Better Climate™ CHALLENGE
U.S. DEPARTMENT OF ENERGY

Driving Change Together: Breakout Session on Decarbonization Challenges and Solutions

Thursday, February 8, 2024 – Working Lunch

U.S. DEPARTMENT OF ENERGY

Agenda

- Introduction and overview (10 min)
- Icebreaker (10 min)
- Structured Discussion (25 min)
- Summary, Action items, Closing remarks (15 min)

Icebreaker

1. Please state your name and organization.

2. What is the most energy and carbon-intensive thermal process in your industry/facilities? (Please try your best to be concise)

Introduction and Overview

Objective:

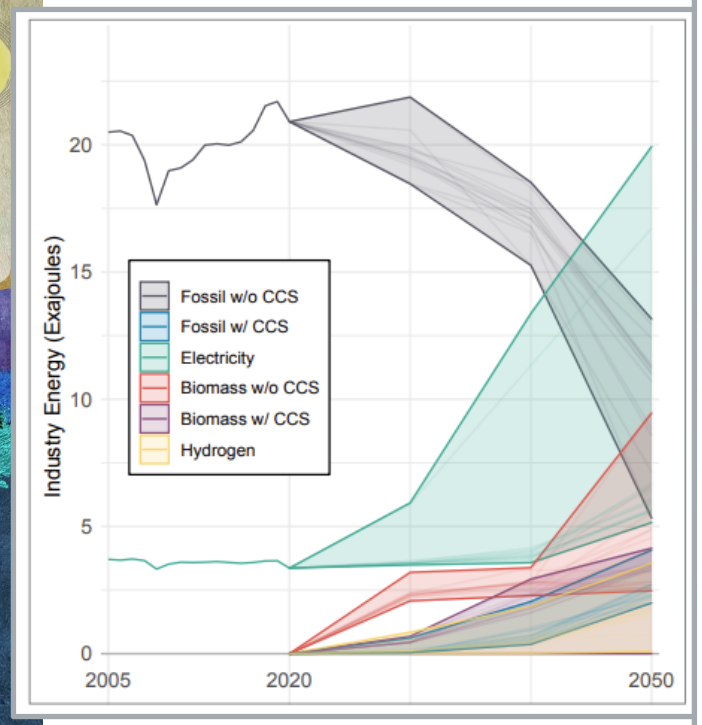
The objective of this session is to facilitate discussions, identify opportunities, and address barriers associated with **decarbonization technologies for scope 1 emissions especially industrial thermal loads**.

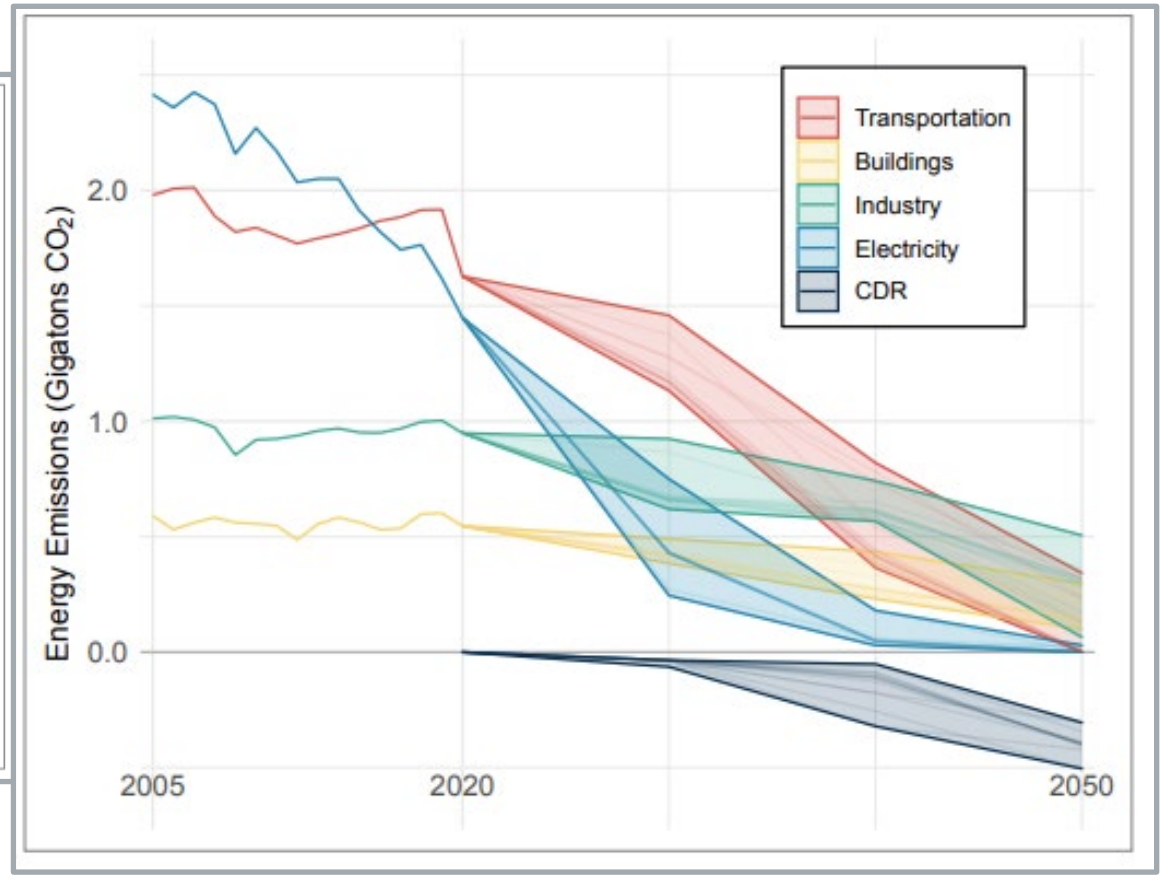
Logistics:

- We will ask a few polls as well as discussion questions.
- Please write down your responses on the post-it notes and place them on the corresponding whiteboards.
- You will have the opportunity to collectively review the notes on the whiteboard, brainstorm, and make additions/modifications.
- Our volunteers will then review all the notes and provide a summary at the end of our session.

Net-Zero Industrial GHG Emissions by 2050

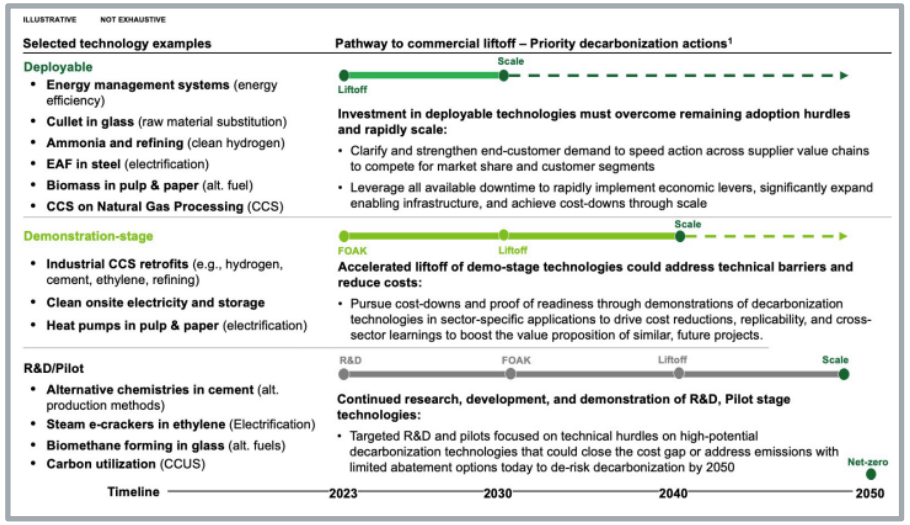
- The Biden Administration's Long-Term Strategy of the United States sets the ambitious goal of **Net-zero GHG by 2050**
- What does that look like for Industry?





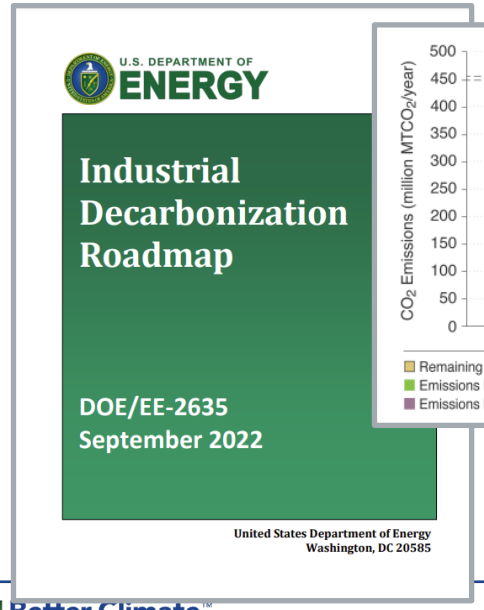
https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf

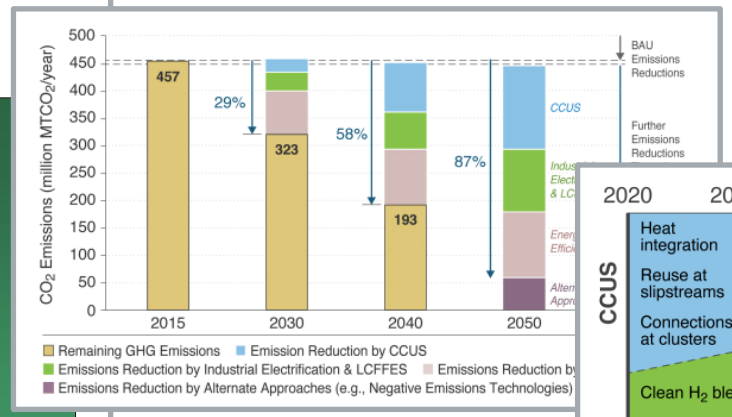
Building upon Prior Work

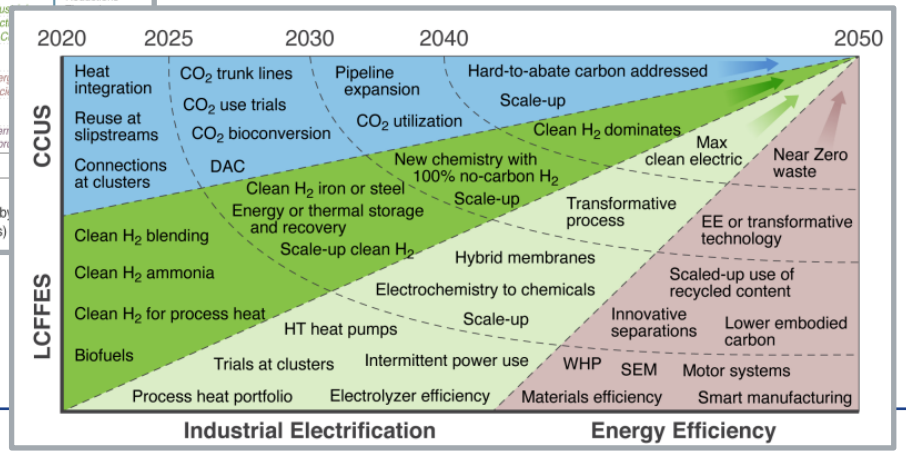


The Pathways to Commercial Liftoff: Industrial Decarbonization

- Prioritized near-/mid-term objectives to put the U.S. on path towards net-zero GHG by 2050



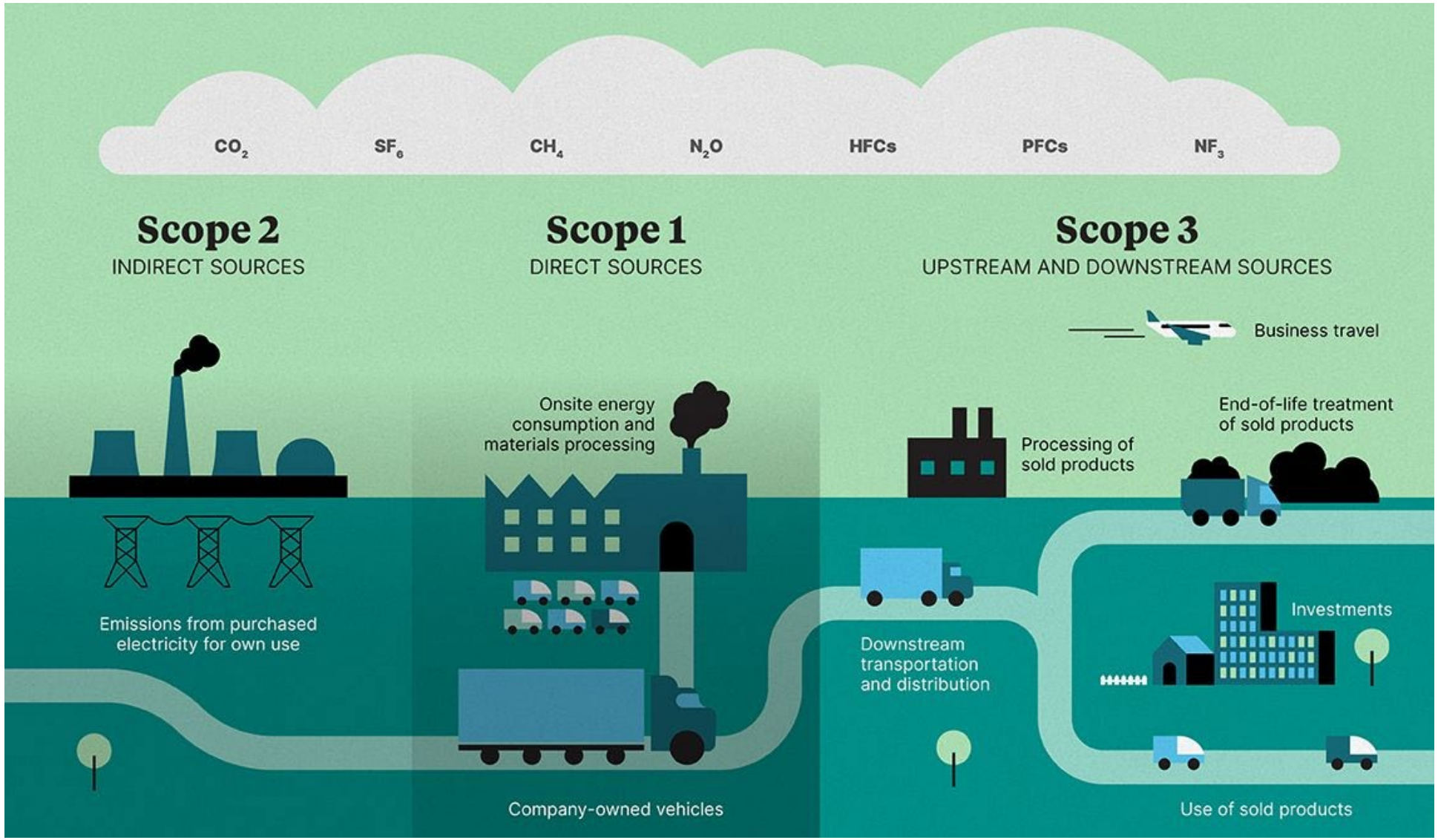




The Industrial Decarbonization Roadmap

- Opportunity Space (the technical potential) comes into focus
- Highlights a range of opportunities without charting a course

To Decarbonize the Industry, We Must Address Scope 1 Emissions, Which Primarily Stem from Onsite Combustion and Process Heating

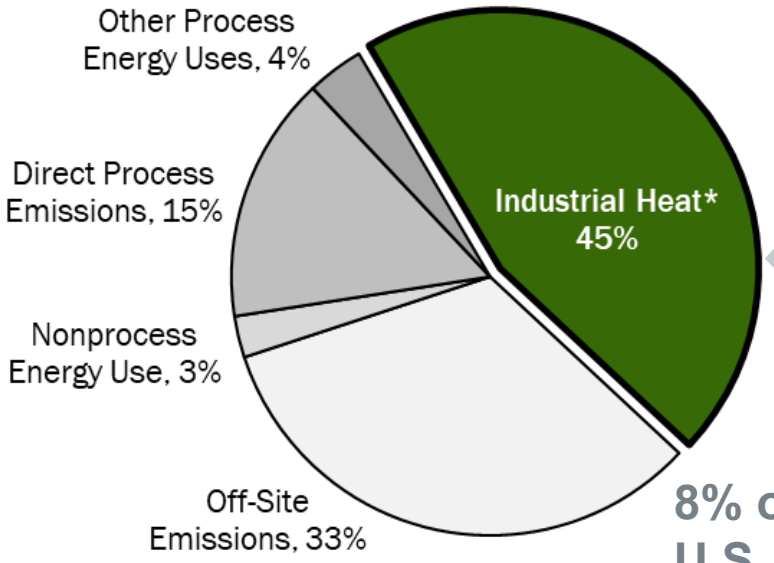


Source: Constantine Komodromos, September 28, 2023

To Reach Net-Zero, We Must Decarbonize Industrial Process Heat

90% of process heat is generated from the unabated burning of fossil fuels

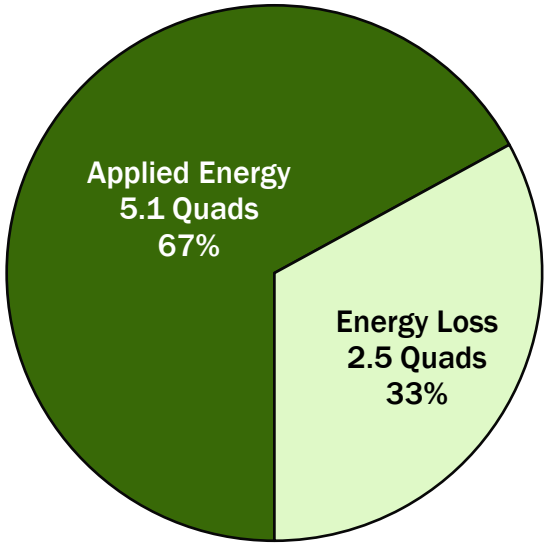
GHG emissions from U.S. manufacturing



Currently used fuels	% of total fuel usage
Natural Gas	55%
Byproduct Fuels	36%
Coal	4%
Other	5%

8% of ALL U.S. emissions

One-third of energy consumed for process heating is ultimately lost as waste heat



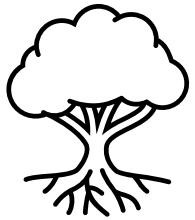
Industrial Heat includes process heating, conventional boilers, and CHP/cogeneration.
Manufacturing sector excludes agriculture, construction, or mining.

DOE AMO. 2021. Manufacturing Energy and Carbon Footprints.
https://www.energy.gov/eere/amo/manufacturing-energy-and-carbon-footprints-2018-mecs

What is Process Heat?

Process heat is the application of heat in industry to manufacture materials, goods, and products.

drying
paper, batteries

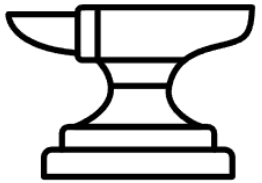


steam
pasteurized food

distillation
high purity chemicals

melting
formed plastics, semiconductors

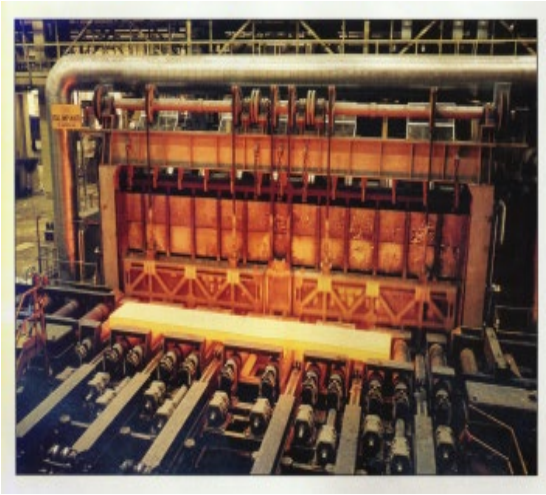
smelting
iron, copper, aluminum



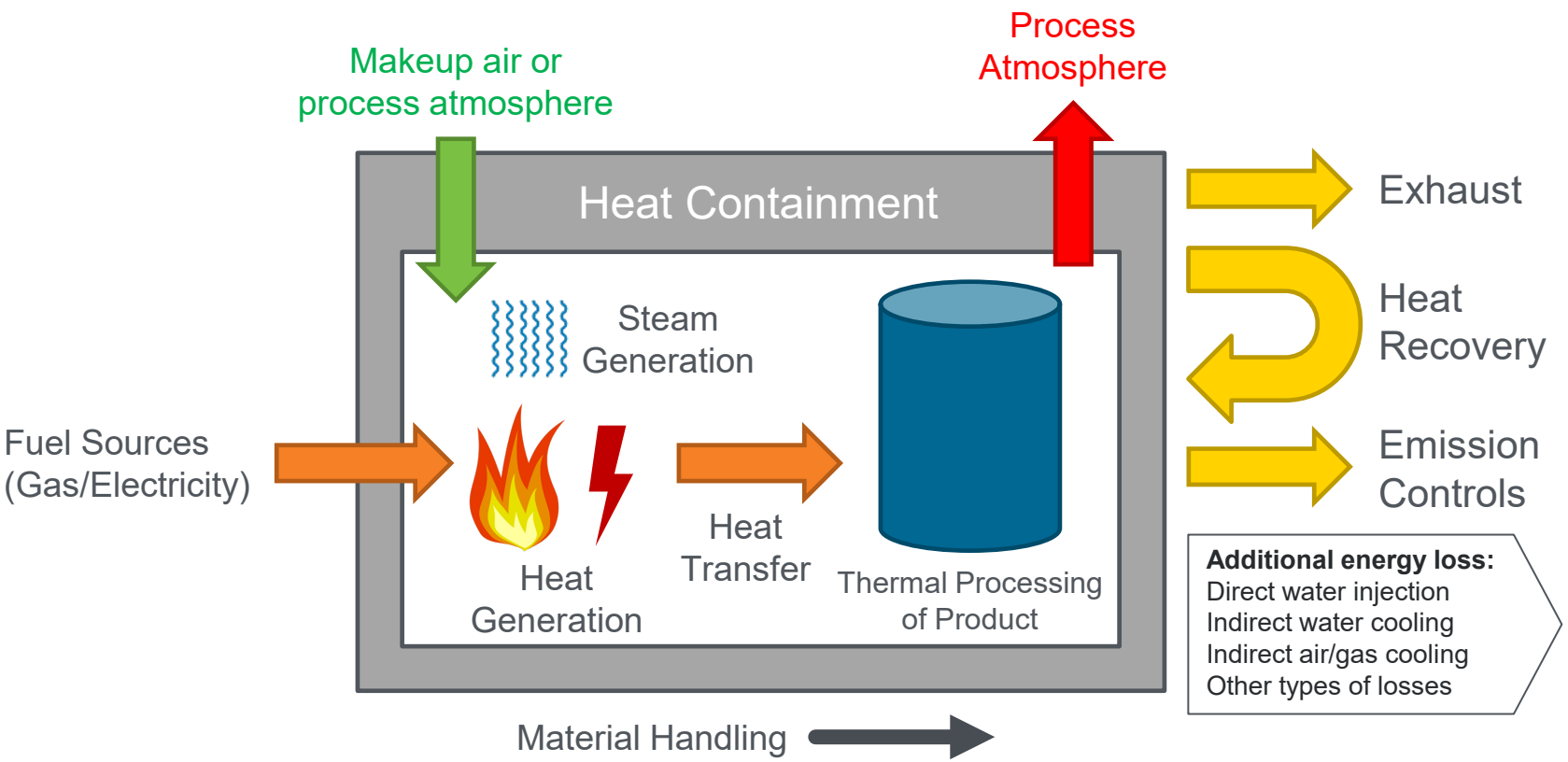
calcining
cement, lime

~500°F **Process Temperatures Needed** **>1500°F**

Process Heating Systems are Exceptionally Heterogeneous



Process Heating System Components



Crosscutting Enabling Technology

Smart Sensors/ Controls & Internet of Things	Advanced Materials	Design Tools/ Systems Integration

Industrial Decarbonization Pillars
(Source: DOE's Decarbonization Roadmap)

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Industrial Decarbonization Roadmap

DOE/EE-2635
September 2022

United States Department of Energy
Washington, DC 20585

https://www.energy.gov/sites/default/files/2022-09/Industrial%20Decarbonization%20Roadmap.pdf

Energy Efficiency	Industrial Electrification	Low-Carbon Fuels, Feedstocks, and Energy Sources (LCFFES)	Carbon Capture, Utilization, and Storage (CCUS)
Energy efficiency advancements minimize industrial energy demand, directly reducing the GHG emissions associated with fossil fuel combustion.	Industrial process technologies that utilize electricity for energy, rather than combusting fossil fuels directly, enable the sector to leverage advancements in low-carbon electricity from both grid and onsite generation sources.	Substitution of low- and no-carbon fuels and feedstocks for fossil fuels can further reduce combustion-associated emissions for industrial processes.	This multi-component strategy for mitigating difficult-to-abate emissions involves capturing generated CO_2 before it can enter the atmosphere; utilizing captured CO_2 whenever possible; and storing captured CO_2 long-term to avoid atmospheric release.
Energy efficiency technology examples: • Energy management approaches • Thermal integration of process heat • Smart manufacturing • Improved technologies and processes; system integration	Industrial electrification technology examples: • Electrification of process heat (e.g., heat pumps) • Electrification of hydrogen production for industrial process use	LCFFES technology examples: • Fuel-flexible processes • Clean hydrogen fuels and feedstocks • Biofuels and biofeedstocks • Concentrating solar power • Nuclear • Geothermal	CCUS technology examples: • Post-combustion chemical absorption of CO_2 • CO_2 pipelines and other CCUS-supportive infrastructure

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Polls

Poll Questions

1. **Which specific technology areas are you most interested in exploring for decarbonizing industrial thermal loads?**
   a) Energy Efficiency
   b) Electrification
   c) Low-Carbon Fuels, Feedstocks, Energy Sources
   d) Carbon Capture, Utilization, and Storage

2. **Are you currently implementing any technologies beyond energy efficiency to decarbonize your thermal loads in your facilities?**
   a) Yes, we have already implemented few projects
   b) Yes, we are planning to implement
   c) No, we are waiting for more certainty in those other areas

3. **How likely is it that your company will invest time and effort in the R&D of step change decarbonization technologies for industrial thermal loads?**
   - Scale 1 to 10

Discussion – Barriers and Challenges

Discussion – Barriers and Challenges

Question 1: Current Challenges

1. What specific scope 1 emissions systems in your facilities pose significant challenges for achieving net-zero emissions by 2050?
2. Are there particular technical hurdles that need to be overcome to decarbonize these systems?

Discussion – Barriers and Challenges

Question 2: Technology Adoption and Future Technologies

1. What barriers do you encounter in adopting new decarbonization technologies for achieving net-zero emissions in your facilities?
2. Are there specific technologies you believe have the potential for a step-change impact on your facility/company's GHG emissions, potentially leading to zero-emission technologies?

Discussion – Barriers and Challenges

Question 3: Collaborative Opportunities

1. In what ways do you see collaboration with national laboratories enhancing your efforts to achieve net-zero emissions by 2050?
2. Are there specific types of R&D collaborations you are interested in exploring, particularly those that align with ambitious technologies for net-zero emissions?

Summary, Action items, Closing remarks

- Question 1: Current Challenges
- Question 2: Technology Adoption and Future Technologies
- Question 3: Collaborative Opportunities

Thank you!