

Carbon Neutral: Leading the Way to Net Zero Greenhouse Gas Emissions

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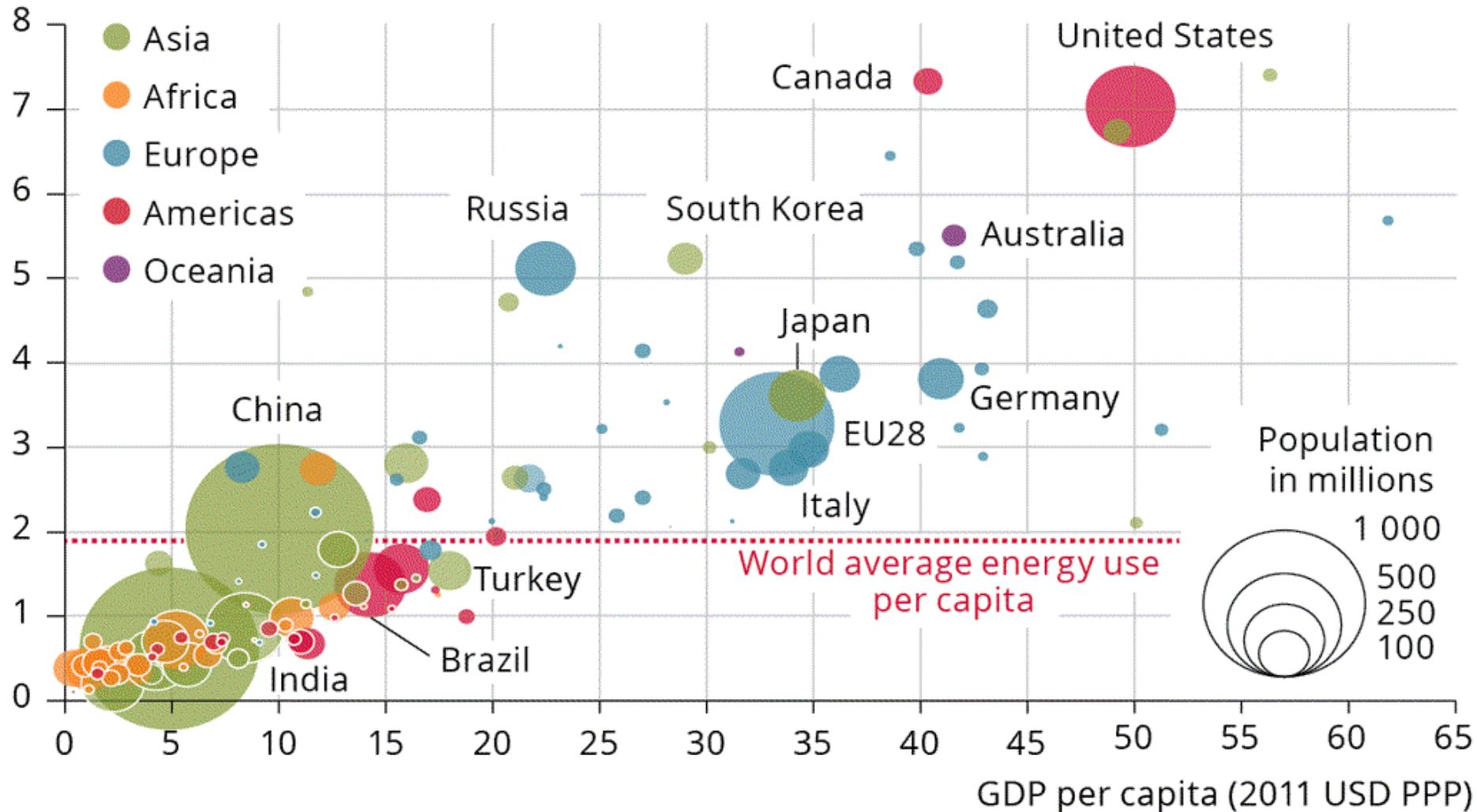
Norwegian Consulate General
Houston



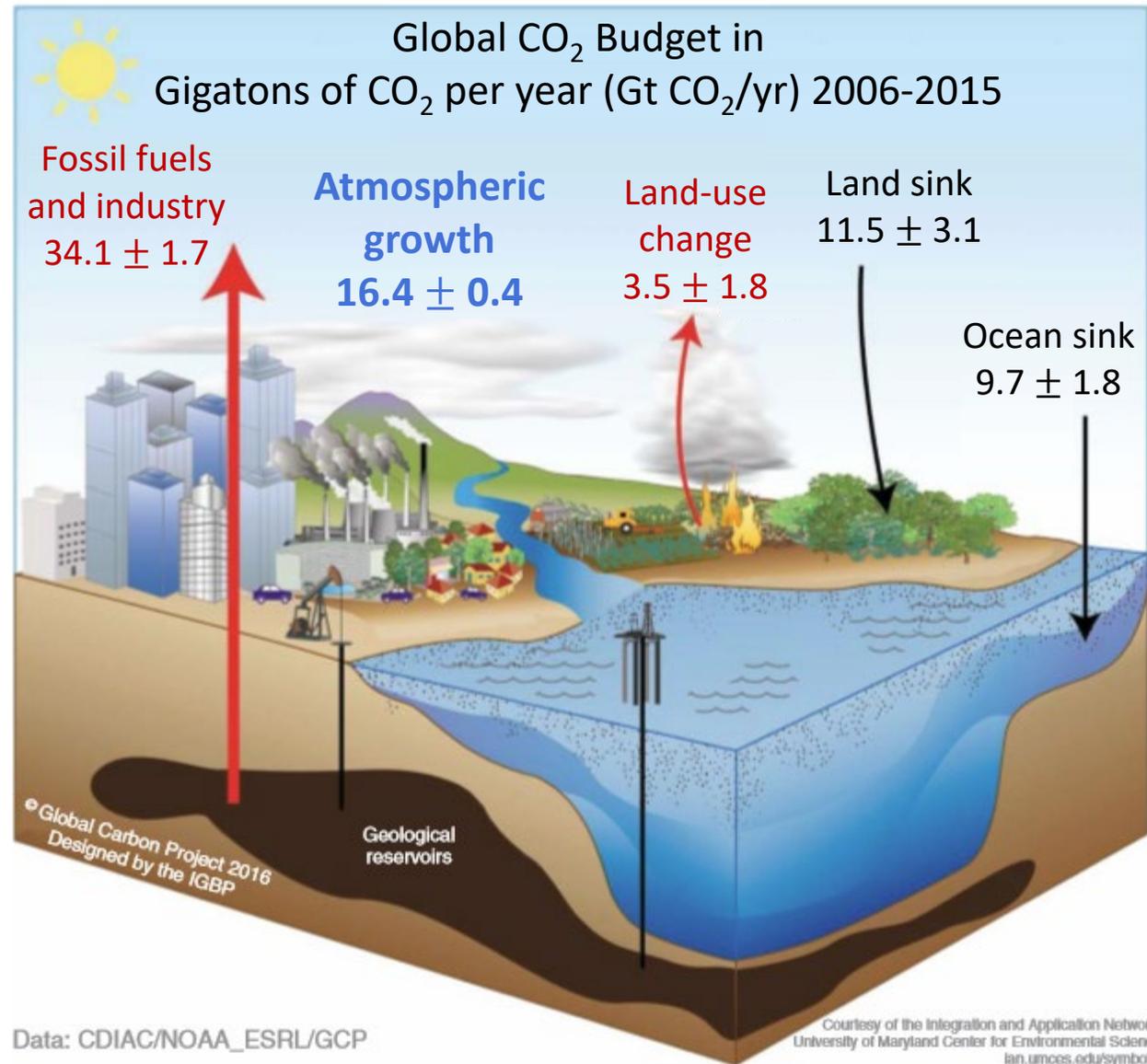
Norwegian Ministry
of Petroleum and Energy

Correlation of Energy Consumption and Gross Domestic Product (GDP) Per Person

Energy use in tonnes of oil equivalent per capita



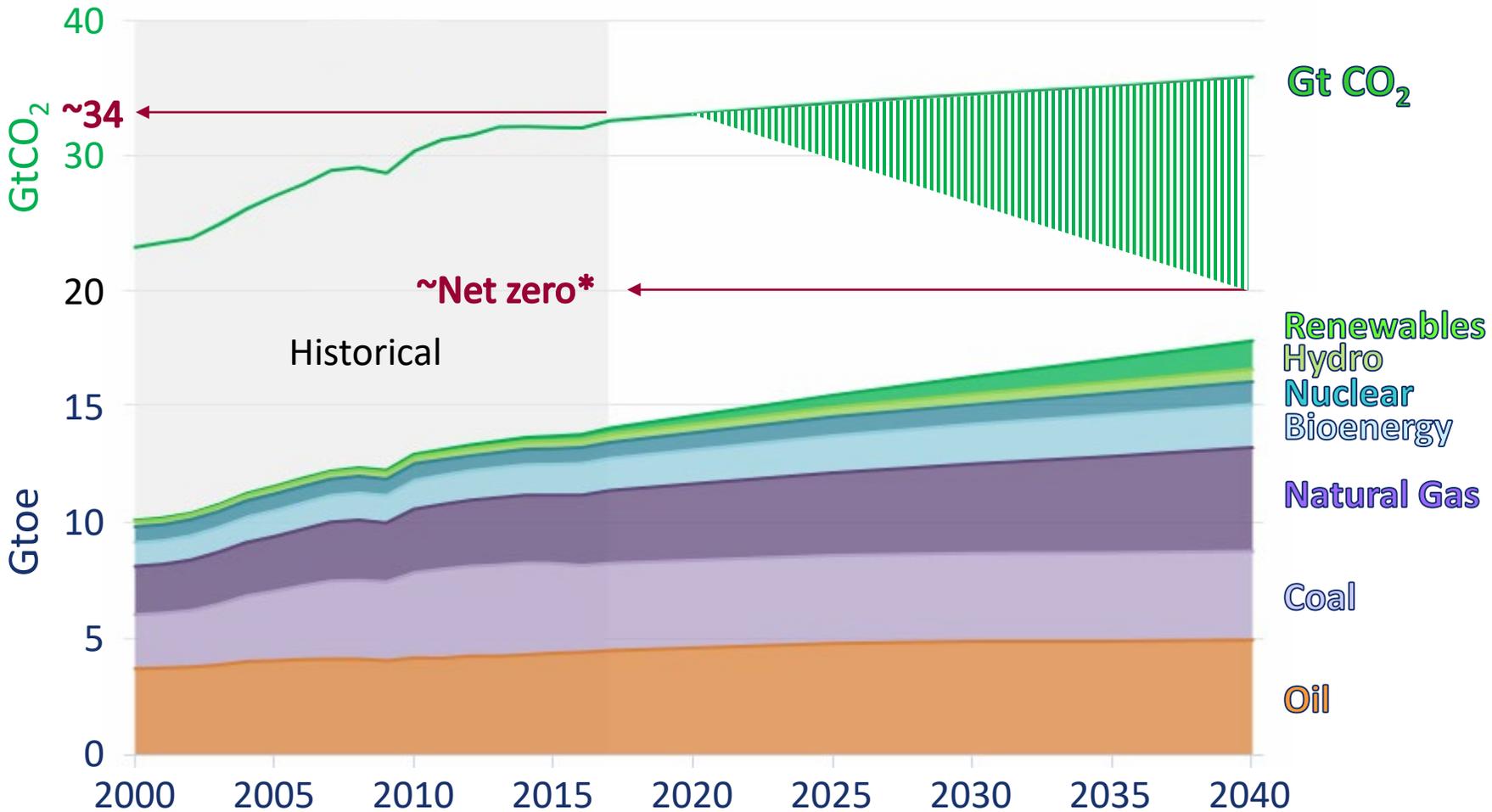
Anthropogenic Impacts on Global Carbon Cycle



Hypotheses

- There is a market for zero carbon fuel.
- The petroleum industry can leverage free market forces to achieve net zero GHG emissions at minimum cost to consumers.
- Industry leadership can
 - Leapfrog government policies
 - Apply transformative technology as needed
 - Ensure energy security for the long term

Size of the Prize

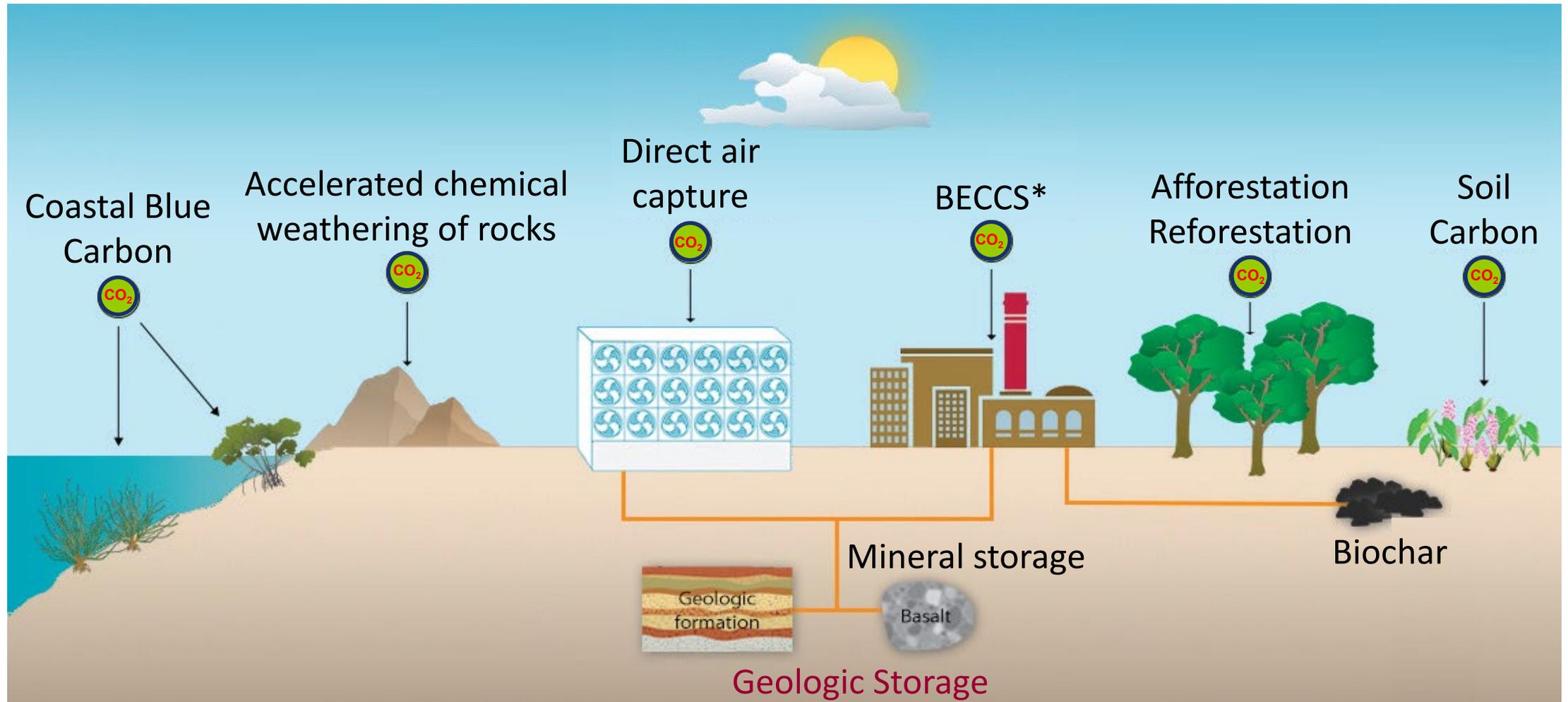


*with global sink ~20 GtCO₂/yr

IEA World Energy Outlook 2018



Negative Emissions Technologies (NETs)



*Biomass energy with carbon capture and storage

National Academies 2019

Geologic CO₂ Storage Options

Carbon Capture Utilization and Storage (CCUS)

- CO₂ Enhanced Oil Recovery (EOR+)
 - Conventional reservoirs (onshore and offshore)
 - Tight oil
 - Residual oil zone (ROZ)
- CO₂ enhanced coalbed methane production

Carbon Capture and Storage (CCS)

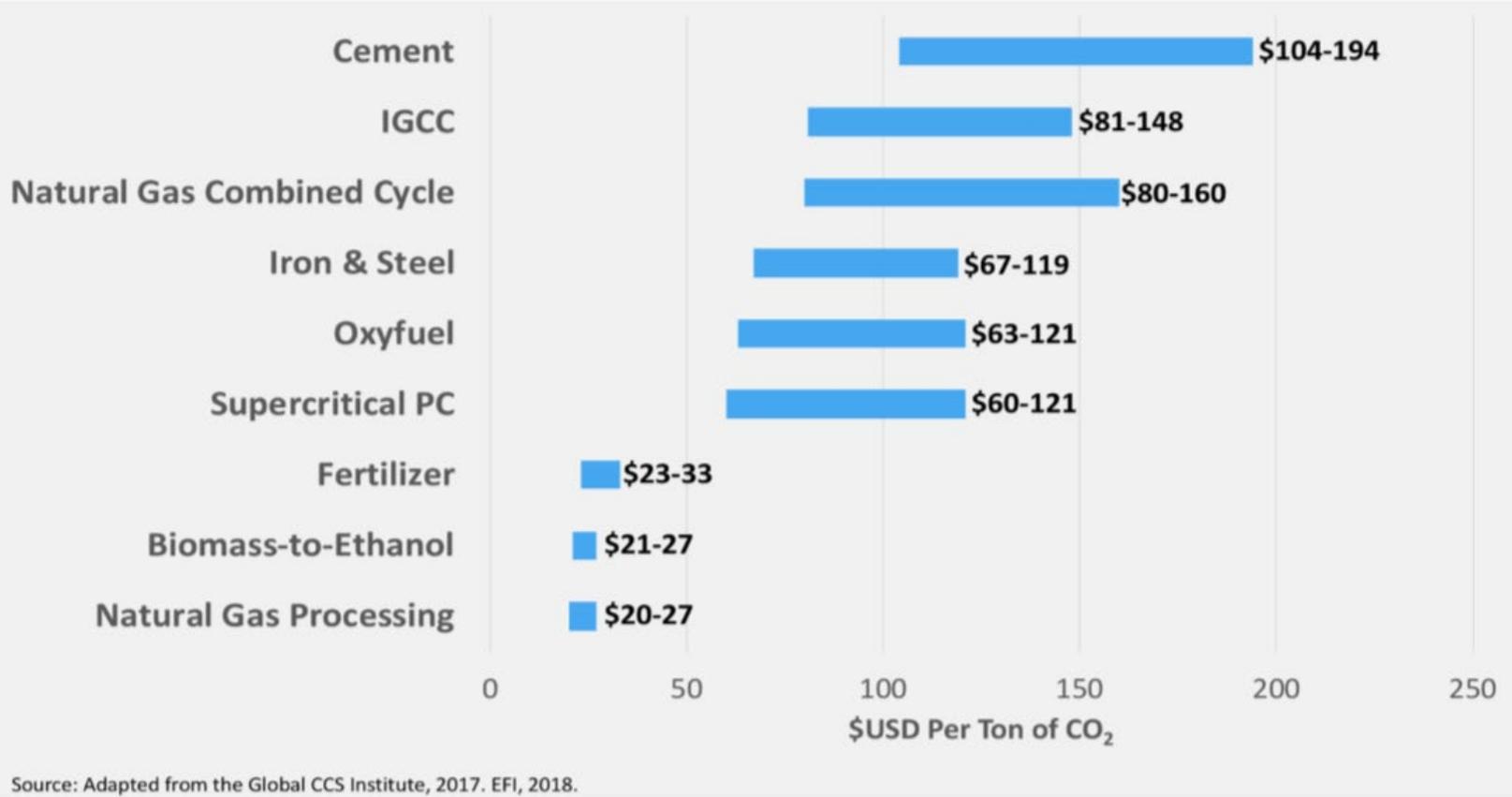
- Saline aquifer storage
- Storage in depleted gas reservoirs
- Mineral storage

Nongeologic CCUS 

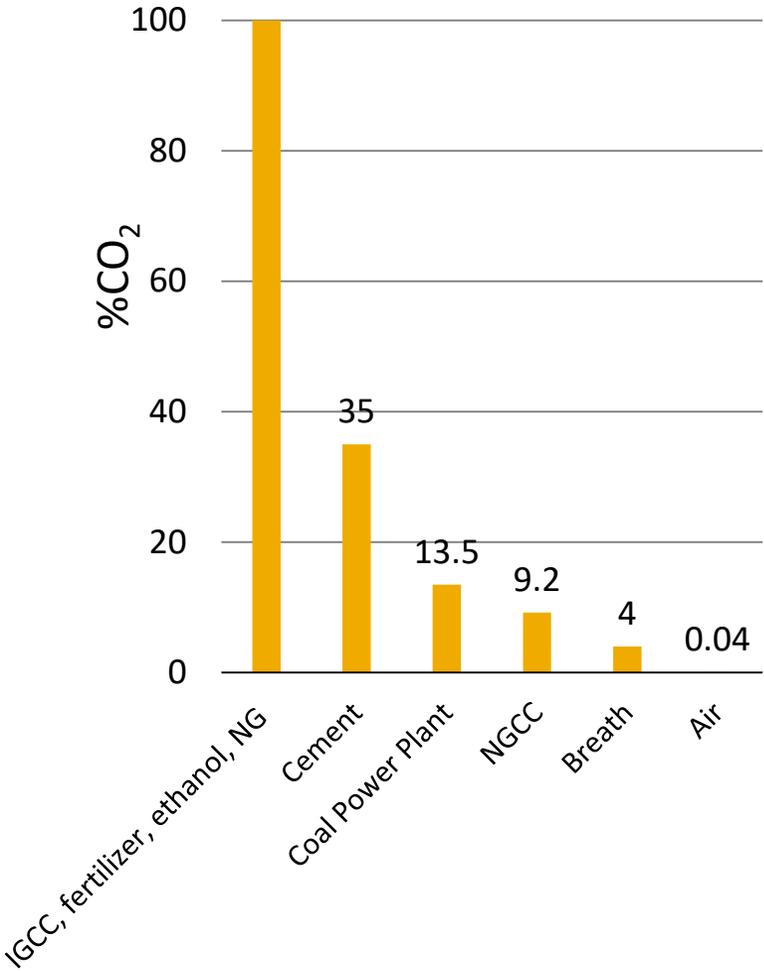
NOTE: CCUS and CCS require carbon capture



Estimated CCS Costs



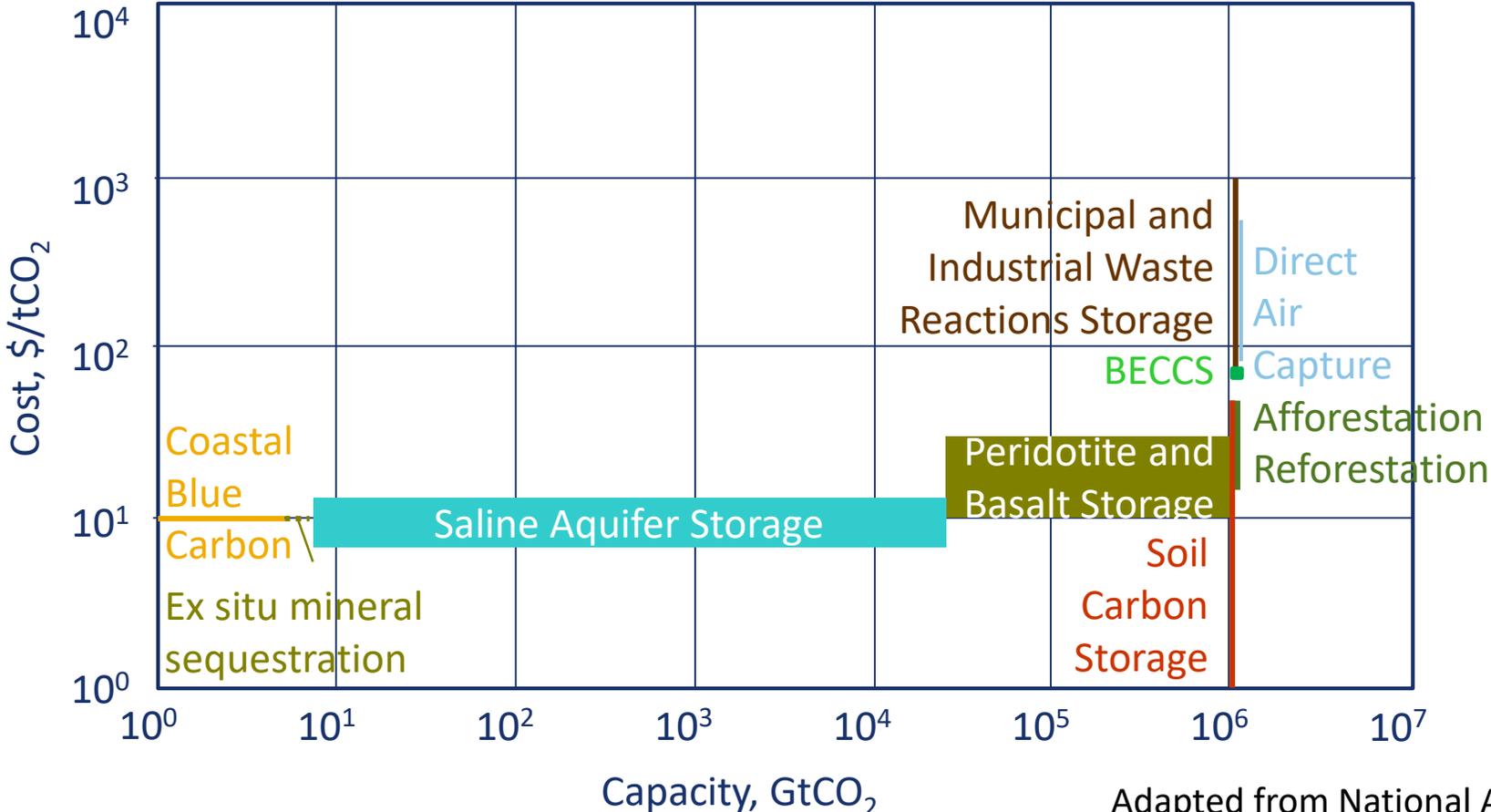
Bushman, et al. 2018



For USD/MSCF CO₂ divide by ~20

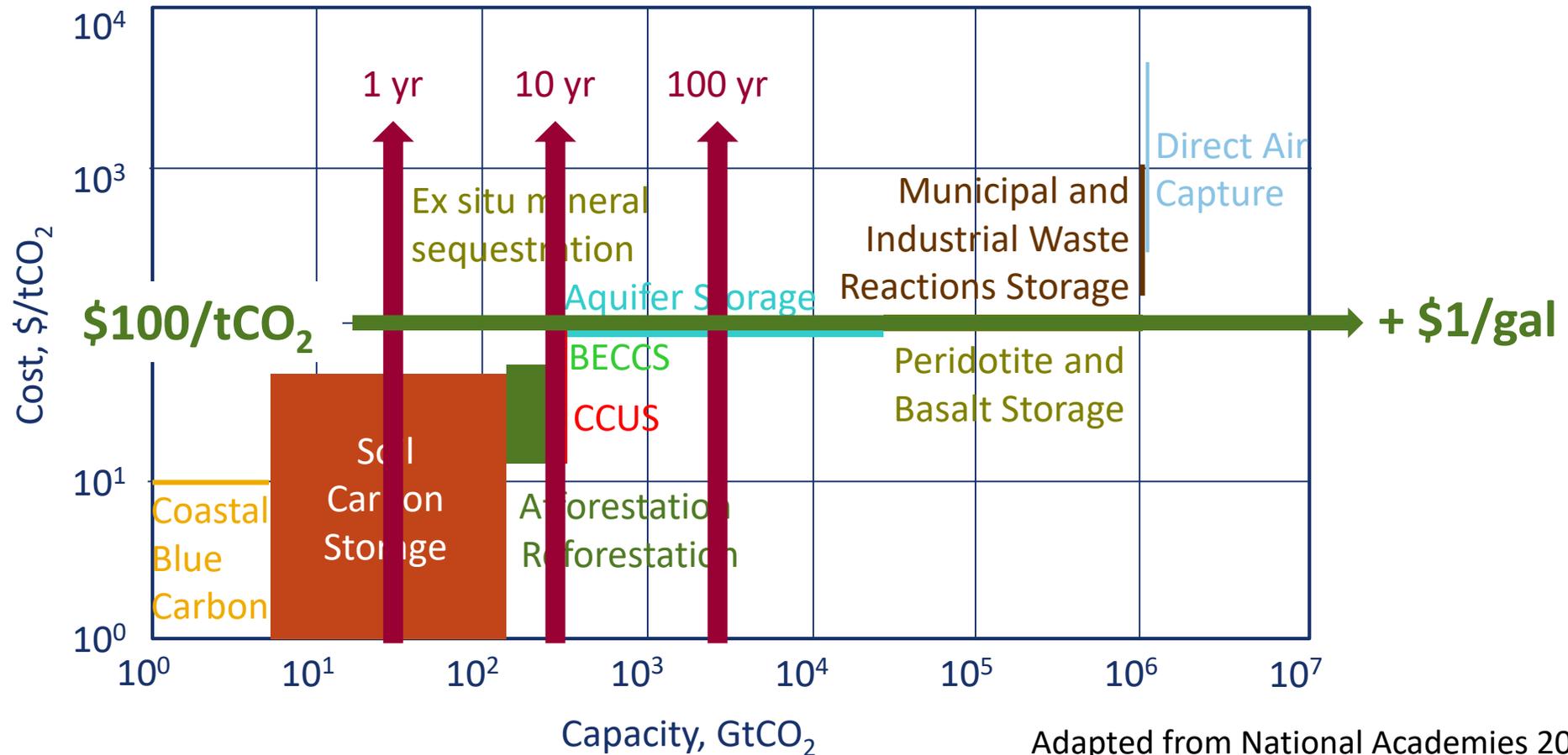


Negative Emissions Technology (NET) Capacities



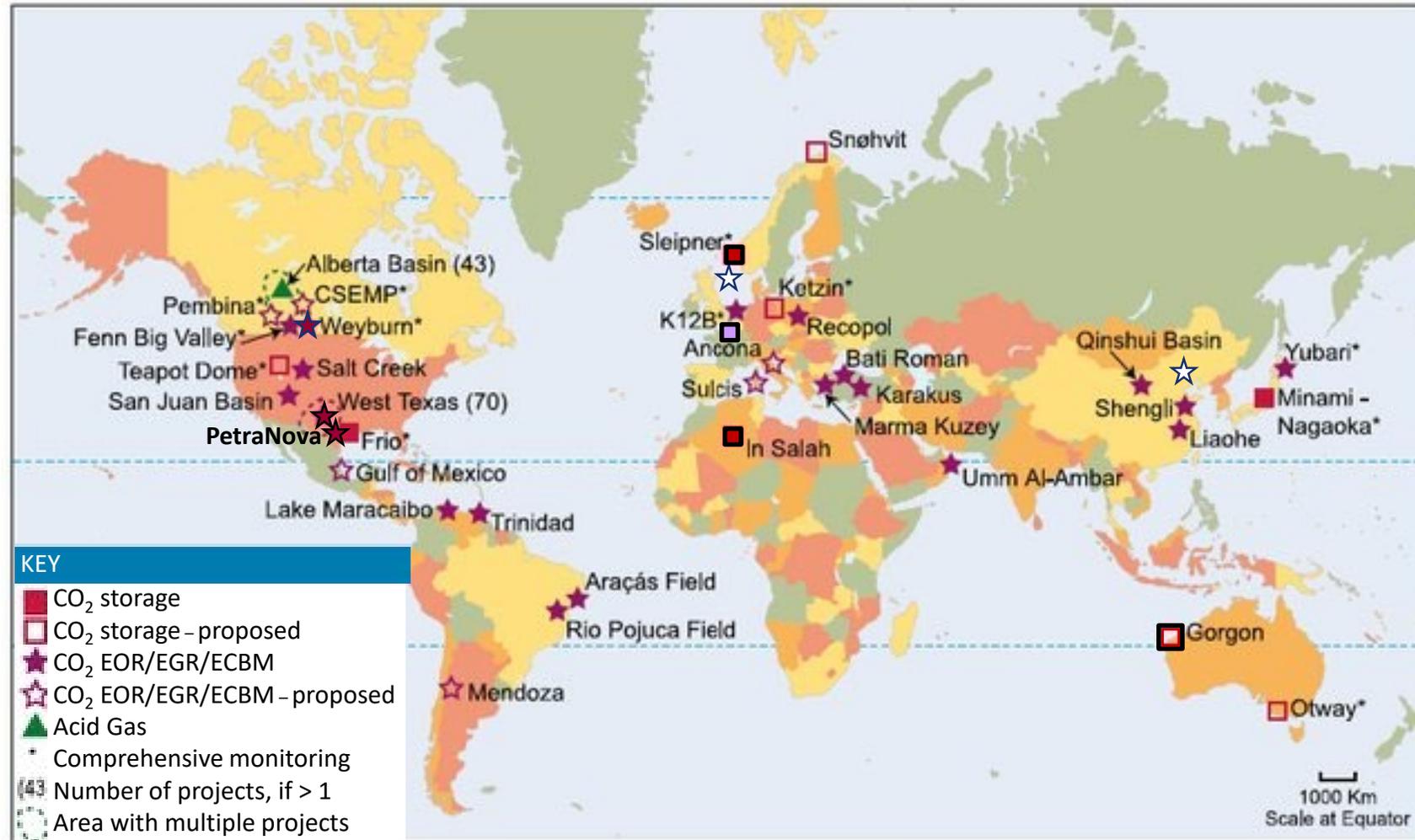
Bio Energy with Carbon Capture and Storage (BECCS)

NET Capacity Costs over Time



Including capture cost at \$80/tCO₂

Existing and Proposed CCS and CCUS Projects



Modified from IPCC Chapter 5



SPE Net Zero Carbon Opportunity



Critical new market for our workforce