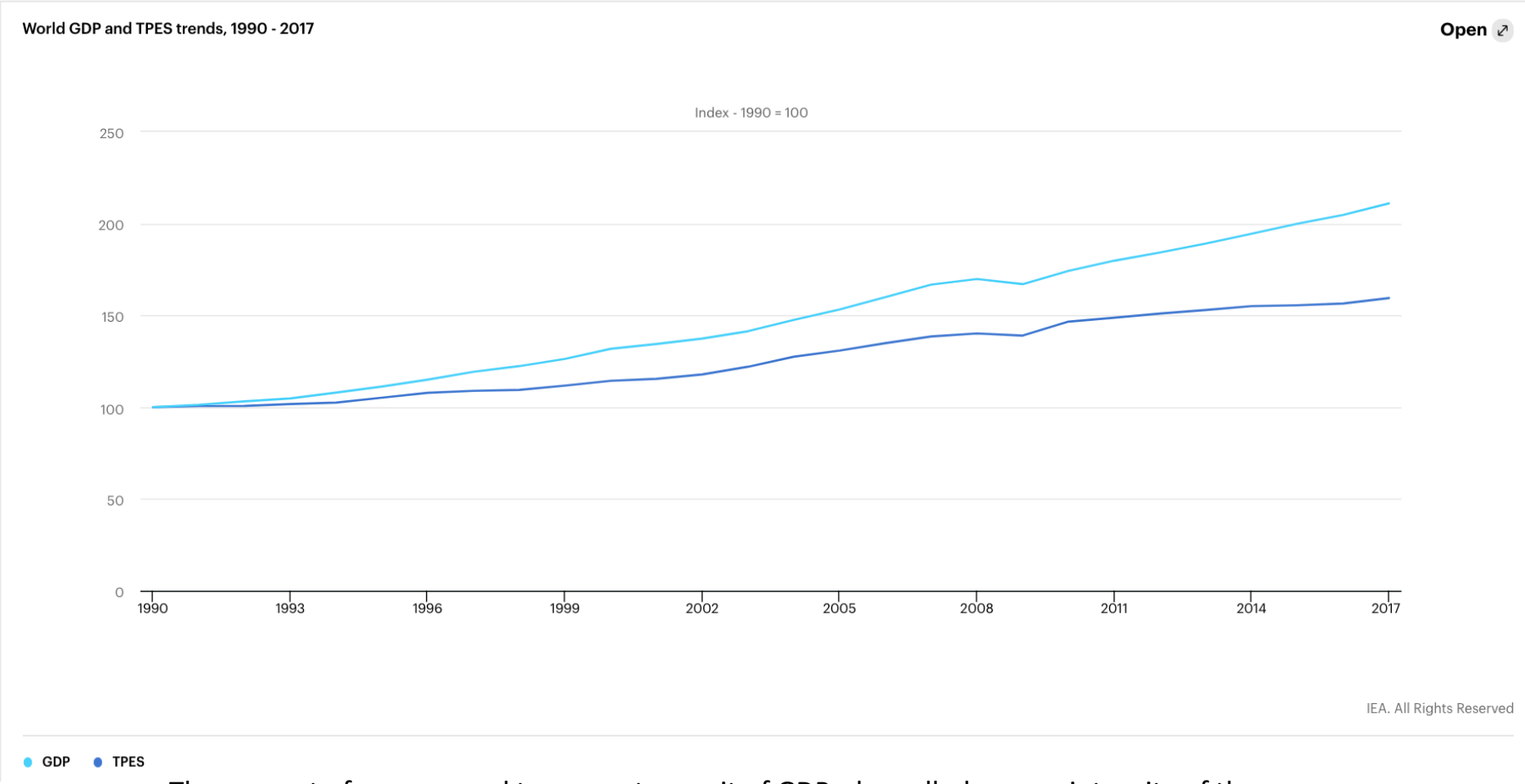
Source: EEA

Between 1990 and 2017, a relative decoupling of gross inland energy consumption from economic growth occurred in the EU, energy intensity in the EU fell by 37% (1.7% per year) during this period.

Explore more on EU energy intensity here

Energy Intensity in the World

What does it mean *decoupling* economic growth from energy consumption?



The amount of energy used to generate a unit of GDP, also called energy intensity of the economy (TPES/GDP) decreased globally by 35% between 1990 and 2017, with large regional variations. In non-OECD this fall has been greater. For example, in China[3], intensity more than halved (-70%) over this period.

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

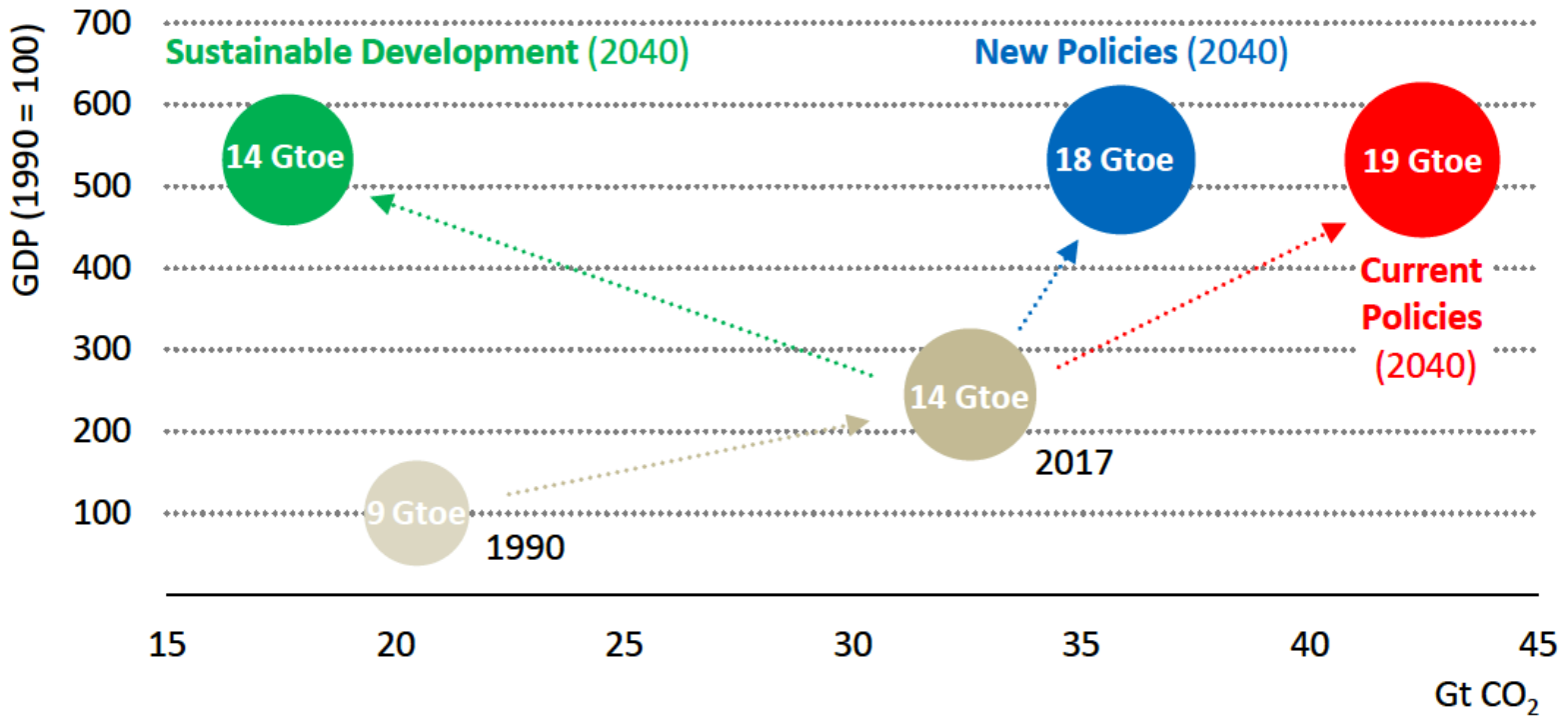
van Vuuren et al (2012) An energy vision: the transformation towards sustainability — interconnected challenges and solutions. Current Opinion in Environmental Sustainability 2012, 4:18–34

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?

How will the future of energy look like?

Figure 1.2 ▷ World primary energy demand and energy-related CO_2 emissions by scenario



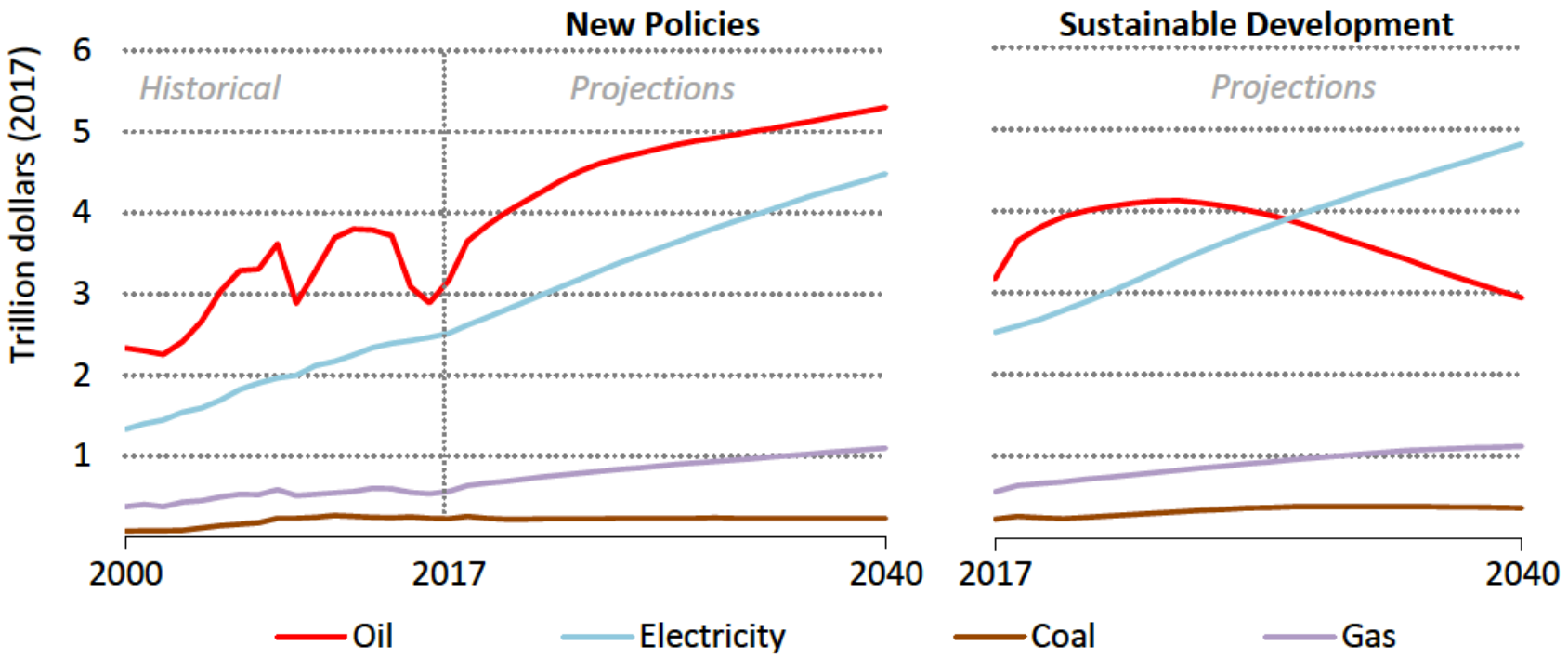
Achieving sustainable development goals requires a complete reversal of the historic relationship between economic growth, energy demand and emissions

Notes: Bubble size and numbers represent total primary energy demand. Gtoe = gigatonnes of oil equivalent or 1 000 Mtoe; Gt CO_2 = gigatonnes of CO_2.

Source: World Energy Outlook 2018, IEA

How will the future of energy look like?

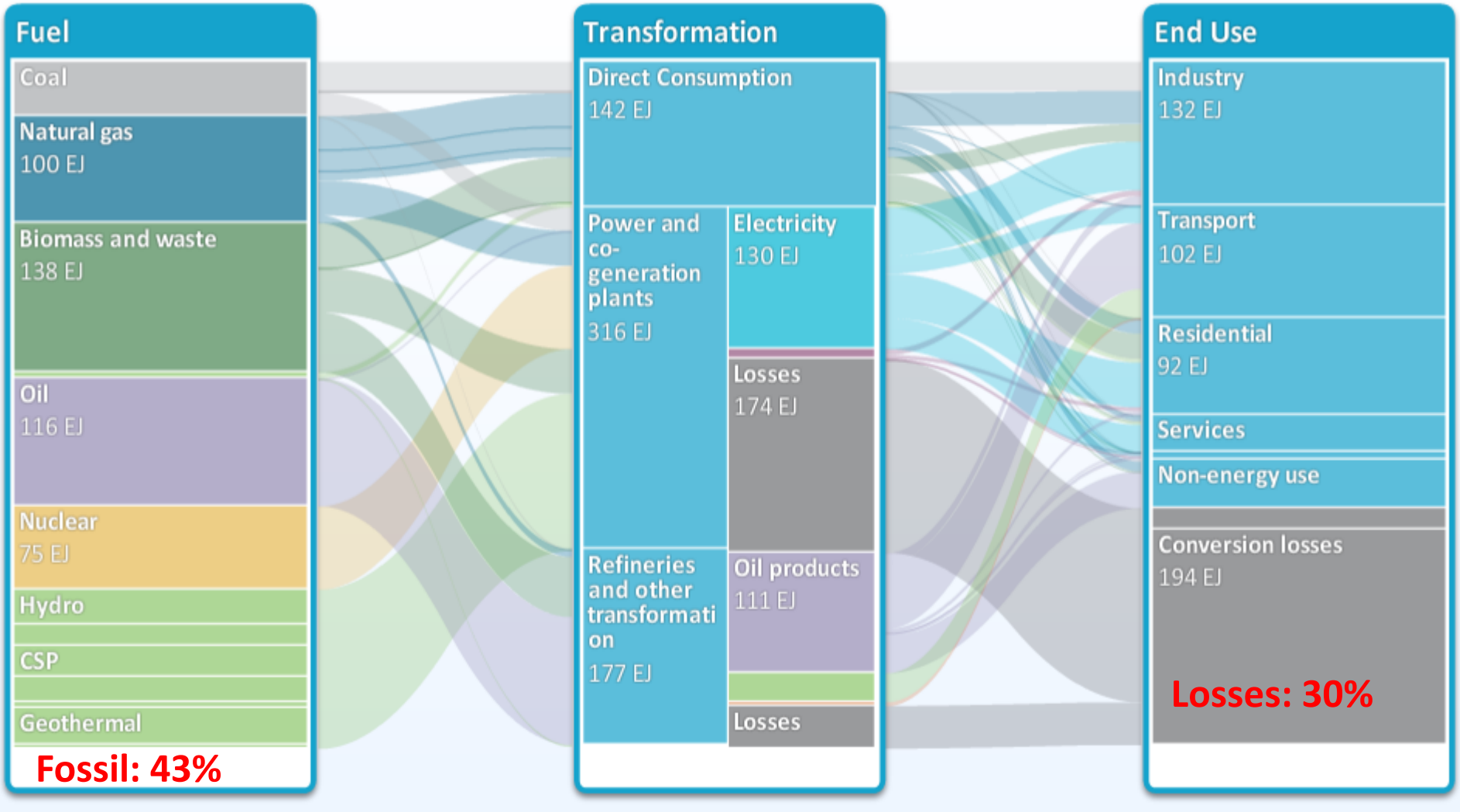
Figure 1.13 ▷ Global end-user energy spending by fuel and scenario



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

Source: World Energy Outlook 2018, IEA

World Energy Balance - 2050



Source: IEA, ETP 2017