

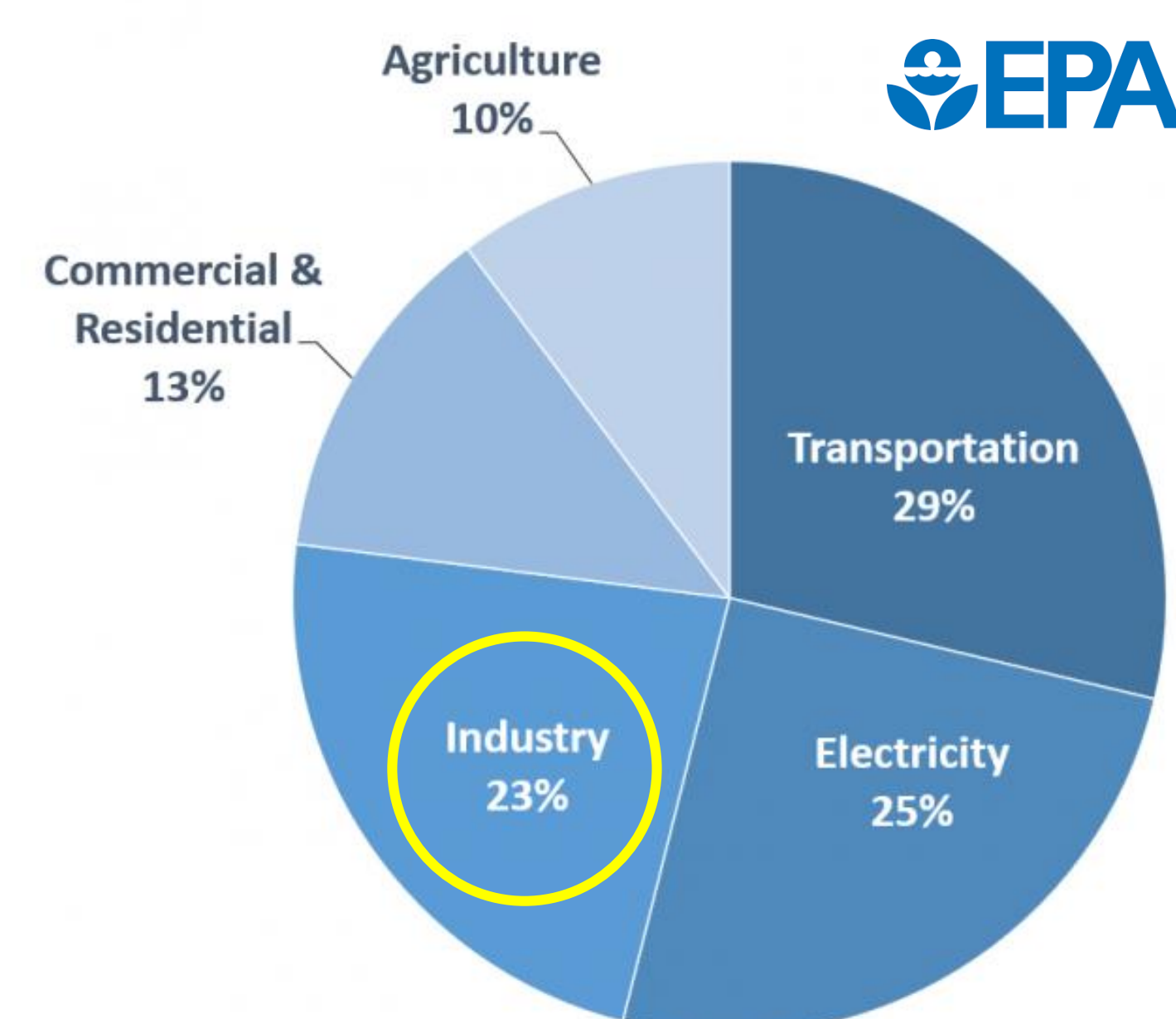
A Lifecycle Framework for Industrial Decarbonization



Clifford K. Ho,¹ Carlos Quiroz Arita, Anthe George, Kristin Hertz, Jessica Rimsza, Erik D. Spoerke, and Andrea Ambrosini
¹ ckho@sandia.gov

Problem Statement

Total U.S. Greenhouse Gas Emissions
by Economic Sector in 2019



Total U.S. Emissions in 2018 = 6.6 billion metric tons of CO₂ equivalent.
<https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>

Nearly a **quarter** of all greenhouse gas emissions in the U.S. are from Industrial Processes and Manufacturing



Cement and steel production



Food processing and drying



Chemicals (e.g., NH₃)



Electrification/automation



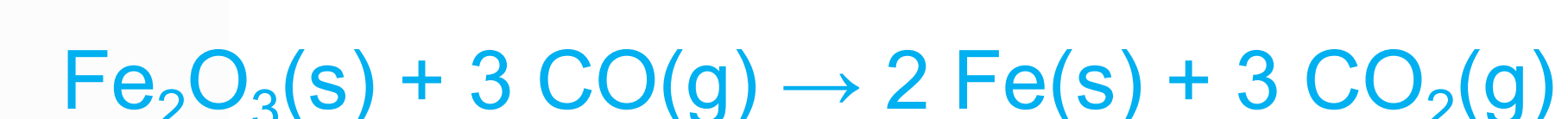
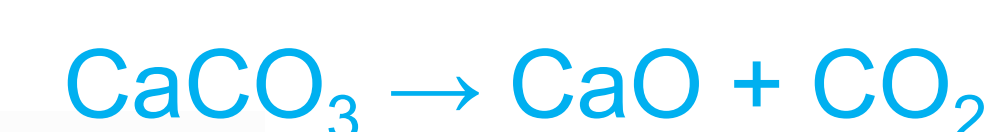
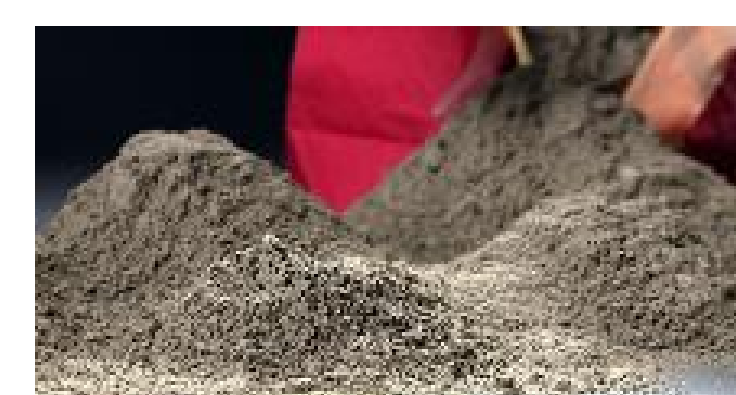
Petroleum refining

Objective

Develop a probabilistic lifecycle assessment framework and technoeconomic analysis to prioritize and conduct RD&D that achieves desired metrics for industrial decarbonization*

*Metrics may include emissions reductions, cost, safety, equity/justice, and others

1. Carbon-free feedstock & chemical processes

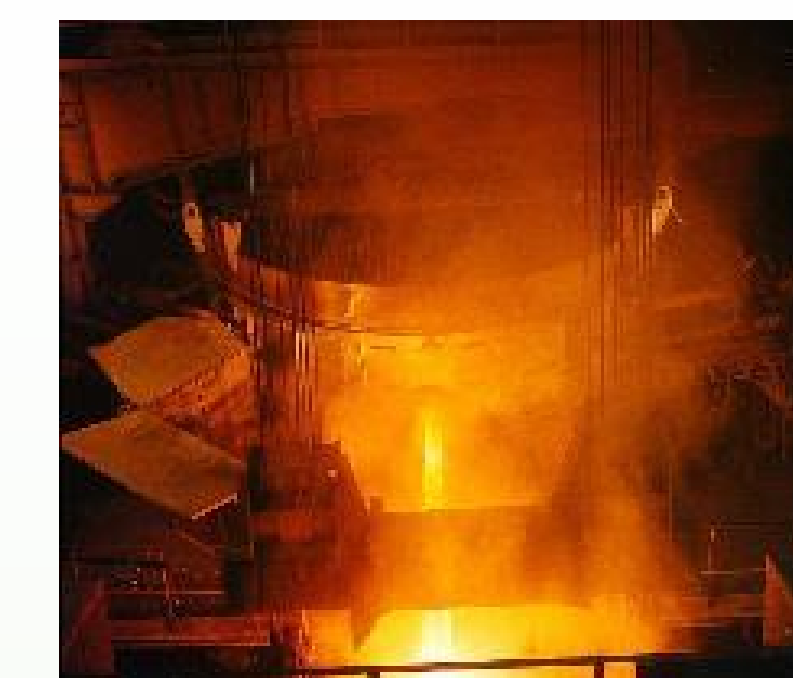


Approach

4. Recycling, repurposing, and recovery



2. Fossil-free heat and electricity sources



3. Novel capture and sequestration methods



Decrease CO₂ emissions across entire product life cycle from feedstock, to processing, to sequestration, and finally to recycling of materials to feedstock