



# IEDO Cross-Sector Technologies (CST) Subprogram Overview

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Industrial Efficiency and Decarbonization Office

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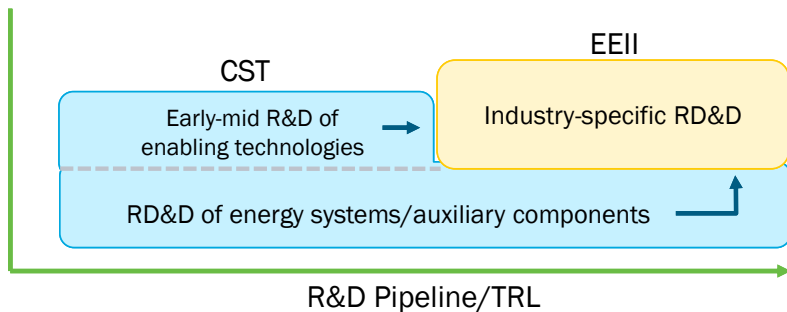
Washington, D.C.



# Cross-Sector Technologies within IEDO RD&D

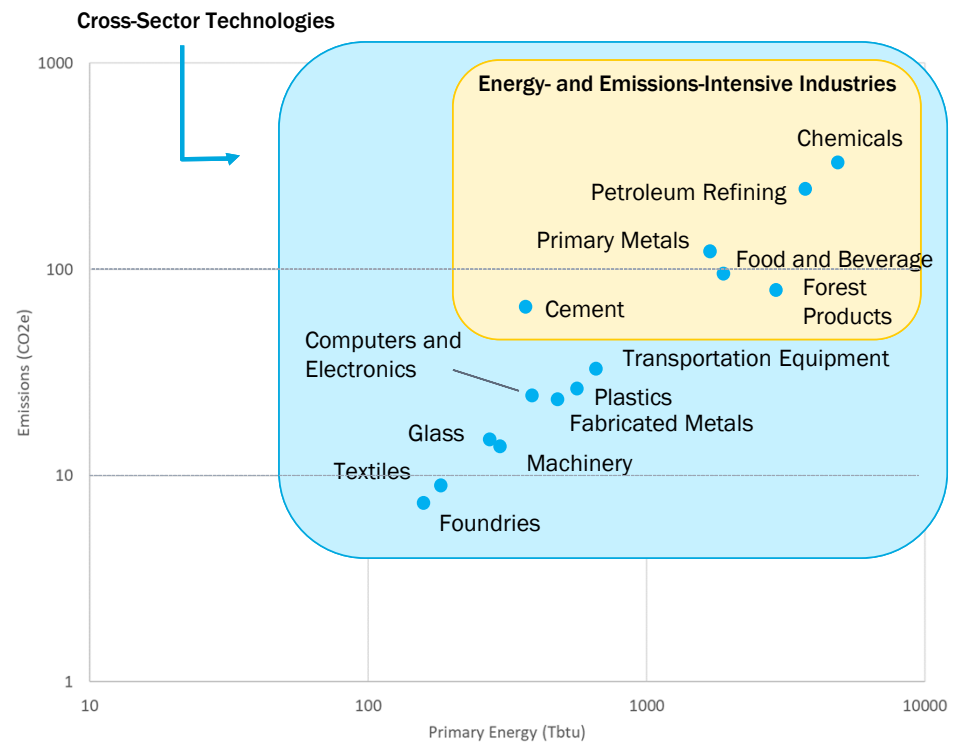
Accelerates the readiness of component and equipment technologies with decarbonization impact across multiple industries.

- Prioritize equipment that can be integrated with existing processes.  
Enabling technologies developed under CST (mid-TRL) that present integration challenges in industry-specific applications can be further advanced under EEII.
- Advance energy systems and auxiliary components, e.g., waste heat recovery, sensors and controls, thermal energy storage (CST only).
- Develop emerging, next-generation production technologies.



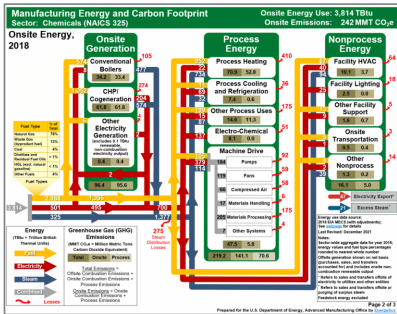
A significant number of energy and emissions reduction challenges are common across all industrial subsectors.

## IEDO RD&D Landscape



Manufacturing Energy and Carbon Footprints, DOE AMO, 2022.

# Key Insights from Stakeholder Engagement and Analysis



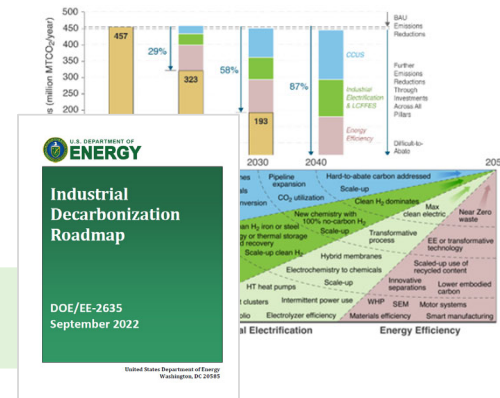
## Manufacturing Energy and Carbon Footprints

Analytical basis to identify cross-cutting opportunities through mapping of energy and emissions by manufacturing end-use

- Process heating is the largest source of end-use energy
- >60% of energy consumed in the manufacturing sector is from fossil fuels

## Industrial Decarbonization Roadmap

Key cross-cutting opportunities, including scaling of electrotechnologies, enabling technologies for hydrogen as a LCCFES, and thermal energy storage



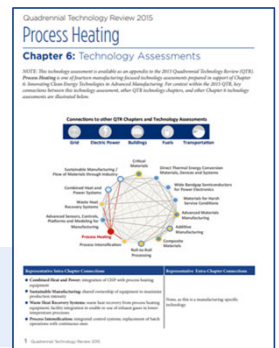
## Thermal Process Intensification (TPI) Workshop

R&D needs for thermal processing systems, including:

- Increasing use of electrotechnologies and systems utilizing low carbon fuels
- Development and use of smart manufacturing technologies
- Improvements to waste heat management systems
- Materials R&D for next generation thermal systems

## DOE Quadrennial Technology Review 2015

R&D opportunities for process heating technologies, including next-generation heat generation systems, sensors and controls, and modeling and simulation.

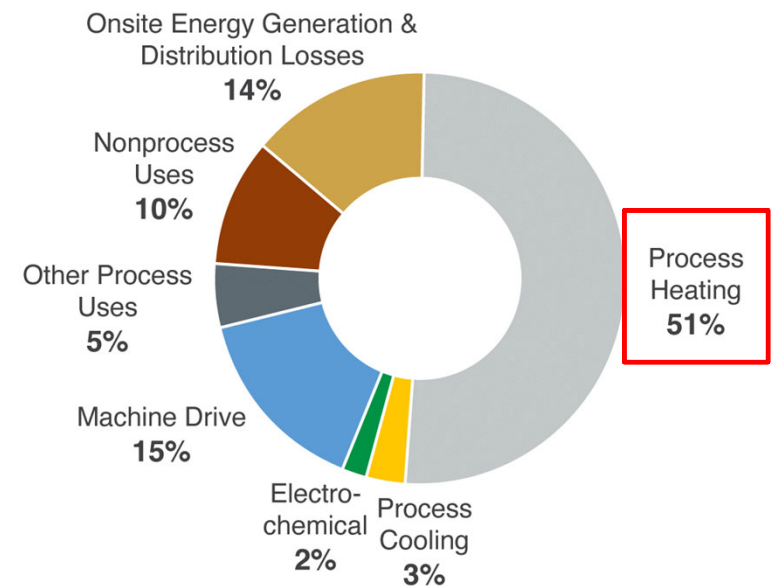


# Key Opportunities for Cross-sector Decarbonization

## Process heating

- Largest opportunity for cross-sector impact.
- Accounts for 51% of manufacturing energy use, >90% of this energy is from fossil-fuels.<sup>1</sup>
- Technologies that reduce heating requirements or convert to electric heating are critical to decarbonization.

**Breakdown of Energy Use Onsite at Manufacturing Facilities, 2018<sup>2</sup>**



<sup>1</sup>Decarbonization Roadmap

<sup>2</sup>Manufacturing Energy and Carbon Footprint, 2018

# Key Opportunities for Cross-sector Decarbonization

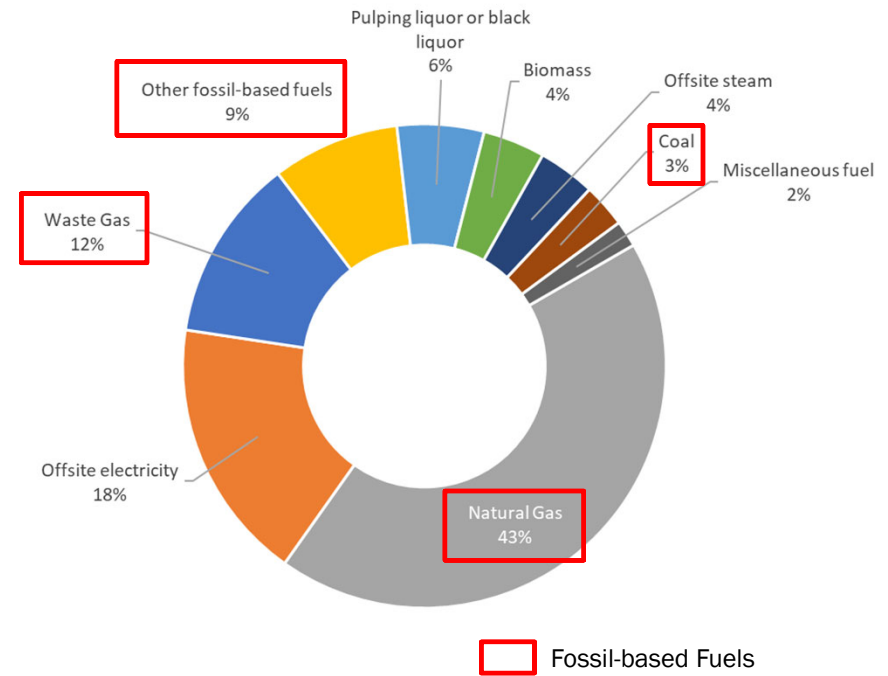
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## Low carbon fuels, feedstocks, and energy sources

- Displace the need for all fossil energy end uses—particularly process heating, onsite generation, and machine drives.
- Bio-derived fuels, waste/byproducts, energy storage systems, and H<sub>2</sub> use can reduce fossil fuel and offsite electricity demand.

**Breakdown of Energy Sources at Manufacturing Facilities, 2018<sup>2</sup>**



<sup>1</sup>Decarbonization Roadmap

<sup>2</sup>Manufacturing Energy and Carbon Footprint, 2018

# Key Opportunities for Cross-sector Decarbonization

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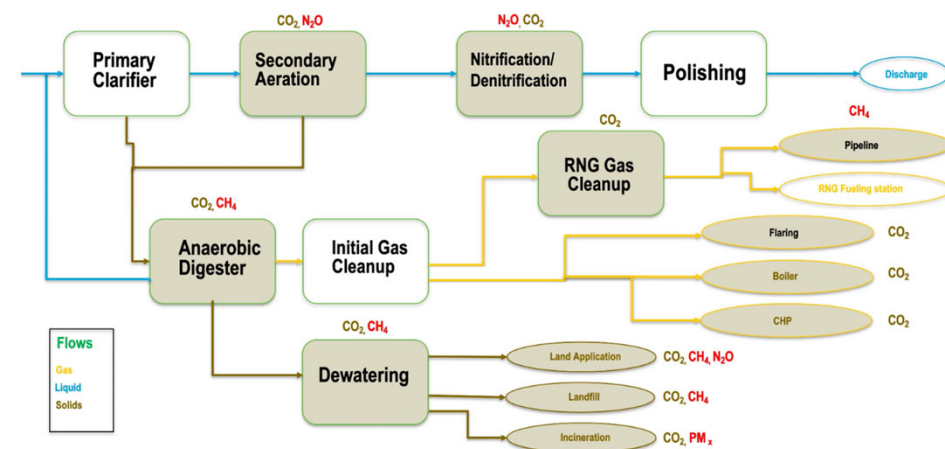
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## Water and wastewater treatment

- Nearly all industrial operations consume water and produce wastewater.
- Wastewater treatment from municipal, industrial, and agricultural sources is a major source of energy-related and other GHG emissions (CH<sub>4</sub> and NO<sub>x</sub>). These emissions are tracked separately from manufacturing emissions.

Block Flow Diagram of Wastewater Treatment Process



Sources of emissions shown in brown colored boxes

# Key DOE Initiative: Industrial Heat Shot



## Cross-Sector Technologies activities will support the Industrial Heat Shot

### CST Alignment



Generate Heat  
from Clean Electricity

Thermal Processes and Systems – Institute 7: Electrification of Process Heat. Leverage the Institute model to establish an innovation ecosystem to accelerate development and deployment of eletrotechnologies.



Innovative Low- or No-Heat  
Process Technologies

Thermal Processes and Systems – Priorities include low thermal budget processes, no-heat separation technologies, heat pumps. Funded through FOAs.



Integrate Clean Heat  
from Alternative Sources

Low-carbon Fuels, Feedstocks, and Energy Sources; Emerging Technologies – Priorities include thermal energy storage, low-carbon fuels, such as hydrogen and bio-based. Funded through FOAs.

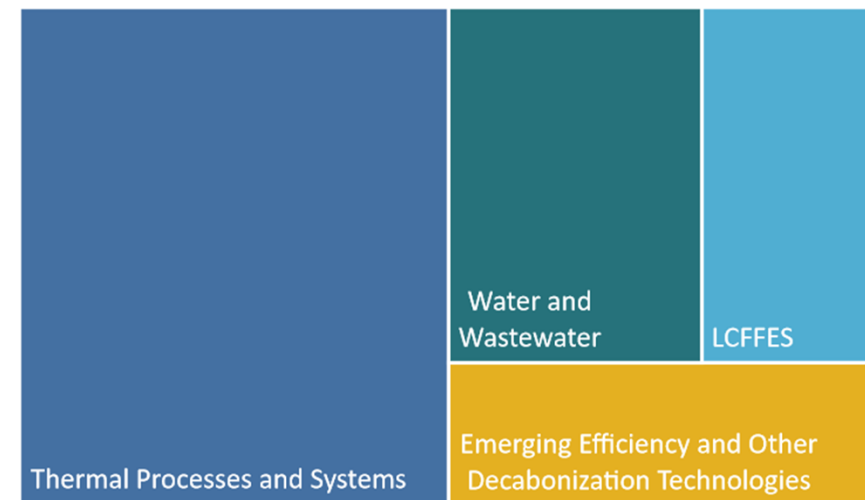
# CST Program Priorities and Budget Structure

## Industrial Decarbonization is a decades-long journey.

- DOE-wide initiatives, inter-office working groups, analysis, and stakeholder technical workshops will continue to refine and inform future priorities.

Key Activity and FY23 Priorities
<p><b><i>Thermal Processes and Systems</i></b></p> <ul style="list-style-type: none"> <li>• Electrification</li> <li>• Innovative low- and no-heat processes</li> </ul>
<p><b><i>Low Carbon Fuels, Feedstocks, and Energy Sources (LCFFES)</i></b></p> <ul style="list-style-type: none"> <li>• Enable use of low carbon fuels and feedstocks, including H<sub>2</sub>, bio-derived fuels.</li> <li>• Flexible CHP</li> </ul>
<p><b><i>Emerging Efficiency and Other Decarbonization Technologies</i></b></p> <ul style="list-style-type: none"> <li>• Flexible industrial energy use</li> <li>• Thermal energy storage</li> </ul>
<p><b><i>Energy &amp; Emissions Reductions from Water and Wastewater Treatment</i></b></p> <ul style="list-style-type: none"> <li>• Decarbonization of water resource recovery facilities</li> </ul>

CST Budget Breakdown\*  
FY24 Request: \$141M



\*Relative size of investment



## Key Next Steps: FOAs

- Setting up Institute 7.
- FY22 IE&D FOA selections forthcoming.
- Execute ongoing FOAs.

Status	WRRF <sup>1</sup>	FY23 MT FOA
Approximate Federal Funding	\$23M	\$42.4M (for CST)
Anticipated Number of Awards	7-8	12-21 (for CST)
Schedule		
FOA Issue	Complete ✓	Complete ✓
Concept Paper Submission	Complete ✓	Complete ✓
Full Application Submission	Complete ✓	6/23/23 – ongoing
Selection Notification	6/16/23	September 2023
Award Negotiation	Summer-Fall 2023	September – December 2023

<sup>1</sup>WRRF – water resource recovery facility

# Key Next Steps: Stakeholder Engagement and Analysis

**Stakeholder Workshops: Engage industry (small, medium, large), academia, National Laboratories, and non-profits to continue to inform CST program priorities.**

**Analysis: Continue to identify opportunities for cross-sector RD&D.**

Subprogram Topic Area	Objective	Tentative Date
Thermal Processes and Systems	Discuss challenges and R&D opportunities for low-carbon process heating.	May 2023
Emerging Technologies	Identify R&D opportunities and its associated challenges and metrics for next-generation cross-sector technologies.	May 2023
CHP	Discuss emerging opportunities for CHP in the industrial sector.	May 2023
LCFFES	Discuss challenges, R&D opportunities, and metrics for hydrogen and non-hydrogen LCFFES.	Q4 FY23
Water/Wastewater	Identify approaches to evaluate GHG emissions from WRRF.	Q4 FY23

Subprogram Topic Area	Analysis and Objective
LCFFES	Biofuel and Biomass Combustion: Evaluate characteristics, challenges, and opportunities for biofuel and biomass combustion as a fossil fuel replacement.
LCFFES	Boundary Conditions Assessment: Define appropriate boundary conditions of industrial processes to better describe opportunity space, e.g., what materials can be tolerated, what temperature range is acceptable?
Emerging Technologies	Waste Heat Recovery: Refine/iterate on existing analysis to frame IEDO priorities for waste heat.
Emerging Technologies	Thermal Energy Storage: Build off the Energy StorM workshop, defining the opportunities and priorities for the office.
Process Heating	Electro-Technologies Inventory: Inventory of existing and emerging electro-technologies and key equipment manufacturers. Working in collaboration with IEDO Strategic Analysis team (e.g., ORNL).
Water/ Wastewater	GHG Analysis for WRRF: Estimate GHG emissions from WRRFs, led by NREL and LBNL. Complements workshop planned for Q3 FY23.



# Thank you

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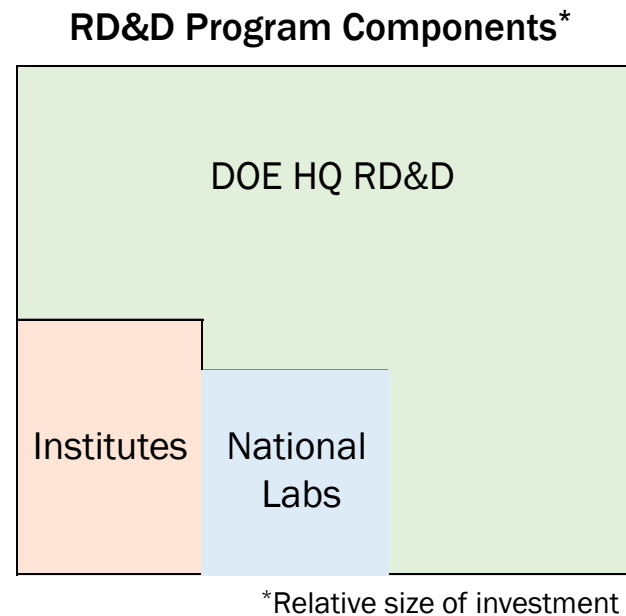


Back-up

# RD&D Program Execution

Complementary RD&D components are leveraged to accelerate development and industrialization of cross-sector technologies.

DOE HQ	Primary mechanism for applied R&D / pilot-scale demonstration; largest source of funding.	FOA SBIR/STTR	FY22: IE&D and WRRF FOAs; SBIR/STTR FY23: MT FOA; SBIR/STTR
Institutes	Collaborative R&D with academia, National Labs, and industry; testbed for concepts and components.	Institute FOA	Institute 7 Award NAWI
National Laboratories	Industrialize technologies and early market transition; leveraging institutional technical expertise and resources.	Lab Call AOP	FY22 TCF Lab Call AOP (annual)



**IE&D:** Industrial Efficiency and Decarbonization; **WRRF:** Water Resource Recovery Facility; **MT FOA:** Multi-topic Funding Opportunity Announcement; **SBIR/STTR:** Small Business Innovation Research/Small Business Technology Transfer; **NAWI:** National Alliance for Water Innovation; **TCF:** Technology Commercialization Fund; **AOP:** Annual Operating Plan