MIT Climate Action Symposium

Economy-wide Deep Decarbonization

February 25, 2020

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ENERGY

Pop Quiz

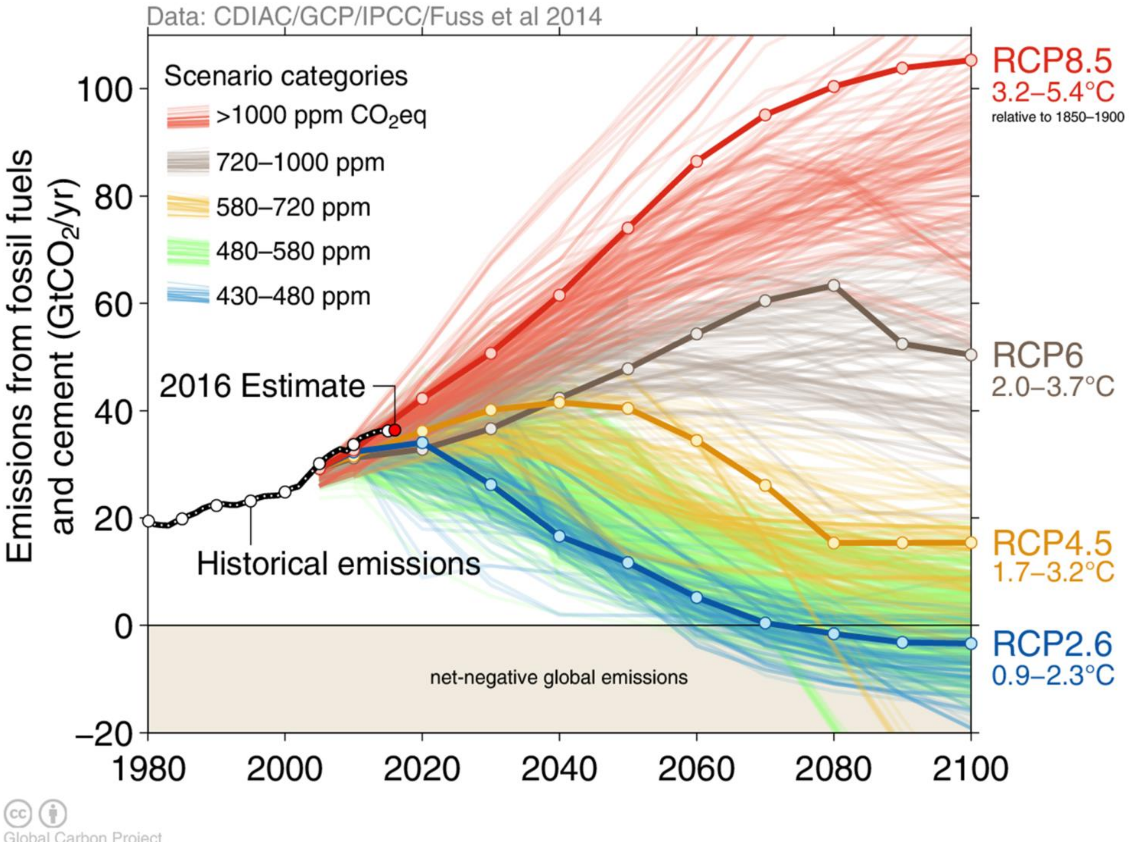
1 °C

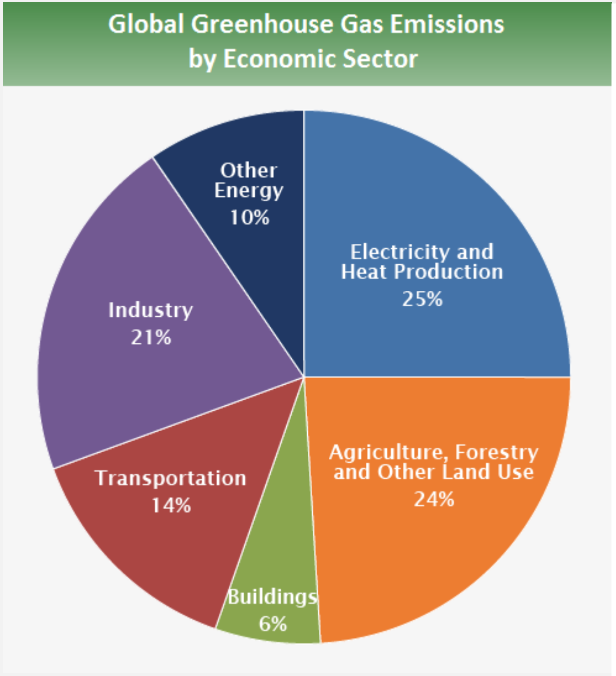
2 °C

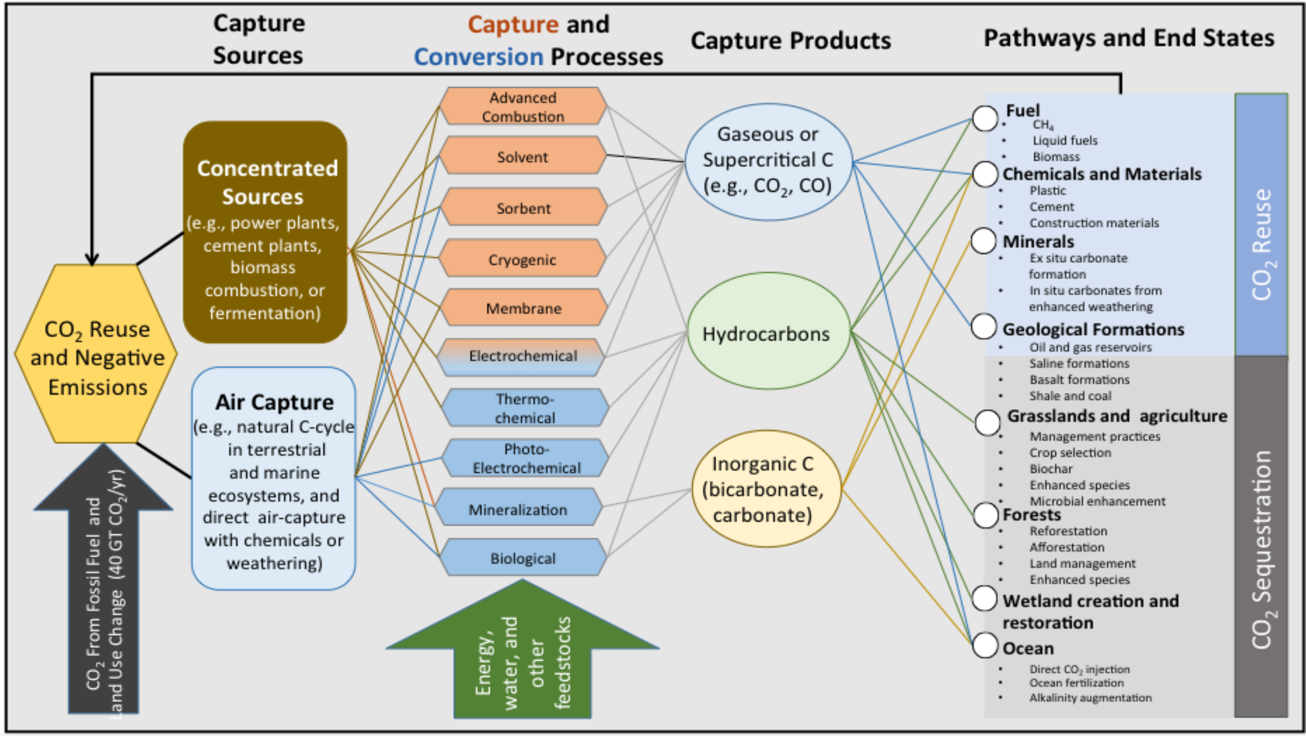
800 $GtCO_2$

40 $GtCO_2$/yr

20 years



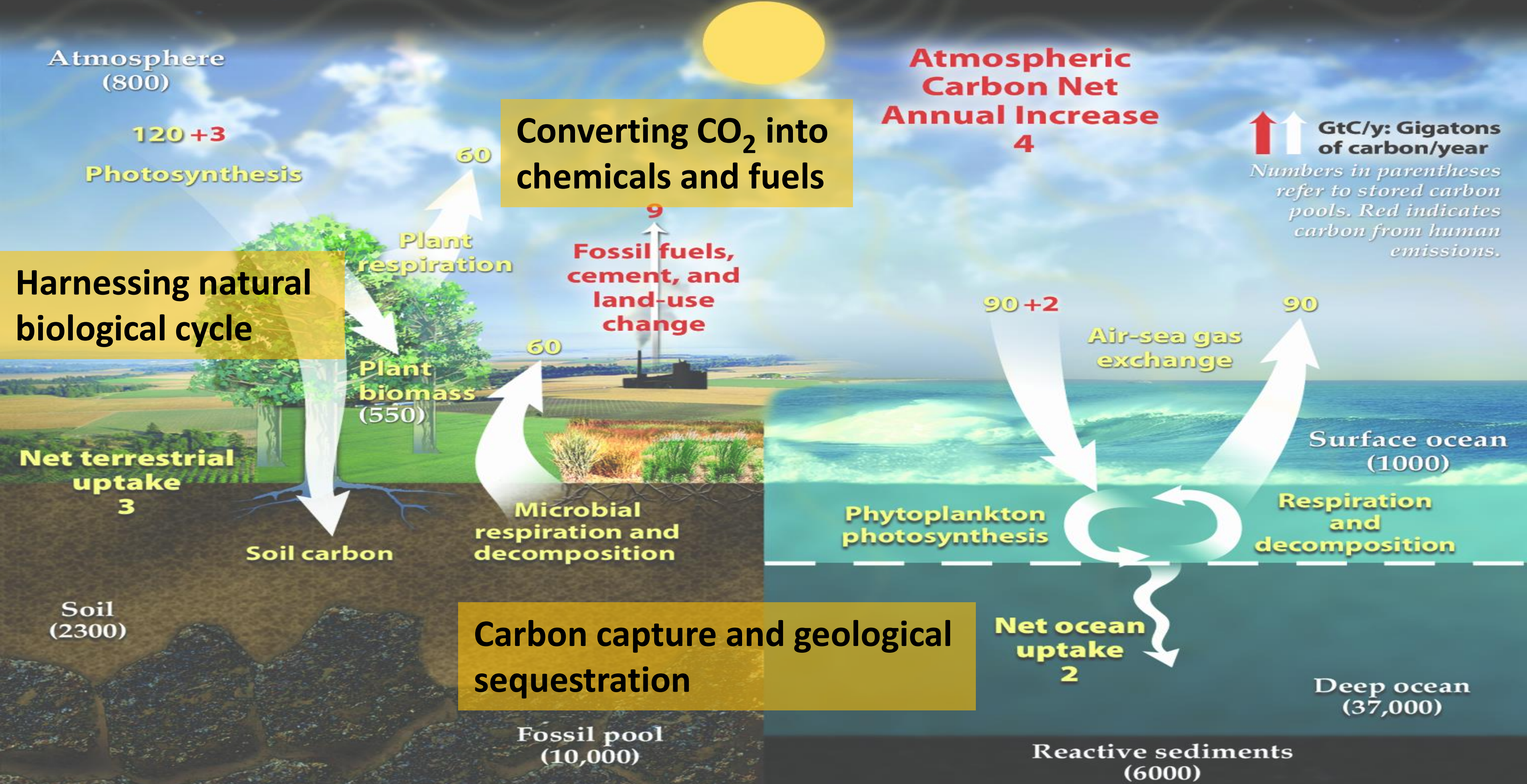




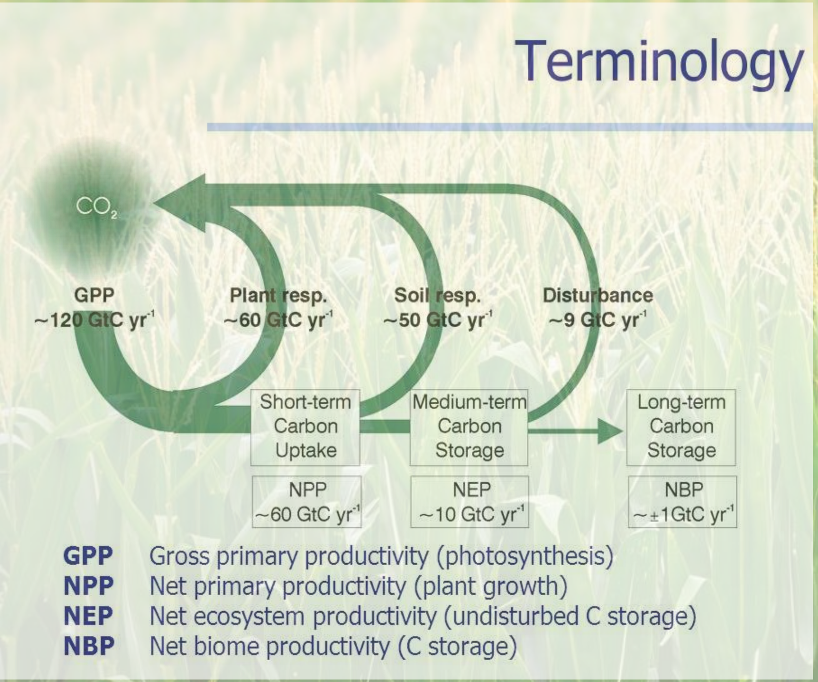
IT IS COMPLEX: Many options, multiple pathways – science, engineering, economics, scale, finance, markets, regulations, supply chains, policy, consequences interplay

DOE SEAB CO2 Utilization Report (2016); Majumdar & Deutch, *Joule* **2**, 801 (2018)

Global Carbon Management at Gigaton Scale

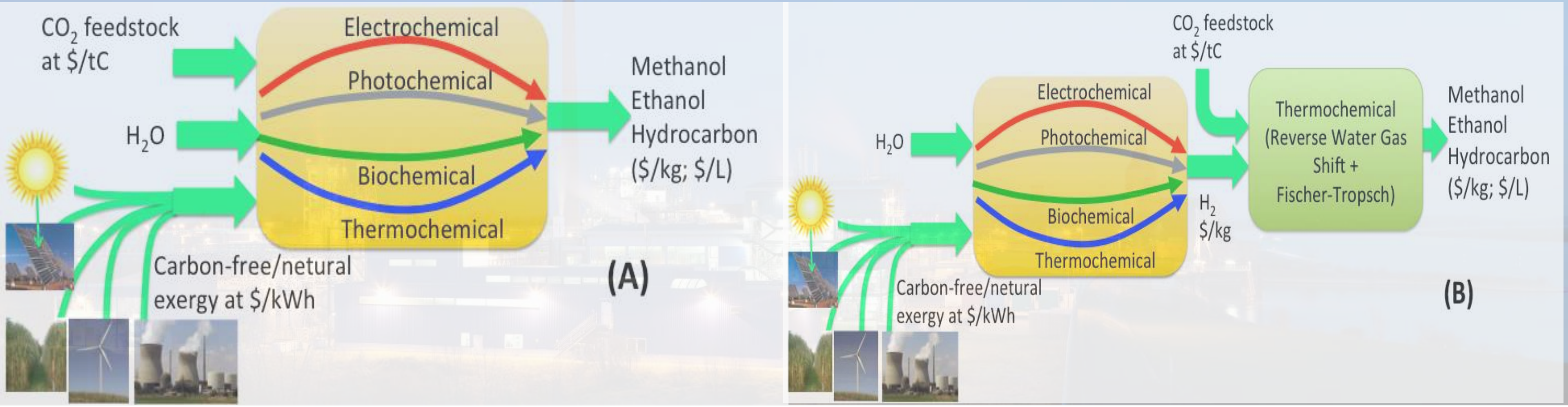


Harnessing Natural Biological Carbon Cycle



Research Needs

- How can we increase photosynthetic efficiency in crops and trees?
- Can we increase marine biomass (macroalgae) at scale?
- Can we develop crops with deeper roots and higher lignin to increase soil carbon?
- Can we develop seeds and land management for no-till agriculture?
- How can we understand and manage ecological impact of such agriculture?



How can one develop CO_2-Free Exergy at <$30/MWh at PetaWattHr Scale?

- Solar, Wind, Hydroelectric, Geothermal
- Nuclear Heat

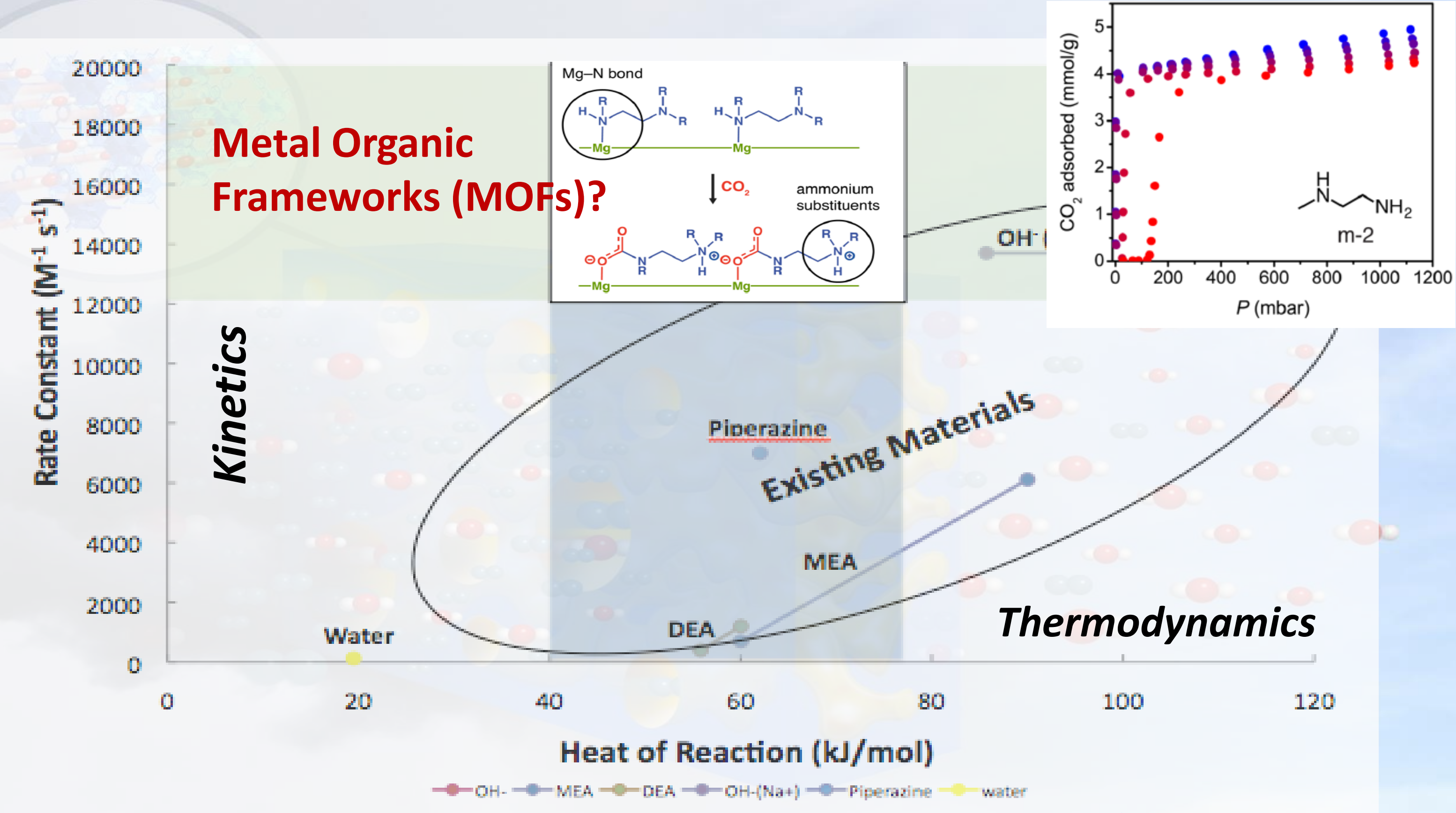
How can we produce CO_2-free Hydrogen at < $1.50/kg at Gigaton Scale

- Electrolysis (today $3-5/kg)
- Methane Pyrolysis
- Steam-Methane Reforming with CO_2 Capture ($2-2.50/kg)

Sorbents for CO_2 Capture

Siegelman et al., *JACS* **139**, 10526 (2017)

Increasing Capital Costs



Low Selectivity

Increasing Energy/Operating Costs

Average Atmospheric Methane Concentrations

Measured in parts per billion, or ppb

Article

Preindustrial $^{14}CH_4$ indicates greater anthropogenic fossil CH_4 emissions

https://doi.org/10.1038/s41586-020-1991-8
Received: 27 May 2019
Accepted: 27 November 2019
Published online: 19 February 2020

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Atmospheric methane (CH_4) is a potent greenhouse gas, and its mole fraction has

Methane removal and atmospheric restoration

Zeolites and other technologies should be evaluated and pursued for reducing methane concentrations in the atmosphere from 1,860 ppb to preindustrial levels of ~750 ppb. Such a goal of atmospheric restoration provides a positive framework for change at a time when climate action is desperately needed.

R. B. Jackson, E. I. Solomon, J. G. Canadell, M. Cargnello and C. B. Field

WE NEED RESEARCH ON SELECTIVE CH_4 SORBENTS!

Source: The 2° Institute, www.methanelevels.org

“We are now faced with the fact that tomorrow is today. We are confronted with the fierce urgency of now. In this unfolding conundrum of life and history, there ‘is’ such a thing as being too late.,”

Martin Luther King Jr.