



# Overview of Industrial Efficiency and Decarbonization Research, Development, and Demonstration

Dr. Avi Shultz ([avi.shultz@ee.doe.gov](mailto:avi.shultz@ee.doe.gov))

Deputy Director

Industrial Efficiency and Decarbonization Office

US Department of Energy

NSF Workshop on Advanced Manufacturing for  
Industrial Decarbonization

Arlington, VA

August 3, 2023



# Building a Net-zero, Clean Energy Future

The U.S. industrial sector (manufacturing, agriculture, mining, and construction) accounts for:

**33%** of the nation's primary energy use

**30%** of CO<sub>2</sub> emissions

Anticipated industrial sector energy demand growth of 30% by 2050 may result in a:

**17%** CO<sub>2</sub> emissions increase\*

\*EIA, Annual Energy Outlook 2021 with Projections to 2050.



*Energy-Related  
CO<sub>2</sub> Emissions  
By Sector*

# Decarbonizing Industry is an Opportunity for America's Economy

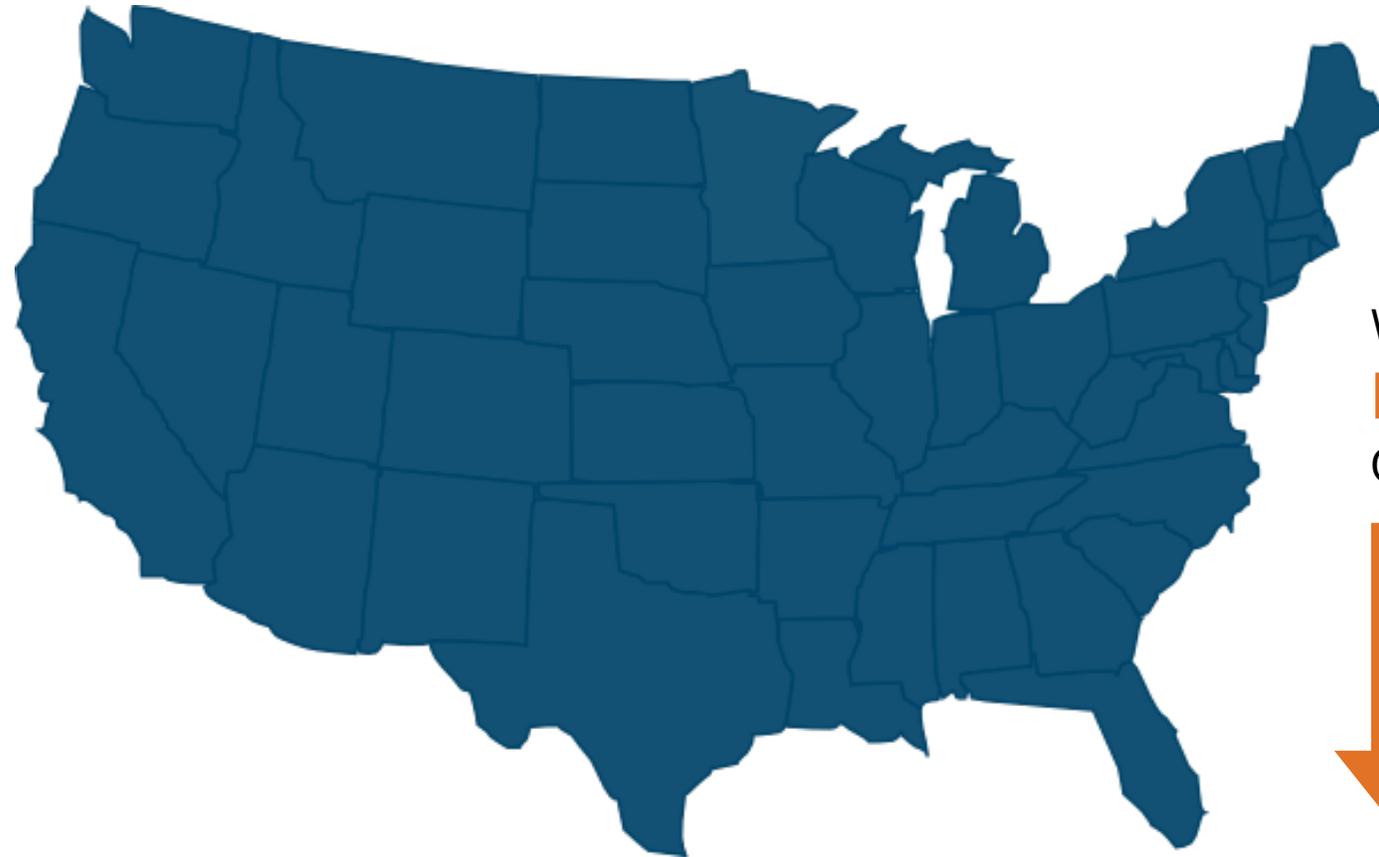
U.S. manufacturing subsector...



**CONTRIBUTES**  
\$2.35 trillion to  
the U.S. Economy

**GENERATES**  
11% of U.S. GDP

**CREATES**  
11.4 million jobs



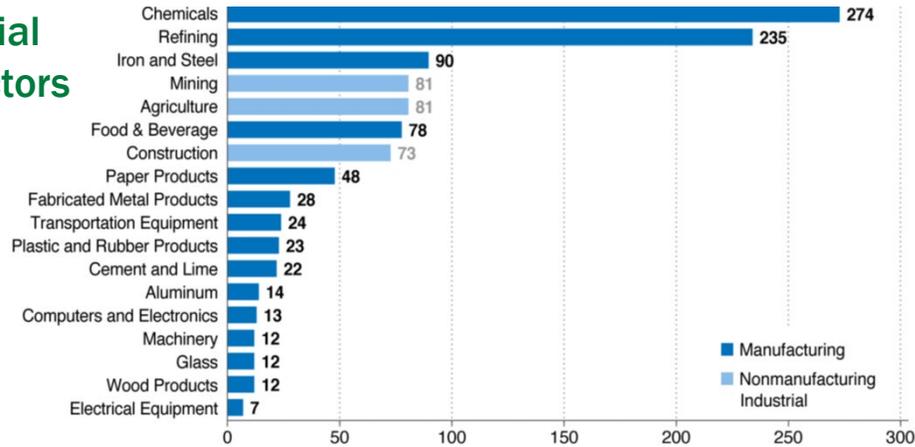
While working to  
**DECREASE**  
CO<sub>2</sub> emissions



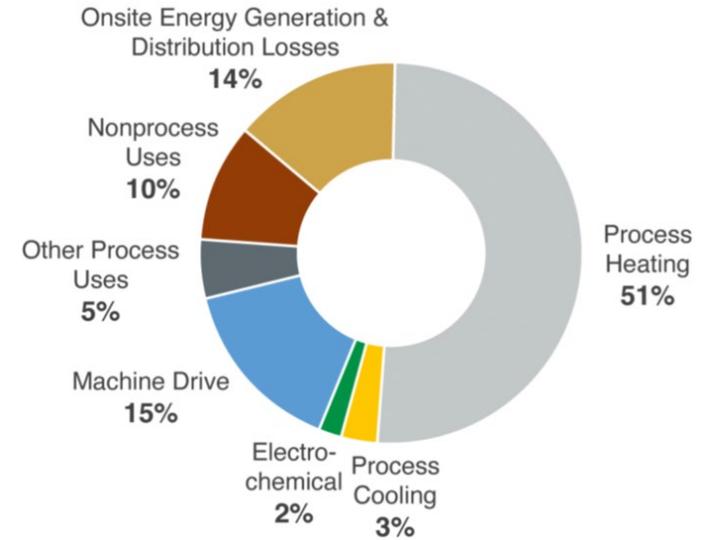
# Systemic Barriers to Industrial Decarbonization

## No One-Size-Fits-All Solution

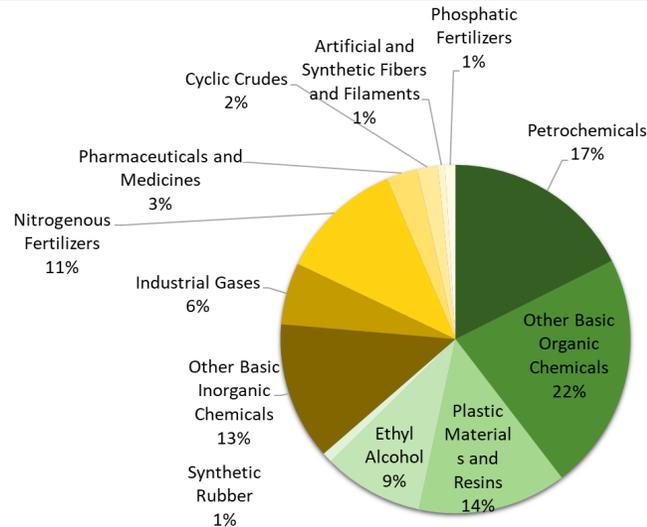
### Industrial Subsectors



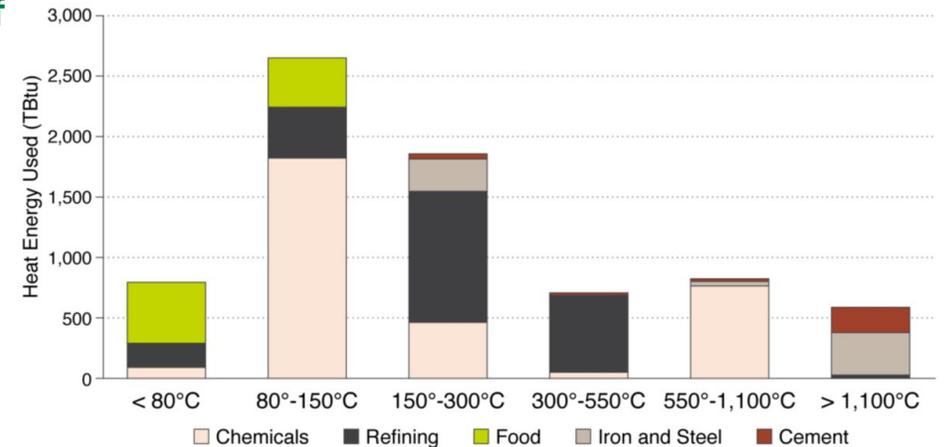
### Onsite Energy Use



### Chemical Products

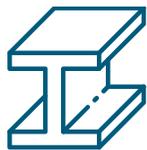
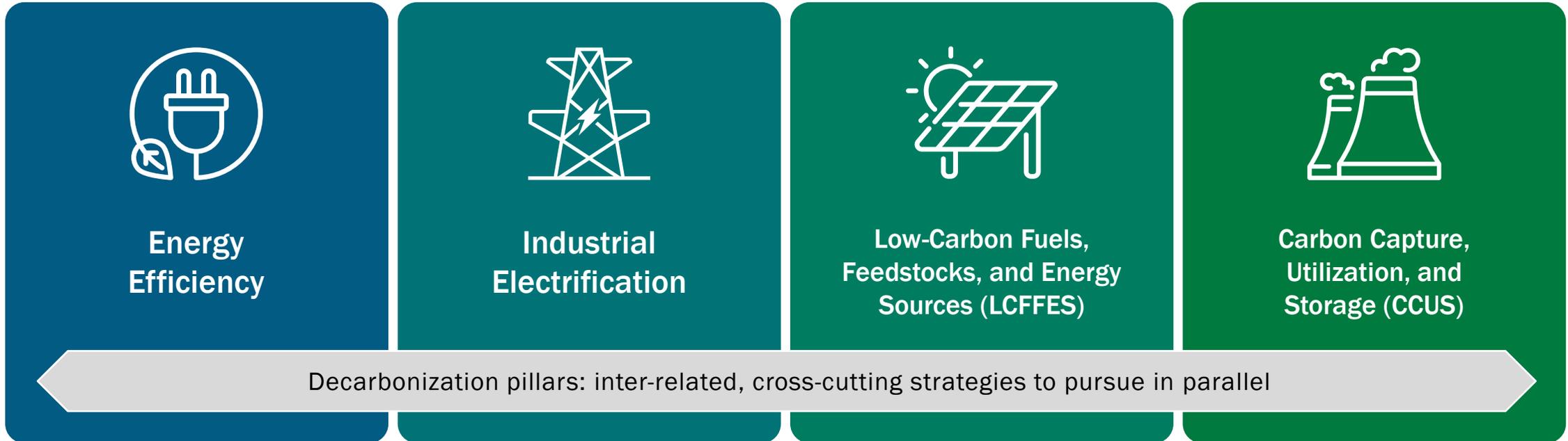


### Distribution of Process Heat



# DOE Industrial Decarbonization Roadmap

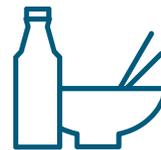
## Industrial Decarbonization Pillars



Iron & Steel



Chemicals



Food & Beverage



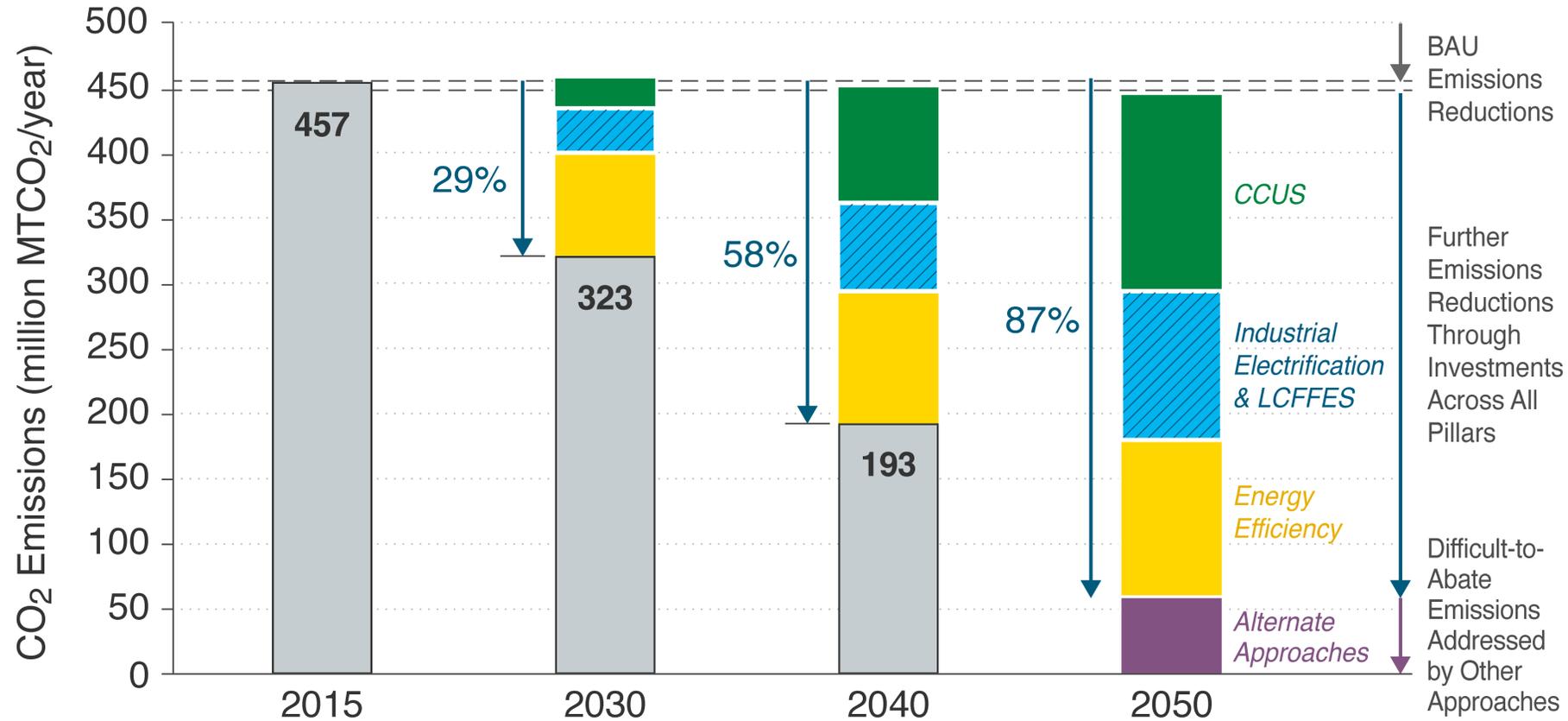
Petroleum Refining



Cement

[energy.gov/eere/doe-industrial-decarbonization-roadmap](https://energy.gov/eere/doe-industrial-decarbonization-roadmap)

# Path to Net-Zero Emissions by 2050



- Remaining GHG Emissions
- Emissions Reduction by CCUS
- Emissions Reduction by Industrial Electrification & LCFES
- Emissions Reduction by Energy Efficiency
- Emissions Reduction by Alternate Approaches (e.g., Negative Emissions Technologies)

# Systemic Barriers to Industrial Decarbonization

## Risk to Industry's Bottom Line

Investment scale → In the range of

**\$11-21 Trillion**

just for 4 sectors:



**cement**



**steel**



**ammonia**



**ethylene**

(McKinsey, 2018)

Estimated that

**60%** of heavy industry emissions reductions

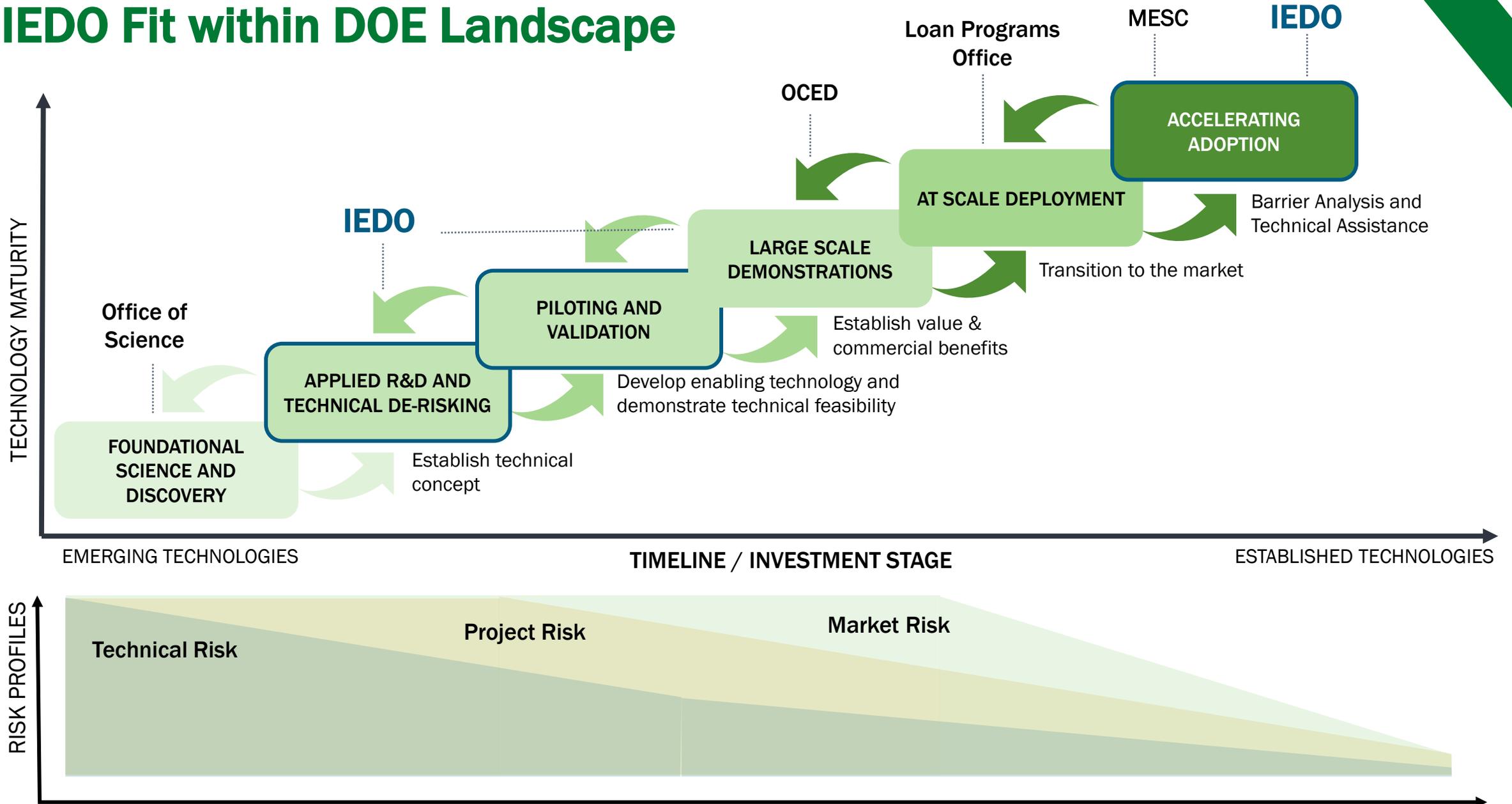


by 2050 will come from technologies that are **not currently market ready**

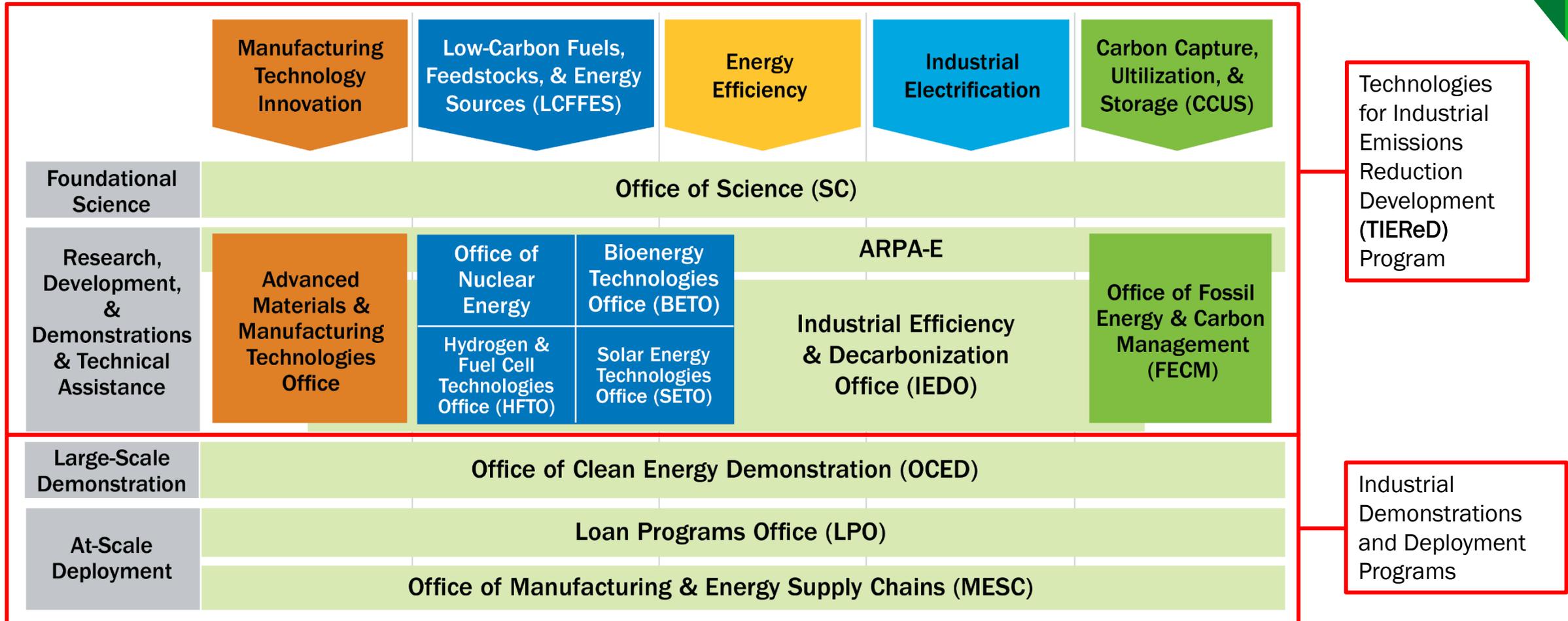
(IEA, 2022)

Targeted investment for research, development, and pilot-scale demonstrations can help U.S. industry overcome these barriers

# IEDO Fit within DOE Landscape



# DOE Offices Share a Common Strategic Framework



[www.energy.gov/industrial-technology/](http://www.energy.gov/industrial-technology/)

# Industrial Efficiency and Decarbonization Office (IEDO)

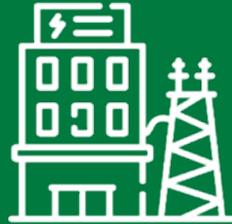


Energy- and Emissions-Intensive Industries

FY23 = \$131M



Dr. Paul Majsztrik



Cross-sector Technologies

FY23 = \$90.5M



Isaac Chan



Technical Assistance and Workforce Development

FY23 = \$45M



Anne Hampson

# \$266.5

Million FY23 Budget



Dr. Steven McKnight  
Acting Director



Dr. Avi Shultz  
Deputy Director



Joe Cresko  
Chief Engineer



Lauren Hall  
Operations Supervisor



Ava Coy  
Program Manager  
Technical Project Officers



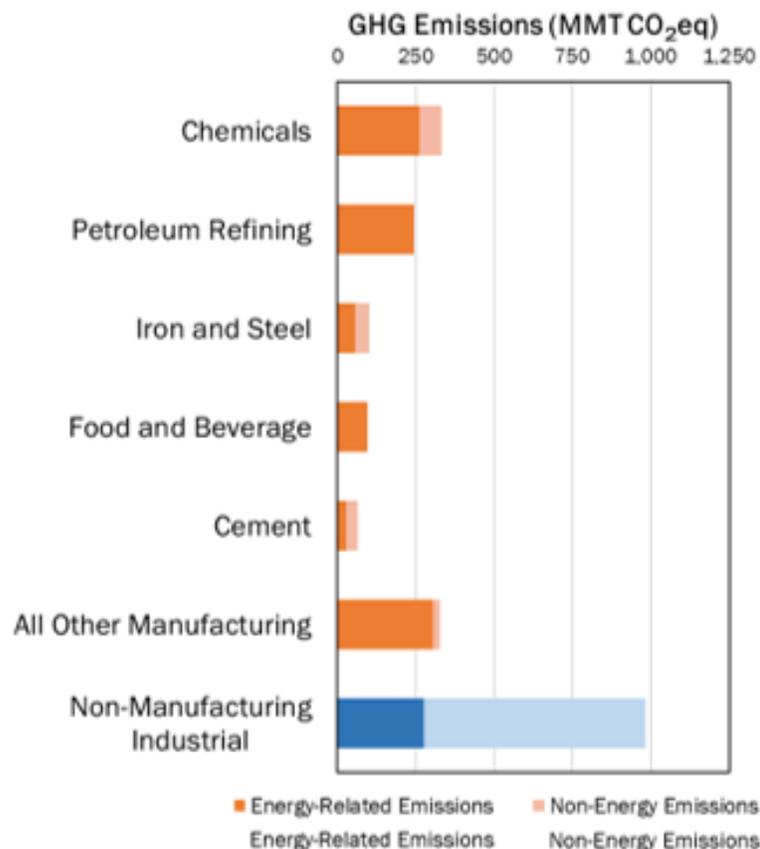
Mattie Gainer  
Strategic  
Communications Lead

# Energy- and Emissions-Intensive Industries



Dr. Paul Majsztik  
Program Manager

IEDO accelerates the readiness of emerging, industry-specific technologies to decarbonize the most energy- and emissions-intensive industrial subsectors.



## IRON AND STEEL

1,469 TBtu  
100 MMT CO<sub>2</sub>e



## CHEMICALS

(including production of low-carbon fuels)  
4,842 Tbtu  
332 MMT CO<sub>2</sub>e



## FOOD & BEVERAGE

1,935 TBtu  
96 MMT CO<sub>2</sub>e



## FOREST PRODUCTS

2,883 TBtu  
80 MMT CO<sub>2</sub>e



## CEMENT & CONCRETE

367 TBtu  
66 MMT CO<sub>2</sub>e

EIA Monthly Energy Review, Manufacturing Energy Consumption Survey; EPA GHGRP Inventory, DOE [Manufacturing Energy and Carbon Footprint](#),

# IEDO Priorities

Chemicals/Refining	Iron and Steel	Cement and Concrete	Food and Beverage	Forest Products
Sustainable Feedstocks (especially carbon)	Alternative reductants - hydrogen, ammonia for DRI/HBI; biomass for solid pig iron	Alternative binders and process routes to OPC	Low-carbon fuels or electrification for steam boilers	Increase biomass utilization
Low Carbon Fuels	Molten ore processing – molten oxide electrolysis; hydrogen plasma direct smelting	Carbon capture from limestone decarbonation	Low-temperature waste heat recovery from process exhausts	Low-carbon fuels for lime kilns
Low Carbon and Electrified Process Heating	Carbon Capture and Storage on Existing BF/BOF facilities	Clinker Substitutes	Alternative protein products	Low-carbon fuels or Electrification for steam boilers
Electrochemical reactors	Electrowinning - molten salts; aqueous	CO <sub>2</sub> mineralization	Smart/Flexible manufacturing processes	Energy efficient separations for concentrating liquor
Waste heat recovery	Low-carbon fuels and electrification for process heating, reheats	Waste heat recovery	Drying and dewatering innovations	Process Electrification
Carbon capture integration	Waste heat recovery	Electrification & low carbon fuels	Waste management and reduction	Carbon capture integration with boilers
High efficiency thermal reactors		Alternative building materials	Innovative cooling, refrigeration and freezing solutions	Drying and dewatering innovations
Advanced separations			Wastewater Recovery and Reuse	Increase fiber yield of pulping
Material reuse				Increasing solids content in paper forming

# IEDO Priorities

## Crosscutting: Carbon Capture, Utilization, and Storage (CCUS)



Chemicals/Refining	Iron and Steel	Cement and Concrete	Food and Beverage	Forest Products
Sustainable Feedstocks (especially carbon)	Alternative reductants - hydrogen, ammonia for DRI/HBI; biomass for solid pig iron	Alternative binders and process routes to OPC	Low-carbon fuels or electrification for steam boilers	Increase biomass utilization
Low Carbon Fuels	Molten ore processing – molten oxide electrolysis; hydrogen plasma direct smelting	<b>Carbon capture from limestone decarbonation</b>	Low-temperature waste heat recovery from process exhausts	Low-carbon fuels for lime kilns
Low Carbon and Electrified Process Heating	<b>Carbon Capture and Storage on Existing BF/BOF facilities</b>	Clinker Substitutes	Alternative protein products	Low-carbon fuels or Electrification for steam boilers
Electrochemical reactors	Electrowinning - molten salts; aqueous	CO <sub>2</sub> mineralization	Smart/Flexible manufacturing processes	Energy efficient separations for concentrating liquor
Waste heat recovery	Low-carbon fuels and electrification for process heating, reheats	Waste heat recovery	Drying and dewatering innovations	Process Electrification
<b>Carbon capture integration</b>	Waste heat recovery	Electrification & low carbon fuels	Waste management and reduction	<b>Carbon capture integration with boilers</b>
High efficiency thermal reactors		Alternative building materials	Innovative cooling, refrigeration and freezing solutions	Drying and dewatering innovations
Advanced separations			Wastewater Recovery and Reuse	Increase fiber yield of pulping
Material reuse				Increasing solids content in paper forming

# IEDO Priorities

## Crosscutting: Low-Carbon Fuels and Electrified Heating



Chemicals/Refining	Iron and Steel	Cement and Concrete	Food and Beverage	Forest Products
Sustainable Feedstocks (especially carbon)	Alternative reductants - hydrogen, ammonia for DRI/HBI; biomass for solid pig iron	Alternative binders and process routes to OPC	<b>Low-carbon fuels or electrification for steam boilers</b>	Increase biomass utilization
<b>Low Carbon Fuels</b>	Molten ore processing – molten oxide electrolysis; hydrogen plasma direct smelting	Carbon capture from limestone decarbonation	Low-temperature waste heat recovery from process exhausts	<b>Low-carbon fuels for lime kilns</b>
<b>Low Carbon and Electrified Process Heating</b>	Carbon Capture and Storage on Existing BF/BOF facilities	Clinker Substitutes	Alternative protein products	<b>Low-carbon fuels or Electrification for steam boilers</b>
Electrochemical reactors	Electrowinning - molten salts; aqueous	CO <sub>2</sub> mineralization	Smart/Flexible manufacturing processes	Energy efficient separations for concentrating liquor
Waste heat recovery	<b>Low-carbon fuels and electrification for process heating, reheats</b>	Waste heat recovery	Drying and dewatering innovations	Process Electrification
Carbon capture integration	Waste heat recovery	<b>Electrification &amp; low carbon fuels</b>	Waste management and reduction	Carbon capture integration with boilers
High efficiency thermal reactors		Alternative building materials	Innovative cooling, refrigeration and freezing solutions	Drying and dewatering innovations
Advanced separations			Wastewater Recovery and Reuse	Increase fiber yield of pulping
Material reuse				Increasing solids content in paper forming

# IEDO Priorities

## Crosscutting: Energy and Materials Efficiency



Chemicals/Refining	Iron and Steel	Cement and Concrete	Food and Beverage	Forest Products
Sustainable Feedstocks (especially carbon)	Alternative reductants - hydrogen, ammonia for DRI/HBI; biomass for solid pig iron	Alternative binders and process routes to OPC	Low-carbon fuels or electrification for steam boilers	Increase biomass utilization
Low Carbon Fuels	Molten ore processing – molten oxide electrolysis; hydrogen plasma direct smelting	Carbon capture from limestone decarbonation	<b>Low-temperature waste heat recovery from process exhausts</b>	Low-carbon fuels for lime kilns
Low Carbon and Electrified Process Heating	Carbon Capture and Storage on Existing BF/BOF facilities	Clinker Substitutes	Alternative protein products	Low-carbon fuels or Electrification for steam boilers
Electrochemical reactors	Electrowinning - molten salts; aqueous	CO <sub>2</sub> mineralization	<b>Smart/Flexible manufacturing processes</b>	Energy efficient separations for concentrating liquor
<b>Waste heat recovery</b>	Low-carbon fuels and electrification for process heating, reheats	<b>Waste heat recovery</b>	Drying and dewatering innovations	Process Electrification
Carbon capture integration	<b>Waste heat recovery</b>	Electrification & low carbon fuels	Waste management and reduction	Carbon capture integration with boilers
High efficiency thermal reactors		Alternative building materials	Innovative cooling, refrigeration and freezing solutions	Drying and dewatering innovations
Advanced separations			Wastewater Recovery and Reuse	Increase fiber yield of pulping
Material reuse				Increasing solids content in paper forming

# IEDO Priorities

## Crosscutting: Water Treatment and Management



Chemicals/Refining	Iron and Steel	Cement and Concrete	Food and Beverage	Forest Products
Sustainable Feedstocks (especially carbon)	Alternative reductants - hydrogen, ammonia for DRI/HBI; biomass for solid pig iron	Alternative binders and process routes to OPC	Low-carbon fuels or electrification for steam boilers	Increase biomass utilization
Low Carbon Fuels	Molten ore processing – molten oxide electrolysis; hydrogen plasma direct smelting	Carbon capture from limestone decarbonation	Low-temperature waste heat recovery from process exhausts	Low-carbon fuels for lime kilns
Low Carbon and Electrified Process Heating	Carbon Capture and Storage on Existing BF/BOF facilities	Clinker Substitutes	Alternative protein products	Low-carbon fuels or Electrification for steam boilers
Electrochemical reactors	Electrowinning - molten salts; aqueous	CO <sub>2</sub> mineralization	Smart/Flexible manufacturing processes	Energy efficient separations for concentrating liquor
Waste heat recovery	Low-carbon fuels and electrification for process heating, reheats	Waste heat recovery	<b>Drying and dewatering innovations</b>	Process Electrification
Carbon capture integration	Waste heat recovery	Electrification & low carbon fuels	Waste management and reduction	Carbon capture integration with boilers
High efficiency thermal reactors		Alternative building materials	Innovative cooling, refrigeration and freezing solutions	<b>Drying and dewatering innovations</b>
Advanced separations			<b>Wastewater Recovery and Reuse</b>	Increase fiber yield of pulping
Material reuse				Increasing solids content in paper forming

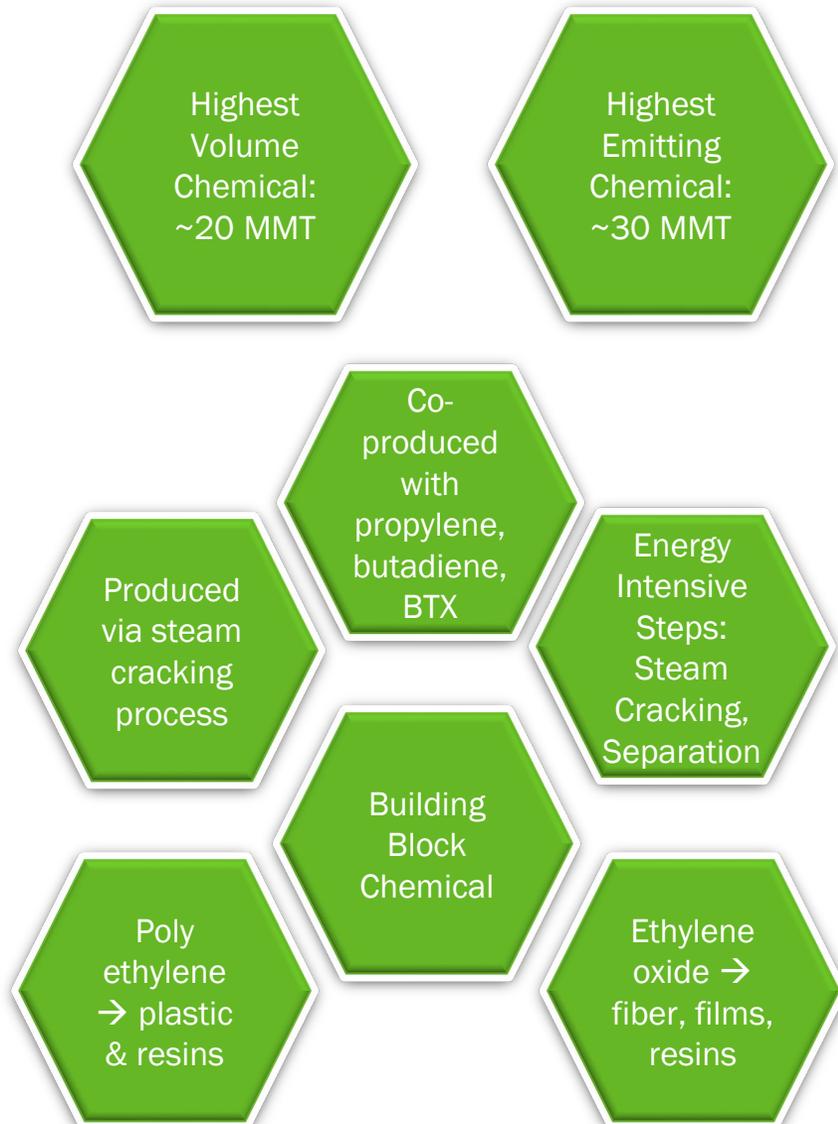
# IEDO Priorities

## Sector-Specific Innovations



Chemicals/Refining	Iron and Steel	Cement and Concrete	Food and Beverage	Forest Products
Sustainable Feedstocks (especially carbon)	Alternative reductants - hydrogen, ammonia for DRI/HBI; biomass for solid pig iron	Alternative binders and process routes to OPC	Low-carbon fuels or electrification for steam boilers	Increase biomass utilization
Low Carbon Fuels	Molten ore processing – molten oxide electrolysis; hydrogen plasma direct smelting	Carbon capture from limestone decarbonation	Low-temperature waste heat recovery from process exhausts	Low-carbon fuels for lime kilns
Low Carbon and Electrified Process Heating	Carbon Capture and Storage on Existing BF/BOF facilities	Clinker Substitutes	Alternative protein products	Low-carbon fuels or Electrification for steam boilers
Electrochemical reactors	Electrowinning - molten salts; aqueous	CO <sub>2</sub> mineralization	Smart/Flexible manufacturing processes	Energy efficient separations for concentrating liquor
Waste heat recovery	Low-carbon fuels and electrification for process heating, reheats	Waste heat recovery	Drying and dewatering innovations	Process Electrification
Carbon capture integration	Waste heat recovery	Electrification & low carbon fuels	Waste management and reduction	Carbon capture integration with boilers
High efficiency thermal reactors		Alternative building materials	Innovative cooling, refrigeration and freezing solutions	Drying and dewatering innovations
Advanced separations			Wastewater Recovery and Reuse	Increase fiber yield of pulping
Material reuse				Increasing solids content in paper forming

# Chemicals Example: Decarbonization of Ethylene



## Decarbonization Pathways

### Feedstock

- CO<sub>2</sub> via thermal or electrochemical pathways
- Biomass via thermal or enzymatic pathways
- CH<sub>4</sub> via oxidative coupling of methane
- Material reuse, plastic upcycling

### Process Heating: Steam Cracking

- Electrification of steam cracker via electrified steam, rotary olefin cracker
- Electrochemical CO<sub>2</sub> conversion
- Photocatalytic conversion

### Process Heating: Separations

- Membranes (non-thermal separations)
- Avoid separations through optimized selectivity

### Reduced Demand

- Direct conversion of feedstock to end product



>85% net reduction vs. fossil-based sources

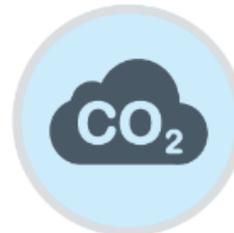


2035

## 2050 Resource Supply



1,050 MMT biomass and waste



450 MMT CO<sub>2</sub>



...can be converted into...



>400 MMT\* fuels and chemicals



\*This Shot assumes that 50% of marine, rail, off-road, hydrocarbon chemicals and 100% of aviation demand will be met by hydrocarbon fuels in 2050.

# Cross-Sector Technologies

The Cross-Sector Technologies subprogram accelerates the readiness of energy- and emissions-reducing components, systems, and operational technologies, across a broad range of industries.



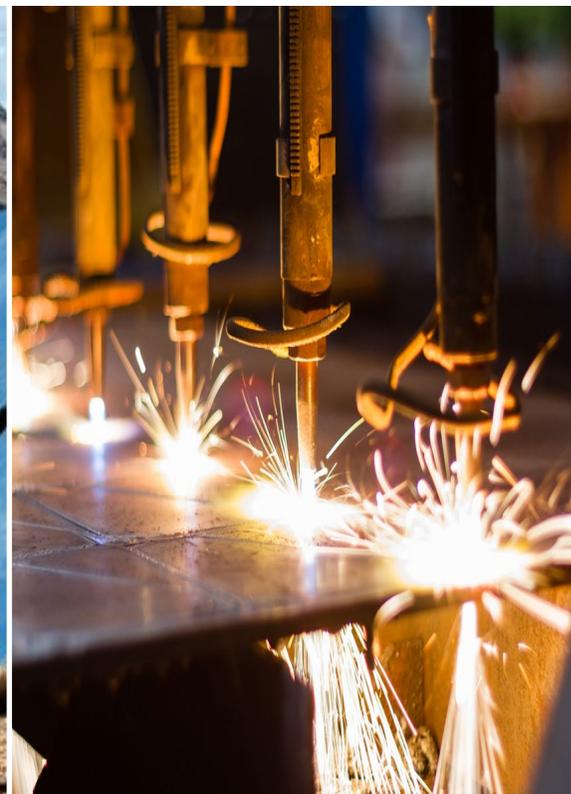
Isaac Chan  
Program Manager



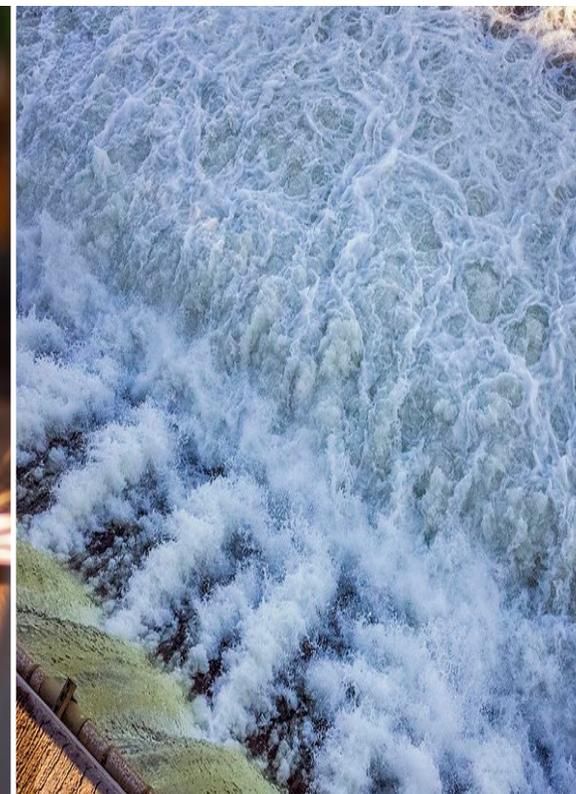
Thermal Process  
& Systems



Low-Carbon Fuels,  
Feedstocks, & Energy Sources



Emerging Efficiency



Water & Wastewater  
Treatment

# Tackling Emissions from Industrial Heat Across the Industrial Sector

Develop cost competitive industrial heat decarbonization technologies with:

   
> 85% Lower Emissions 2035



**drying**  
paper,  
batteries



**steam**  
pasteurized food

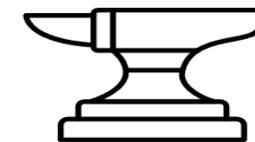


**distillation**  
high purity  
chemicals



**melting**  
formed plastics,  
semiconductors

**smelting**  
iron, copper,  
vehicle bodies



**calcining**  
cement,  
fuel cell catalysts



Industrial Heat Shot

# IEDO Activities in support of the Industrial Heat Shot



Generate Heat  
from Clean Electricity

Electrification of Process Heat: Develop and support innovation ecosystem to accelerate development and deployment of eletrotechnologies, including heat pumps



Innovative Low- or No-Heat  
Process Technologies

Priorities include low thermal budget processes and no-heat separation technologies



Integrate Clean Heat  
from Alternative Sources

Priorities include thermal energy storage, low-carbon fuels, such as hydrogen and bio-based

# Arizona State University to Lead New DOE Institute Focused on Electrifying Process Heat

- The Electrified Processes for Industry without Carbon (EPIX) Institute is DOE's 7th Clean Energy Manufacturing Innovation Institute.
- EPIX will:
  - Allocate up to \$70M in federal funding over the next 5 years to fund RD&D projects to electrify process heating.
  - Mobilize a multisector coalition of private companies, National Labs, universities, labor unions, and community partners to create an innovation ecosystem.
  - Bridge the gap between research and commercialization to move novel electrification processes out of the lab and into the market.



ELECTRIFIED PROCESSES FOR  
INDUSTRY WITHOUT CARBON



# IEDO's Technical Assistance Efforts

**Technical Assistance:** Partners with and enables industry to accelerate the adoption of technologies, programs, and best practices that improve efficiency and decarbonization.

**Workforce Development:** Promotes the development of a diverse mix of new workers and upskills existing workers for the industrial jobs of today and the future.



Anne Hampson  
Program Manager



Public /private partnerships to help industrial organizations set and achieve energy intensity reduction goals



Education and training for the current and future manufacturing workforce



No-cost tools and resources for manufacturers to reduce GHG emissions and improve energy efficiency and competitiveness



End-user support, stakeholder engagement, and technical services for the industrial sector

**PROGRAMS INCLUDE:** ONSITE ENERGY | PROGRAM 50001 | READY & SEP 50001 | WORKFORCE DEVELOPMENT

# Why Companies Join Better Plants

## Market Leadership

### Developing Innovative, Replicable Solutions with Market Leaders

- National Recognition
- Peer to Peer Networking
- Better Building Solutions Center

## Technical Assistance

### Making Energy Efficient Investments Easier

- Technical Account Managers
- Software tools for energy management and analysis
- Financing Navigator
- Diagnostic Equipment Program
- Technical Publications

## Access to Innovation

### Innovation to Drive Savings

- DOE National Lab Visits
- Industrial Technology Validation

## Workforce Development

### Helping You Meet Your Challenges of Today, and Tomorrow

- In-Plant Trainings
- Virtual trainings
- Energy and Decarbonization bootcamps



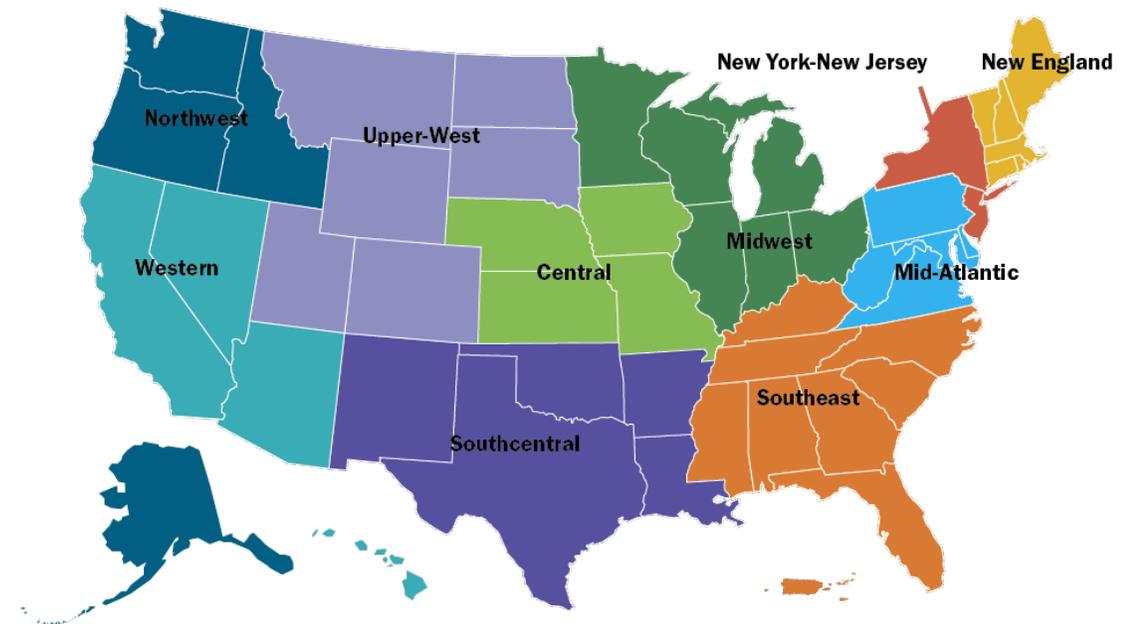
# IEDO Onsite Energy Program

The Onsite Energy Program is a new initiative to provide technical assistance for industrial facilities and other large energy users to increase the adoption of onsite clean energy technologies.

battery storage | combined heat and power | district energy | geothermal |  
industrial heat pumps | renewable fuels | solar PV | solar thermal | thermal storage | wind

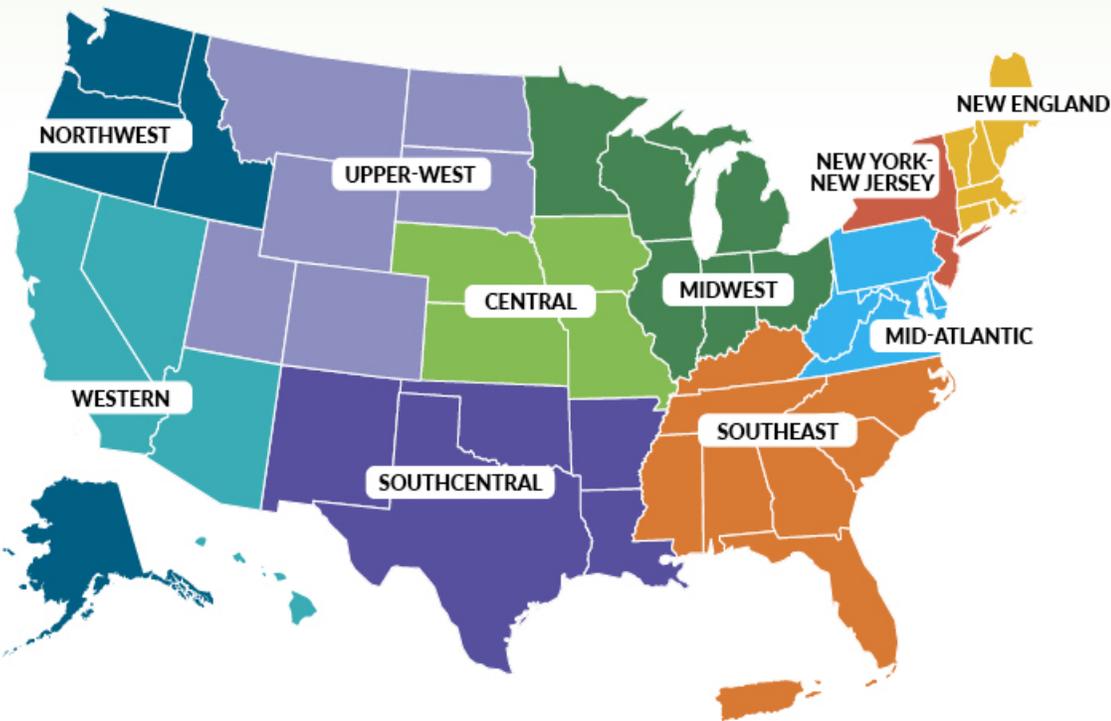
**The Onsite Energy Program will establish a regional network of Technical Assistance Partnerships (TAPs) to help:**

- Deploy onsite renewable energy and storage technologies
- Identify cost-effective options for achieving clean energy targets
- Highlight pathways for accelerating the integration of onsite clean energy technologies
- Reduce greenhouse gas emissions while prioritizing energy justice and workforce development



## DEPARTMENT OF ENERGY SELECTS

# Nine Organizations to Implement Onsite Energy Technical Assistance Partnerships to Decarbonize America's Industrial Sector



**Northwest**  
AK, ID, OR, WA

Washington State University  
Energy Program

**Midwest**  
IL, IN, MI, MN, OH, WI

University of Illinois Chicago

**New York-New Jersey**  
NY, NJ

Pennsylvania State University

**Western**  
AZ, CA, HI, NV

Optony Inc.

**Central**  
IA, KS, MO, NE

University of Illinois Chicago

**New England**  
CT, MA, ME, NH, RI, VT

University of New Hampshire

**Upper-West**  
CO, MT, ND, SD, UT, WY

Cascade Energy, Inc.

**Southeast**  
AL, FL, GA, KY, MS, NC, PR, SC, TN, VI

North Carolina State University

**National Selection**

University of Connecticut

**Southcentral**  
AR, LA, NM, OK, TX

Houston Advanced Research  
Center

**Mid-Atlantic**  
DC, DE, MD, PA, VA, WV

Pennsylvania State University



U.S. DEPARTMENT OF **ENERGY** | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY  
INDUSTRIAL EFFICIENCY & DECARBONIZATION OFFICE

# Industrial Efficiency and Decarbonization FOA

Announced June 15: 40 Projects Across 21 States Will Advance Technologies to Decarbonize American Industry and Help Create Good-Paying Jobs

- Decarbonizing Chemicals (*9 projects, \$38.3 million*)
- Decarbonizing Iron and Steel (*10 projects, \$31.9 million*)
- Decarbonizing Food and Beverage Products (*3 projects, \$11.4 million*)
- Decarbonizing Cement and Concrete (*5 projects, \$16.4 million*)
- Decarbonizing Paper and Forest Products (*6 projects, \$16.2 million*)
- Cross-Sector Decarbonization Technologies (*7 projects, \$20.4 million*)

Full project descriptions here: <https://www.energy.gov/eere/iedo/funding-selections-industrial-efficiency-and-decarbonization-foa-0>

# Fiscal Year 2023 Multi-topic FOA

## March 2023: IEDO Announced \$156 Million for Applied Research and Development Projects to Drive Industrial Decarbonization

The FOA builds on the findings from the Industrial Decarbonization Roadmap and seeks projects in multiple topics:

- Topic 1: Decarbonizing Industrial Heat
- Topic 2: Low-Carbon Fuels Utilization RD&D
- Topic 3: Exploratory Cross-Sector R&D
- Topic 4: Decarbonizing Chemicals
- Topic 5: Decarbonizing Iron and Steel
- Topic 6: Decarbonizing Food and Beverage Products
- Topic 7: Decarbonizing Cement and Concrete
- Topic 8: Decarbonizing Forest Products



**Mandatory Concept Papers Due:**

**April 17, 2023**

**Full Applications Due:**

**June 23, 2023**

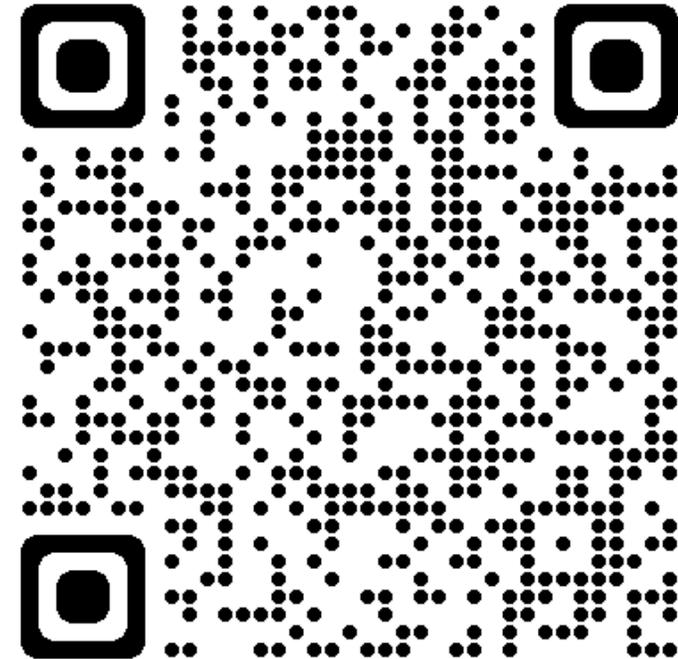
**Selections Anticipated:**

**September 2023**

# IEDO is Hiring - Join Our Team!

## Current IEDO Career Opportunities

- Cross-Sector Industrial Decarbonization Technologies Technology Manager (Process Heating)
- Energy- and Emissions Intensive Industries Sr. Technology Manager (Iron/Steel)
- Energy- and Emissions-Intensive Industries Technology Manager (Cement/Concrete)
- Technical Assistance and Workforce Development Technology Manager



Interested in applying?

Visit our careers page or scan the QR code:

<https://www.energy.gov/eere/iedo/iedo-careers>

Email: [IEDOJobs@ee.doe.gov](mailto:IEDOJobs@ee.doe.gov)

# Thank You!

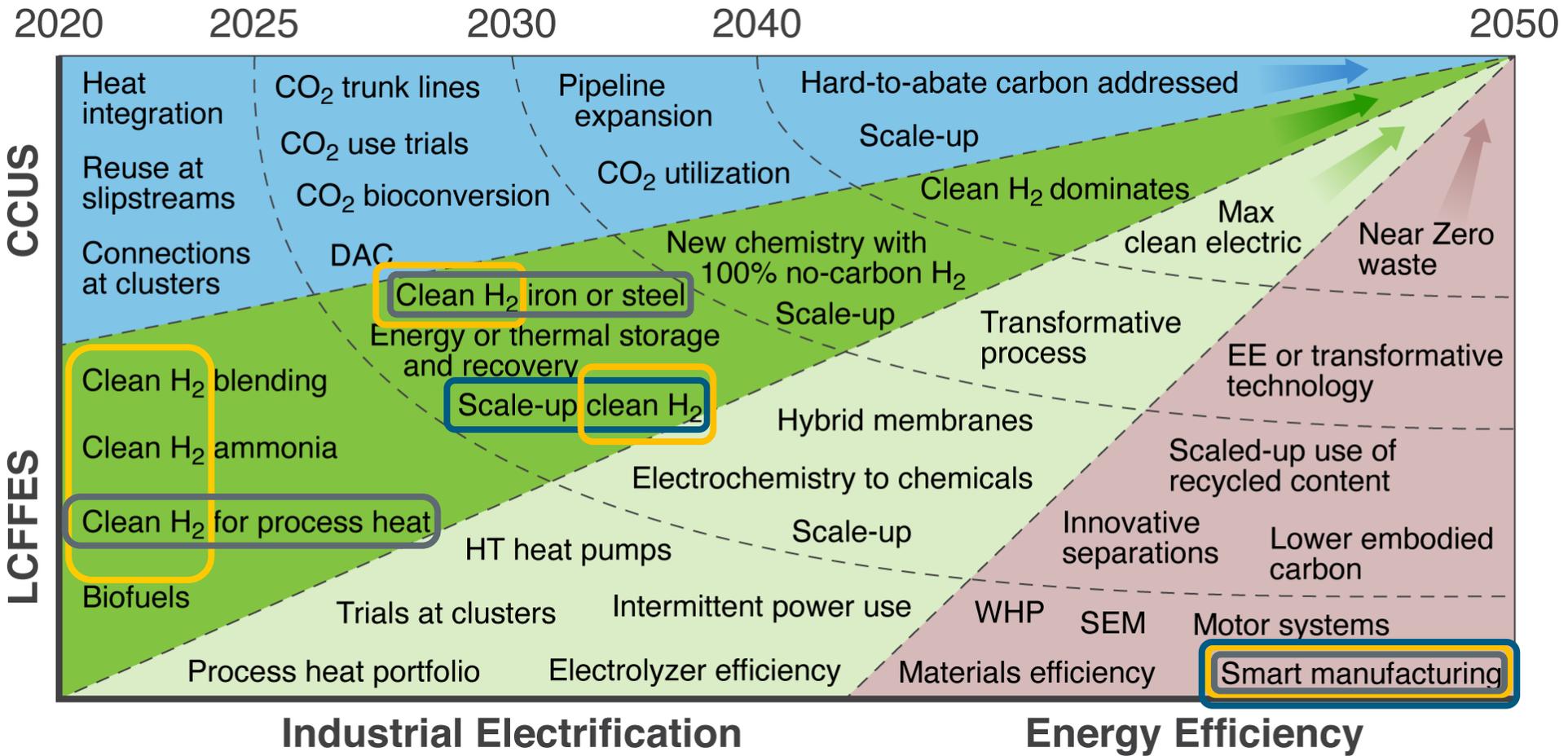
Subscribe to our newsletter “The Production Line” to get the latest information on:

- Announcements
- Funding opportunities
- Events
- Tool and resources
- And more!

To sign up visit: <https://www.energy.gov/eere/iedo/subscribe-iedo-newsletter>



# Industrial Decarbonization is also a systems challenge



Industrial GHGs require approaches at multiple levels:

- Core process
- Facility
- Beyond plant bounds

- What are the implications of:
- Expanded H<sub>2</sub> generation & use
  - New thermal energy sources & systems
  - Smart manufacturing, automation, & data analytics
  - Transition to clean electricity
  - Policies

Landscape of major RD&D investment opportunities for industrial decarbonization between now and 2050.  
 LCFES = Low Cost Fuels, Feedstocks, and Energy Sources; CCUS = Carbon Capture Utilization and Storage  
 Source: [Industrial Decarbonization Roadmap](#)

# Overview of 48C Round 1 (2023)

## What is the Qualifying Advanced Energy Project 48C Credit?

- Competitively-awarded Investment Tax Credit (ITC) established in 2009 and functions very similar to FOA
- Expanded by IRA with **\$10B** for (1) clean energy manufacturing & recycling, (2) critical materials, and (3) industrial GHG emissions reduction projects
- Projects receive 30% ITC (or 6% if prevailing wage and apprenticeship requirements not met)
- DOE will accept a first round of applications in 2023 to allocate up to \$4B, with additional competitive application rounds in future years
- Approximately 40% of credits (\$1.6B) will be allocated to projects in coal communities (if sufficient meritorious applications are received)

### Legend

- Scope defined by ARRA in 2009
- Scope added by IRA

### Clean Energy Manufacturing and Recycling

- Re-equip, expand, or establish Industrial or manufacturing facility for production or recycling of clean energy and energy efficiency technologies

### Critical Materials Processing, Refining, and Recycling

- Re-equip, expand, or establish an industrial facility to process, refine, or recycle critical materials (50 USGS minerals + DOE critical materials)

### Industrial GHG Emissions Reductions

- Re-equips industrial or manufacturing facility to reduce greenhouse gas emissions by at least 20%

## Timeline and Review

- **Notice Released:** May 31
- **Informational Webinar:** June 27
- **Concept Papers Due:** July 31
- **Full Applications Due:** Fall 2023

DOE will evaluate proposals against technical review criteria reflecting four major priority measures, and pass recommendations to Treasury:

1. Commercial Viability
2. Greenhouse Gas Emissions Impacts
3. Strengthening U.S. Supply Chains and Domestic Manufacturing for a Net-Zero Economy
4. Workforce and Community Engagement

With merit review scores plus program policy factors DOE will rank all meritorious projects into a final list for up to \$4 billion in allocations for IRS

**Allocation Decisions:** No later than March 31, 2024



# Program Update: Industrial Demonstrations Program

The Industrial Demonstrations Program offers up to **\$6 billion** for transformational, advanced industrial facilities that can achieve deep decarbonization in energy intensive industrial subsectors.

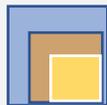
## Project Types



**Near-Net-Zero Facility Builds**



**Facility-level Installations and Overhaul Retrofits**



**System Upgrades and Retrofits for Critical Unit Operations or Single Process Lines**

## Program Priorities

**Deep decarbonization**, by demonstrating significantly less carbon-intensive industrial production processes

**Timeliness**, through rapid technology demonstrations that can address emissions in the near-term, meet funding horizons, and be replicated by fast followers

**Market viability**, with projects spurring follow-on investments and partnerships between buyers and sellers of materials

**Community benefits**, tailored through labor and community engagement; diversity, equity, inclusion, and accessibility; environmental justice; and opportunities for communities



6/1

Encourage / Discourage Notifications



8/11 @ 5 p.m. ET

Applications Due



Winter 2023/2024

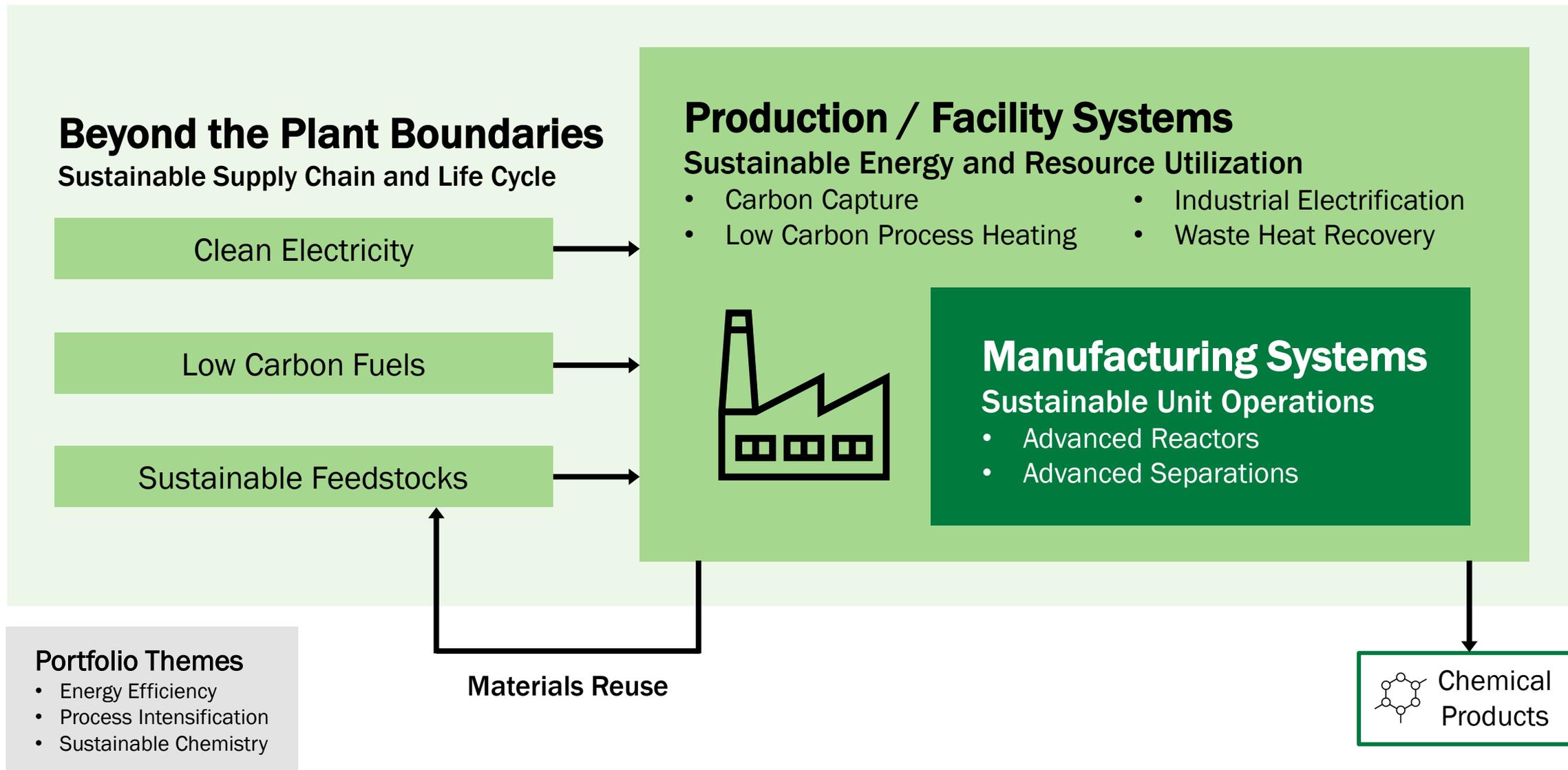
Selections Announced



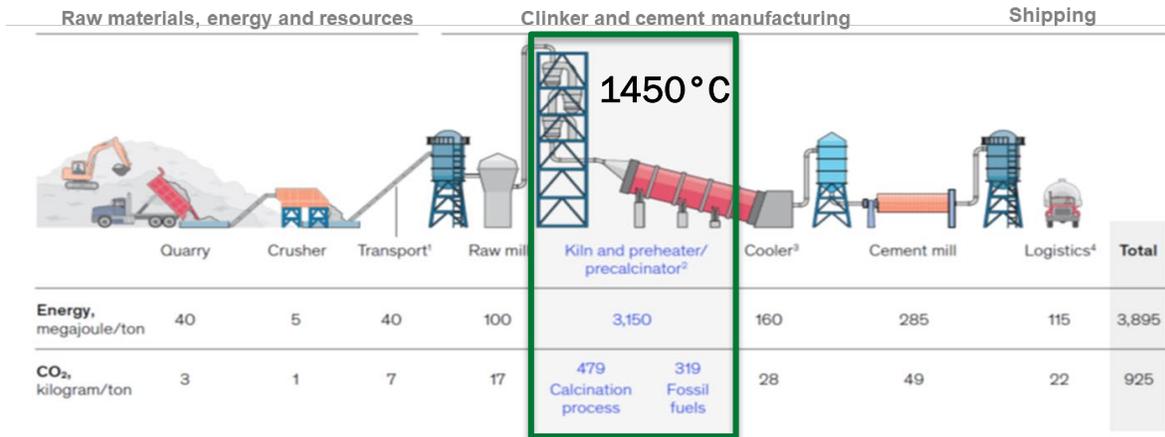
**OCED**

Office of Clean Energy Demonstrations

# IEDO Strategies for Chemicals Sector Decarbonization



# Cement and Concrete Example



## Feedstocks

- Cement Clinker: Limestone (CaCO<sub>3</sub>) + Sand/Clay/Shale (**local**)
- Concrete: Cement, sand, gravel, water (**local materials**)
- Fuel: Coal/waste oil/tires/trash (kiln heating)

## Cement (Clinker) Process

- Limestone calcination (CaCO<sub>3</sub> → CaO + CO<sub>2</sub>)
- High-temperature pyro-process (1450°C) to form cement phases
- Process emissions (~60%) and fuel (~40%) → ~90% of cement CO<sub>2</sub>

# Decarbonization Pathways

## Cement/concrete formulation

- Replace clinker with SCMs & fillers (mineral substitutes)
- Alternative cement formulations (limestone calcined clay)
- Concrete mix design optimization

## Cement Process

- Alternative fuels/electric (doesn't address process emissions)
- Alternative chemical process
- CCUS

## Alternative Cement/Binder

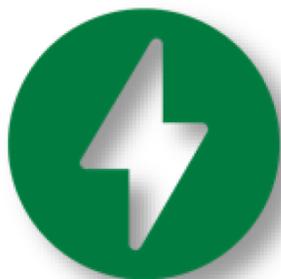
- Novel alternative cement chemistry & raw materials

## CO<sub>2</sub> Mineralization

- CO<sub>2</sub> cured concrete & SCMs

# Better Plants Impact

**280+** partners  
**> 3,500** facilities  
**74** goals achieved



**2.2 QBTU**  
of energy saved



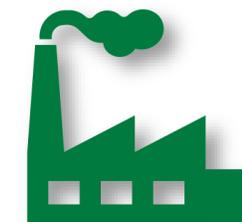
**1.8%**  
average annual  
energy intensity  
improvement rate



**\$10.6 billion**  
saved



**131 million**  
metric tons of CO<sub>2</sub> saved



**14%**  
of the U.S.  
manufacturing footprint