Industrial Decarbonization and U.S. DOE Technical Assistance to Implement Decarbonization Strategies

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Agenda

- Decarbonizing the Industrial Sector
- U.S. DOE “Industrial Decarbonization Roadmap”
- No-Cost U.S. DOE Technical Assistance Resources through UIC
- $300K DOE IAC Implementation Grant for Industrial Manufacturers

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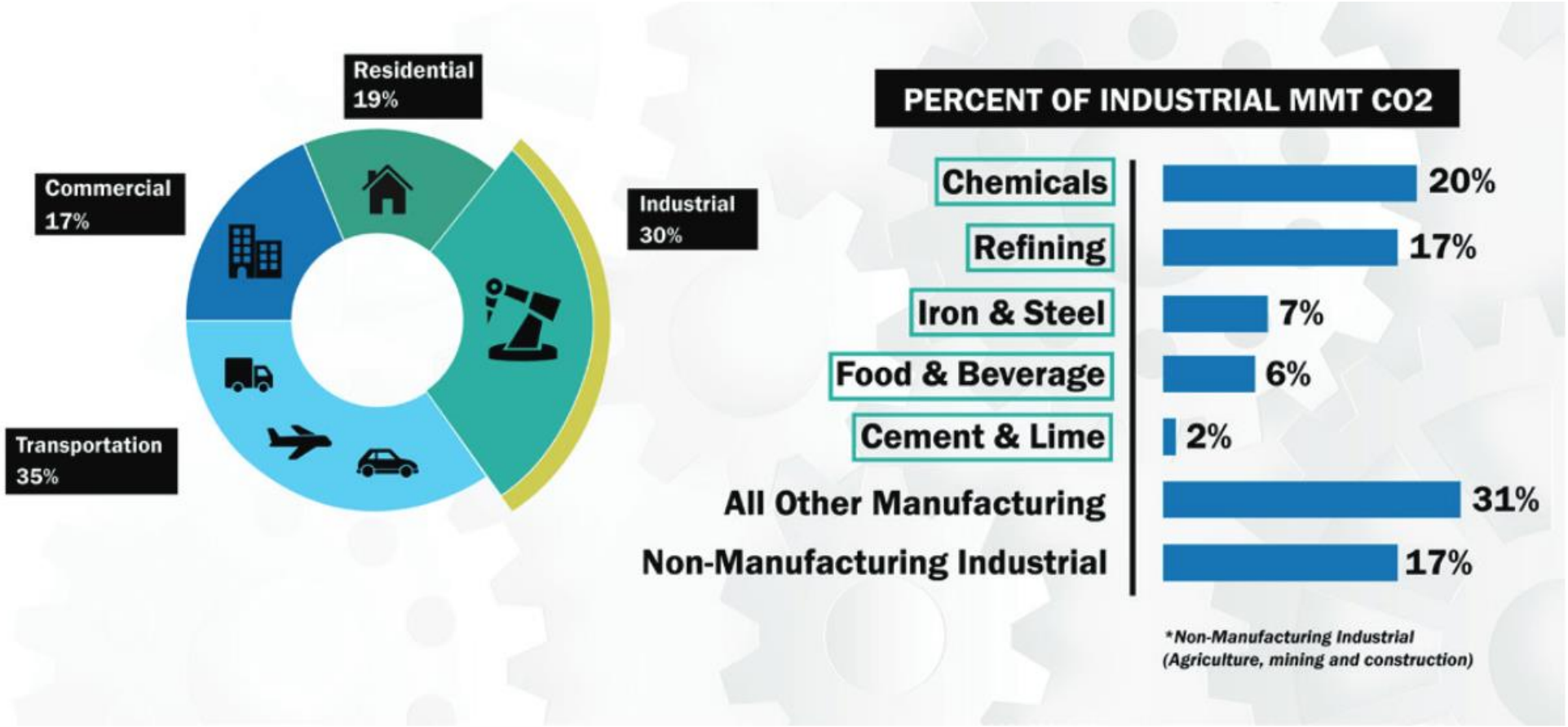
U.S. Primary Energy-Related CO2 Emissions by Economic Sector



Source: https://www.energy.gov/eere/doe-industrial-decarbonization-roadmap

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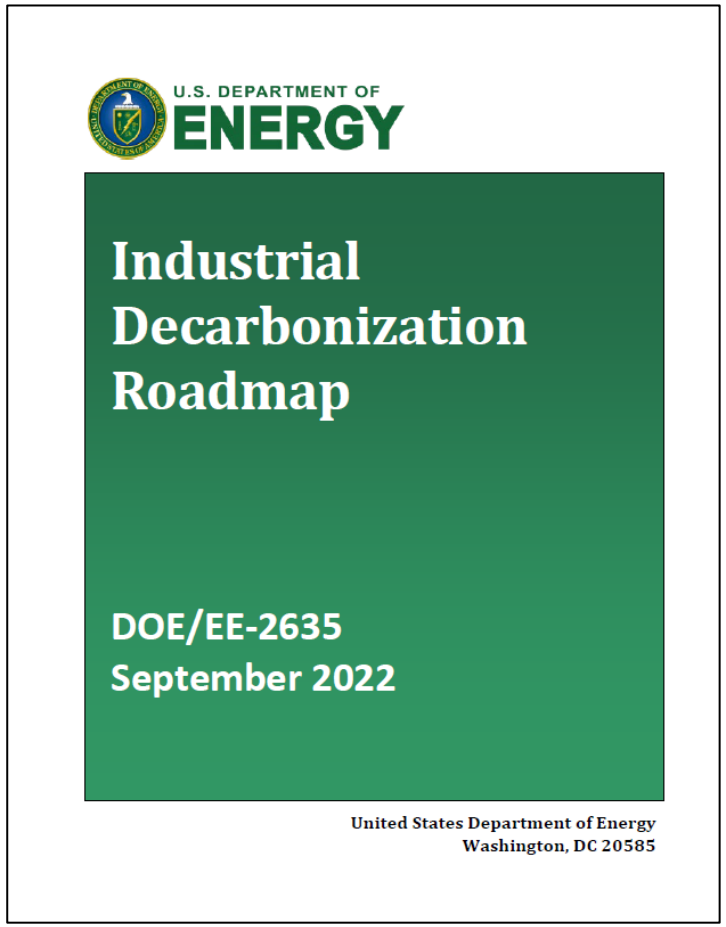
U.S. DOE "Industrial Decarbonization Roadmap"



"The science is clear that significant greenhouse gas (GHG) emissions reductions are needed to moderate the severe impacts of ongoing climate change."

"The industrial sector is the backbone of America's economy… however, the industrial sector currently accounts for **approximately one third of our nation's energy-related carbon dioxide (CO2) emissions.**"

"The U.S. industrial sector is considered a **'difficult-to-decarbonize' sector** of the energy economy, in part because of the diversity of energy inputs that feed into a heterogenous array of industrial processes and operations."

Source: https://www.energy.gov/eere/doe-industrial-decarbonization-roadmap

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Distribution of Process Heat Temperature Ranges by Industrial Subsector

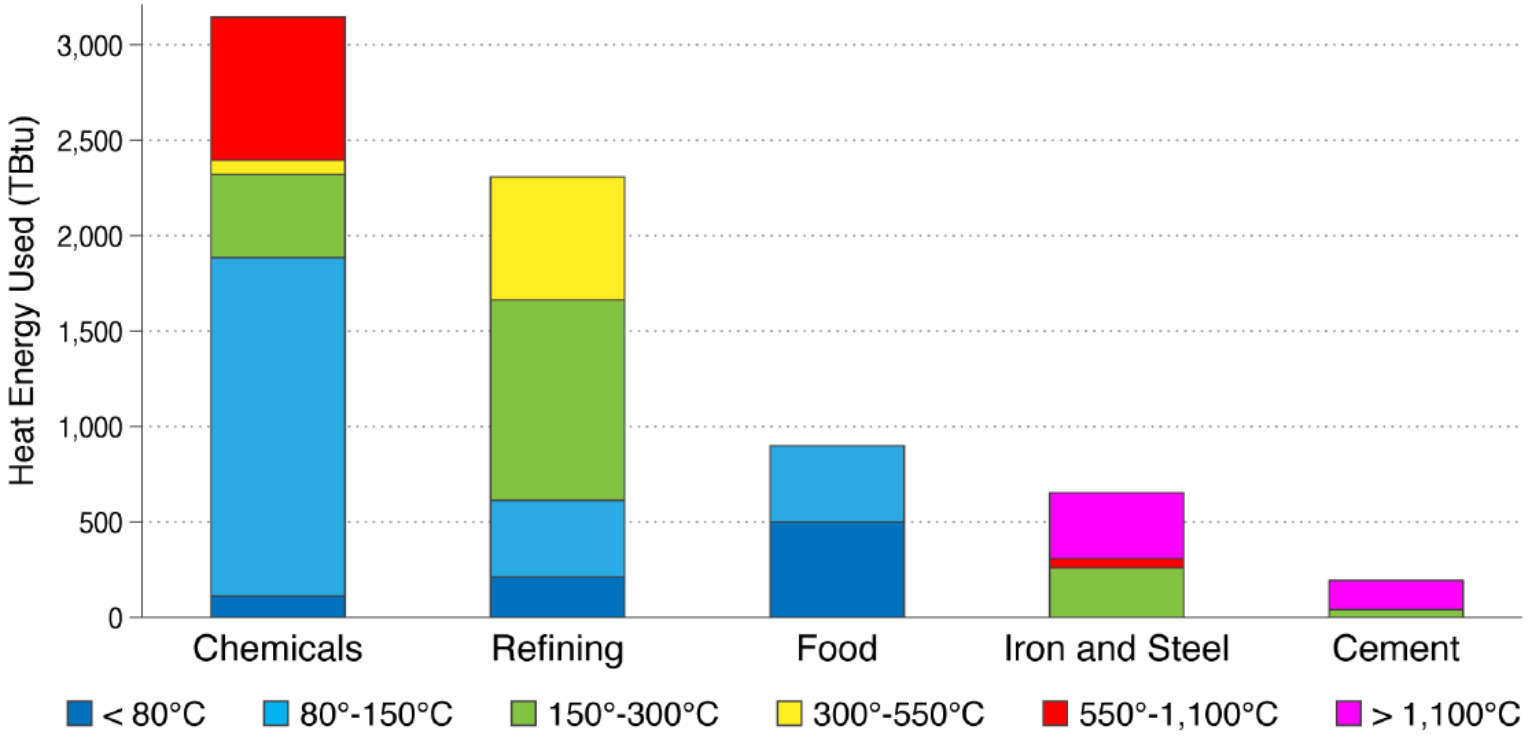


FIGURE 6. DISTRIBUTION OF PROCESS HEAT TEMPERATURE RANGES BY INDUSTRIAL SUBSECTOR IN 2014.

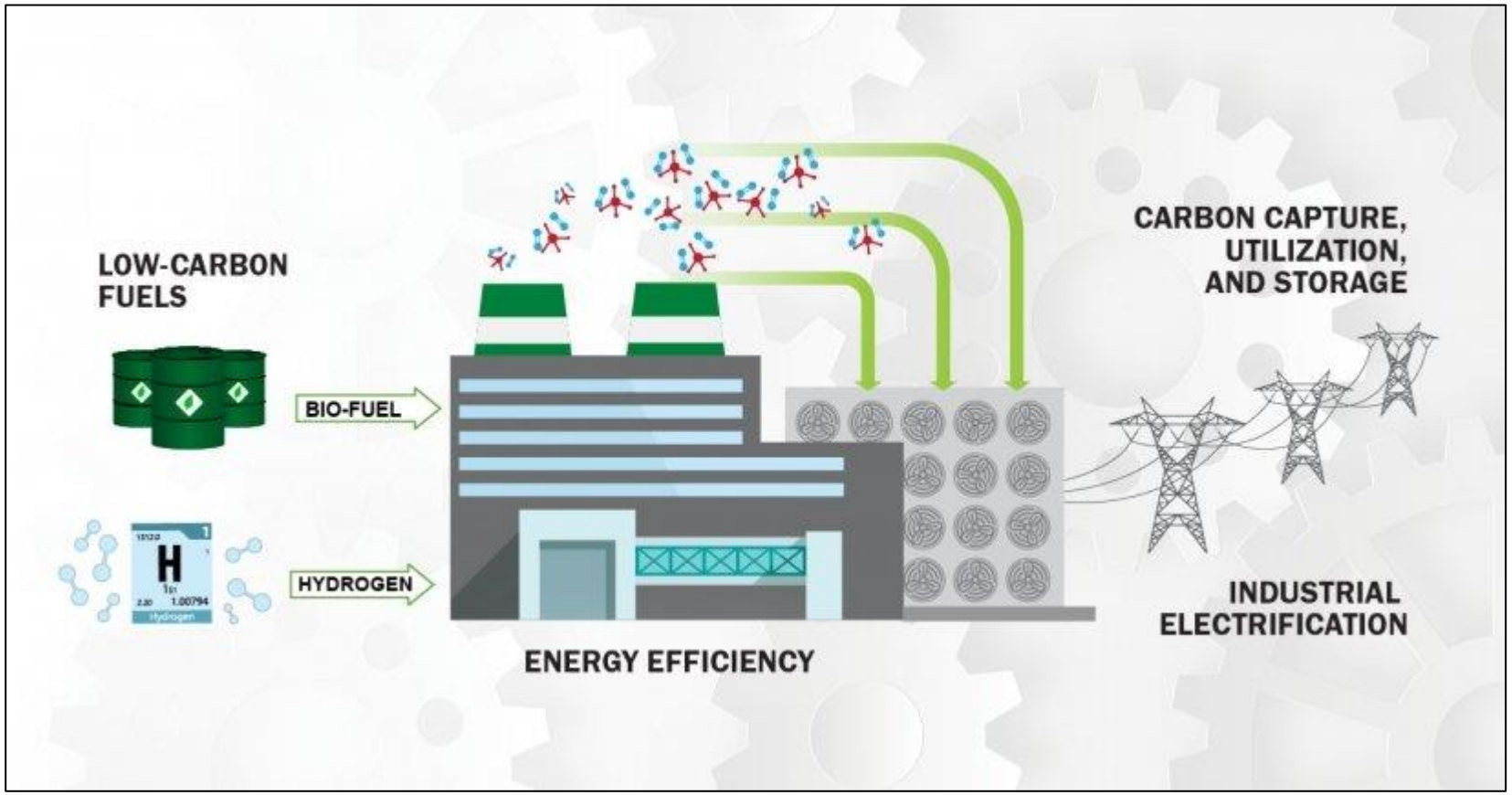
TEMPERATURE RANGES ARE IN °C AND HEAT USE IS IN TRILLION BTU (TBTU). DATA SOURCE: MCMILLAN 2019[81]

Source: https://www.energy.gov/eere/doe-industrial-decarbonization-roadmap

U.S. DOE Strategies for Decarbonizing U.S. Industries

The DOE Industrial Decarbonization Roadmap identifies 4 key technological pillars to significantly reduce emissions for the five subsectors studied. With the application of alternative approaches, 100% of annual CO2 emissions could be mitigated. Key pillars include:

1. Energy Efficiency
2. Industrial Electrification
3. Low-Carbon Fuels, Feedstocks, and Energy Sources (LCFFES)
4. Carbon Capture, Utilization, and Storage (CCUS)



Source: https://www.energy.gov/eere/doe-industrial-decarbonization-roadmap

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Key Decarbonization Technology Pillars – Pillars 1 & 2

Photo: https://www.energy.gov/mesc/industrial-assessment-centers-iacs

Photo: https://www.purdue.edu/research/

1) Energy Efficiency

- Greatest opportunities for near-term decarbonization solutions
- In many cases, does not require major changes to industrial processes

Key energy efficiency efforts include:

- Improvements in system efficiencies, process yield, and recovery of thermal energy;
- Expansion of energy management practices;
- Increased implementation of smart manufacturing strategies designed to reduce energy consumption.

Source: https://www.energy.gov/eere/doe-industrial-decarbonization-roadmap

2) Industrial Electrification

- Over 50% of all manufacturing energy is used for thermal processing (<5% of these operations are electrified)
- Electrification, particularly of thermal processes, provides an opportunity to leverage decarbonized and inexpensive electricity sources

Key electrification efforts include:

- improving the energy efficiency of existing electrotechnologies or hybrid systems,
- innovating new electric or hybrid systems,
- overcoming economic and technical barriers to implementing electrotechnologies in existing fossil-based processing systems.

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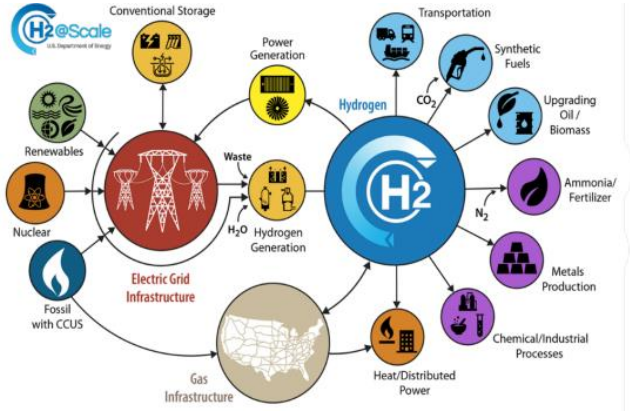
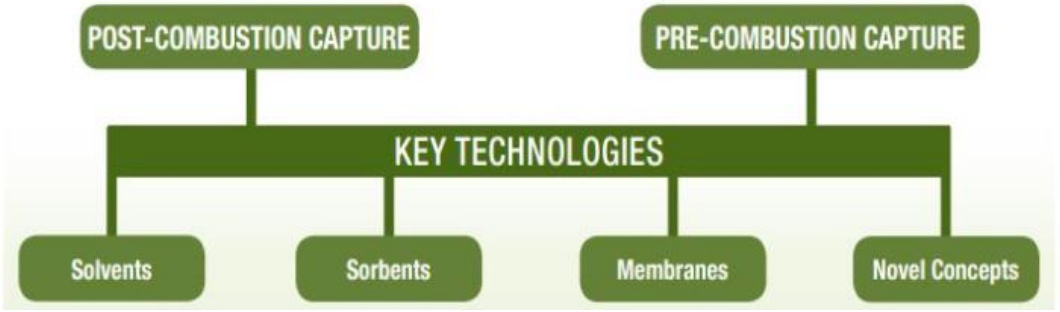
Key Decarbonization Technology Pillars – Pillars 3 & 4





3) Low-Carbon Fuels, Feedstocks, and Energy Sources (LCFFES)

- Includes fuel-flexible processes, clean hydrogen fuels and feedstocks, biofuels and biofeedstocks, nuclear, concentrating solar power, and geothermal.

Key energy efficiency efforts include:

- Development of fuel-flexible processes
- Integration of hydrogen fuels and feedstocks into industrial applications
- Reducing hydrogen cost to $1 per kg and improving efficiency and durability of low- and high-temperature electrolyzers.
- Use of biofuels and bio feedstocks

Source: https://www.energy.gov/eere/doe-industrial-decarbonization-roadmap

4) Carbon Capture, Utilization, and Storage (CCUS)

- Predicted to be the largest source of long-term emission reductions (in the DOE roadmap)
- Both carbon utilization and carbon storage will be critical to achieving the final carbon reductions
- Examples include post-combustion chemical absorption of CO2 or construction of CO2 pipelines and other supportive infrastructure

Key CCUS efforts include:

- Improving efficiency, economic viability, and safety
- Improvements to catalysts and process designs are critical to higher efficiency levels, lower costs, and lower material consumption or waste production.

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Path to Net-Zero Industrial CO2 Emissions in U.S. for 5 Carbon-Intensive Industrial Subsectors

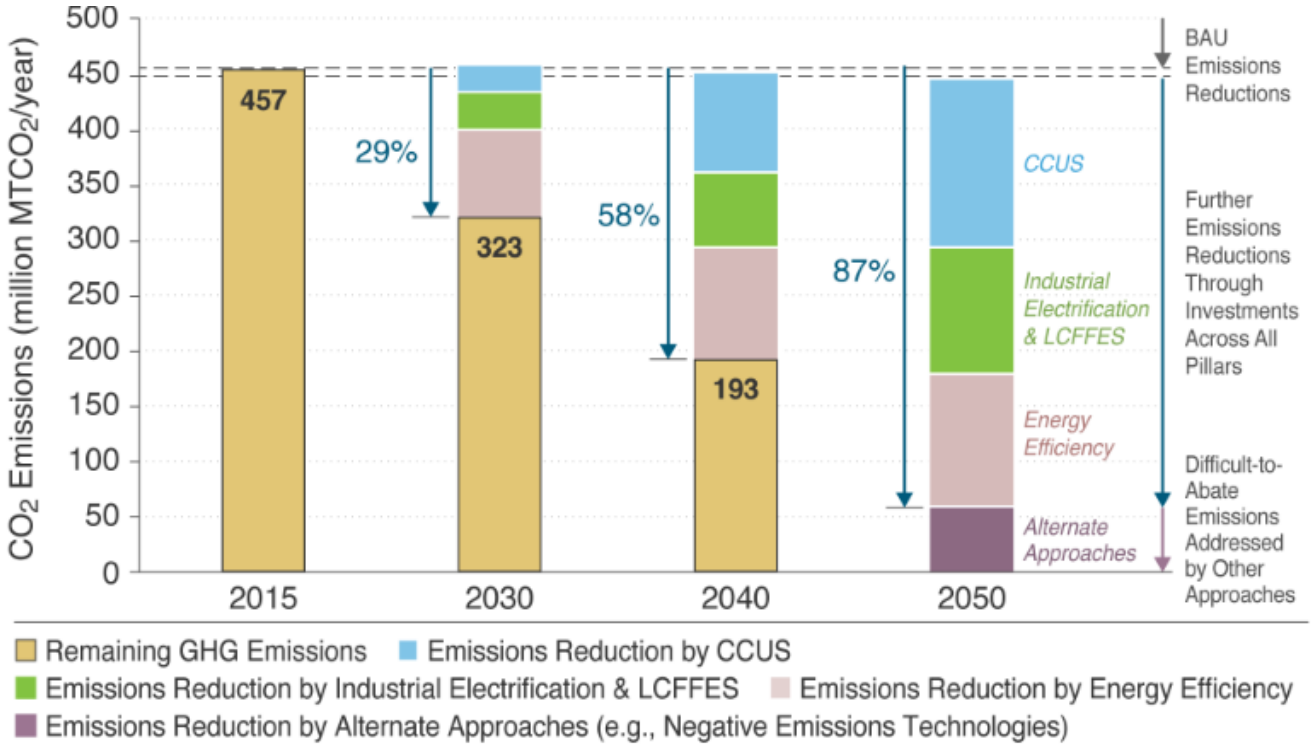

FIGURE ES 1. THE PATH TO NET-ZERO INDUSTRIAL CO_2 EMISSIONS IN THE UNITED STATES FOR FIVE CARBON-INTENSIVE INDUSTRIAL SUBSECTORS, WITH CONTRIBUTIONS FROM EACH DECARBONIZATION PILLAR: ENERGY EFFICIENCY; INDUSTRIAL ELECTRIFICATION; LOW-CARBON FUELS, FEEDSTOCKS, AND ENERGY SOURCES (LCFFES); AND CARBON CAPTURE, UTILIZATION, AND STORAGE (CCUS)). EMISSIONS ARE IN MILLIONS OF METRIC TONS (MT) PER YEAR.

Source: https://www.energy.gov/eere/doe-industrial-decarbonization-roadmap

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Major RD&D Investment Opportunities for Industrial Decarbonization across All Subsectors by Decade & Decarbonization Pillar

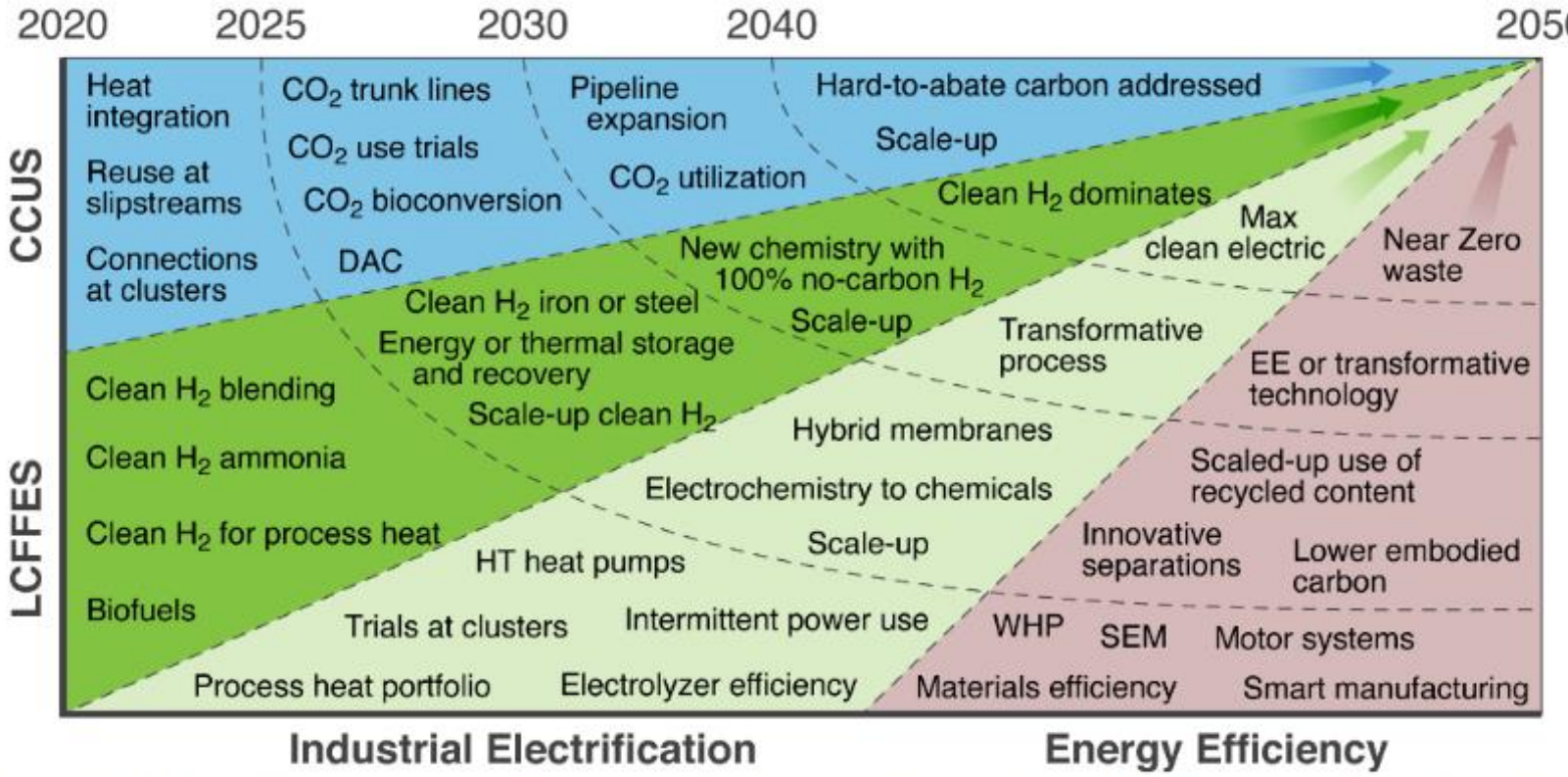

FIGURE 10. LANDSCAPE OF MAJOR RD&D INVESTMENT OPPORTUNITIES FOR INDUSTRIAL DECARBONIZATION ACROSS ALL SUBSECTORS BY DECADE AND DECARBONIZATION PILLAR.

Source: https://www.energy.gov/eere/doe-industrial-decarbonization-roadmap

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No-Cost U.S. DOE Technical Assistance Resources for Industrial Decarbonization

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U.S. Department of Energy Industrial Assessment Centers (IACs)

Industrial Assessment Center
U.S. DEPARTMENT OF ENERGY

- Established by the US Department of Energy in 1976
- One of the US DOE's longest ongoing programs
- Serves small and medium sized US manufacturers and medium to large wastewater treatment plants nationwide
- Teams of university-based faculty and student engineers (trained 3,300+ students to date)

Three main goals of the IAC Program:

1. **Assessments** – Provide no-cost in-depth evaluations of a facility which will include baseline energy analysis, a walkthrough of the facility, and a full list of identified measures including savings, possible incentive funding, and economic analysis
2. **Workforce Development** – IACs are used to train the next-generation of energy savvy engineers, more than 60% of which pursue energy-related careers upon graduation.
3. **Research** – Conduct research on cutting edge technologies to constantly refine the assessment process and identify new potential methods of cost effective energy reduction.

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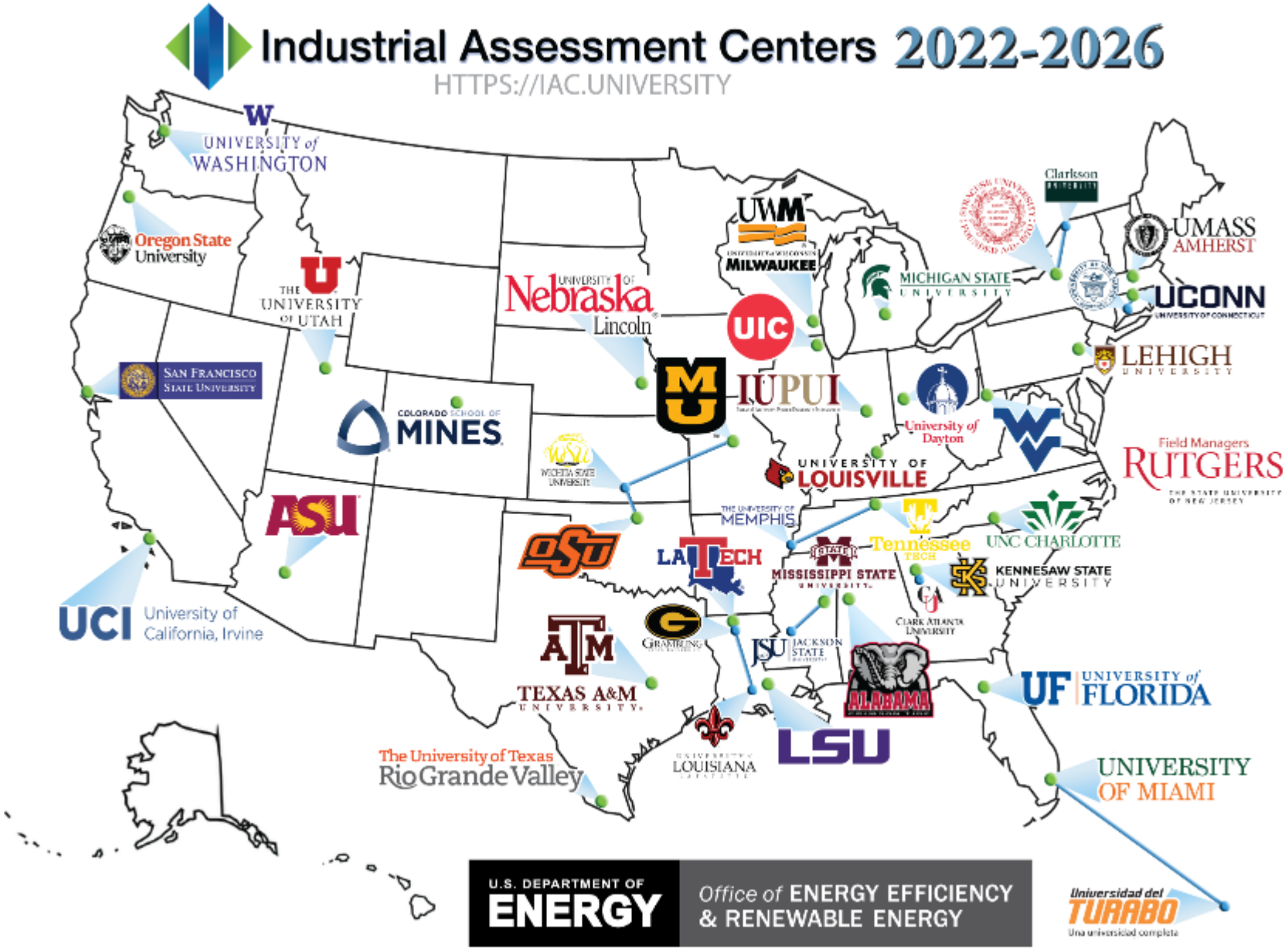

The IAC program has already conducted over 21,472 assessments with more than 159,924 associated recommendations. Average recommended yearly savings is $140,357 (as of 7/22/24).

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Systems and Equipment Assessed during IAC Assessment

- Steam / Hot Water Systems (Boilers, Steam Traps)
- Compressed Air Systems (Compressors, Air Leaks, Storage, End Uses
- Process Heating / Process Cooling (Ovens, Chillers, Cooling Towers)
- Large Motors and Pumps
- HVAC Equipment
- Lighting
- Other Process Equipment
- Cybersecurity

Onsite Energy Technical Assistance Partnerships (TAPs)

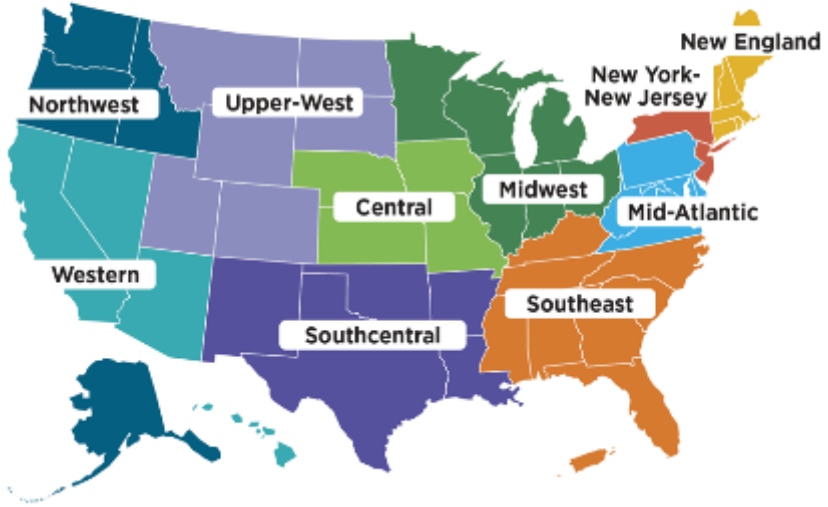
DOE's 10 regional Onsite Energy TAPs provide technical assistance to end users and other stakeholders about technology options for achieving clean energy objectives. Key services include:

Technical Assistance: Screen sites for opportunities to implement onsite energy technologies and provide advanced services to maximize economic impact and reduce risk from initial screening to installation to operation and maintenance.

End-User Engagement: Partner with organizations representing industrial and other large energy users to advance onsite energy as a cost-effective way to transition to a clean energy economy.

Stakeholder Engagement: Engage with strategic stakeholders, including utilities and policymakers, to identify and reduce barriers to onsite energy through fact-based, unbiased education.

Onsite Energy Technical Assistance Partnerships
U.S. DEPARTMENT OF ENERGY



https://betterbuildingssolutioncenter.energy.gov/onsite-energy/taps

U.S. DOE Onsite Energy Program

Onsite Energy Technical Assistance Partnerships
U.S. DEPARTMENT OF ENERGY

The U.S. Department of Energy's (DOE) Onsite Energy Program provides technical assistance, market analysis, and best practices to help industrial facilities and other large energy users increase the adoption of onsite clean energy technologies.

battery storage | combined heat and power | district energy | fuel cells | geothermal | industrial heat pumps

renewable fuels | solar PV | solar thermal | thermal storage | waste heat to power | wind

Technology-Specific Favorable Site-Attributes

Onsite Energy Technical Assistance Partnerships
U.S. DEPARTMENT OF ENERGY

	Solar Photovoltaics	Distributed Wind Turbines	Battery Energy Storage Systems	Combined Heat and Power Systems	Heat Pumps
High $/kWh Electricity Rate	↑	↑	N	↑	↓
High $/kW Demand Charge Rate	N	N	↑	↑	↓
High Nat. Gas Prices	N	N	N	↓	↑
Available Roof Space	↑	N	N	N	N
Available Land Space	↑	↑	N	N	N
High Heating Loads	N	N	N	↑	↑
24/7 Electricity and Heating Loads	↓	↑	↓	↑	N

↑ Positive | N Neutral | ↓ Negative

Note, the magnitude of each site attribute, the combination of two or more site attributes, and the combination technologies may have different outcomes than what is qualitatively characterized in this table as favorable, neutral, and negative criteria.

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$300K DOE IAC Implementation Grant

IAC Implementation Grants

Bipartisan Infrastructure Law Provision 40521.b1

$80M in funding available in the first year (Additional funding available in the next couple years depending on demand)

Grants awards of up to **$300,000 per funding round**, at a 50% cost share[1] (**valid cost share options** include internal capital, in-kind contributions, state and local public programs, private loans – including SBA-guaranteed sources, utility programs, leases, and Energy Savings Performance Contracts)

Eligibility exclusively for **small- and medium-sized manufacturing firms,**[2] and water and wastewater treatment facilities

To **address energy assessment recommendations** by IACs, DOE Combined Heat and Power/Onsite Energy Technical Assistance Partnerships, or other third-party assessors deemed equivalent by DOE

1. *50% cost share means that the applicant must cover at least 50% of the project cost. So, for instance, if an implementation project or projects costs $100k, DOE can make a $50k grant.*
2. *Small and medium-sized manufacturer (an entity that engages in the mechanical, physical, or chemical transformation of materials, substances, or components; or, a water or wastewater treatment facility) is a firm with: gross annual sales of less than $100M, fewer than 500 employees at the plant site, and annual energy bills of $100,000 - $3,500,000. **If the manufacturer/facility is an individual LLC that pays separate taxes from the parent company, then eligibility is based on the LLC.***

MESC

Covered projects include energy assessment report recommendations that:

- Improve site energy and/or material efficiency
- Improve site cybersecurity infrastructure
- Improve site productivity
- Reduce site waste production
- Reduce site greenhouse gas emissions and/or nongreenhouse gas pollution

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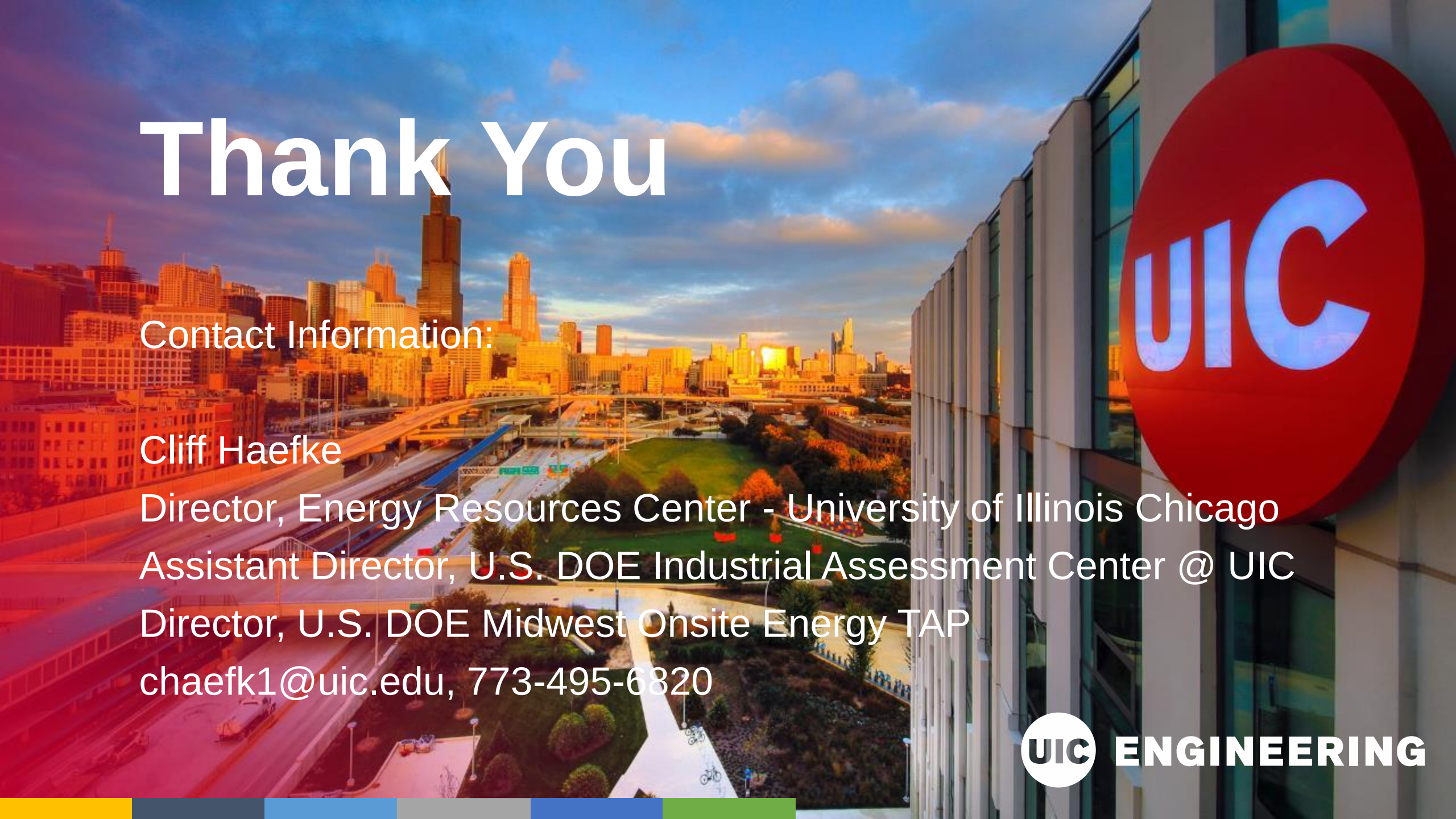
Getting Started with DOE No-Cost Technical Assistance

- Contact a rep at the UIC Energy Resources Center (ERC) to get started
- A UIC-ERC rep will meet with you and discuss your energy goals and objectives to determine which program (or both) is best suited to meet your current/future needs:
  - Energy Efficiency Assessment through U.S. DOE IAC
  - Onsite Energy Assessment through U.S. DOE Onsite Energy TAP

Thank You



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