History greenhouse gas

- importance CO2 as greenhouse gas recognized in ’50’s
- significant change in CO2 concentration due to anthropogenic emission
- increase of 50% in CO2
- need to achieve low-carbon energy transition

1. understanding atmosphere can not be taken for granted
2. realize consequences of cheap fossil fuels
3. need to avoid effects man-made climate change

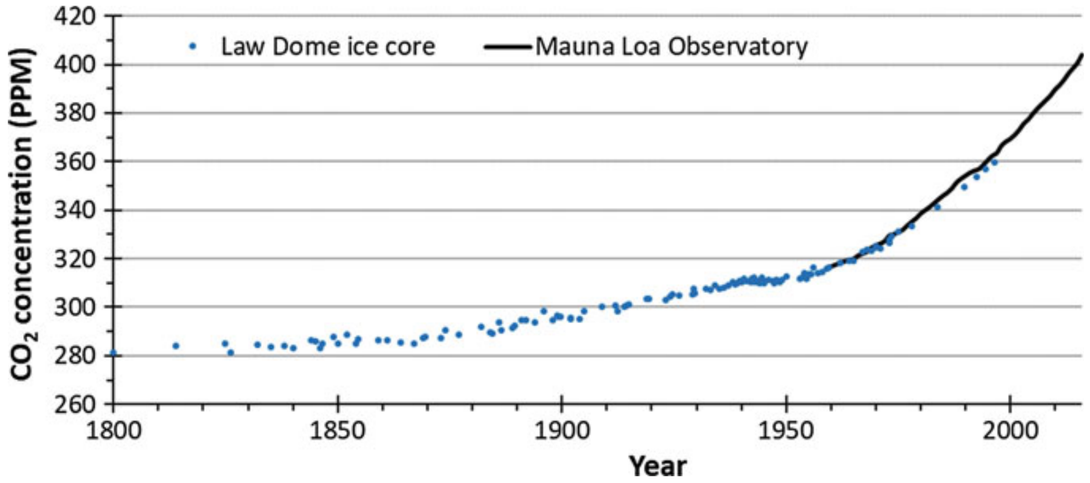
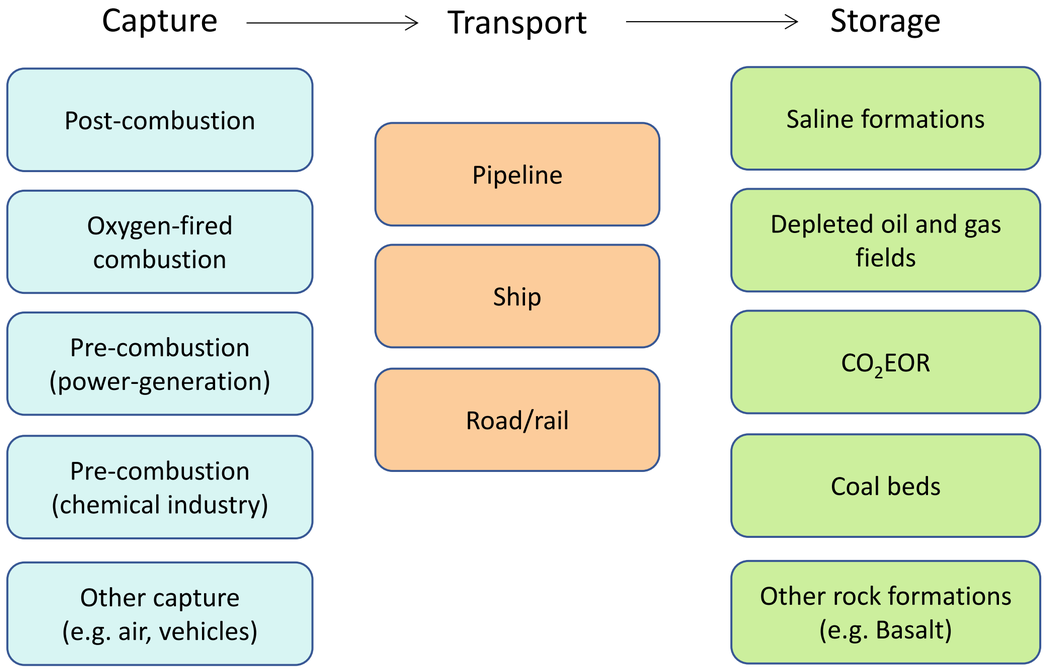


Fig. 1.2 Mean annual CO_2 concentration in the atmosphere from two sources: The Law Dome ice-core dataset (Etheridge et al. 1996; MacFarling Meure et al. 2006); Mauna Loa Observatory measurements from the Earth System Research Laboratory. *Source* www.esrl.noaa.gov/gmd/ccgg/trends/data.html

Why CCS?

- can’t stop using fossil fuels over night
- renewable energy needed for long-term near net-zero
- 80% current energy is from fossil
- renewable energy is intermittent
- need pragmatic approach
  1. improved efficiency
  2. new renewables
  3. switch from coal to natural gas
  4. add nuclear to the mix
  5. deploy CCS



Arguments why CCS is vital

- reduce CO2 power generation & industry
- faster energy transition
- need 10X increase by 2030 compared to current plans to meet Paris agreement

Needs to isolate CO2 from atmosphere for few thousand years

Permanent storage difficult to ensure