Global energy transition: preparing for an unpredictable future

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The global energy context today

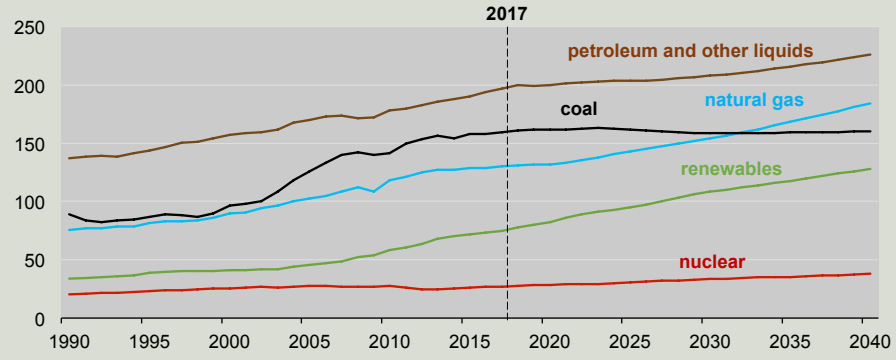
- Global demand for energy continues to rise
  - *as the world economy continues to grow*
- Fuel mix changes significantly
  - *coal losing, renewables gaining, and oil and gas combined holding steady*
- Growth rate of carbon emissions slows sharply
  - *but not enough without further policy changes*

There is no single story about the future of global energy; policies and/or events(?) will determine where to go from here

From: 2016 BP Outlook/IEA

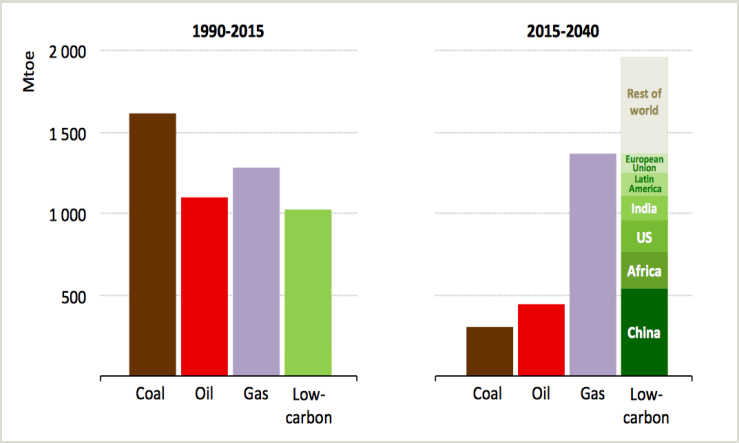
Energy consumption increases for all fuels other than coal (EIA Reference case)

World energy consumption by end-use sector
quadrillion Btu



Source: U.S. Energy Information Administration IEO2017

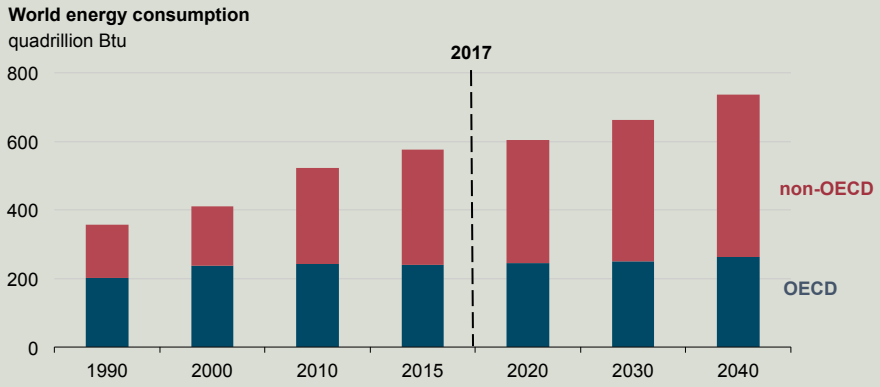
Change in total primary energy demand



Low-carbon fuels & technologies, mostly renewables, supply nearly half of the increase in energy demand to 2040

Source: IEA, WEO 2016

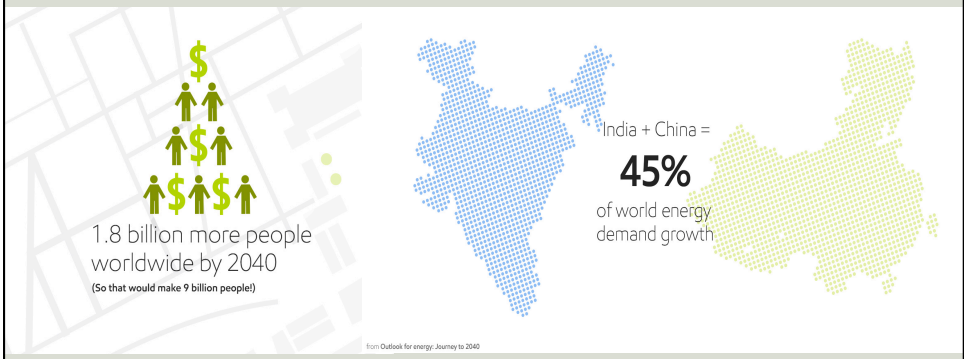
World energy consumption rises 28% between 2015 and 2040 (EIA Reference case)



Source: U.S. Energy Information Administration IEO2017

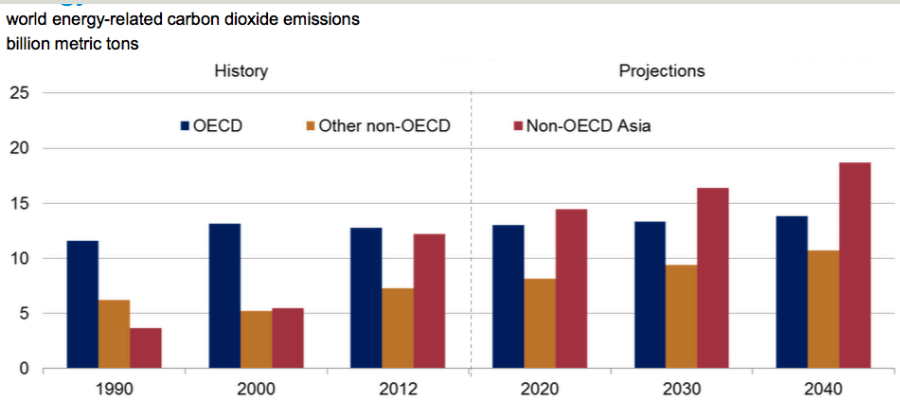
Accelerating Energy Demand

Driven by population growth and economic development



Source: Exxon Outlook for Energy; Journey towards 2040

Non-OECD Asia will account for about 60% of the world increase in energy-related CO2 emissions



Source: EIA, International Energy Outlook 2016

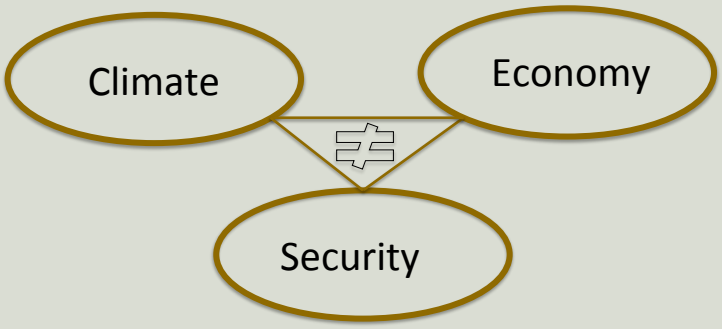
The global energy scene is in a state of flux

Large-scale shifts in the global energy system:

- rapid deployment and deep declines in the costs of major renewable energy technologies
- growing shift towards electricity in energy use across the globe
- profound changes in China's economy and energy policy, moving consumption away from coal
- continued surge in US shale gas and tight oil production

Source: IEA, WEO 2017

Asymmetry in energy policy



- Countries (US, ME, China) often focus on their own *security of supply* and *security of demand*
- Low prices hurt *producers' economies*
- *New climate-related targets* could affect traditional energy demand (Paris)

China's energy mix changes fast

10 years economic growth with "old" energy sources, smog and environmental polution

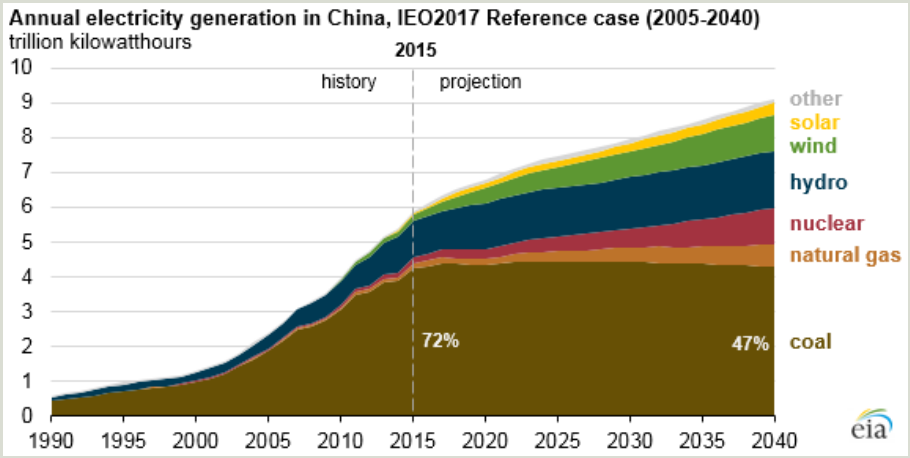
Jan 2017:
China will invest *343 billion* euro in wind-, nuclear-, hydro- and solar-energy (2017-2020)

2015:
- New installed capacity: 32.5 GW wind; 18.3 GW solar
- Total thermal: 990 GW (dominantly coal)

Source: China's 2015 Statistical Communique

SEPTEMBER 27, 2017

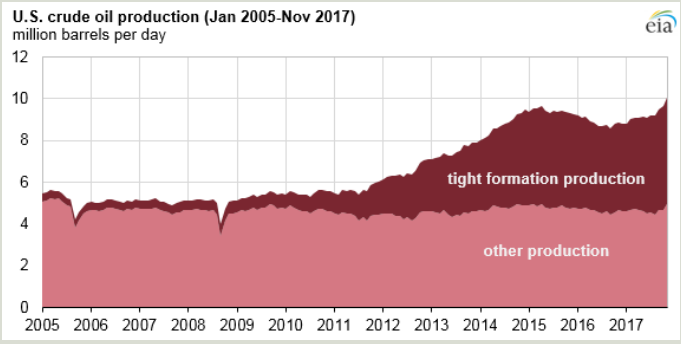
Chinese coal-fired electricity generation expected to flatten as mix shifts to renewables

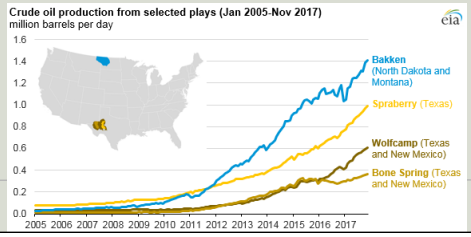


Source: U.S. Energy Information Administration

FEBRUARY 1, 2018

U.S. monthly crude oil production exceeds 10 million barrels per day, highest since 1970





International Oil markets

Brent $75

"This year will be the eighth year of continuous growth since the Great Financial Crisis; and the seventh consecutive year of annual *growth of more than 1 million b/d.*

Our latest forecast suggests that demand will grow by *1.7 million b/d* in 2018, the fifth-highest this century."

"The biggest risk to oil demand's winning growth streak is a trade war undermining the global economy,"

Wood Mackenzie, 2018

Gas demand grows to 2040 in most outlooks

CO_2 emissions (per unit of energy produced) from gas are around 40% lower than coal and around 20% lower than oil.

The pace of this growth will be determined by

- the *affordability* of gas relative to other fuels and technologies
- the *policies* that governments put in place
- the impact of an increasingly liquid and interconnected global gas market on *investment* and *security of supply*

- *the industry demonstrating credibly that methane emissions from oil and gas operations are being minimised.*

EIA, 2017; IEA, 2016

Global Natural Gas Markets in Transition

- The gas landscape is changing: production growth is increasingly driven by the US & Australia; demand growth by developing Asia
- Gas has a key role to play in the low-carbon transition & improving air quality, but methane emissions need to be addressed
- North America is projected to become a major exporter of natural gas by 2020, even though flows from Russia to Europe and Asia are expected to show the largest volumetric growth in trade.

Source: EIA, 2017; IEA, 2016

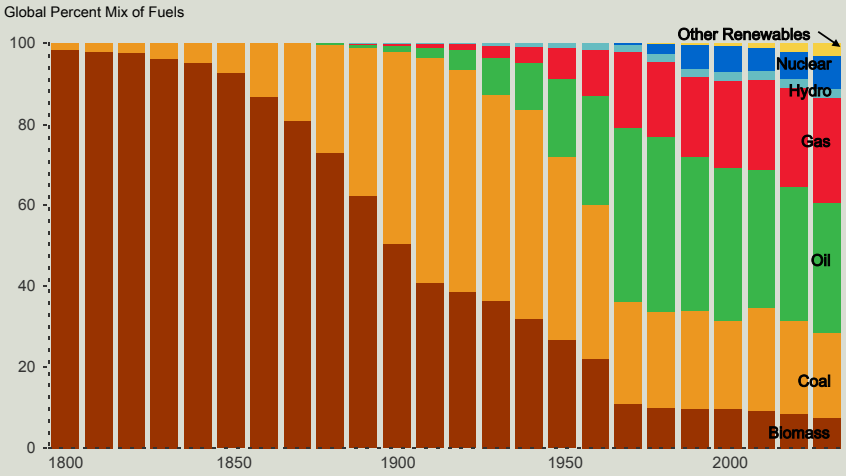
Many global issues increase uncertainty...

- Economic growth in key economies (China, Brazil, Russia, a.o.)
- Implementation and strength of climate policies
- Technology improvement rates (both supply and demand)
- Unrest in oil producing countries
- OPEC production
- Future of nuclear generating capacity

etc

Source: EIA, 2016

Long wavelength energy transitions



Source: Smil, *Energy Transitions*

Energy transitions are unpredictable and take time

International energy transition, no 'one size fit all'; various speed of change

Wind and solar energy are growing rapidly. Yet the world's reliance on fossil fuels isn't changing any time soon.