



THE OXFORD  
INSTITUTE  
FOR ENERGY  
STUDIES

A RECOGNIZED INDEPENDENT CENTRE OF THE UNIVERSITY OF OXFORD



# Lecture 1: Introduction to key themes

James Henderson

April 2020

*The Economics of Energy Corporations*

# Outline of the course

## **Overall objective – understand how senior management use economic models to make investment decisions**

1. Introduction to key themes in the global energy market
2. Introduction to financial modelling as a management tool
  1. Understanding some key concepts
3. Building the asset – estimating costs
4. Generating revenues – production and prices
5. Operating costs – running the plant and paying the government
6. Calculating a discounted cashflow
  1. Why is it important
  2. How is it used to make decisions
7. Testing the investment decisions: running some numbers under different assumptions
8. Answering your questions



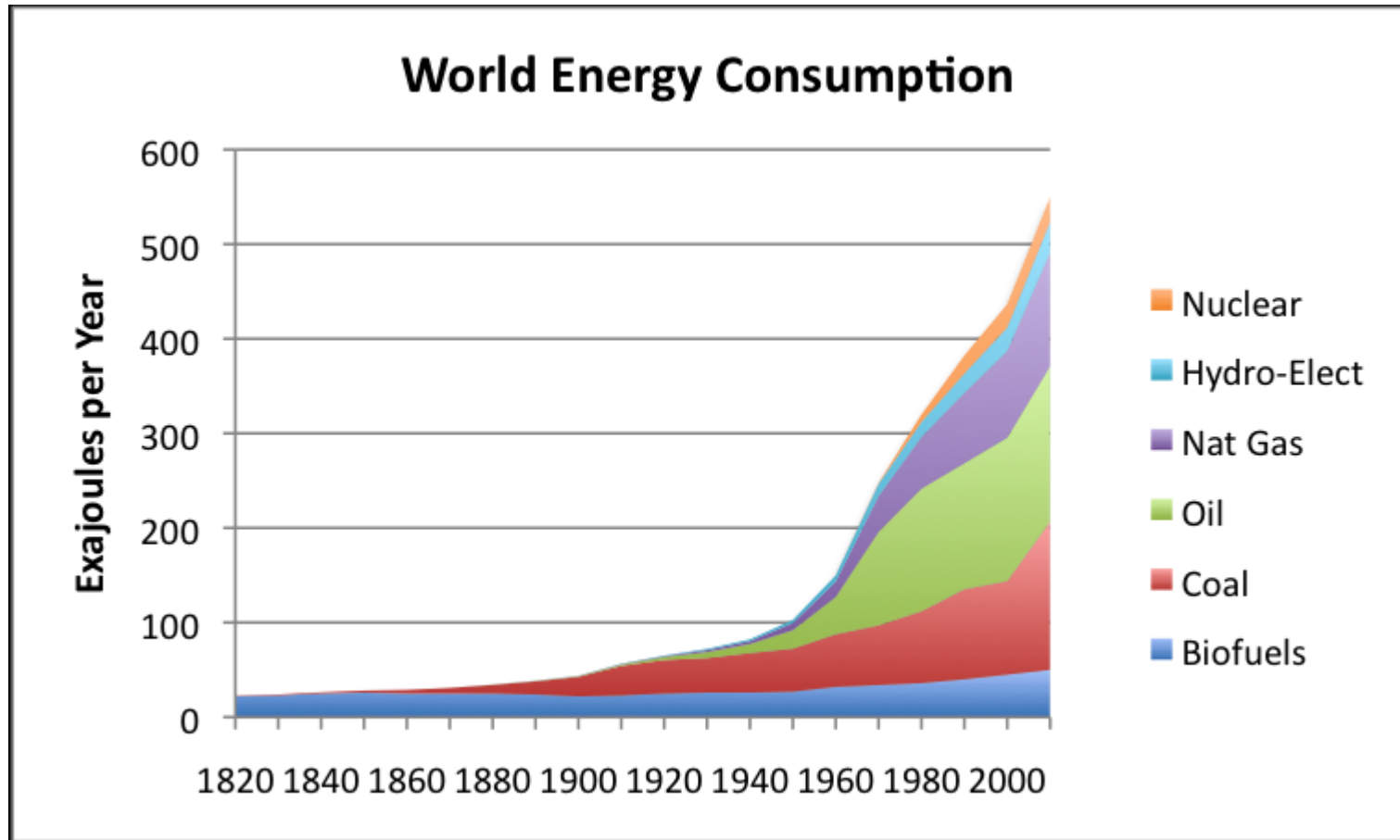
# Assessment

**Overall objective – demonstrate understanding of cashflow models and output**

1. Create a simple cashflow model, given set assumptions
2. Generate NPV and other results
3. Provide an analysis of simple scenarios
4. Write up results in short review (one page)



# World Energy Consumption – A Long-Term View

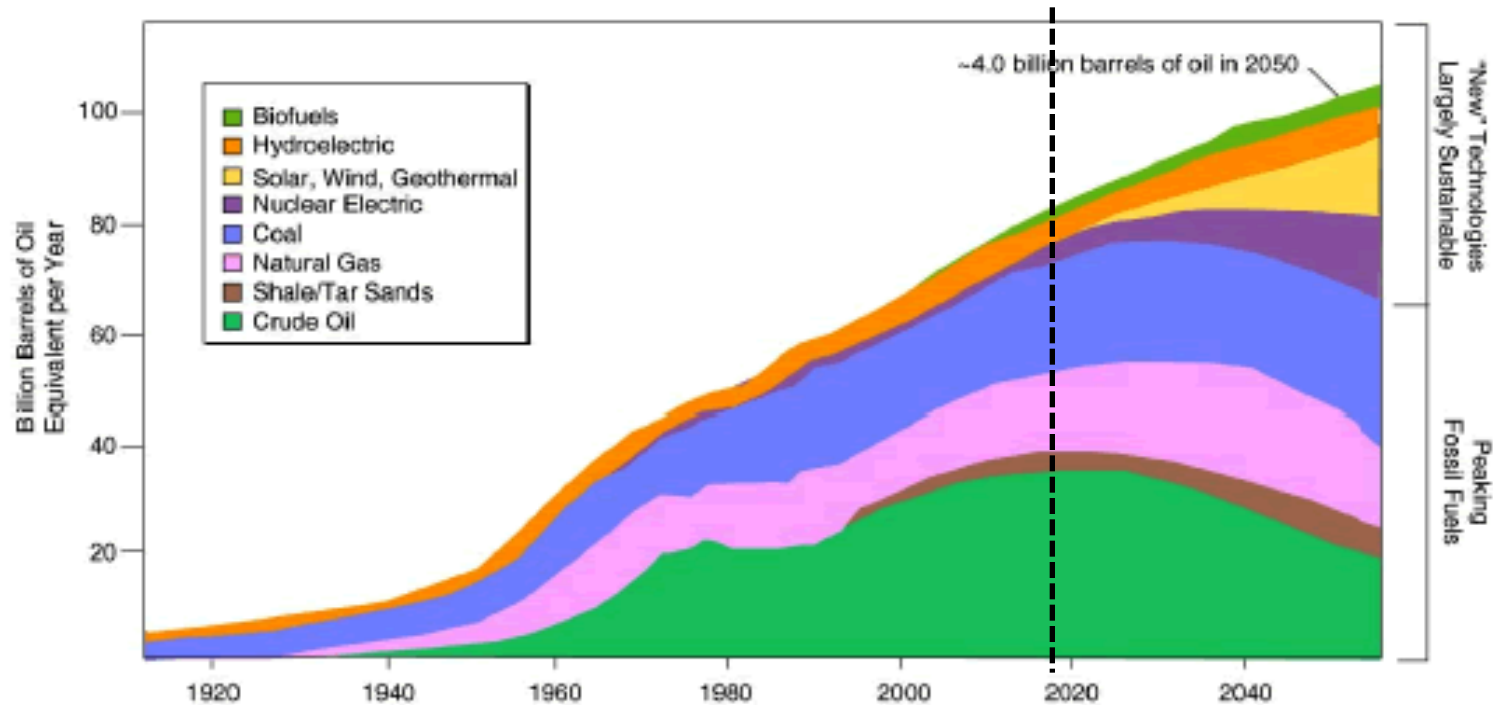


- World energy consumption has grown dramatically in the past century, driven by and catalysing economic growth
- Energy availability supports modern living standards and human development



# World Energy Consumption – A Long-Term View

World Energy Demand—Long-Term Energy Sources

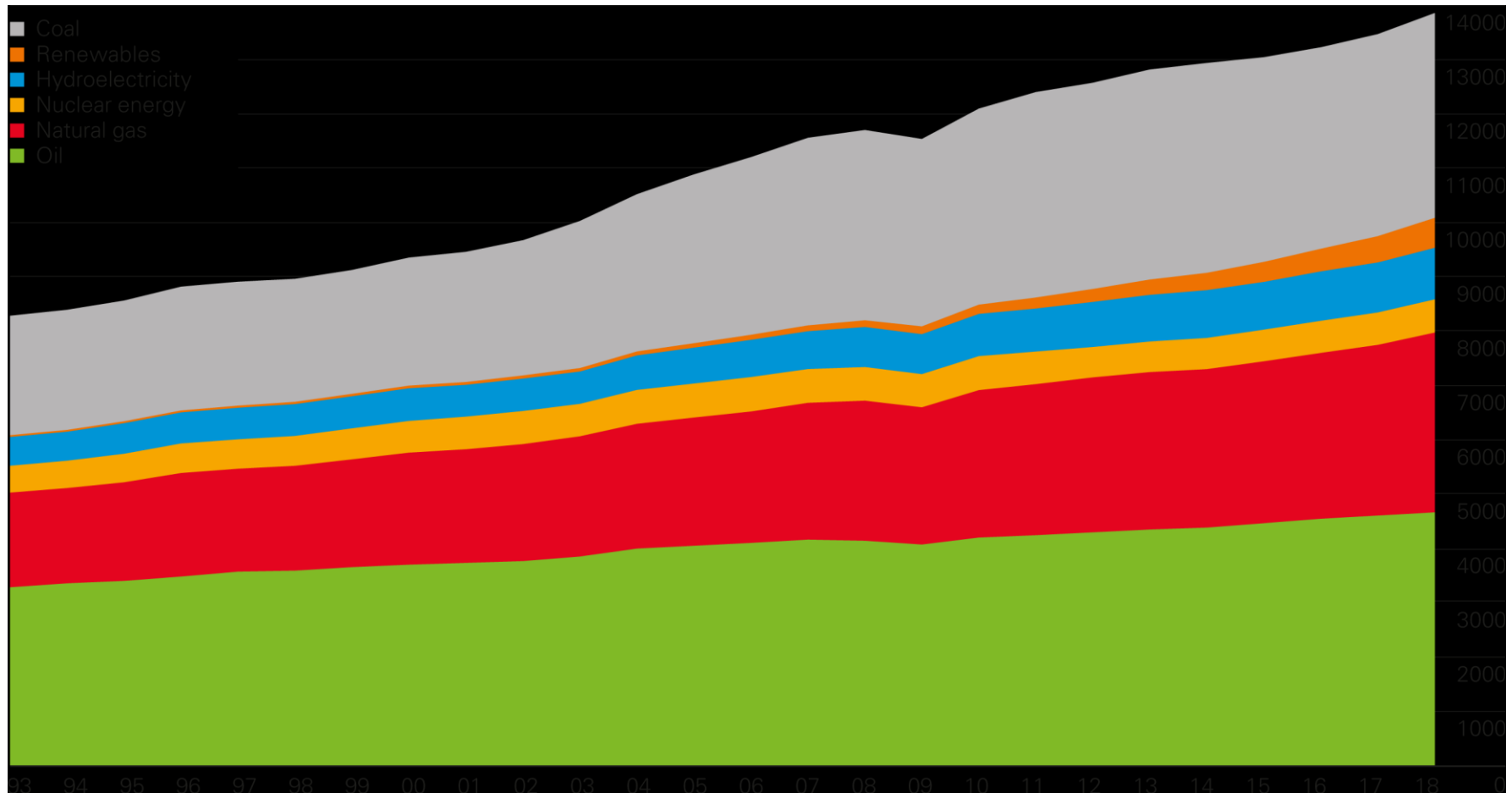


Sources: Lynn Orr, *Changing the World's Energy Systems*, Stanford University Global Climate & Energy Project (after John Edwards, American Association of Petroleum Geologists); SRI Consulting.

- The future looks very different with fossil fuel demand peaking
- Renewables and other new technologies will take a much larger share
- The key question is how fast this energy transition can technically and economically take place?



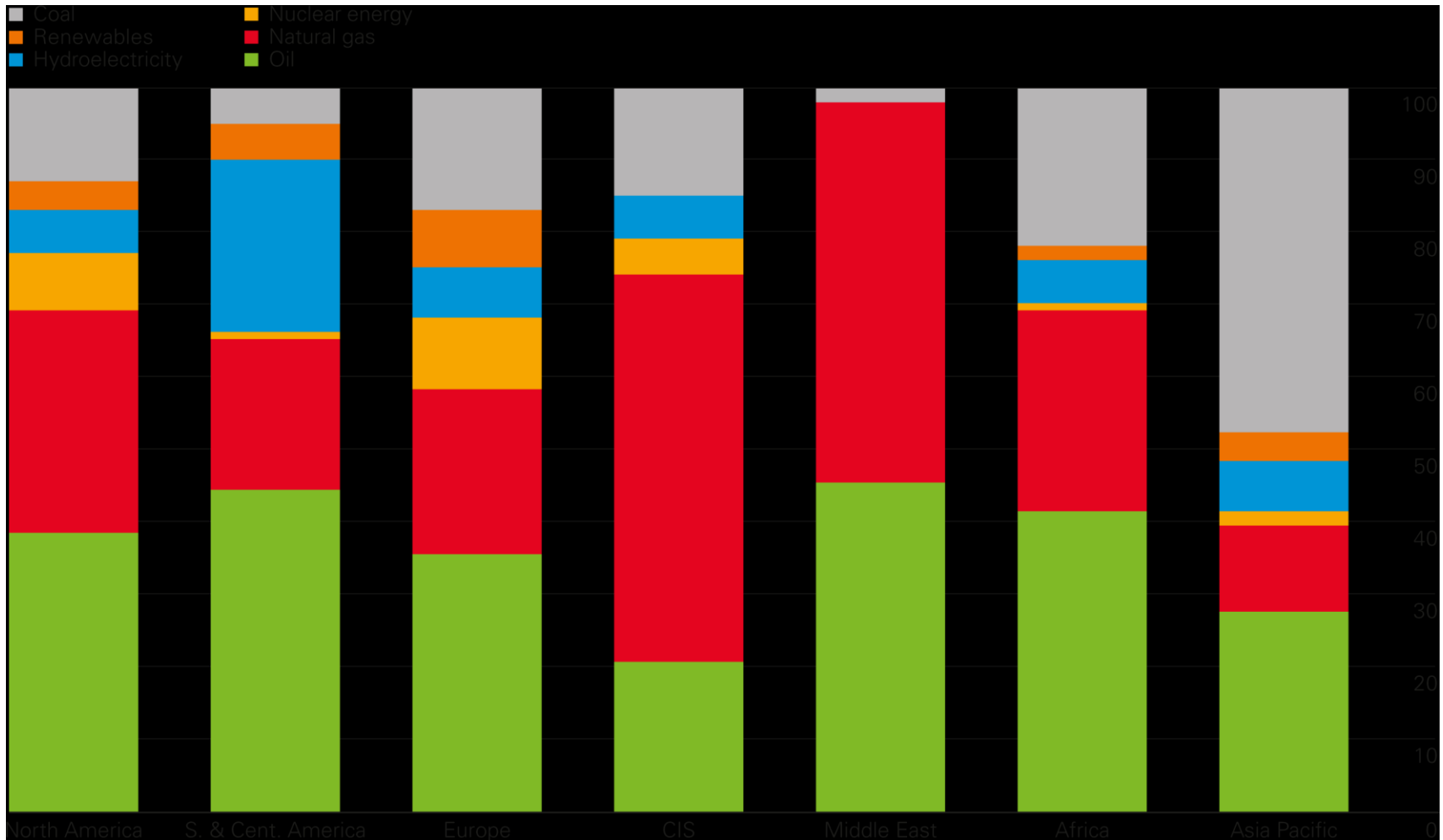
# Primary energy consumption since 1990 (mmtoe)



- Overall energy demand has been growing by around 1% per annum
- The key primary fuels have been hydrocarbons, which account for 80%+ of total energy consumption
- Renewables are growing fast but from a very low base



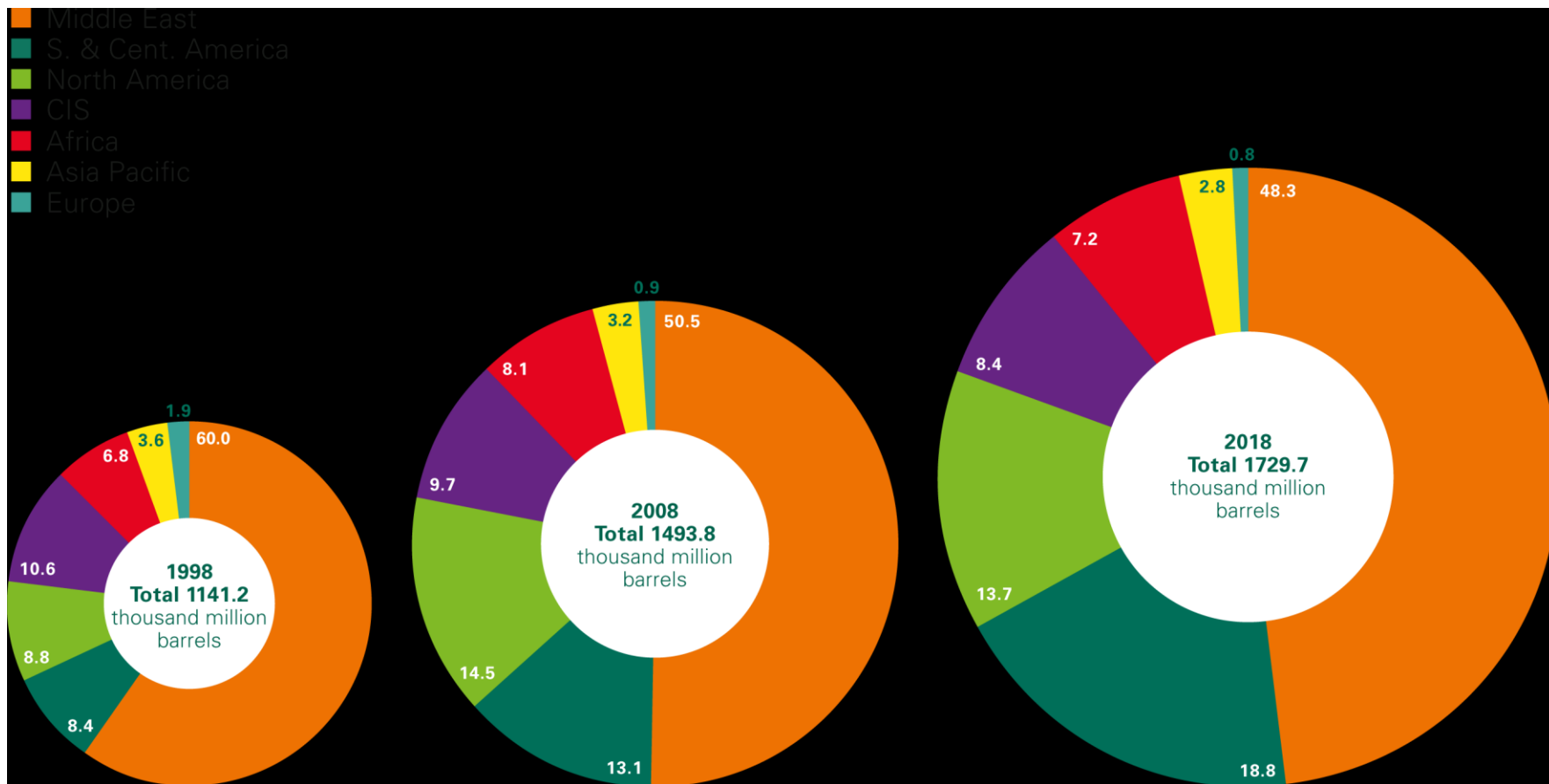
# Primary energy regional consumption by fuel (2018, %)



- Fuel split is very different by region, and is generally driven by indigenous supply
- Countries are reluctant to be over-committed to imports



# The growth in oil reserves and the regional split

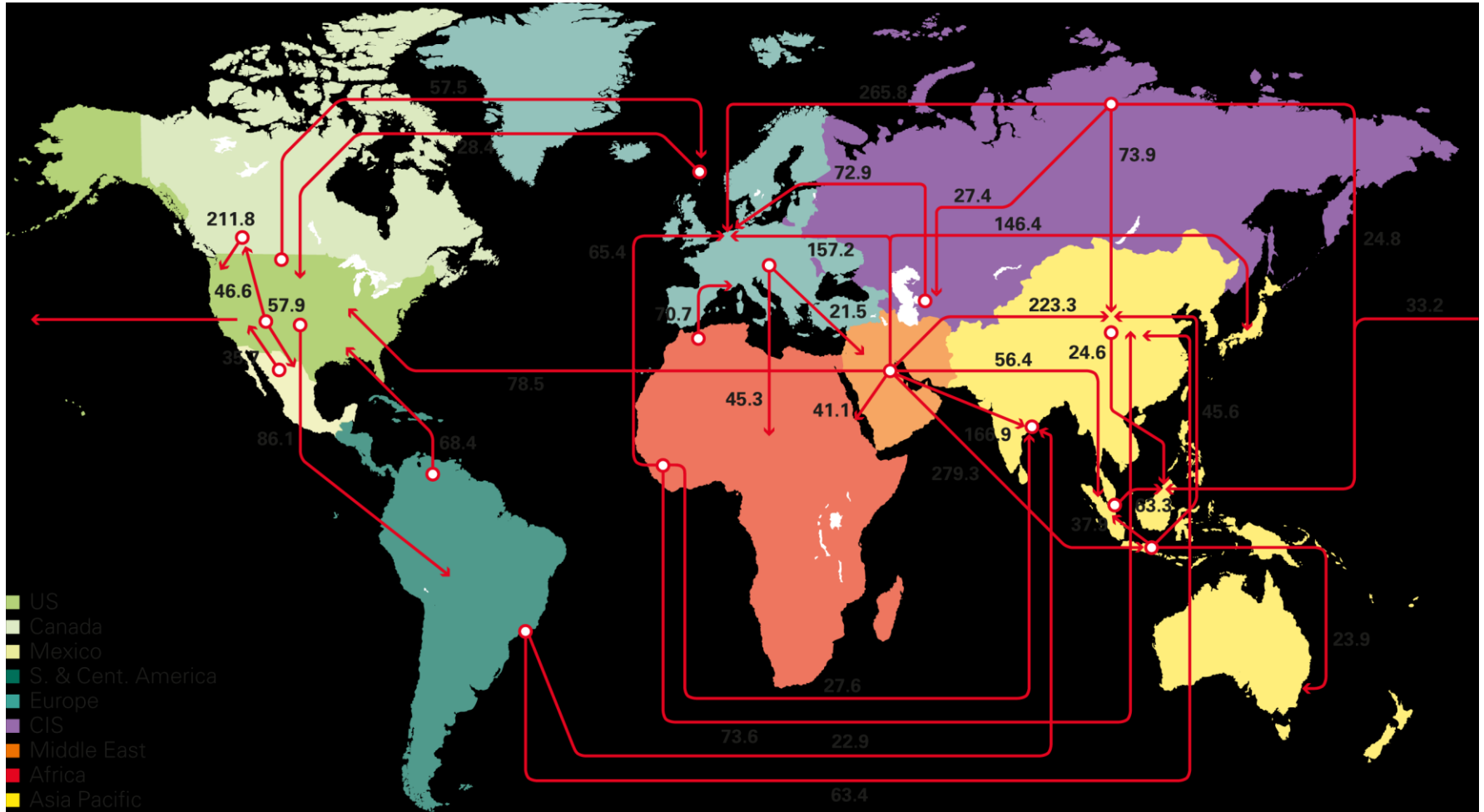


- Oil is not running out – proved reserves are up by 50% since 1995
- Middle East continues to dominate, but other regions are growing – the Americas in particular





# Oil is a global commodity



- Oil is traded in multiple directions across the globe
- Much of the trade originates from the Middle East and flows West and East
- Prices are set relative to a set of global benchmarks



# The global oil market is in turmoil due to Covid-19

## US oil prices turn negative

Price per barrel of WTI



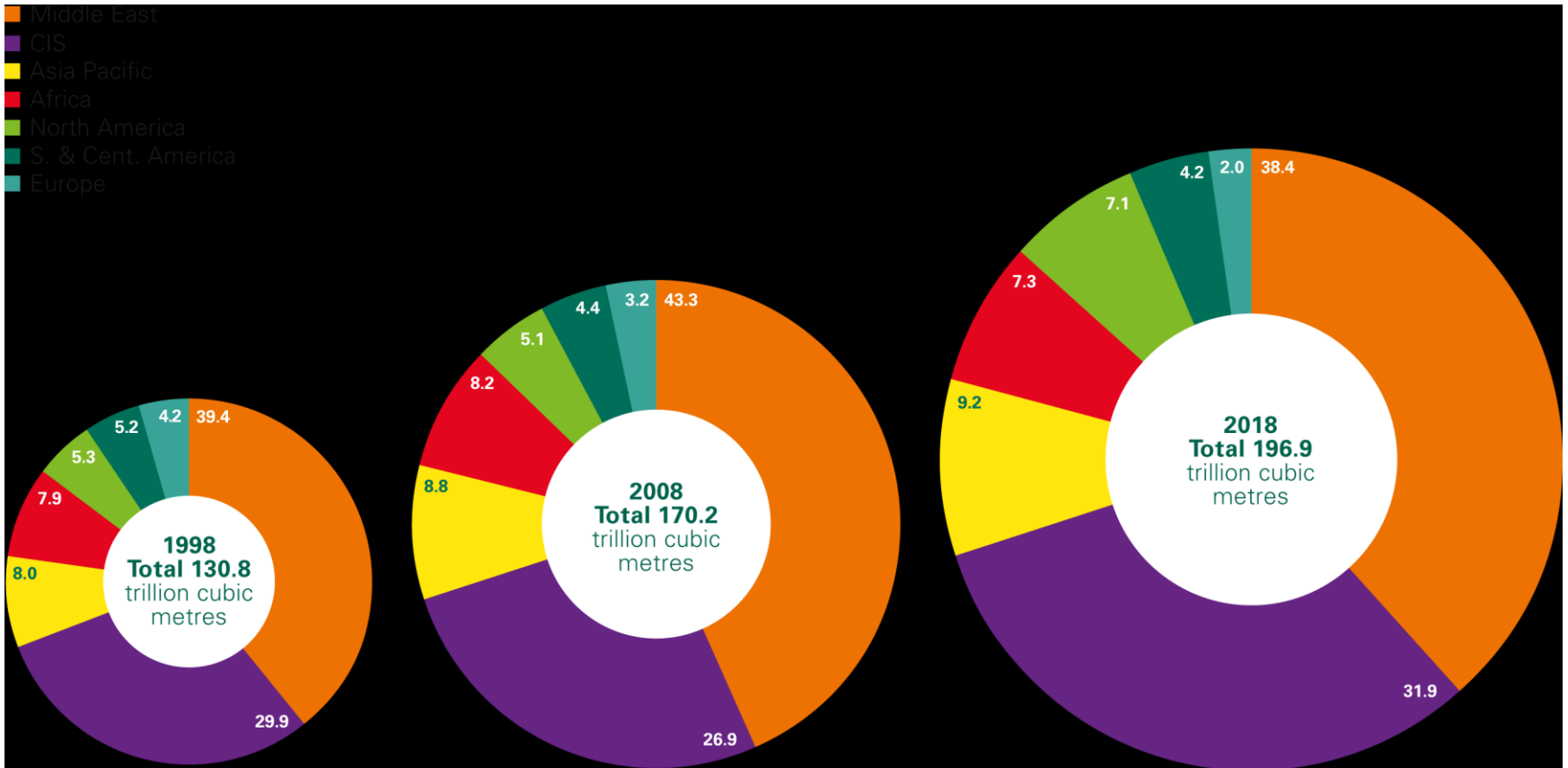
Fi Source: Bloomberg, 20 April 2020, 20:15 GMT

BBC

- Travel has almost stopped, meaning demand for oil in transport has fallen
- Overall demand has fallen by c.25mmbpd, or 25%, in the past two months
- Storage tanks are full so traders are paying people to take oil away



# Gas reserves by region (1998, 2008, 2018)



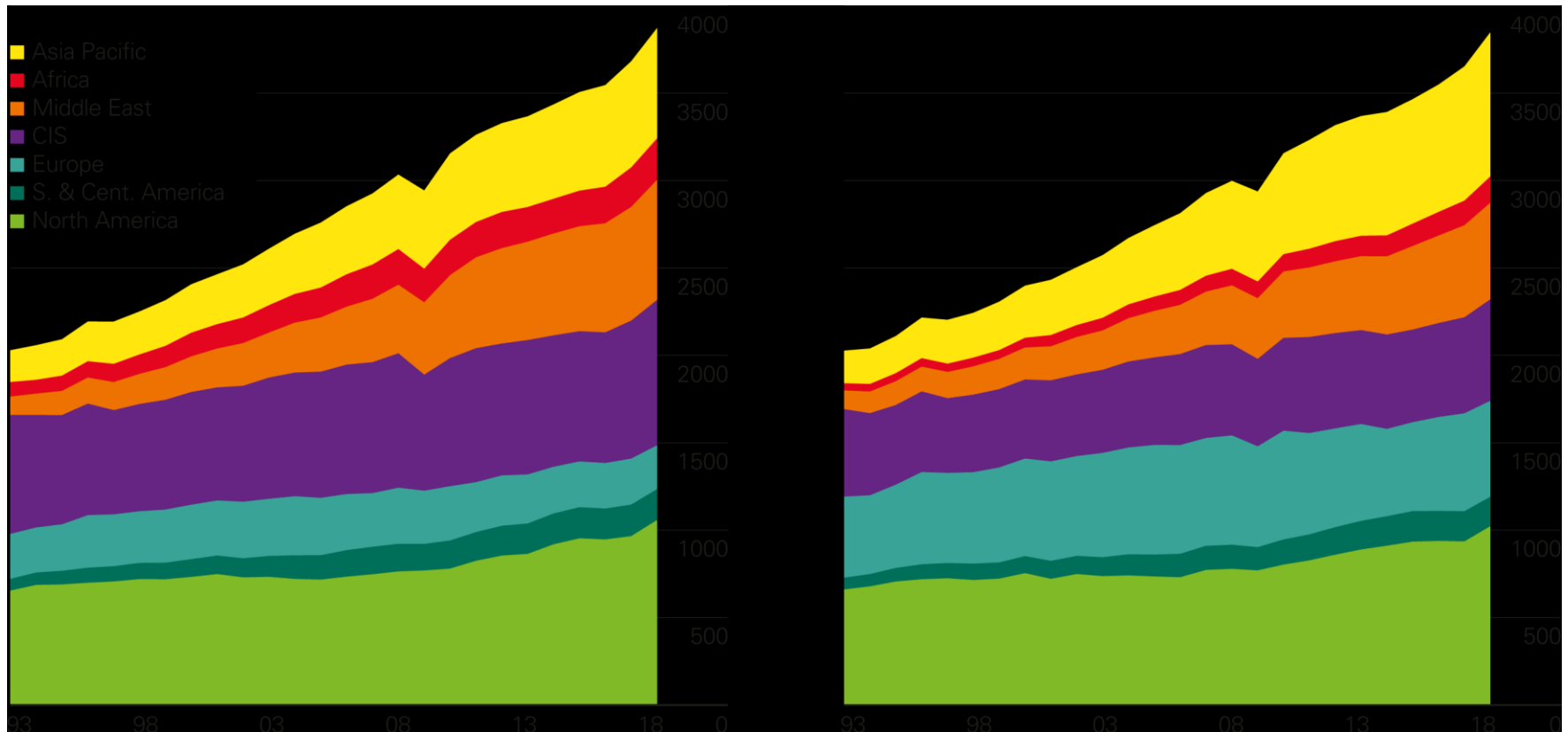
- The Middle East also contains huge amounts of gas, although Russia is the main exporting country
- Gas reserves have grown dramatically as it has increasingly become an important fuel for power generation



# Gas production and consumption by region (bcm)

*Production*

*Consumption*

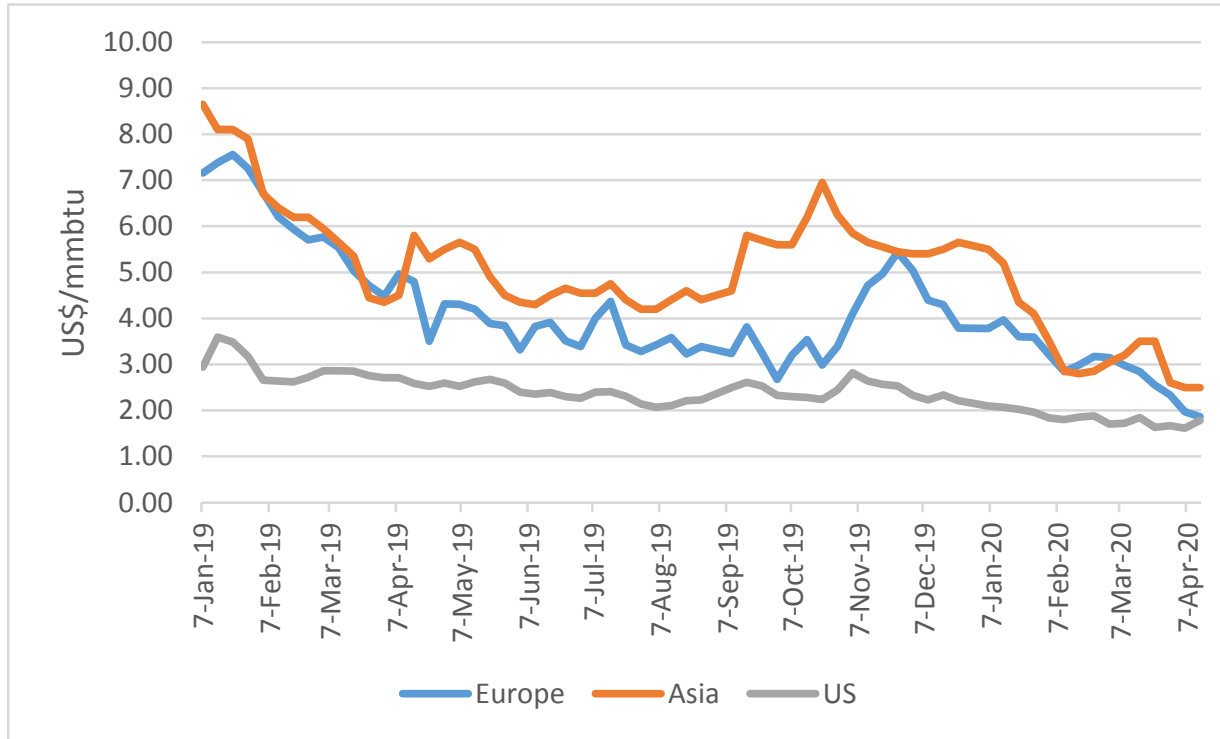


- Europe and North America have traditionally been the largest consumers of gas
- Major infrastructure in both regions facilitates indigenous production and imports
- Asia, the Middle East and Latin America are growing fast, however



# Gas prices have been in decline for longer

*Gas price in US, Europe and Asia*



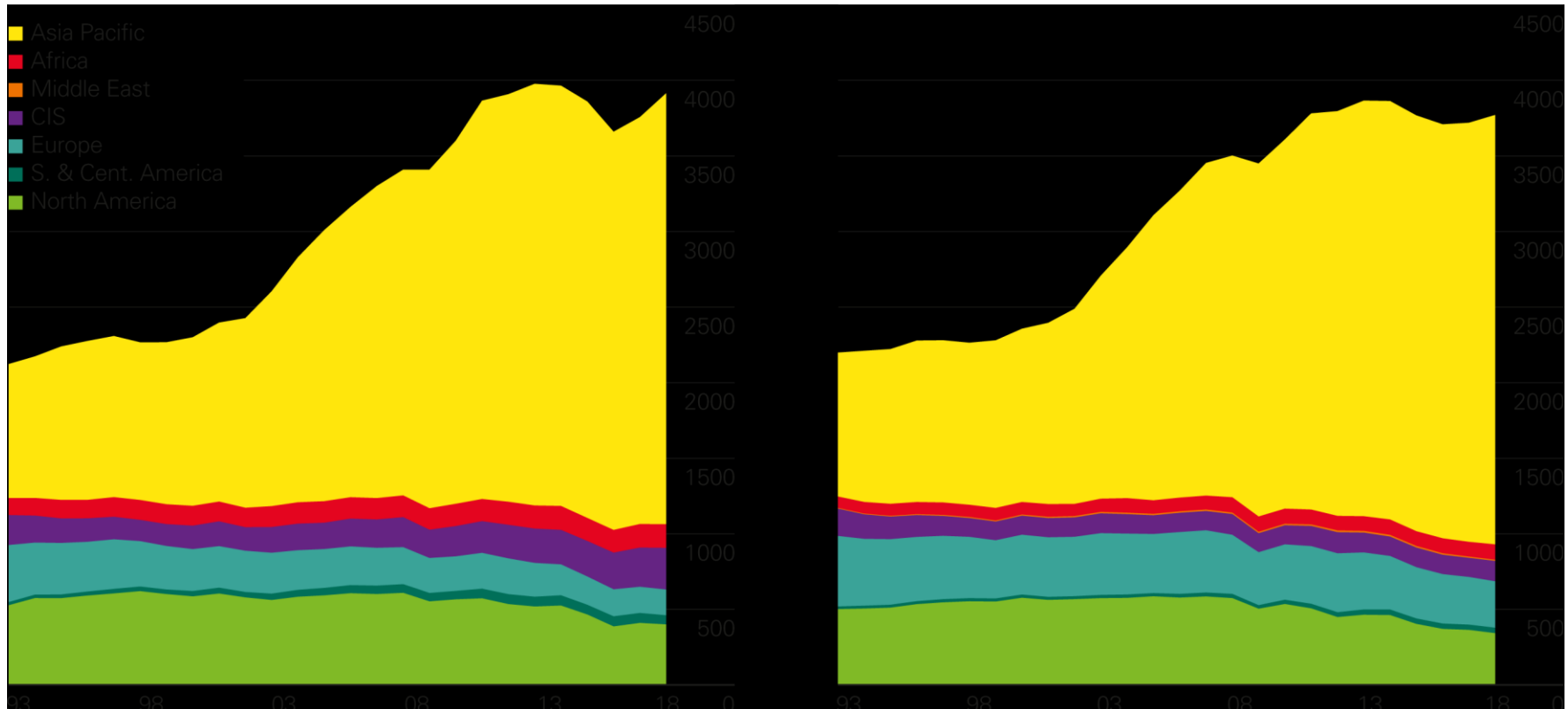
- Gas prices have been in cyclical decline since 2018
- Excess supply has been built due to high prices in the mid-2010s
- Demand has not met expectations and now the Covid-19 pandemic has caused a decline in consumption
- The longer term outlook for gas may be more positive, however



# Coal production and consumption by region (mt)

*Production*

*Consumption*



- The majority of production and consumption is in Asia, and has grown rapidly
- China and India are the key players, as coal is both countries' major indigenous energy resource
- Decline in North America driven by the arrival of shale gas



# Decline in coal industry

## *Employment in US coal industry*

### Coal employment declines in top-producing US state

Wyoming payroll jobs in coal mining industry



Source: US Bureau of Labor Statistics

© FT

## *Global coal price (US\$/t)*



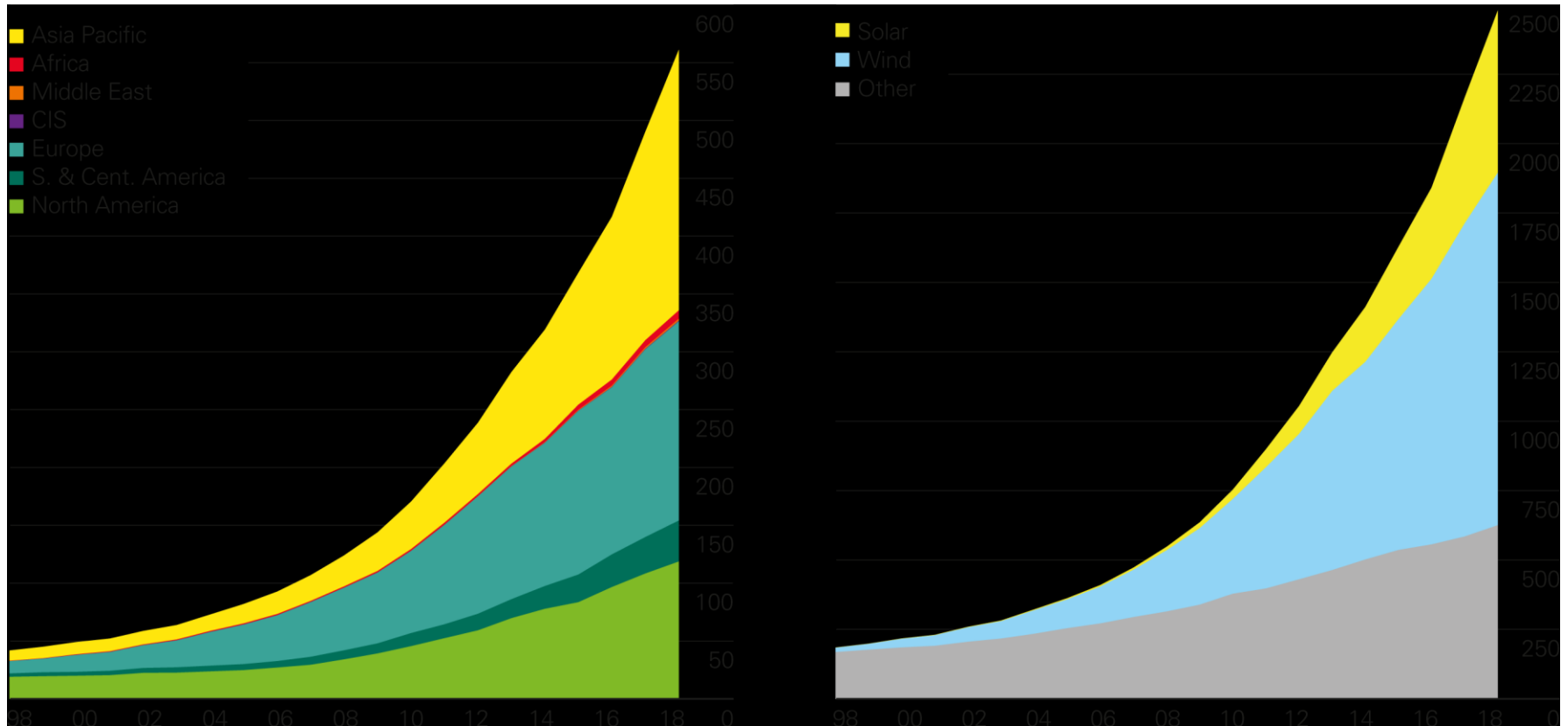
- The coal industry is in long-term decline for environmental and economic reasons
- The US coal industry has collapsed over the past five years
- Cheap gas prices have encouraged a switch from coal, especially in power sector
- Coal is still important in many developing countries, especially in Asia



# Renewable energy consumption by region and source

*Consumption (MMTOE)*

*Source of Renewable Energy*



- Growth in renewable energy has been dramatic – it now accounts for around 9% of the global input to electricity
- Europe has been leading the way, catalysed by policy initiatives in Germany
- Growth in Asia accelerating, as search for indigenous energy continues





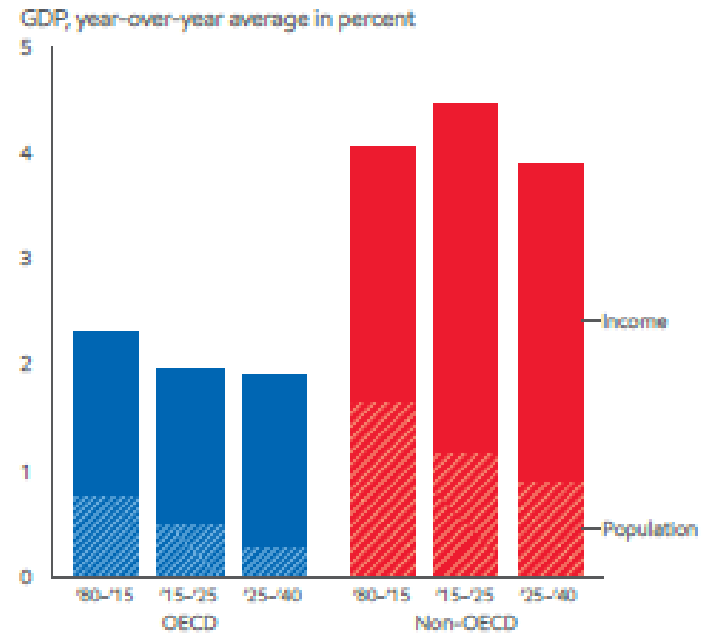
# Key drivers of energy consumption

## World demographics continue to shift



Source: World Bank, EcoinMobil estimates

## Non-OECD leads economic expansion

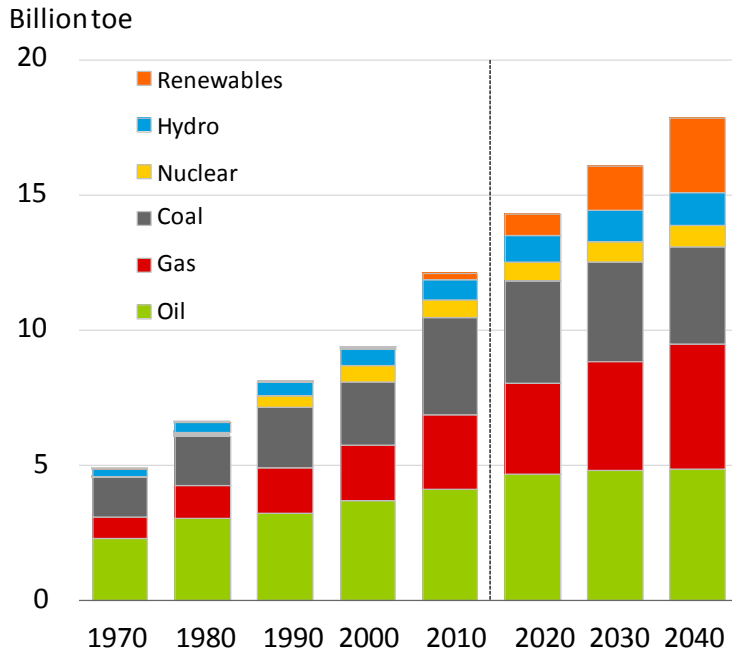


- Global population currently 7.3 billion, expected to reach 9.1 billion by 2040
- Population mainly in non-OECD countries, in many of which the alleviation of energy poverty is a huge issue
- Economic growth is another key driver, leading to increased personal wealth and greater use of energy intensive products
- Again non-OECD countries dominate growth, with their share of global GDP set to rise from 35% to 50% by 2040

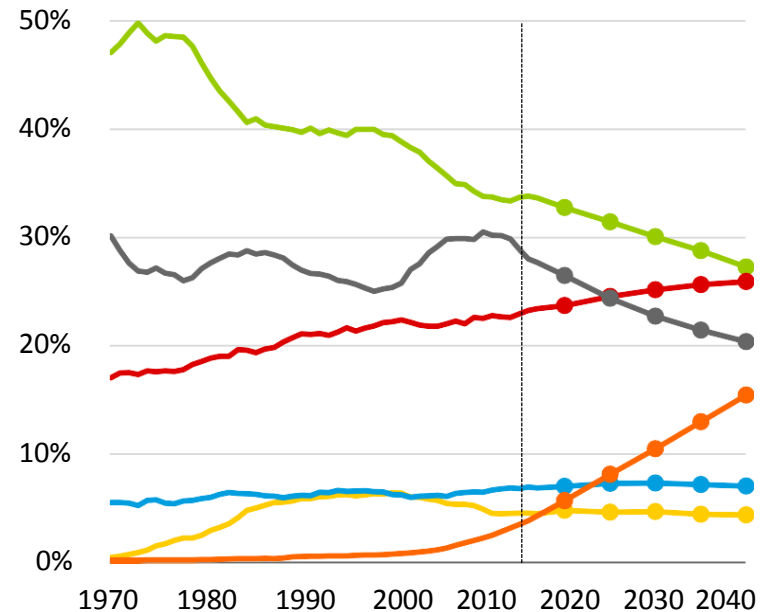


# The shifting global energy economy

Primary energy consumption by fuel



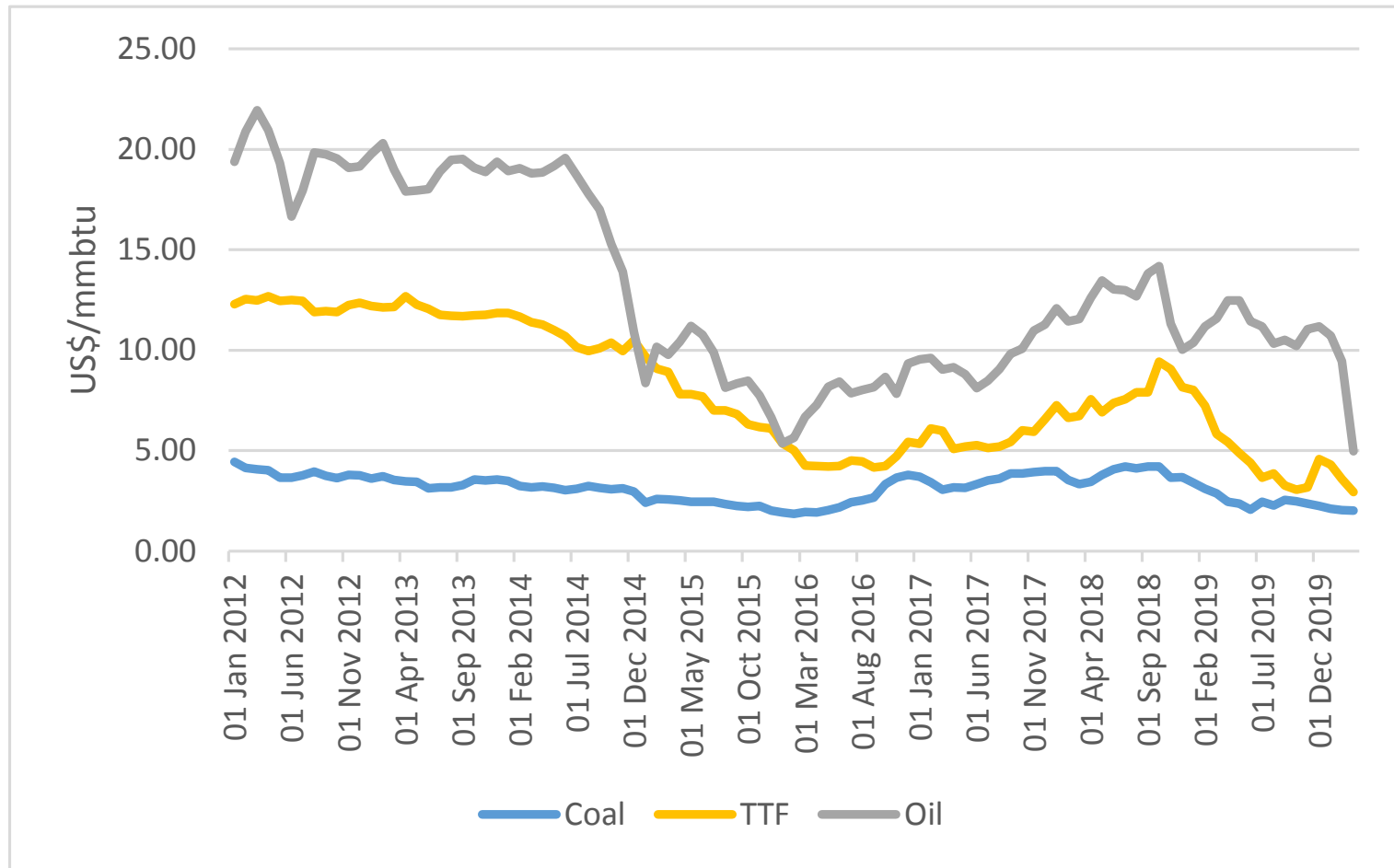
Shares of primary energy



- Rise of renewables now having a noticeable impact on hydrocarbons
- Incremental demand growth is increasingly being accounted for by non-fossil fuels, leading to oversupply and lower prices
- Are we seeing a new paradigm for oil, gas and coal pricing, with significant commercial and political consequences?



# Global energy prices – short and long-term trends



- Are we in a new era of lower commodity prices, or will there be a further rebound as supply and demand re-balance?

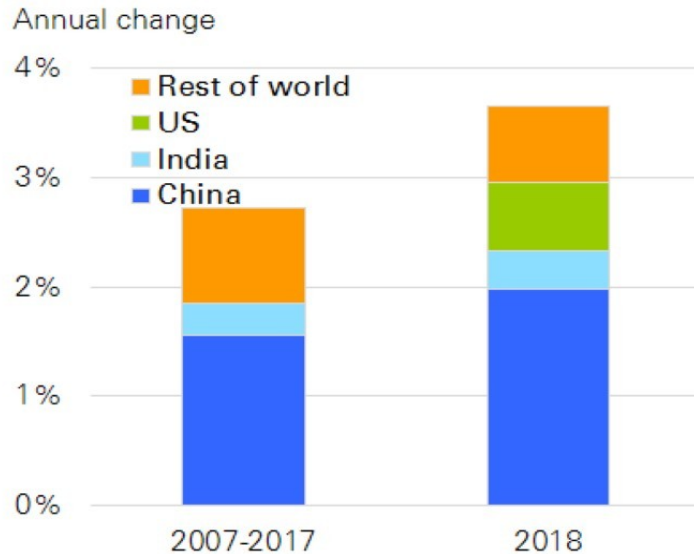


# Power Sector Trends

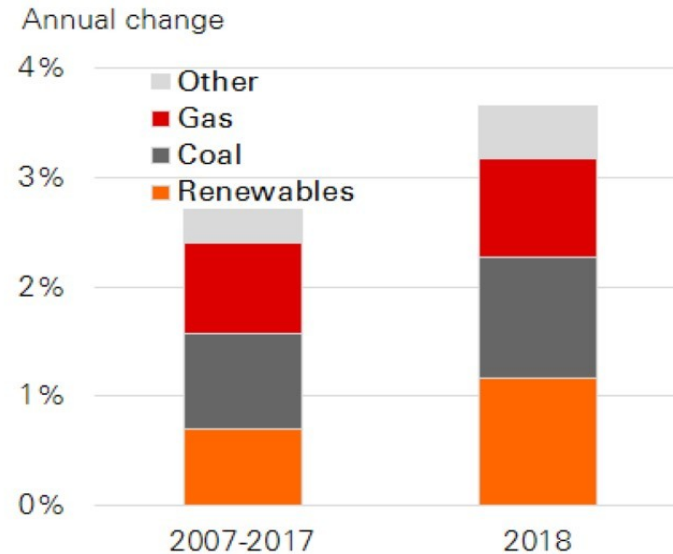


## Growth in power generation

Contributions by region



Contributions by fuel



BP Statistical Review of World Energy

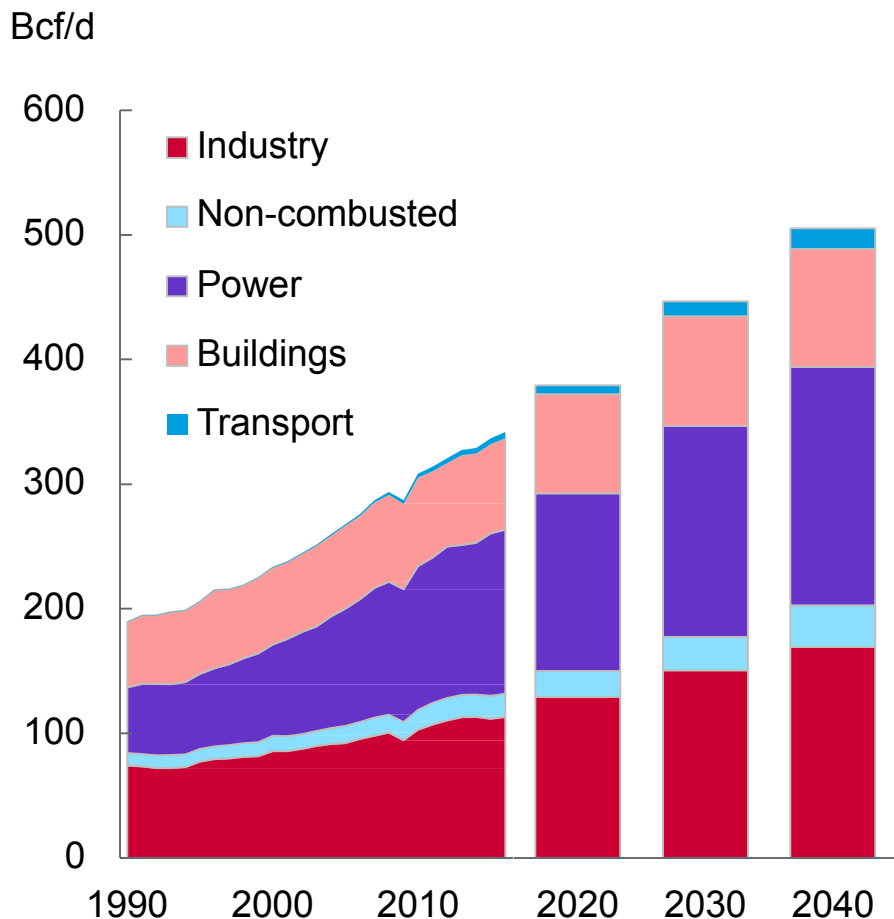
© BP p.l.c. 2019

- GDP growth and power demand are closely correlated
- Electricity demand continues to grow but mix of fuels is changing
- Renewables the largest growing segment, but hydrocarbons still playing a major role
- Existing capacity is cheap to use, even if new capacity is less welcome

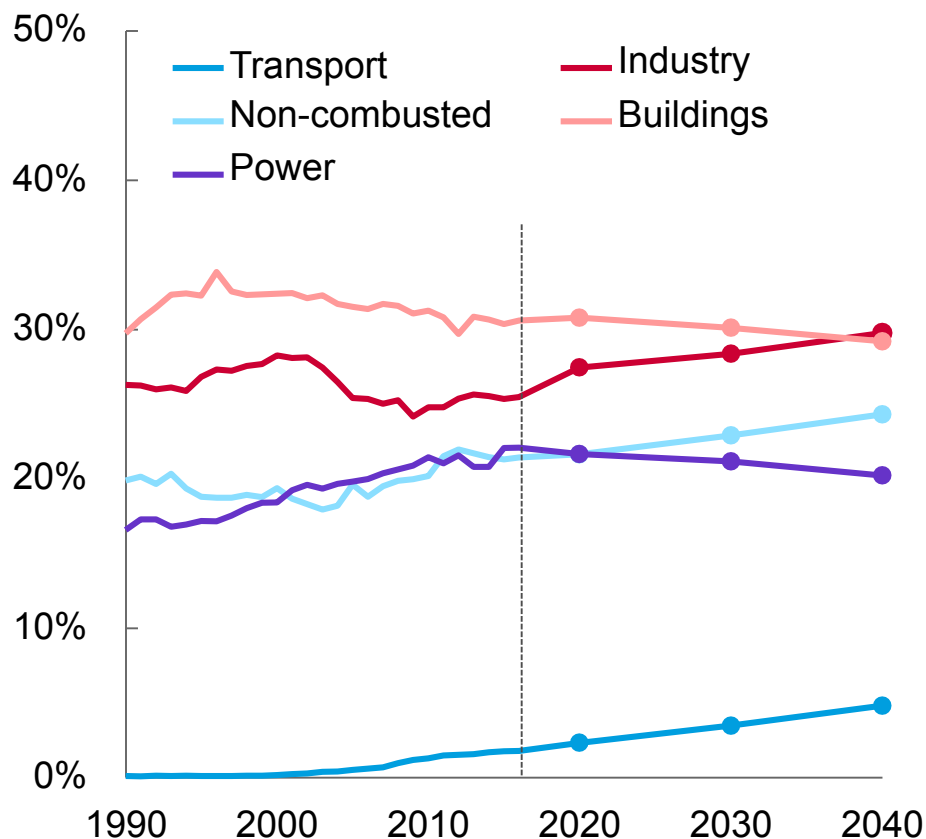


# Natural gas demand growth driven by power and industry

## Gas consumption by sector



## Gas share by sector



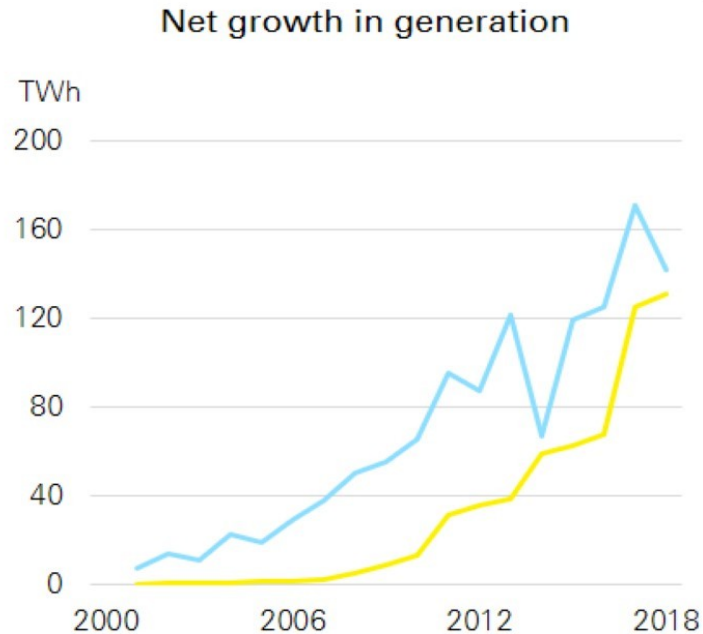
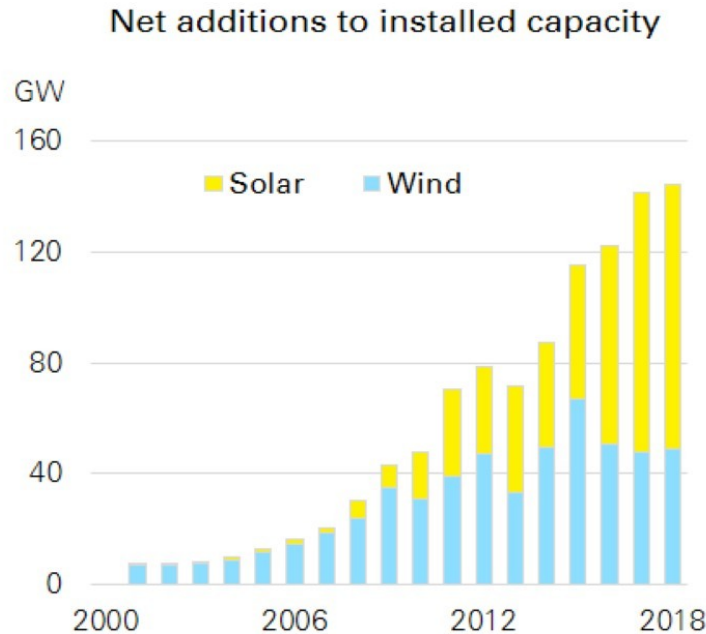
- Industrial demand is key to gas growth, especially petrochemicals
- Demand from power sector also grows, although overall share falls



# Wind power leads the way for renewables



## Wind and solar power



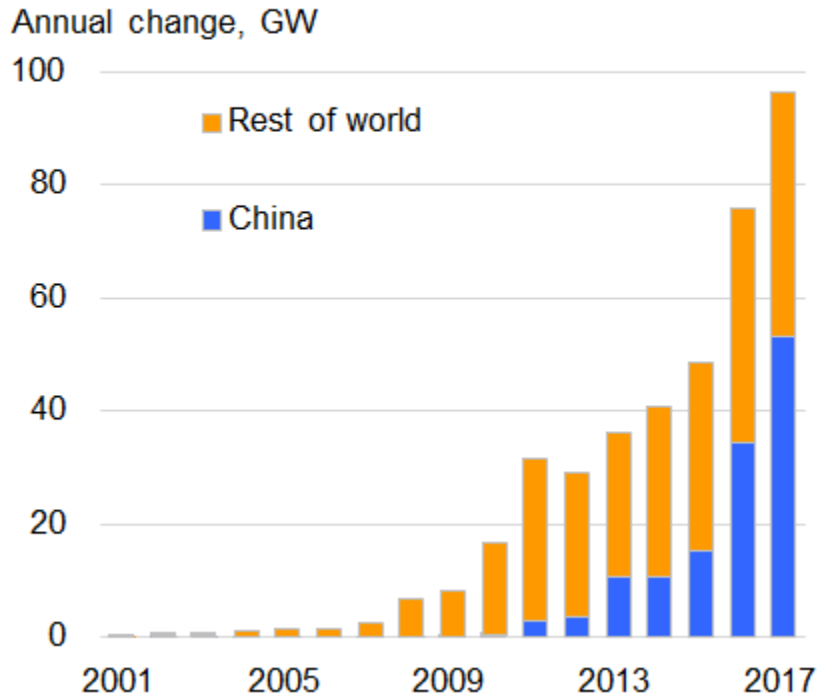
BP Statistical Review of World Energy  
© BP p.l.c. 2019

- Although renewable energy only accounts for 4% of total energy, it grew by 15% in 2018
- It accounted for all the increase in global power generation and nearly 40% of total energy growth
- Solar is growing very fast (33% in 2018) but wind power still leads the way in terms of generation

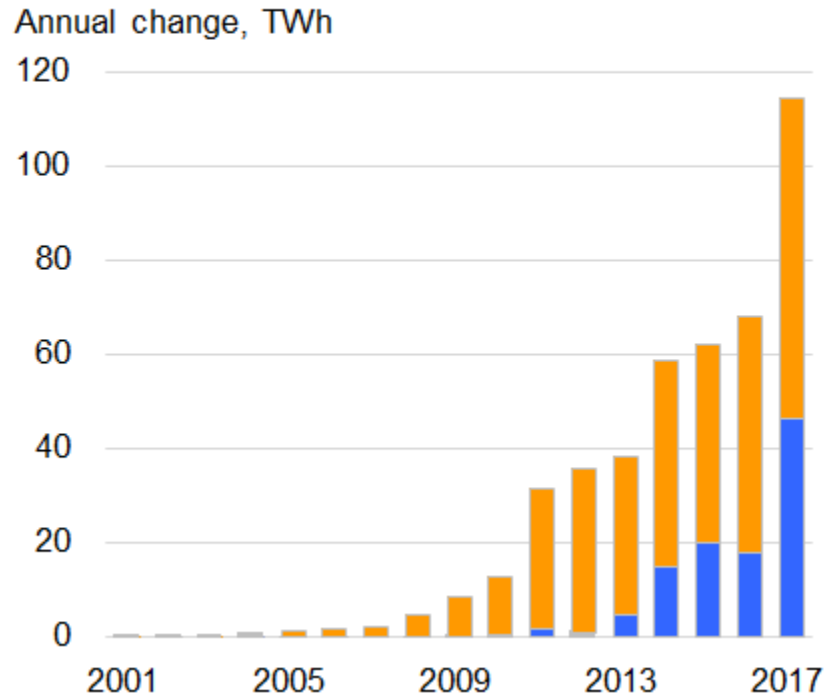


# Solar Power continues to show rapid growth

## Capacity



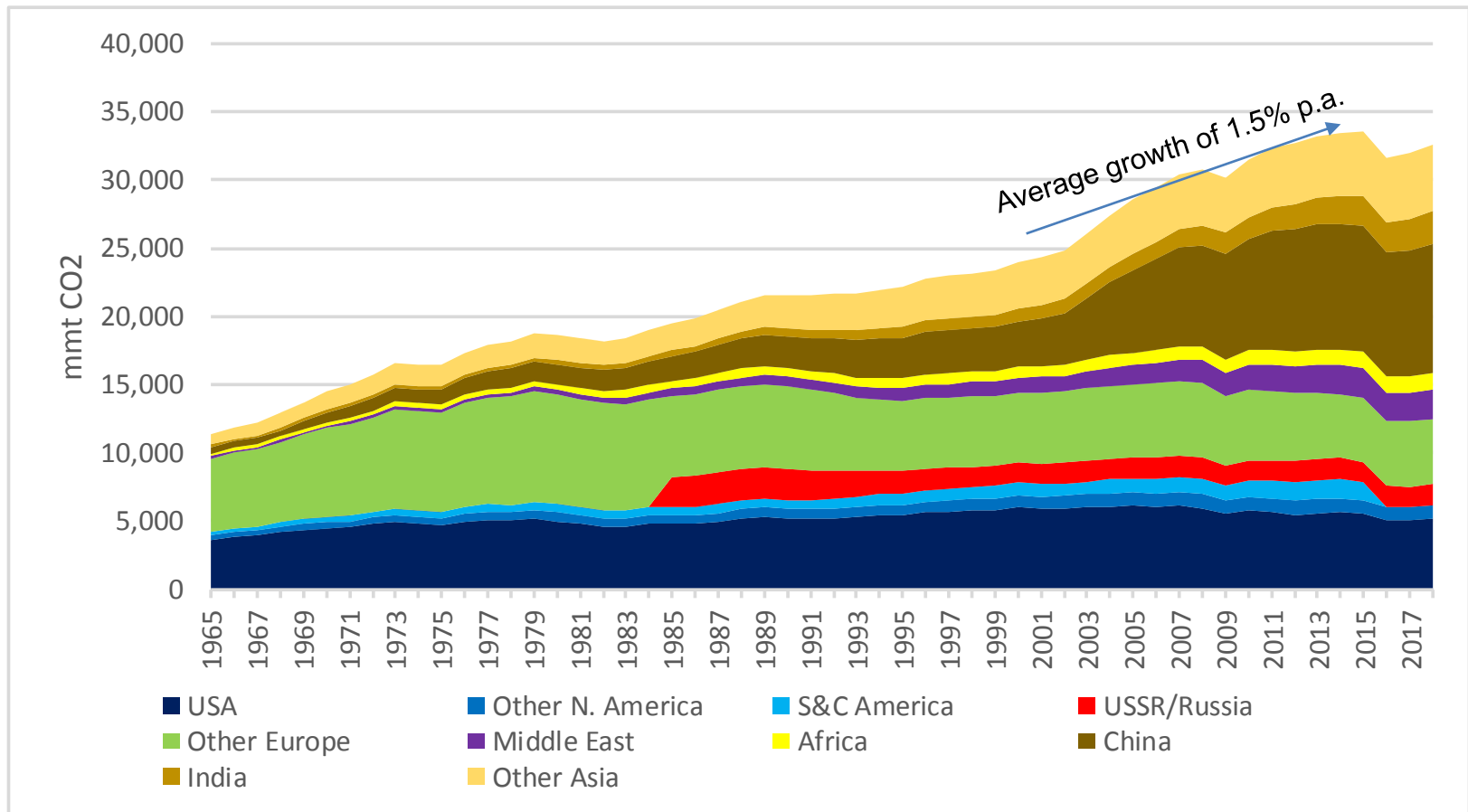
## Generation



- China is leading the way, both as a consumer and as a developer of technology
- The next generation of solar technology could have a dramatic impact and make a significant change to energy security issues



# History of CO2 Emissions



- Carbon emissions have grown consistently to 2014, but were then declined in 2015 and 2016 due to sluggish economic growth and greater energy efficiency
- Key question is whether we have reached a peak, or is this just a cyclical downturn? 2017 and 2018 would suggest the latter, given the return to growth

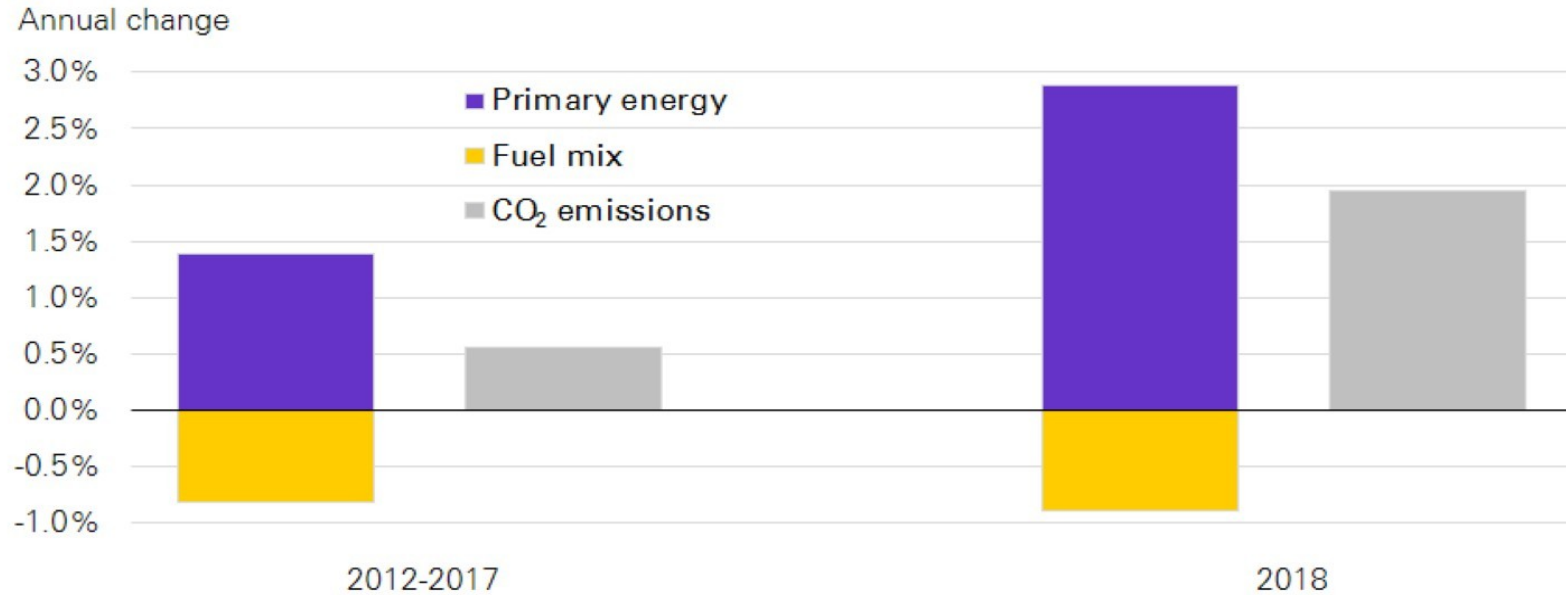




# Carbon emissions rebounded in 2018



## Energy demand and carbon emissions



BP Statistical Review of World Energy

© BP p.l.c. 2019

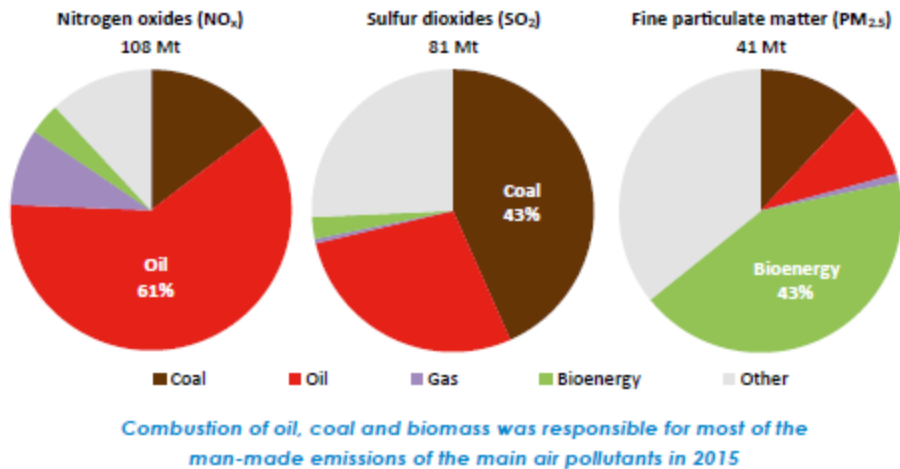
16

- Growing economies = growing energy demand = growing emissions in the current global energy economy
- Can we change course in time to halt this trend?

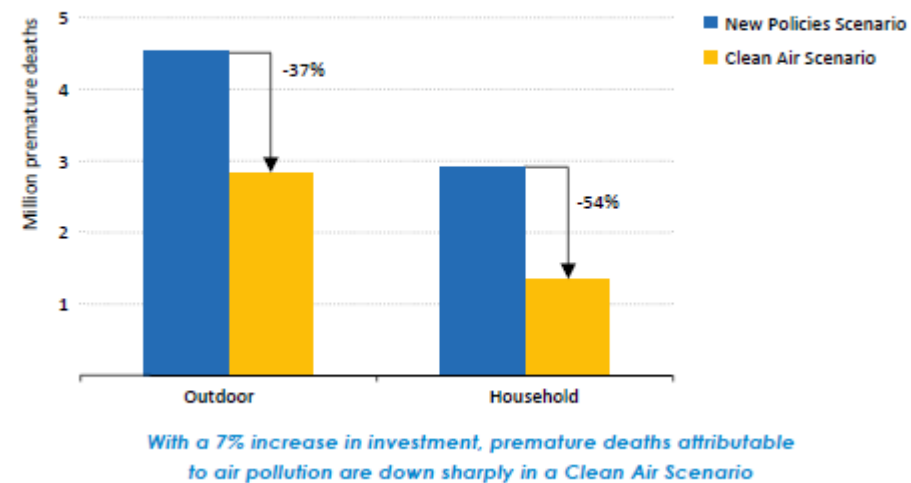


# Air pollution is becoming an almost more important short-term issue

**Figure 2.10** ▶ Estimated anthropogenic emissions of the main air pollutants by source, 2015



**Figure 2.12** ▶ Premature deaths attributable to global air pollution in the New Policies and Clean Air Scenarios, 2040



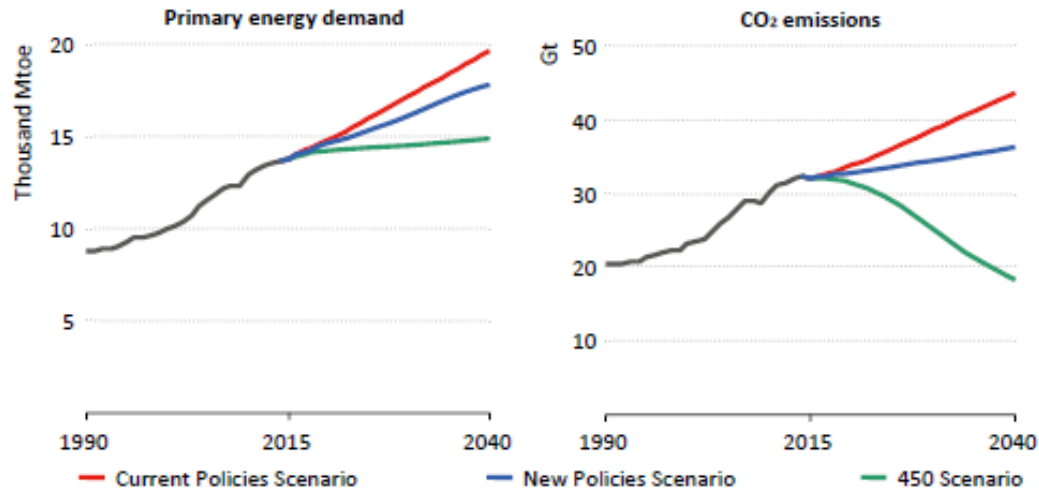
- Air pollution is a more immediate social and political issue than carbon emissions
- China is well known for its poor air quality in many cities, but even in Europe a number of regions are well below acceptable levels
- Governments are aware that a failure to react on a key health issue could lead to a violent backlash
- Air pollution could therefore be a key driver towards a cleaner energy economy



Having said that, in the longer term global warming is the key issue, and things clearly need to change if we are to meet 2 degree target

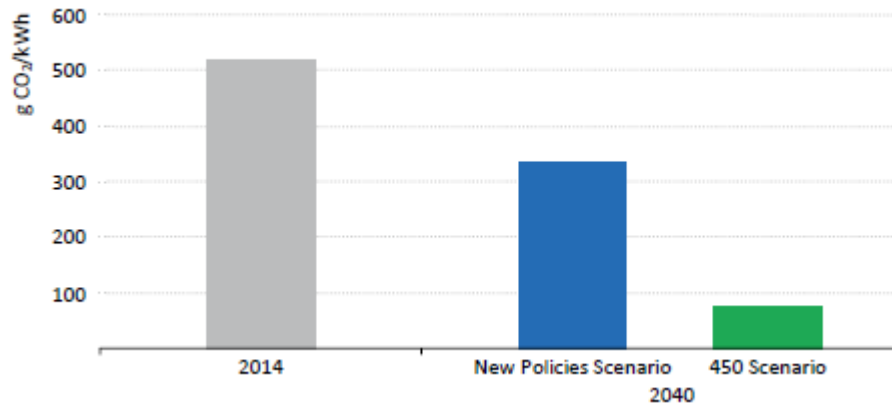
### *Energy demand and CO2 emissions in different IEA scenarios*

Demand must not grow...

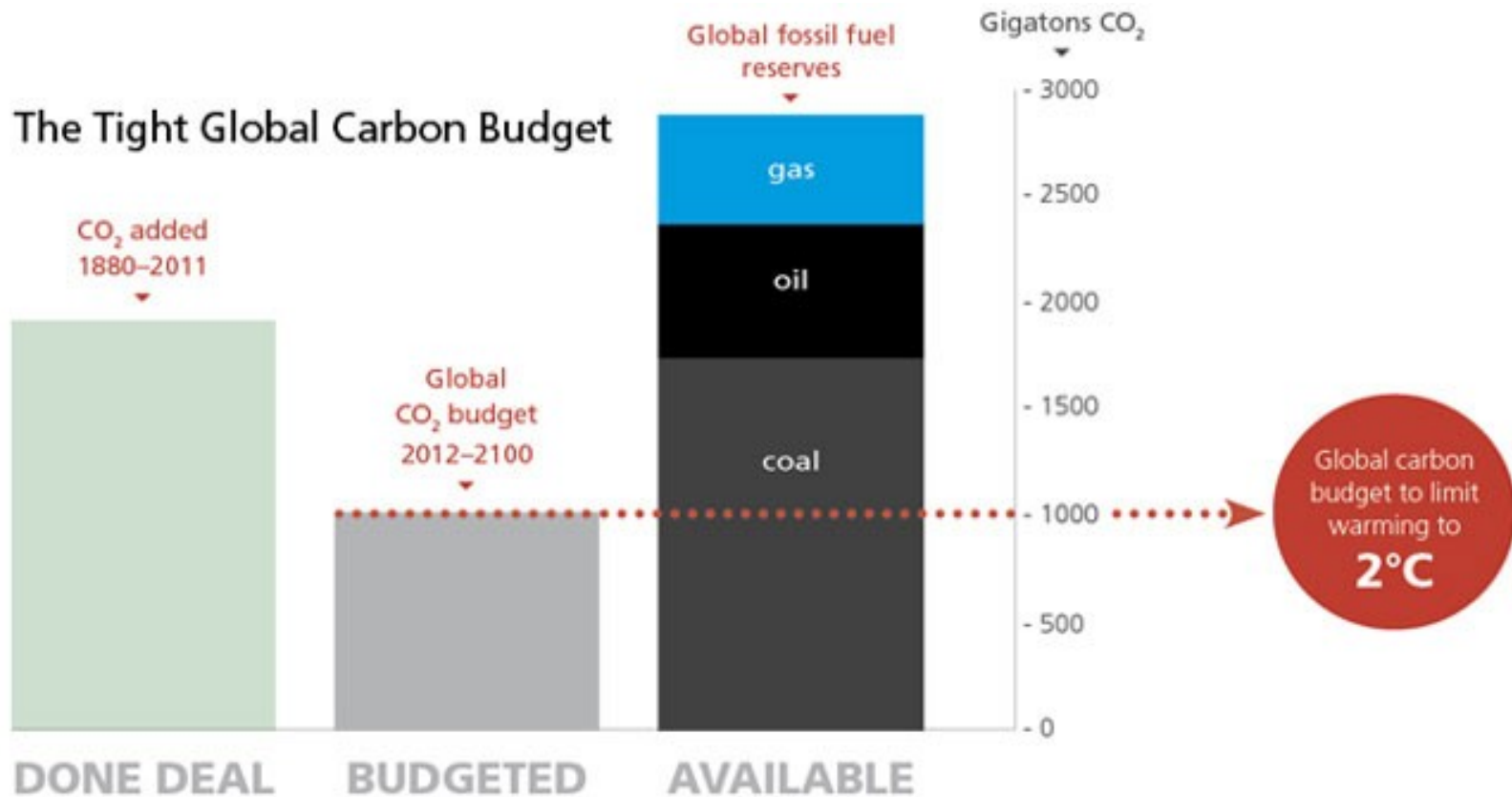


### *Emissions intensity from power sector*

...and renewable output must



# Looking at the global carbon budget, the race is on to produce fossil fuels while you can

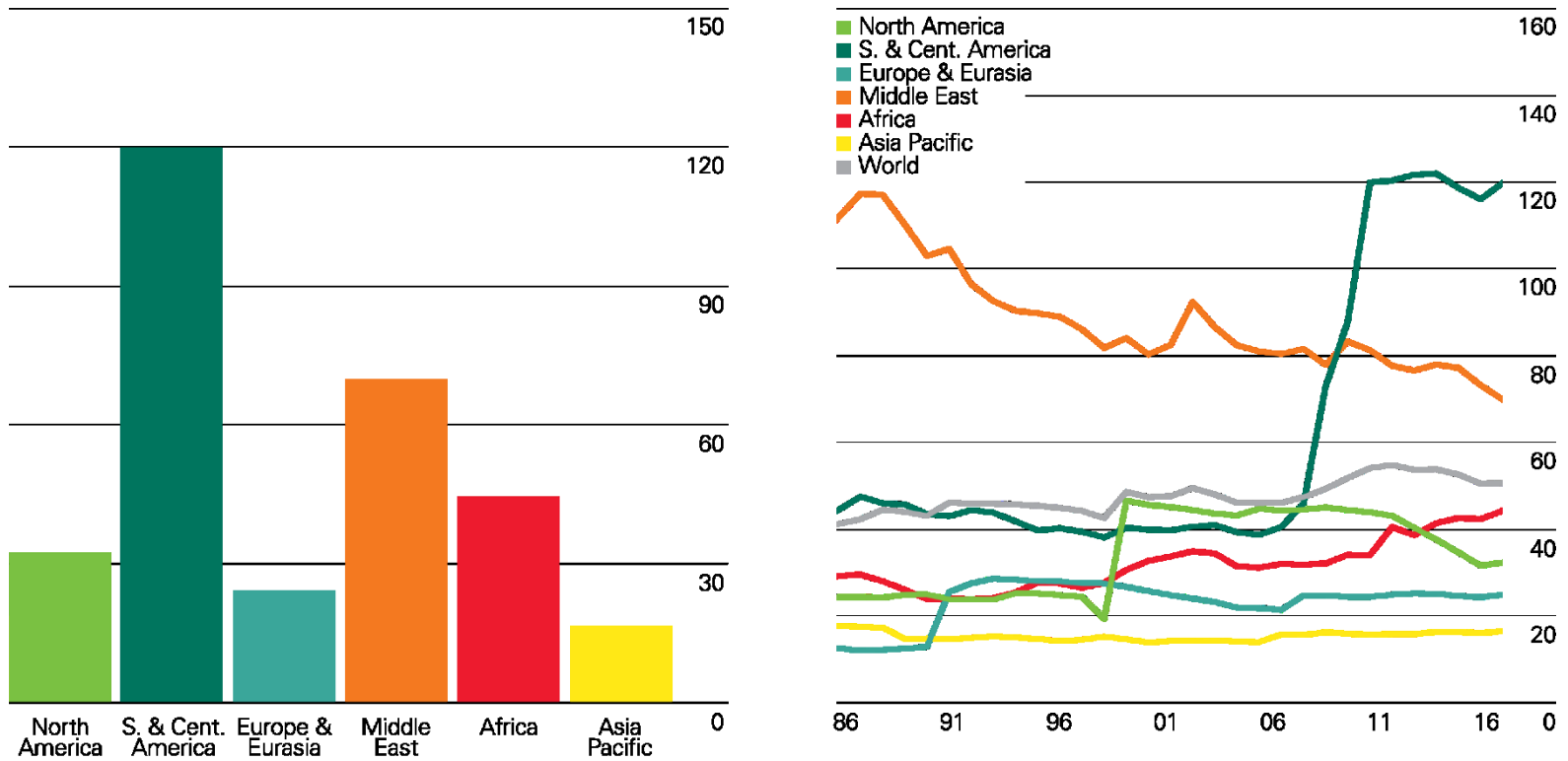


- This has vast political and commercial consequences, as countries and companies have to react to a fast changing energy economy
- The futures of Russia and the Middle East are closely bound up to the issue of whether this carbon budget will or can be enforced



# This leaves a vital question for companies / regions with large fossil fuel reserves

## Fossil fuels reserves to production ratios (years)



- Coal reserves would last well over 100 years in most regions, while oil and gas reserves have a 50 year reserves life on average
- This assumes that no further exploration is ever carried out
- Will these reserves ever be produced, and perhaps more importantly who can get theirs out of the ground first?



# World Energy Demand by Fuel and Scenario

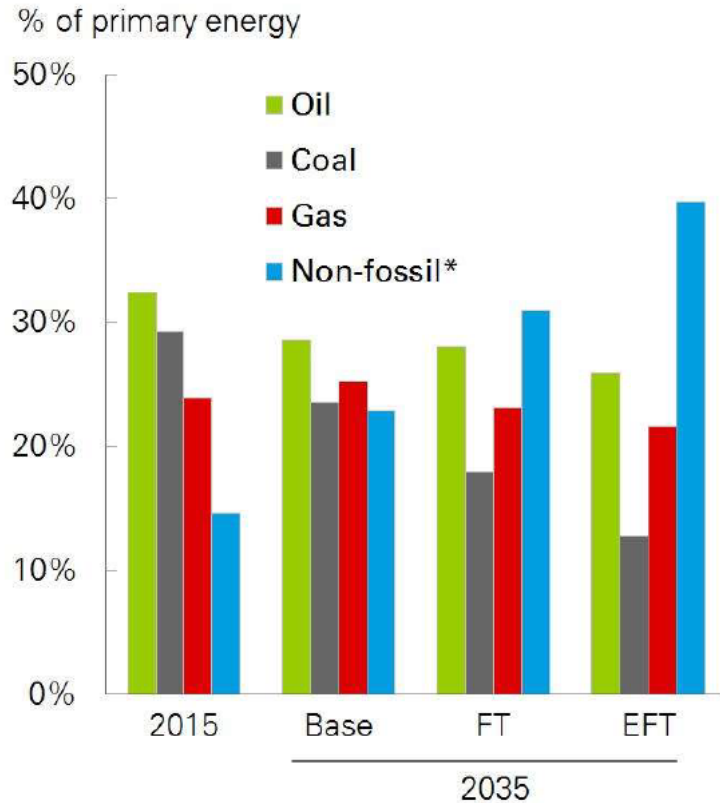
			New Policies		Current Policies		450 Scenario	
	2000	2014	2025	2040	2025	2040	2025	2040
Coal	2 316	3 926	3 955	4 775	4 361	5 327	3 175	3 326
Oil	3 669	4 266	4 577	4 775	4 751	5 402	4 169	3 326
Gas	2 071	2 893	3 390	4 775	3 508	4 718	3 292	3 301
Nuclear	676	662	888	1 181	865	1 032	960	1 590
Hydro	225	335	420	536	414	515	429	593
Bioenergy*	1 026	1 421	1 633	1 883	1 619	1 834	1 733	2 310
Other renewables	60	181	478	478	420	809	596	596
<b>Total</b>	<b>10 042</b>	<b>13 684</b>	<b>15 340</b>	<b>17 866</b>	<b>15 937</b>	<b>19 636</b>	<b>14 355</b>	<b>14 878</b>
<i>Fossil-fuel share</i>	<i>80%</i>	<i>81%</i>	<i>78%</i>	<i>78%</i>	<i>79%</i>	<i>79%</i>	<i>74%</i>	<i>74%</i>
<b>CO<sub>2</sub> emissions (Gt)</b>	<b>23.0</b>	<b>32.2</b>	<b>33.6</b>	<b>36.3</b>	<b>36.0</b>	<b>43.7</b>	<b>28.9</b>	<b>18.4</b>

- The outcomes for hydrocarbons are very different in scenarios that look at current likely outcomes versus outcomes needed to meet climate targets
- In a world where we meet the 2 degree target, coal demand would halve from current levels and oil demand would fall by 25%
- However, fossil fuel share would still be 58% in 450 Scenario

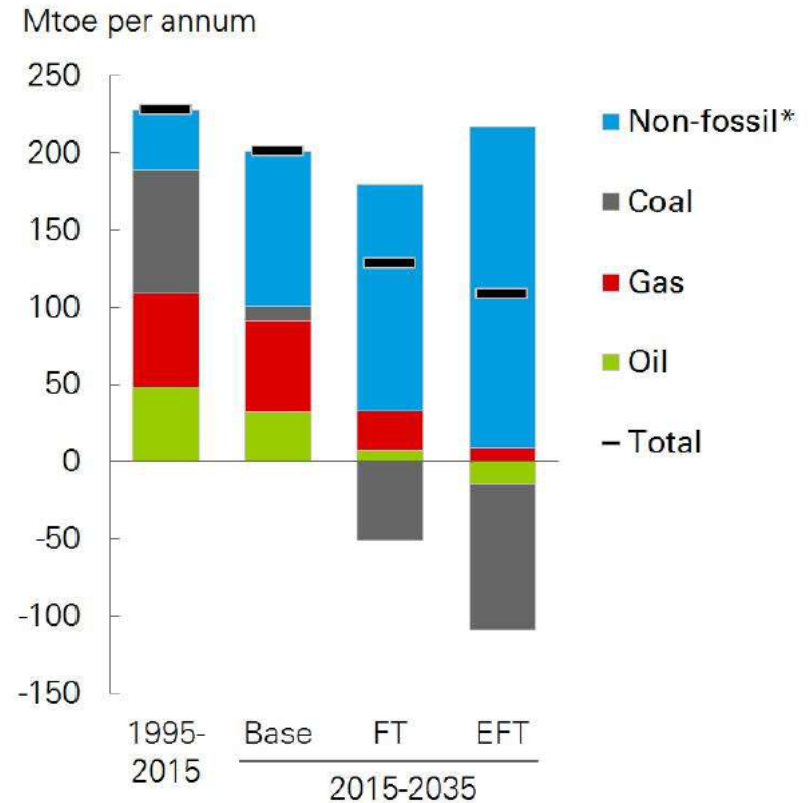


# Impact of fuel mix of various scenarios

## The changing fuel mix



## Annual demand growth by fuel



- The future of coal looks bleak if climate targets are to be met
- However, in the long-term oil and gas also face very challenging futures



# Capital Spending in the Energy Sector

	2010-15*	New Policies		Current Policies		450 Scenario	
	Per year	Cumulative	Per year	Cumulative	Per year	Cumulative	Per year
Fossil fuels	1 112	26 626	1 065	32 849	1 314	17 263	691
Renewables	283	7 478	299	6 130	245	12 582	503
Electricity networks	229	8 059	322	8 860	354	7 204	288
Other low-carbon**	13	1 446	58	1 259	50	2 842	114
<b>Total supply</b>	<b>1 637</b>	<b>43 609</b>	<b>1 744</b>	<b>49 098</b>	<b>1 964</b>	<b>39 891</b>	<b>1 596</b>
Energy efficiency	221	22 980	919	15 437	617	35 042	1 402

\* The methodology for energy efficiency investment derives from a baseline of efficiency levels in different end-use sectors in 2014, the annual figure for energy efficiency in this column is the figure only for 2015. \*\* Includes nuclear and CCS.

- Uncertainty creates a reluctance to invest, but huge amounts of capital will be required to provide energy for a growing population
- Two interesting questions emerge:
  - Will sufficient capital be found to maintain growth in renewables, especially if subsidies start to be removed?
  - Will there be sufficient incentive to invest in the hydrocarbons that will still be needed, if competition drives prices down?
- How much should be left to markets and how might governments intervene?

