



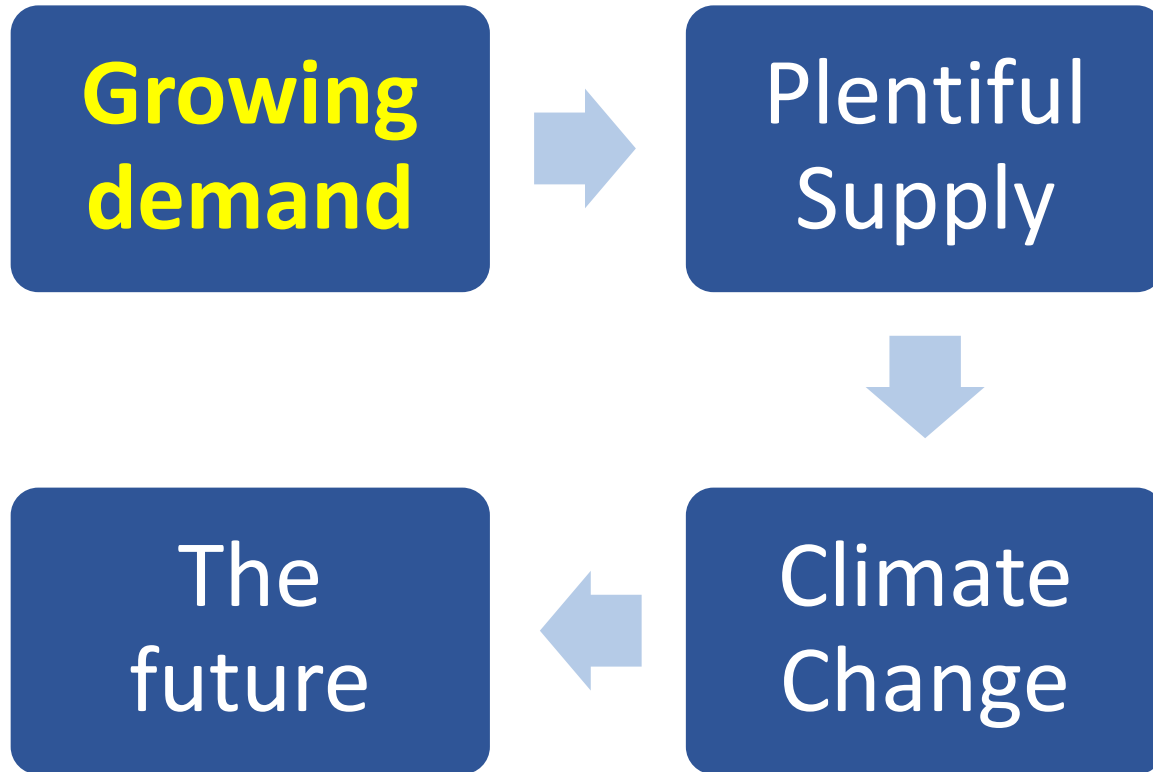
What does the future look like for the Oil & Gas and Energy sector

The Energy Transition

Ian Phillips

SPE Distinguished Lecturer

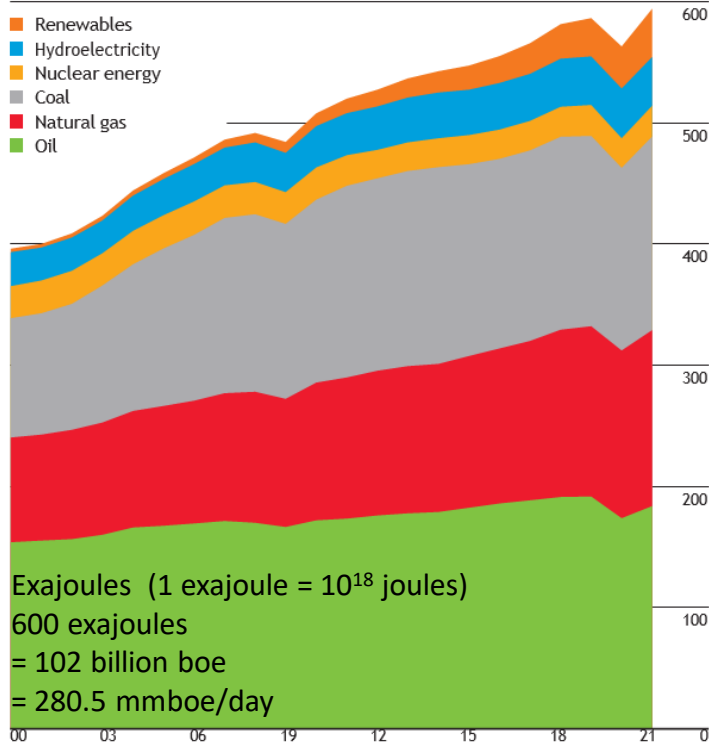
Outline



Growing demand

Global energy consumption

World consumption
Exajoules



BP Statistical Review of World Energy – 2022



Hydrocarbons = 78%

→ Down from 84.3%
in 2 years

→ Oil (29.3%)

→ Coal (25.4%)

→ Gas 23.3%

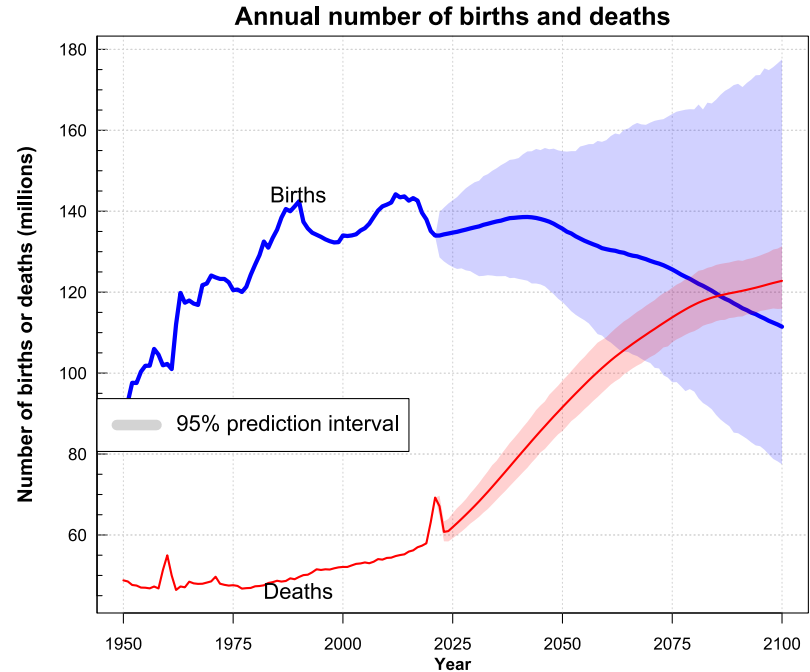
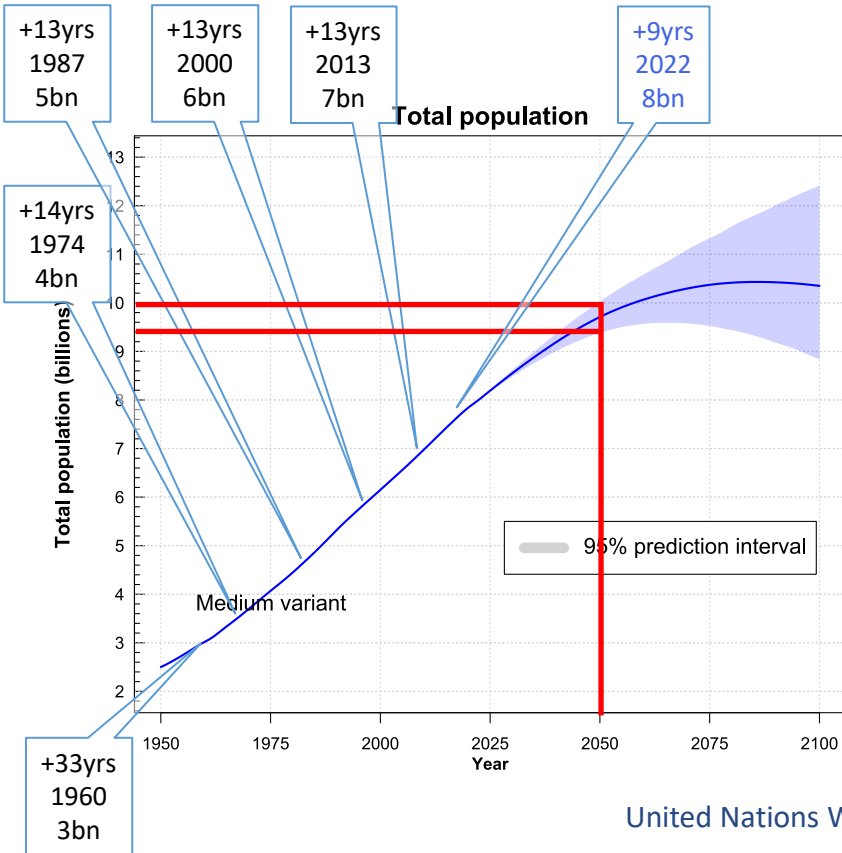
Nuclear = 4.3%

Hydro = 6.8%

Renewables = 6.7%

Growing demand

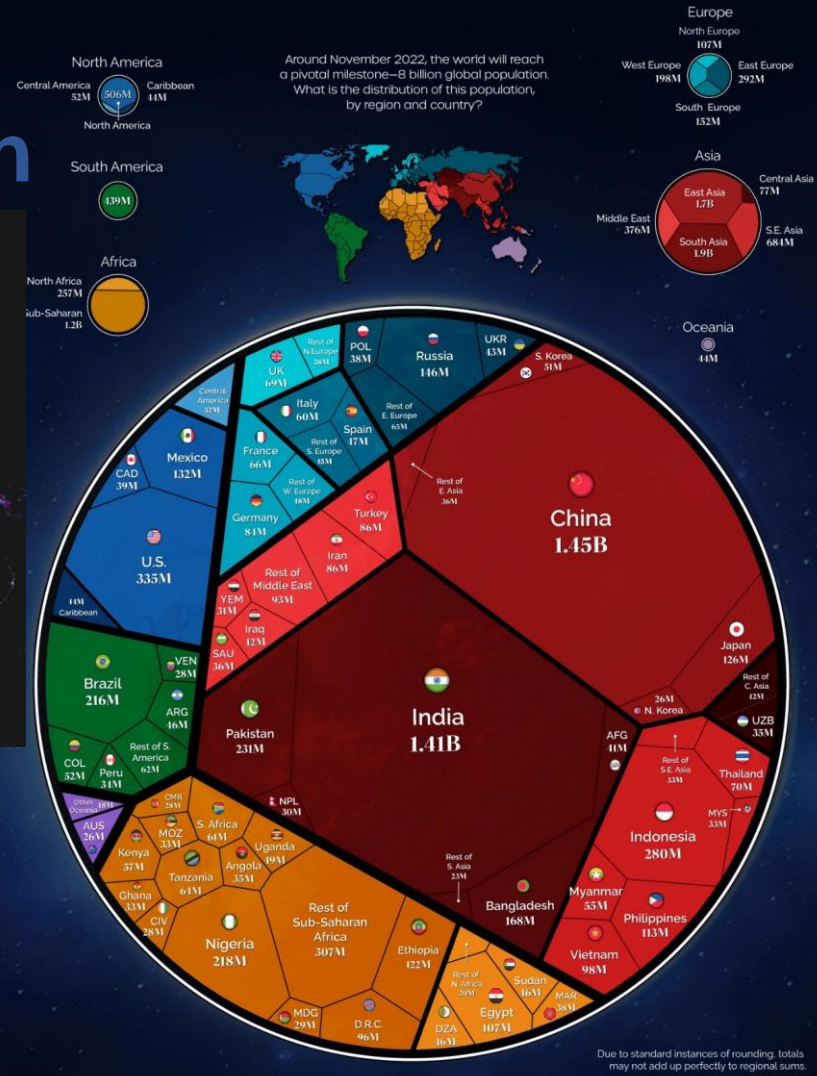
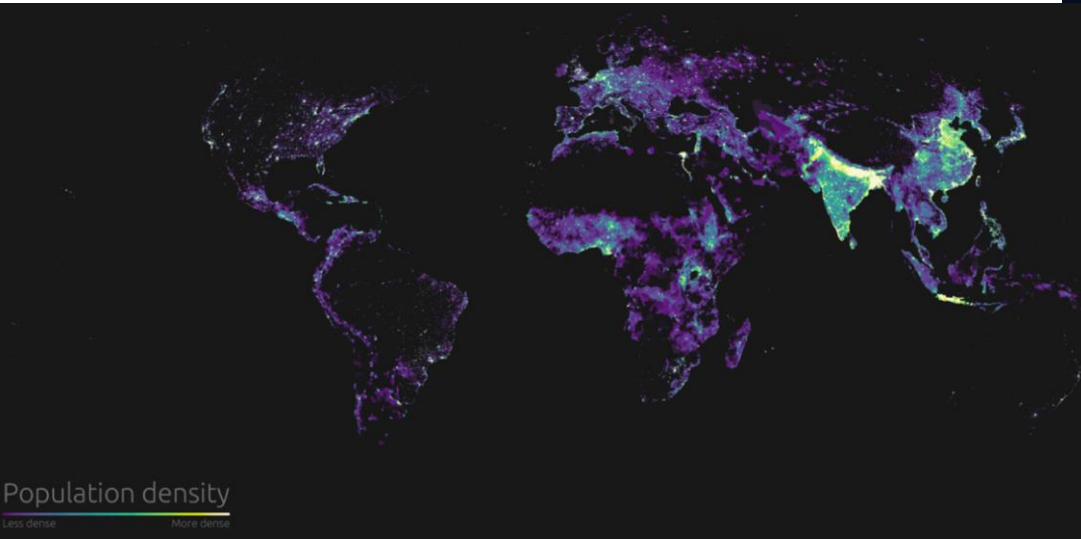
Global population continues to grow



United Nations World Population Prospects 2019

The demand for energy

8 Billion people on earth

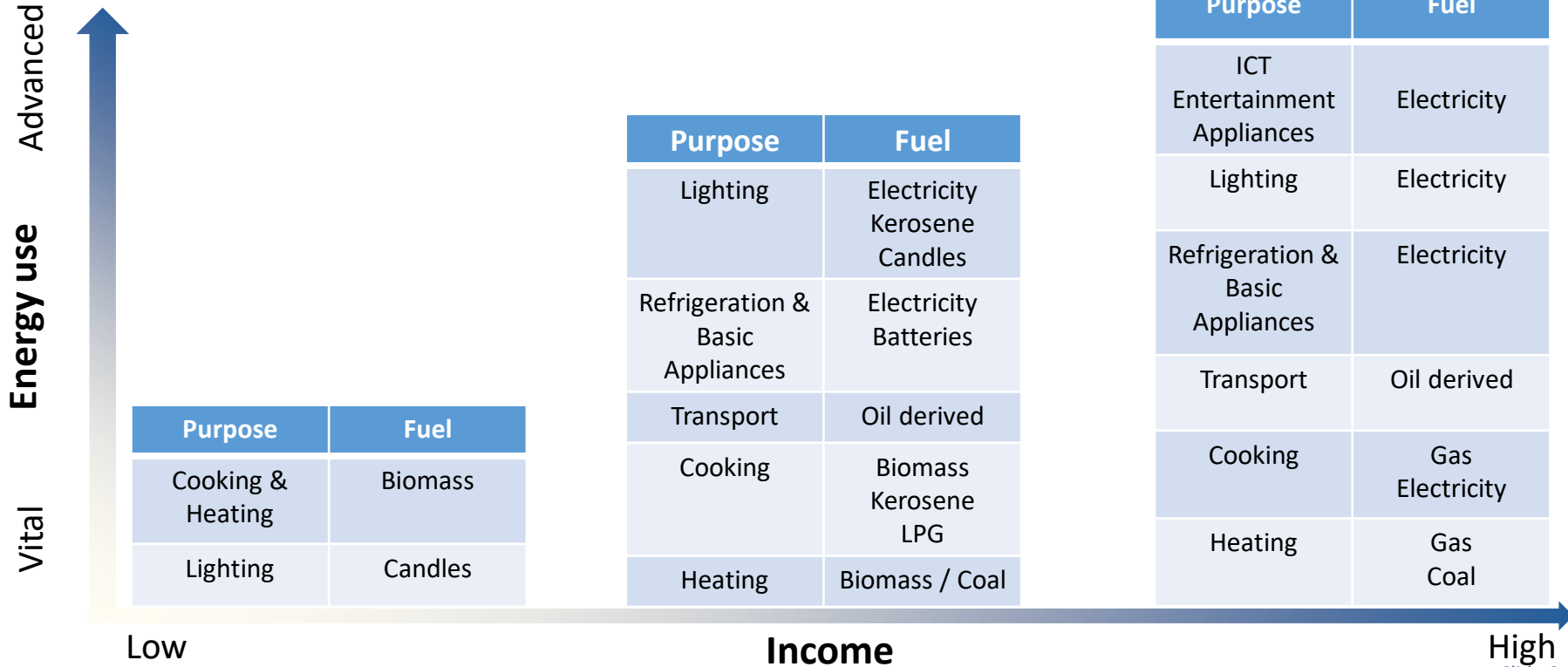


Growing Demand

People want to climb the Energy Ladder



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Growing demand

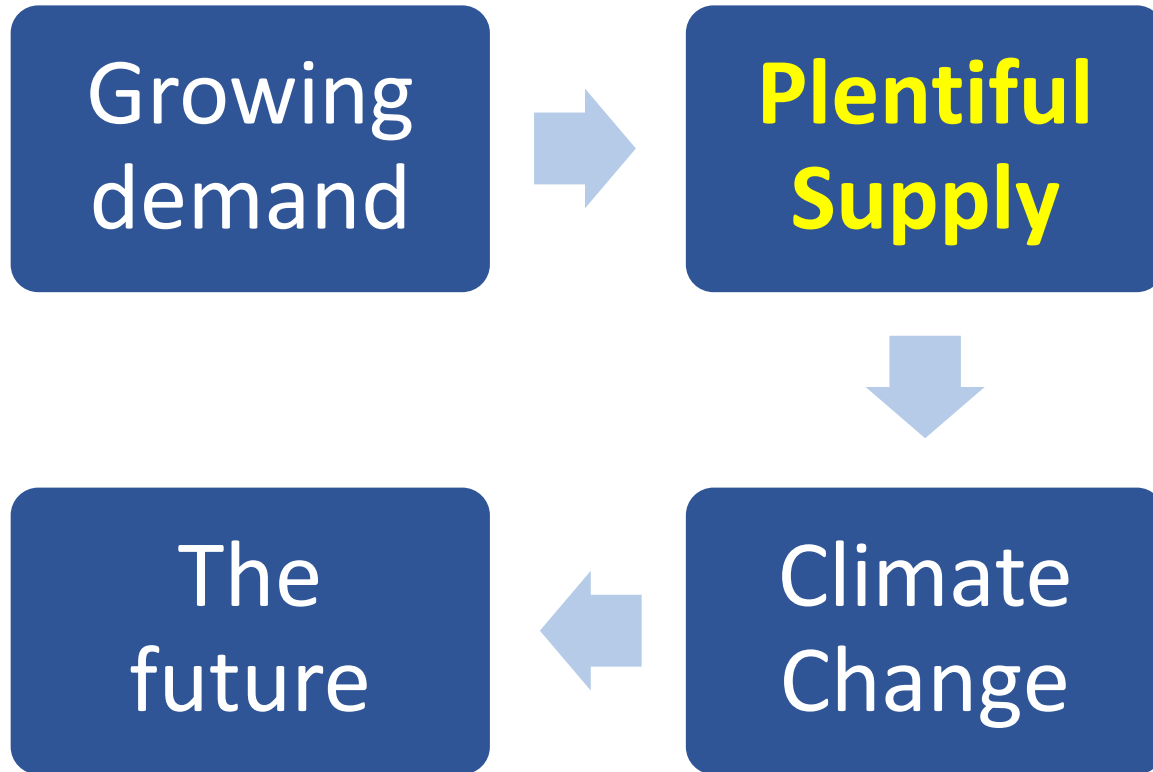
Demand continues to grow worldwide

(2018-2040)



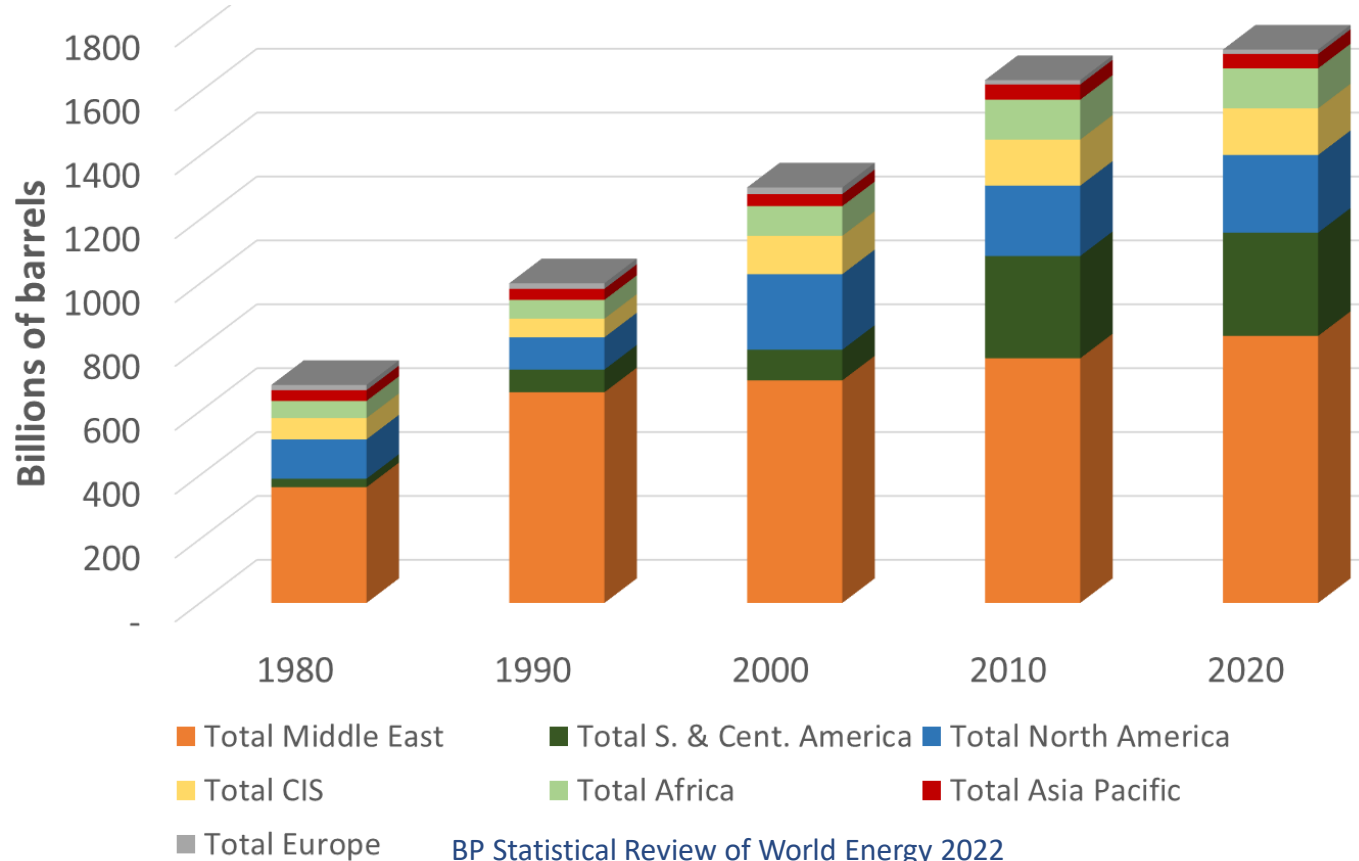
IEA 2018

Outline



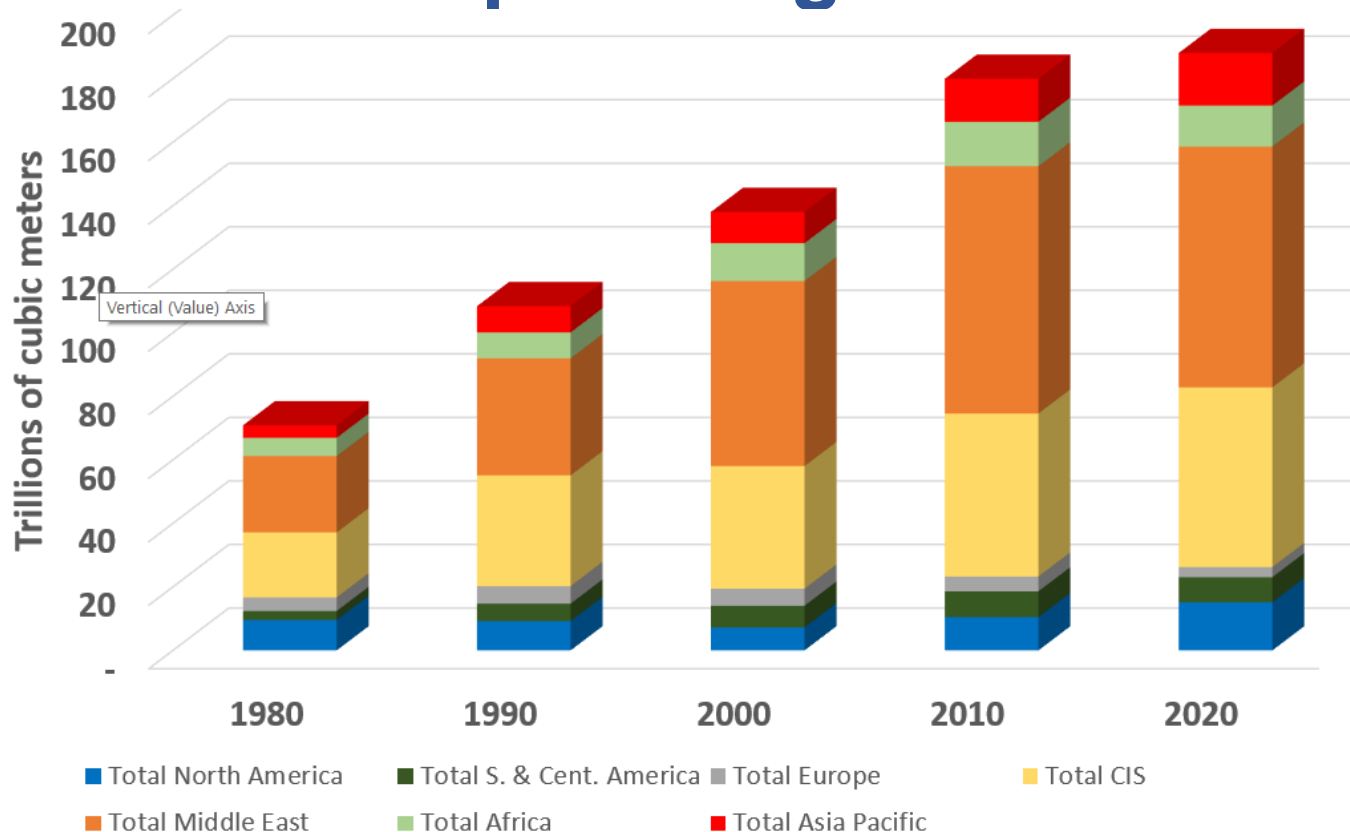
Plentiful supply

Distribution of proven oil reserves



Plentiful supply

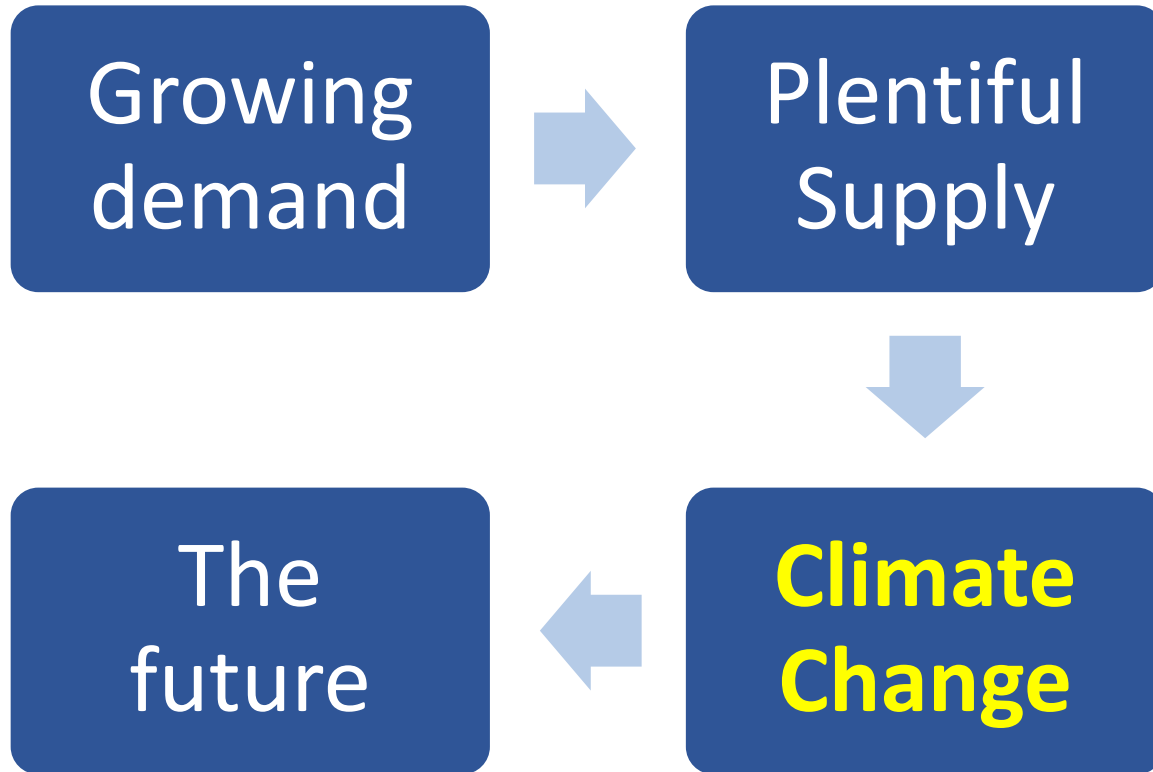
Distribution of proven gas reserves



Substantial new sources available

- Ultra-deep water – ~25 billion barrels
- High Pressure / High Temperature reservoirs - small
- Very Heavy Oils / Tar sands – ~3,800 billion barrels
- Shale Oil / Shale Gas - ~3,000 billion barrels x 2
- Bio-Fuels – small
- Carbon capture for EOR - ~2,000 billion barrels
- New frontiers - ~2,000 billion barrels
- New technology - ~2,000 billion barrels

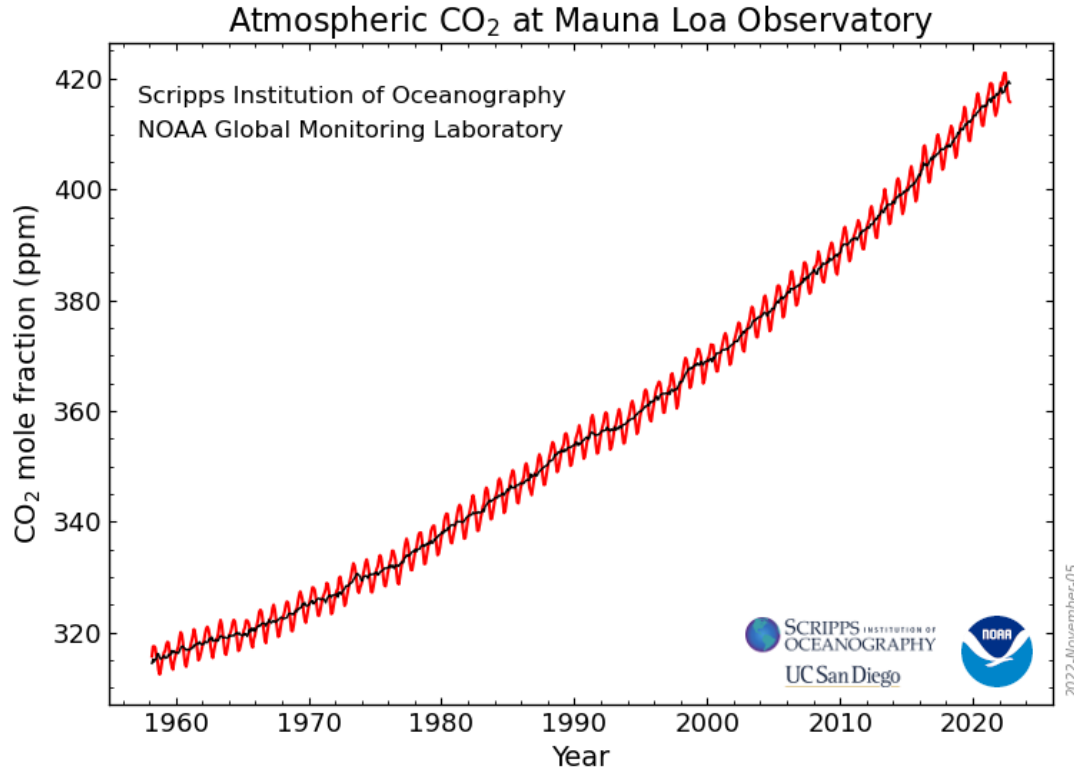
Outline



CO₂ concentrations rising

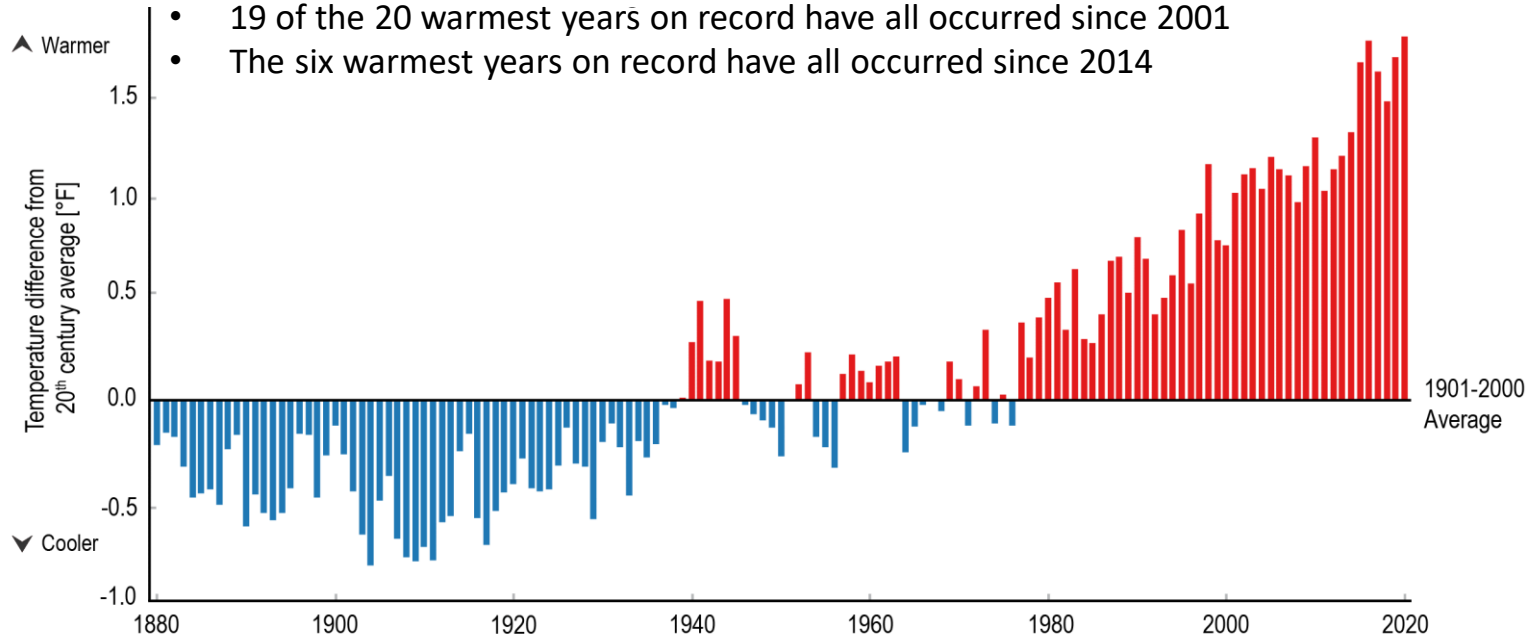


October 2022
415.78 ppm

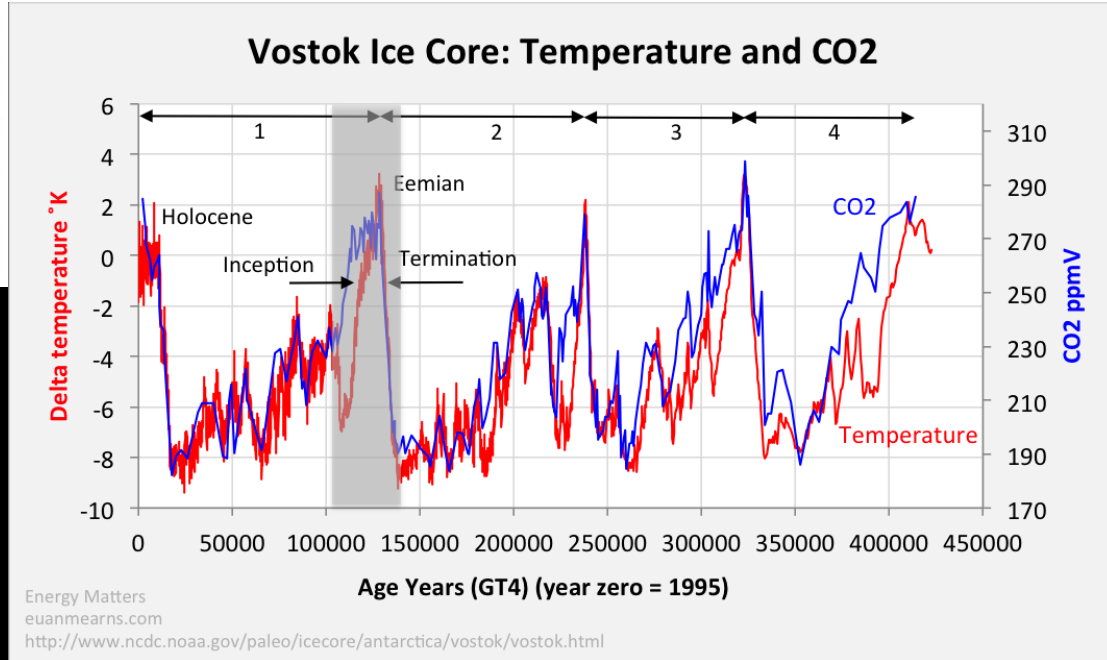
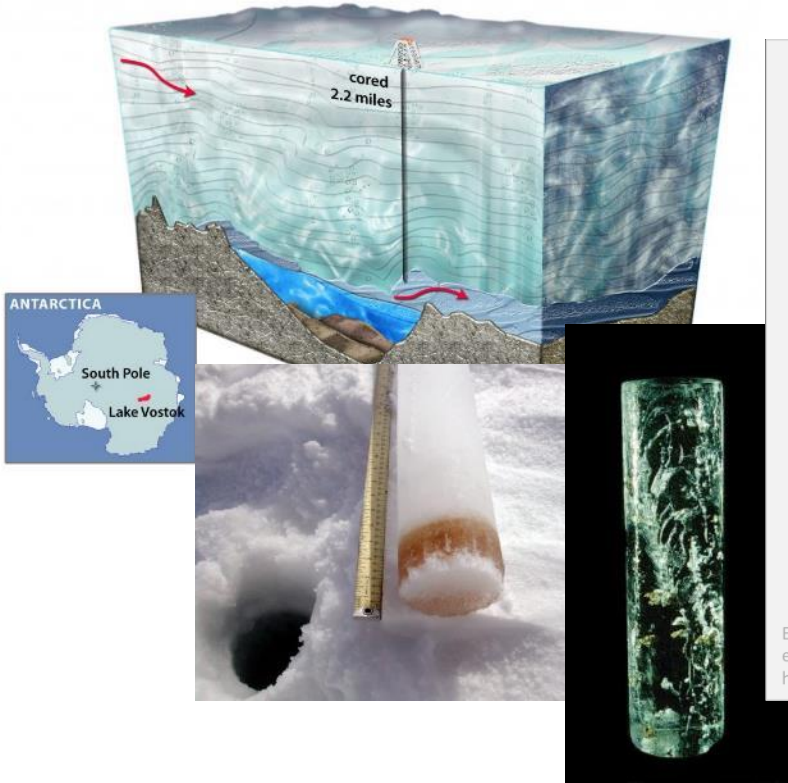


Global temperature rising

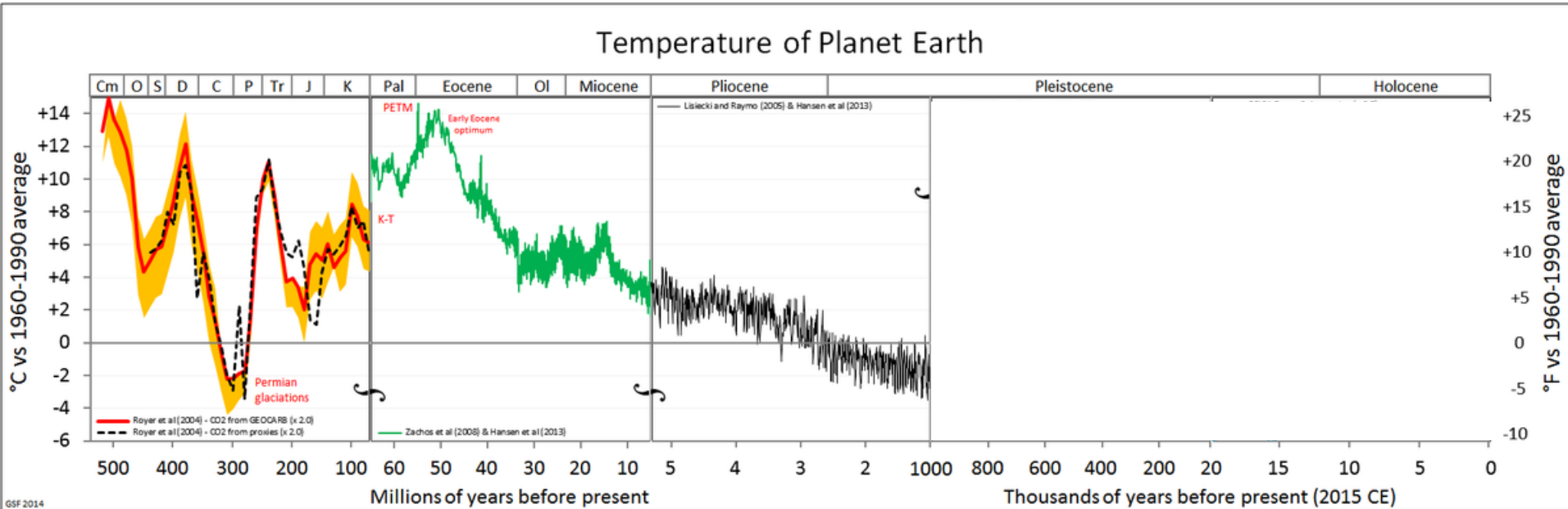
- Since 1901, the planet's surface has warmed by 0.7–0.9°C per century
- The rate of warming has nearly doubled since 1975 to 1.5–1.8°C per century
- 19 of the 20 warmest years on record have all occurred since 2001
- The six warmest years on record have all occurred since 2014



Linkage – CO₂ and temperature



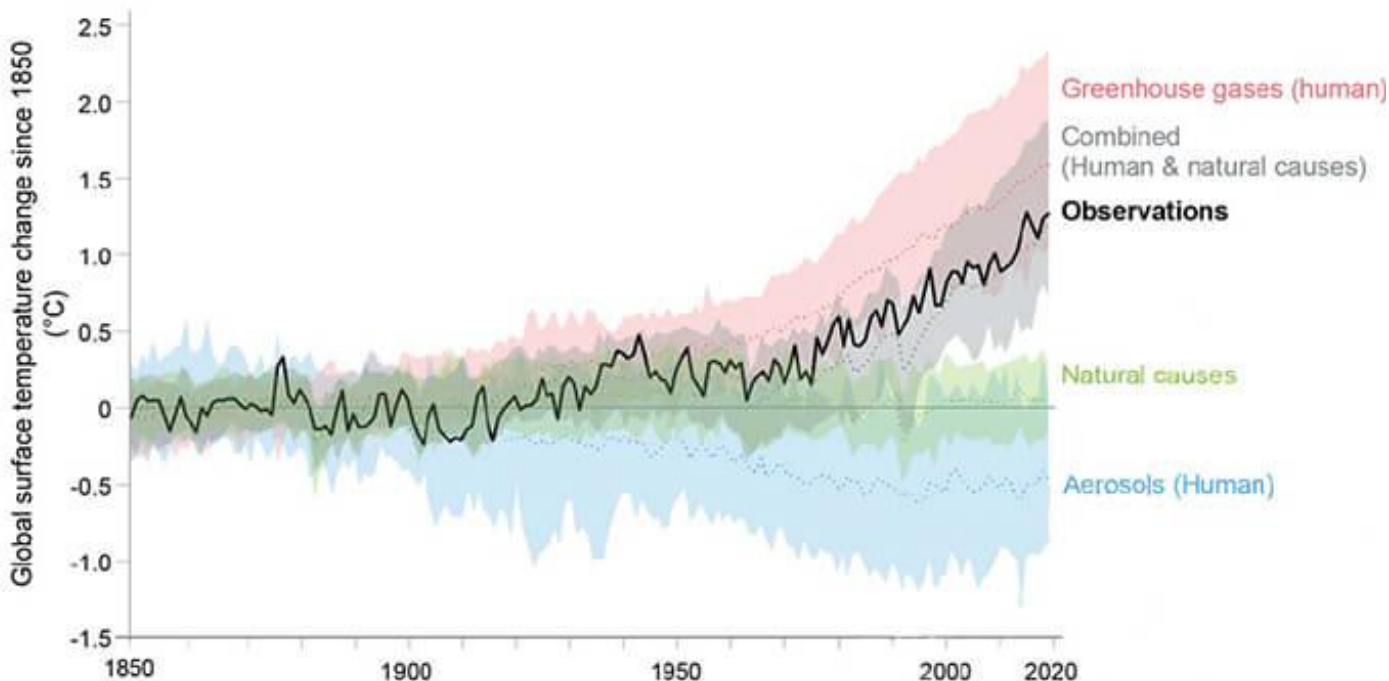
Temperature – the long view



Temperature – with and without us

How do we know humans are causing climate change?

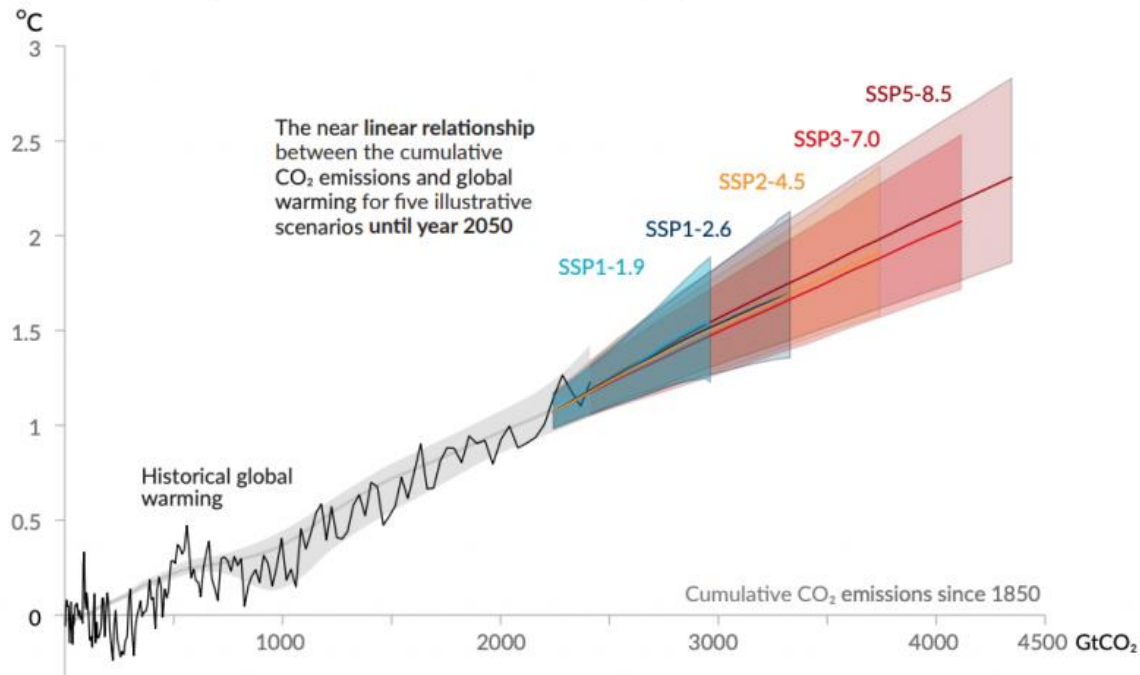
Observed warming (1850-2018) is only reproduced in simulations including human influence.



Projected range of temperature rise

Every tonne of CO₂ emissions adds to global warming

Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO₂ emissions (GtCO₂)

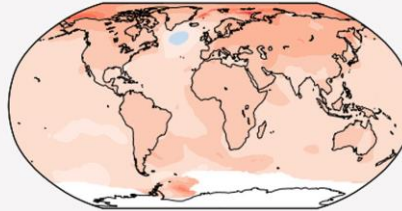


It's going to get a lot warmer

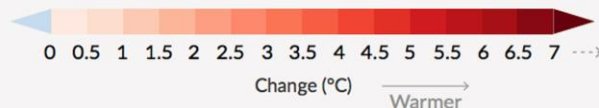
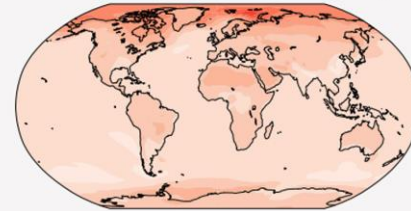
a) Annual mean temperature change (°C) at 1 °C global warming

Warming at 1 °C affects all continents and is generally larger over land than over the oceans in both observations and models. Across most regions, observed and simulated patterns are consistent.

Observed change per 1 °C global warming



Simulated change at 1 °C global warming

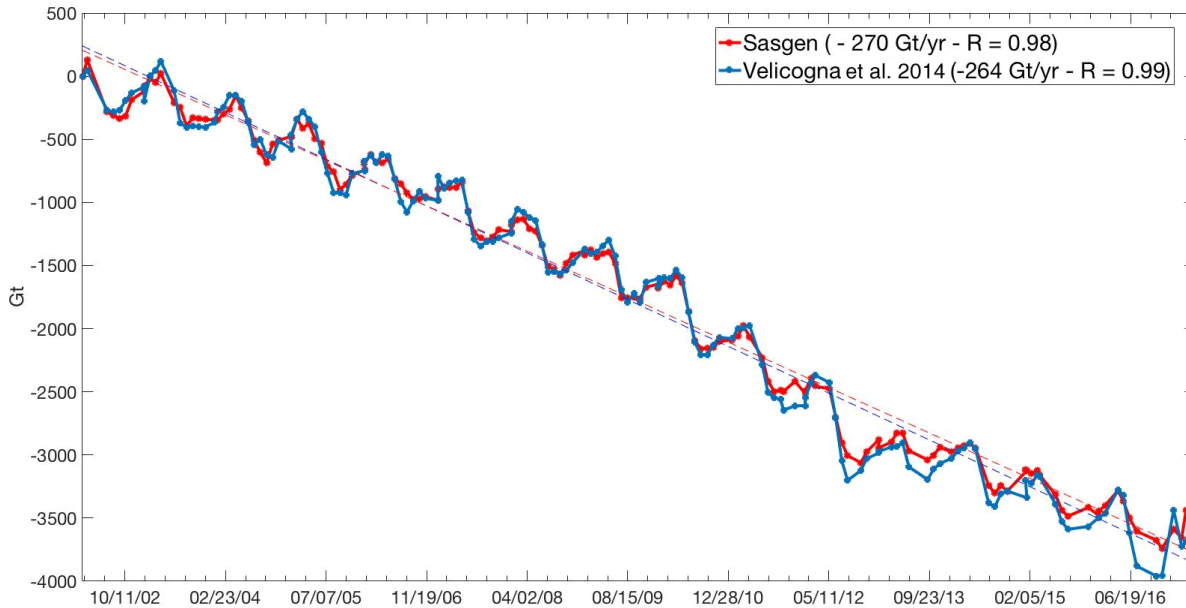


Climate Change

It's happening now !!

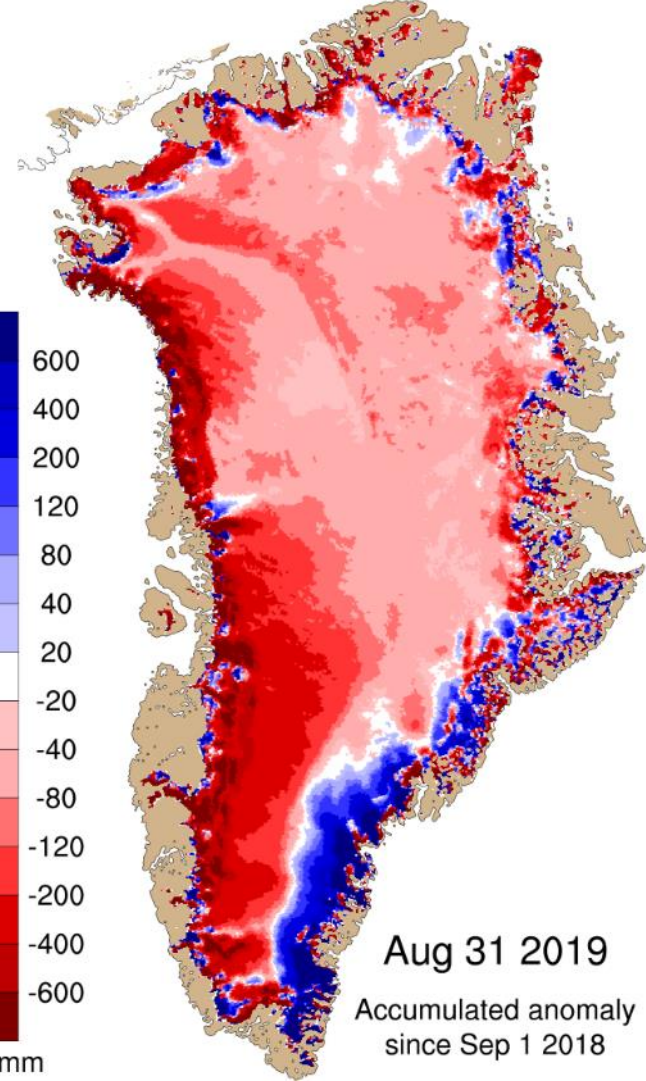
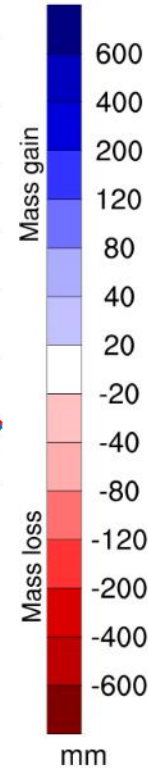


Climate Change It's happening now !!



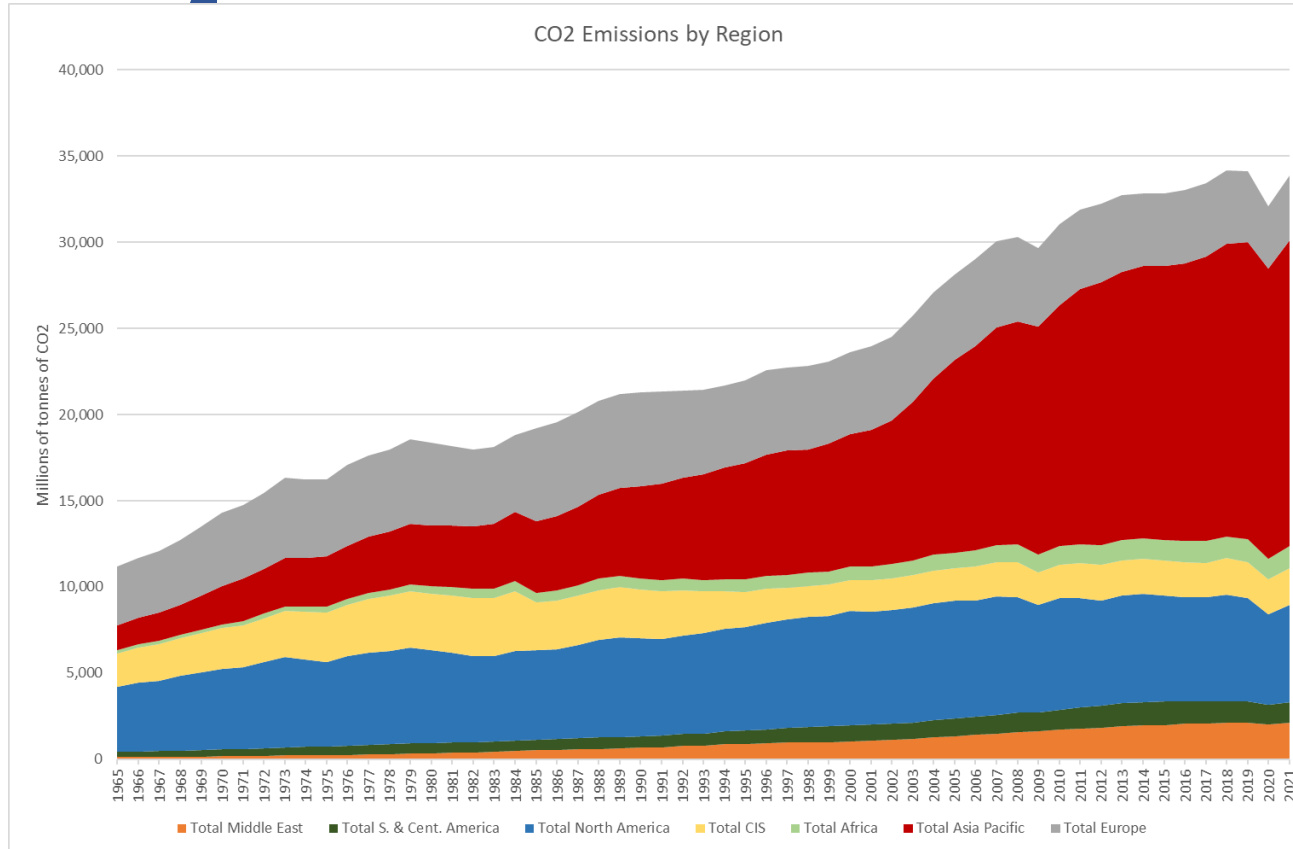
Loss of ice mass on Greenland

www.carbonbrief.org



The Global Energy System today

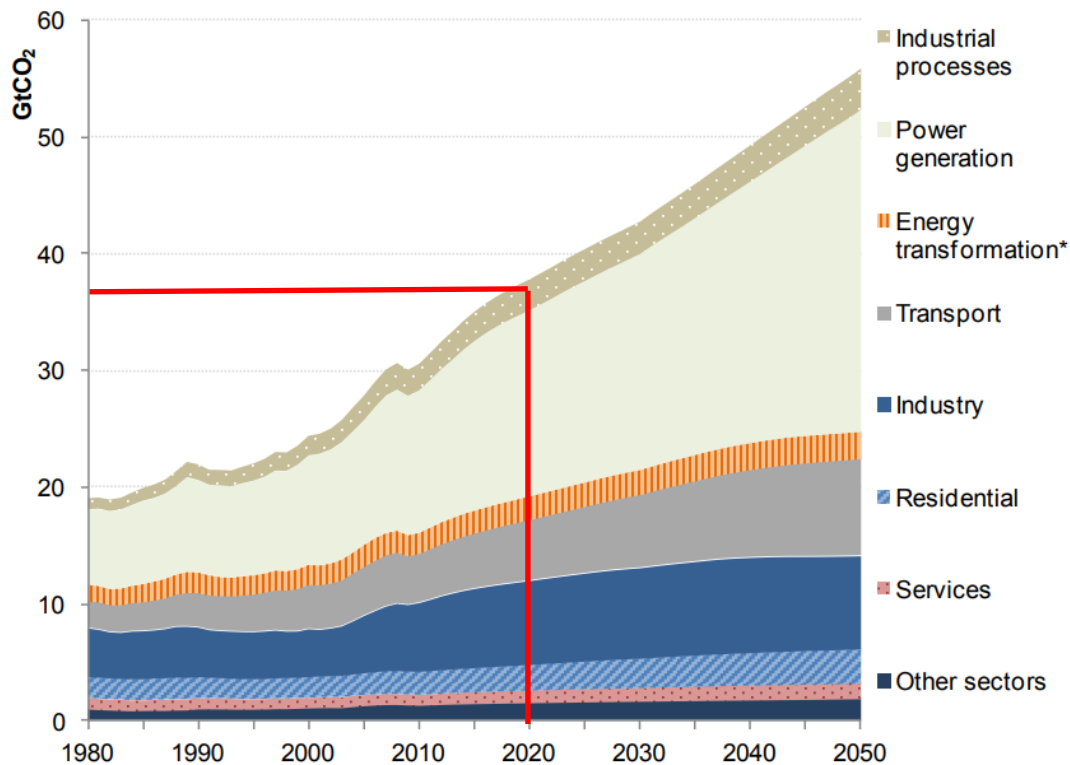
What CO₂ do we emit



Source – BP Statistical Review of World Energy – 2022

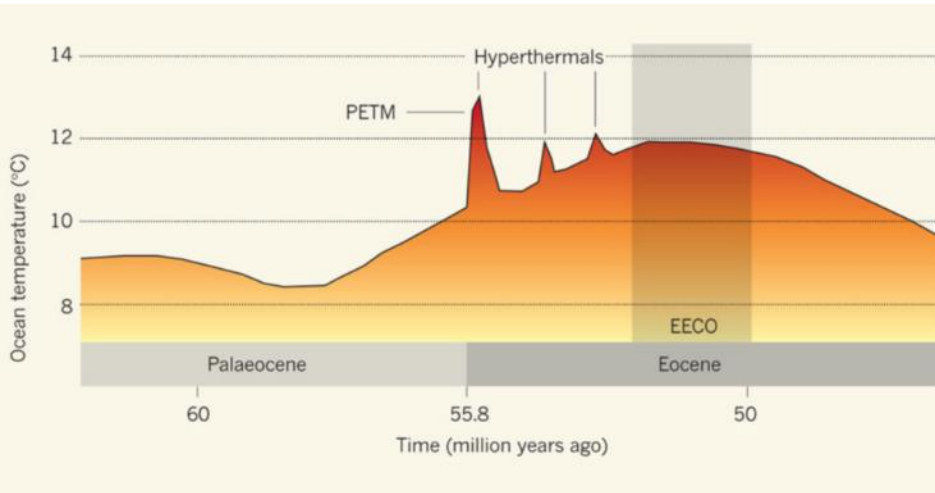
Growing demand

What CO₂ will we emit in the future



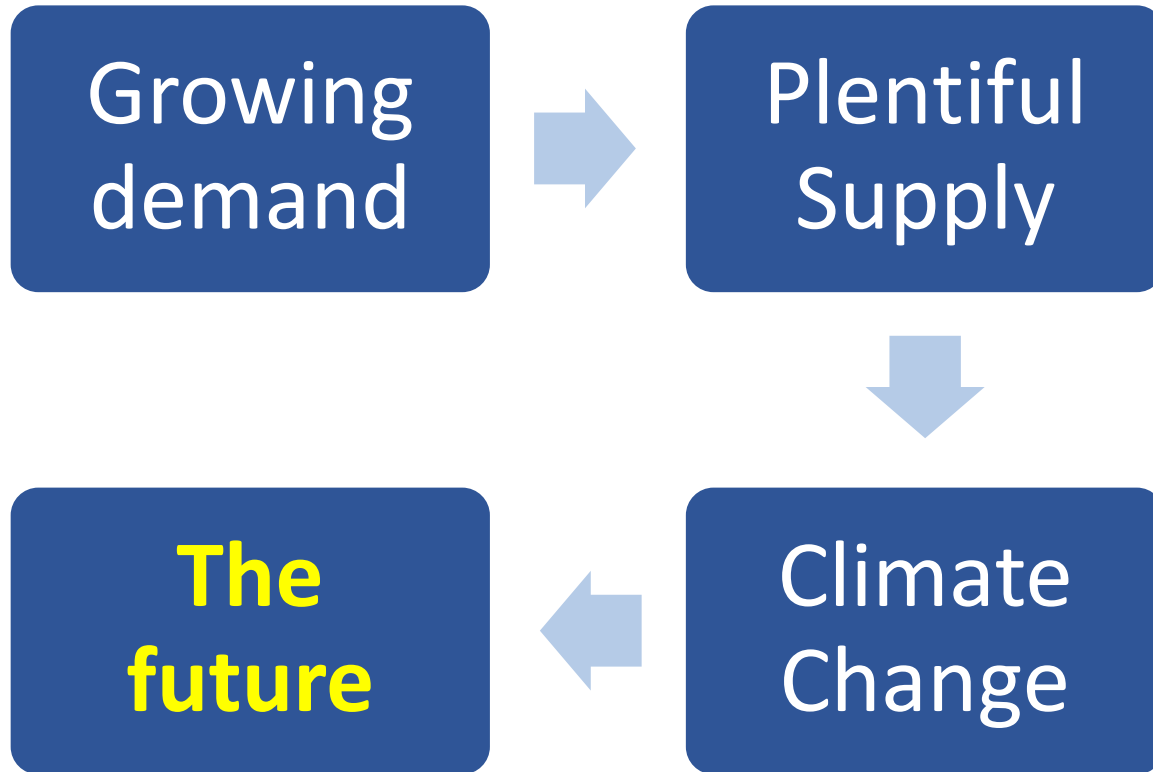
OECD Environmental Outlook to 2050

We've been here before – and it wasn't good



- Paleocene–Eocene Thermal Maximum (PETM)
 - 55 million years ago - lasted 2 million years
 - Massive release of greenhouse gas - CO₂ or methane - probably volcanic
 - ~5°C rise in temperature
 - rapid alterations of marine- and land-derived organic matter
 - storms lasting 1100 to 1400 years
 - 40-60% rate of extinction
- We are heading for 2-10°C rise in temperature

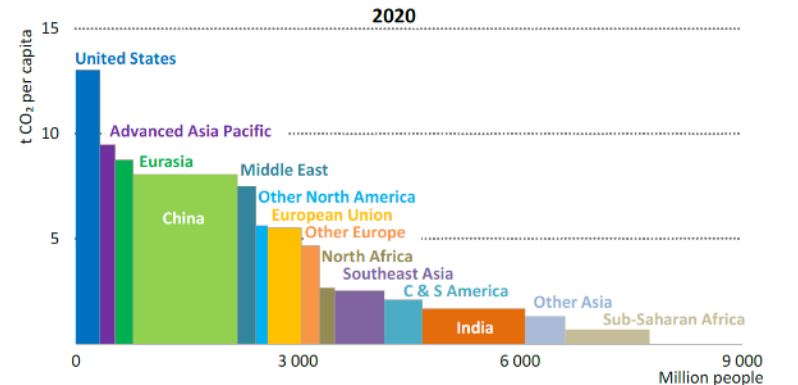
Outline



The Future

The political climate is changing

- Young people have a view
 - They blame the baby-boomers
- Extinction Rebellion hit a nerve
 - Global target – net zero by 2050
 - Chinese net zero by 2060
 - India net zero by 2070
 - Only 25-30 years from now
 - Major change will happen sooner
- A global phenomenon
 - 1 billion people doing most of the damage
 - In Europe / North America / Japan / Australia
 - China and India – outsourced emissions



Oil industry response

- Vision 2035 – net zero goals
 - Strong statement of intent by the UK and Norwegian industry
 - Decarbonise production
 - Offshore production ~3% of UK emissions
 - Decarbonise the product
 - Produce hydrogen
 - CC(U)S
- Not clear if those outside the oil industry believe us
 - Or some of those inside !!
 - Oil industry globally largely not bought in



The Future

Net Zero – Decarbonise production

- >80% of oil and gas emissions from gas turbines
 - Power and compression
 - Major initiatives in floating wind and power from shore



The Future

Energy is changing - wind



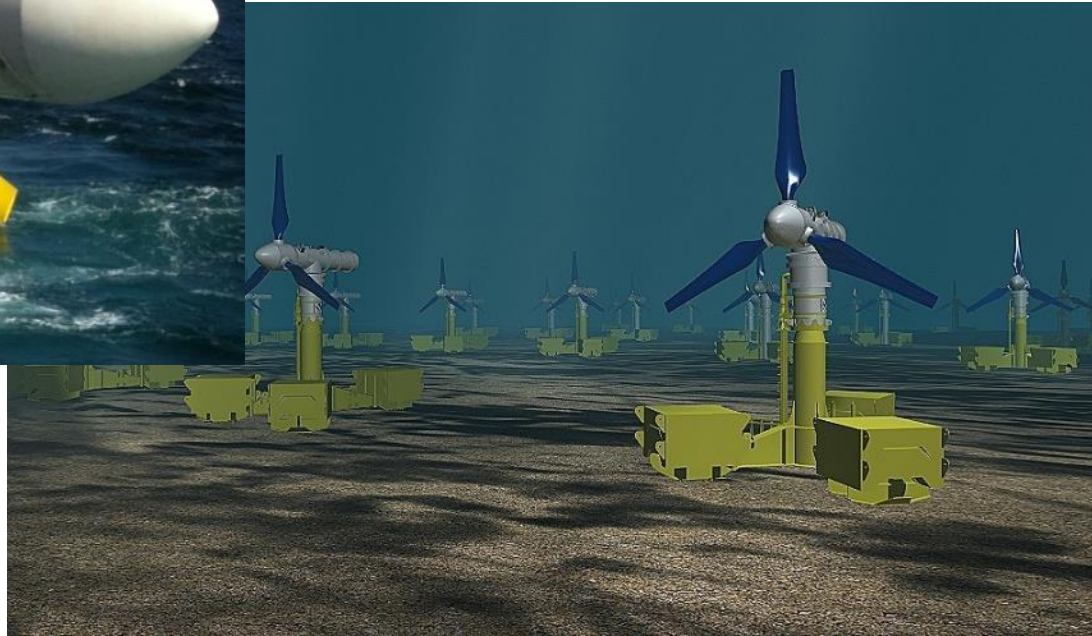
The Future

Energy is changing - solar



The Future

Energy is changing - tidal

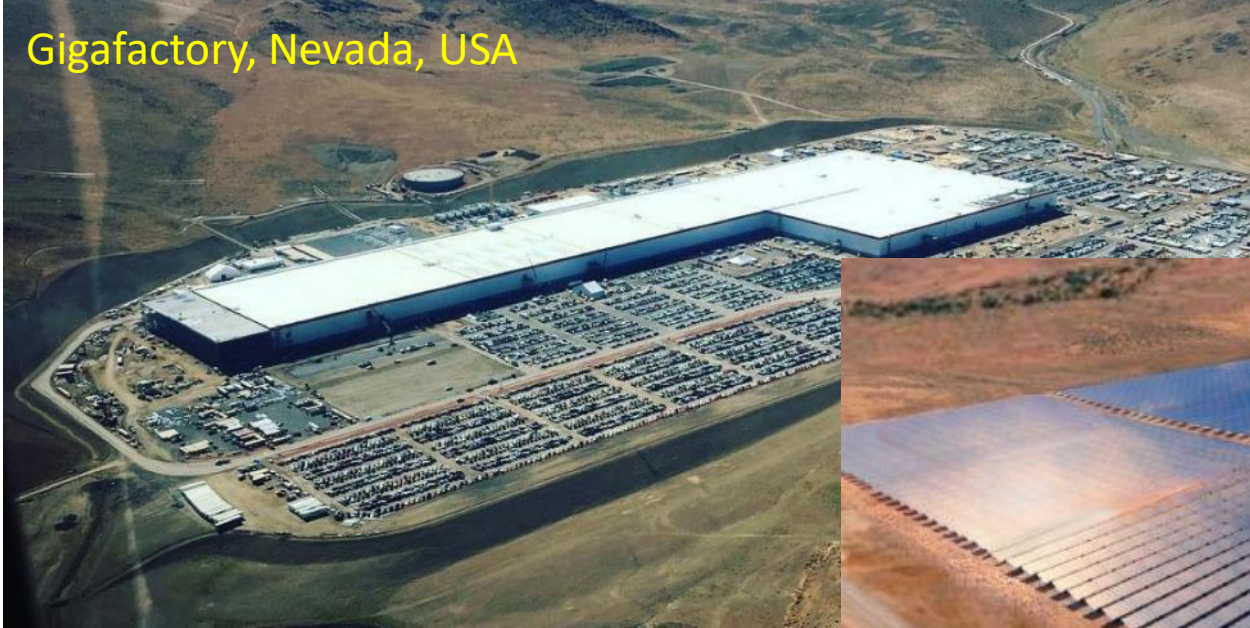


The Future

Energy is changing - storage



Gigafactory, Nevada, USA



Riverland Solar Storage – South Australia
330 MW solar farm linked to a
100 MW/400 MWh battery installation

The Future

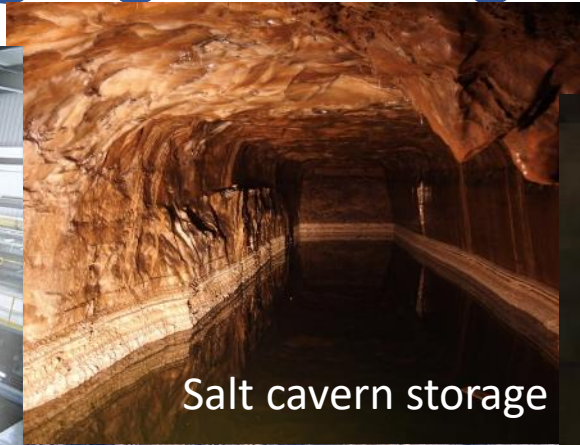
Energy is changing – storage



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Electrolysers



Salt cavern storage



Thermal storage



Tesla PowerWall



Pumped Storage

The Future

Energy is changing – road transport


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The Future

Energy is changing – rail transport

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The Future

Energy is changing – aeroplanes



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Solar Impulse 2

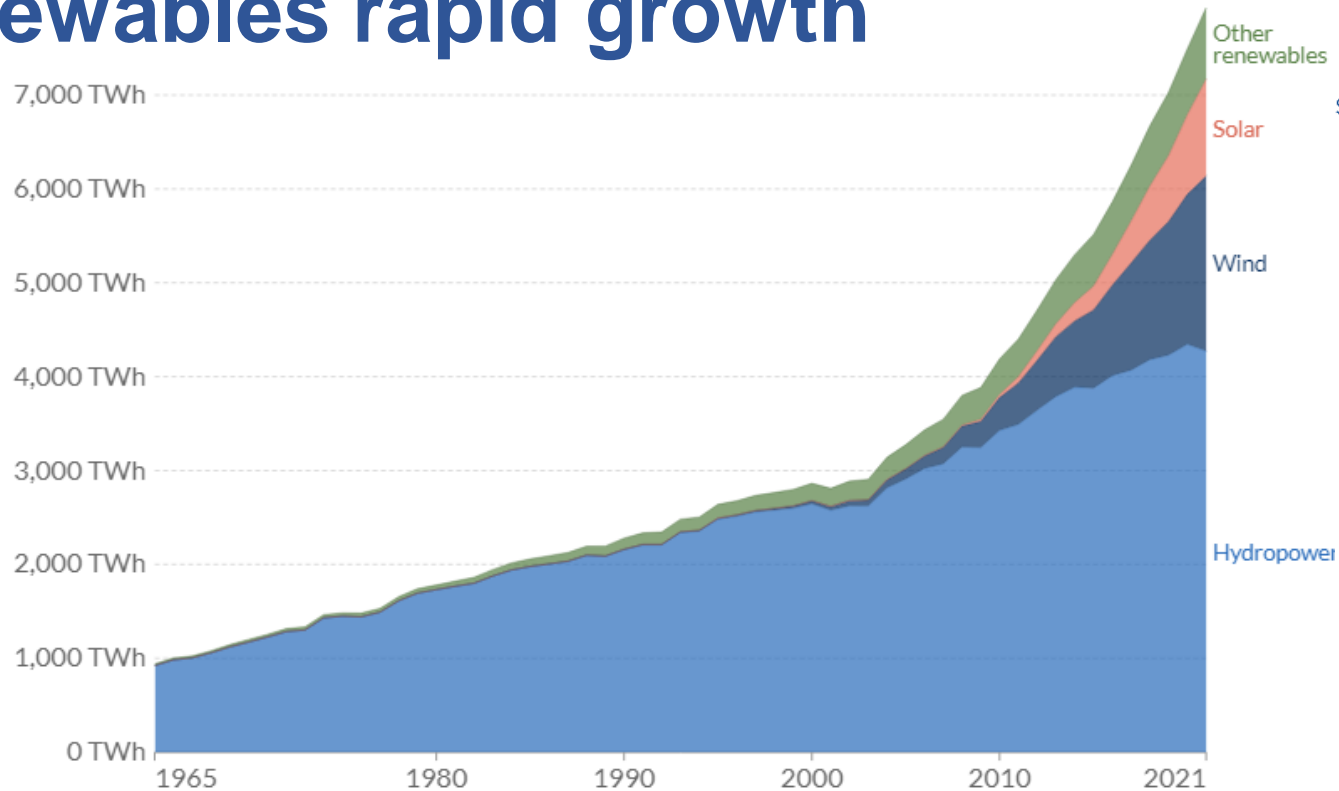
The Future

Energy is changing – transport



The Future

Renewables rapid growth



Source: BP Statistical Review of Global Energy

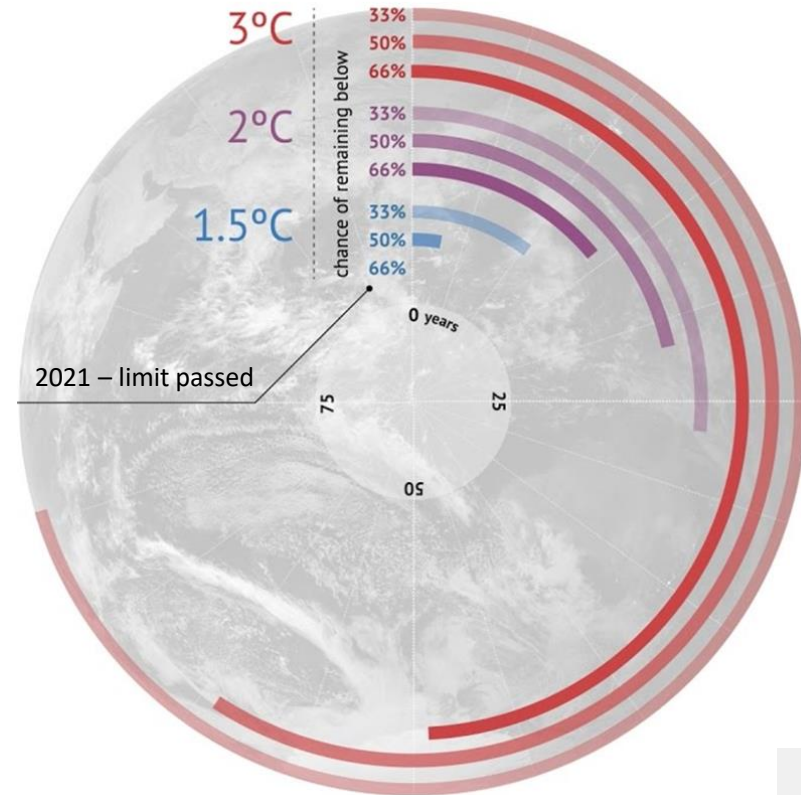
OurWorldInData.org/renewable-energy • C

Note: 'Other renewables' refers to renewable sources including geothermal, biomass, waste, wave and tidal. Traditional biomass is not included.

Carbon budget – 20-40 years

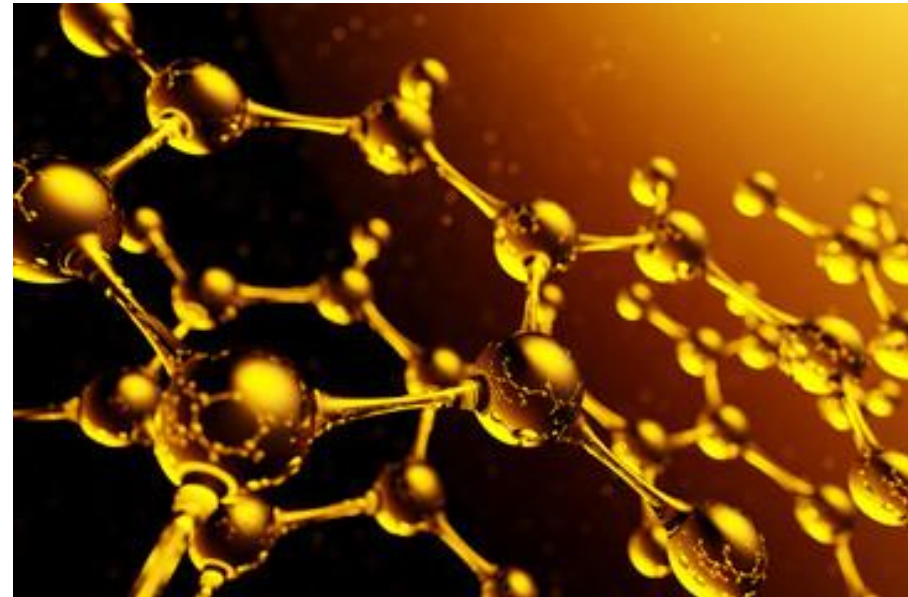


- 2021 emissions
 - 36.3Gt due to fuel use
 - +7 Gt due to agriculture and land use
- We have access to 2795 Gt of CO₂ from in current proven reserves
 - Worth ~US\$27 trillion @\$50 / bbl
 - Need to leave 80% in the ground to avoid exceeding 2°C – writing \$20 trillion off !!
 - Or we need to avoid the emissions



Decarbonising oil and gas

- Oil and gas and coal provides ~80% of the worlds energy
 - and we know where it is
- We can split the hydrocarbon molecule
 - Hydrogen – for use as a fuel
 - Carbon
 - Lots of it
 - Disposal - In the reservoir? On land?
- Technology
 - Steam methane reformation (proven)
 - Carbon catalyst (early stage technology)
 - Biotechnology (early stage technology)



The Future – my opinion

A complex technological and political balancing act



- We are ruining our planet
 - By burning hydrocarbon in every aspect of our civilisation
 - If we don't do something the planet we live on will change dramatically
- Something has to change
 - Make hydrocarbons low carbon
 - Low carbon alternatives
- The public isn't connecting
 - They understand climate change
 - They want life to go on as we know it



The Future – my opinion Things will change



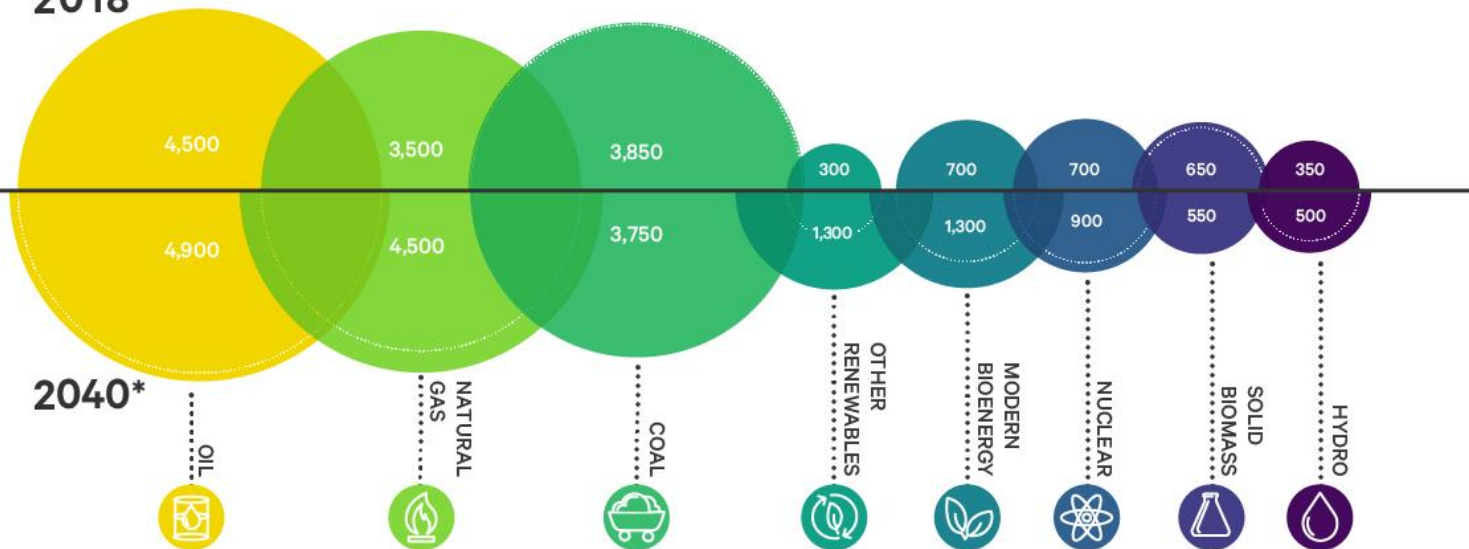
The solution will be a mix of things

- Decarbonised electricity production
 - Wind; Wave; Solar; Hydrogen; Energy storage
- Decarbonised heat
 - Electricity; Hydrogen; Energy storage; Natural gas phased out
- Decarbonise transport
 - Batteries; Hydrogen & Fuel cells
- Use less energy
 - Energy efficiency – insulation; improved technology; less use
 - Major change in lifestyle – travel; food sources; packaging

Could do (a whole lot) better

Changes in the Global Energy Mix

2018



*Based on Stated Policies Scenario

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The Energy Transition

Questions and Answers and Discussion

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