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U.S. DEPARTMENT OF ENERGY

Clean Fuels & Products™

Clean Fuels & Products Shot Summit

April 8: 11:00–2:00pm ET

Introduction Session | Session 1: Societal Considerations/Impacts

April 9: 11:00–4:00pm ET

Session 2: Resource/Feedstock Mobilization | Session 3: Carbon-Efficient Conversion Processes | Session 4: Technology Scaling and Demonstration

We will start momentarily…

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Meeting Recording Announcement

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Housekeeping Reminders

- Audience does not have the ability to unmute and/or turn on camera during this presentation
- Please submit all questions using the Q&A function at the bottom of your screen (Chat is disabled)
- Submit questions at any point during the presentation
- We will collect questions and post responses along with the presentations as soon as possible
- If needed, participants can choose to turn on the Zoom close-captioning feature

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Welcome

CLEAN FUELS & PRODUCTS SHOT SUMMIT

Today, April 8

11:00–2:00pm ET

- Introduction Session
- Session 1: Societal Considerations/Impacts

Tomorrow, April 9

11:00–4:00pm ET

- Session 2: Resource/Feedstock Mobilization
- Session 3: Carbon-Efficient Conversion Processes
- Session 4: Technology Scaling and Demonstration

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Welcoming Remarks

DAVID M. TURK
DEPUTY SECRETARY,
U.S. DEPARTMENT OF ENERGY

DR. GERALDINE RICHMOND
UNDER SECRETARY FOR SCIENCE AND INNOVATION,
U.S. DEPARTMENT OF ENERGY

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Agenda | Day 1 | April 8 | 11:00–2:00pm ET

Opening Session | 11:00–12:30pm ET

Moderator: Dr. Todd Anderson, Director, Biological Systems Science Division, DOE Office of Science

- Introduction to the Clean Fuels & Products Shot Summit
- DOE Office Overviews from the leaders of this Shot: Office of Science, Bioenergy Technologies Office, Office of Fossil Energy and Carbon Management, Industrial Efficiency and Decarbonization Office
- Pillars overview: Four areas of emphasis within the Clean Fuels & Products Shot™ that serve as a guide towards accomplishing the Department's goals for this Shot

Session 1 | Societal Considerations/ Impacts | 12:30–2:00pm ET

Moderator: Dr. Brianna Farber, Energy Future Grants Program Manager, DOE State and Community Energy Programs

Closing Remarks | 2:00pm ET

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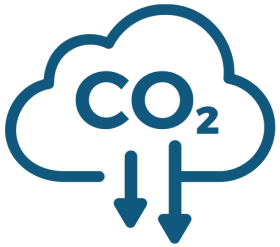
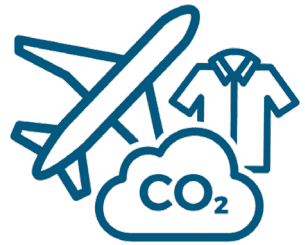
DOE Earthshots Initiatives

Enhanced Geothermal Shot™
Reduce the cost of enhanced geothermal systems by 90%, to $45 per megawatt hour by 2035 to unlock Earth's nearly inexhaustible heat resources to provide reliable, clean power for Americans and expand opportunities for a robust domestic geothermal industry.



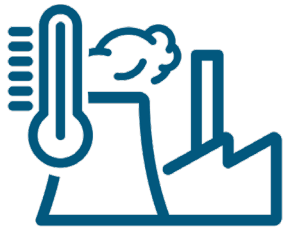
Carbon Negative Shot™
Remove CO2 from the atmosphere and durably store it at meaningful scales for less than $100/net metric ton of CO_2-equivalent within a decade.

Hydrogen Shot™
Accelerate innovation and spur demand of clean hydrogen by reducing the cost by 80%, to $1 per 1 kilogram of clean hydrogen within 1 decade.

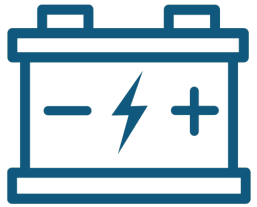


Clean Fuels & Products Shot™
Decarbonize the fuel and chemical industry through alternative sources of carbon to advance cost-effective technologies.

Floating Offshore Wind Shot™
Drive down costs to $45 per megawatt hour by 2035 to spur U.S. leadership in floating offshore wind technology, accelerate decarbonization, and deliver benefits for coastal communities.



Industrial Heat Shot™
Develop cost-competitive industrial heat decarbonization technologies with at least 85% lower greenhouse gas emissions by 2035.



Long Duration Storage Shot™
Achieve affordable grid storage for clean power—anytime, anywhere—by reducing the cost of grid-scale energy storage by 90% for systems that deliver 10+ hours of duration within the decade.

Affordable Home Energy Shot™
Reduce the cost of energy-efficient retrofits in affordable homes by 50% and decrease residents' energy costs by at least 20% within a decade.

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Energy Earthshots Alignment

- Alignment on carbon capture as the front-end technology for utilization (CFP Shot) or storage (Carbon Negative Shot)

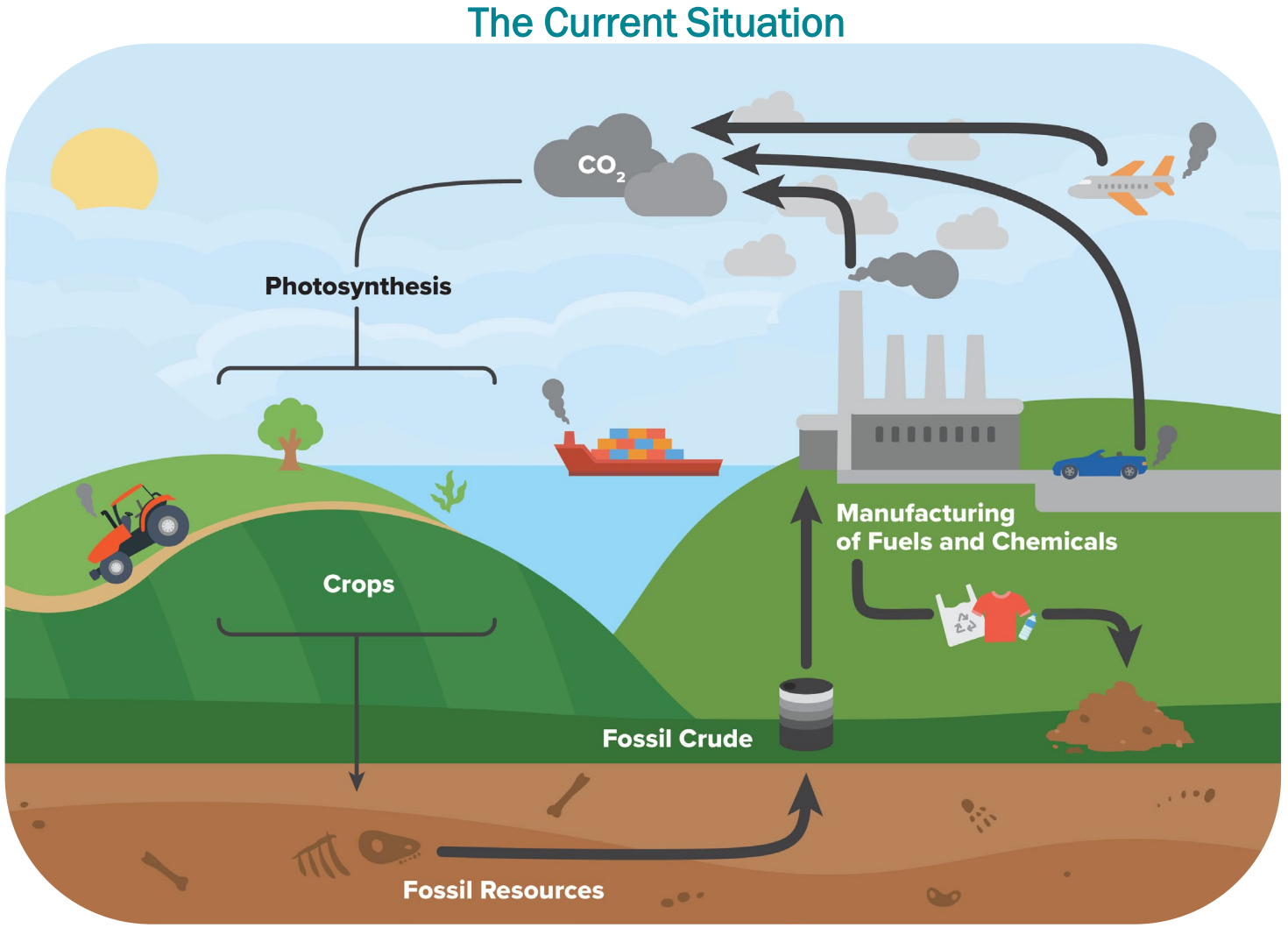
- Alignment on processes to lower process emissions which complement the CFP Shot's focus on feedstock

- Alignment on production and utilization of clean hydrogen to reduce overall lifecycle emissions of fuels and products

Imbalanced Carbon Cycle

- Much of our economy is fueled and derived from fossil carbon resources (namely petroleum, natural gas)
- Transportation and the chemical manufacturing industry are a large source of CO2 production
- CO2 derived from fossil resources produces a net increase in atmospheric carbon
- Increased CO2 in the atmosphere is linked to climate change effects

How to remedy this situation?



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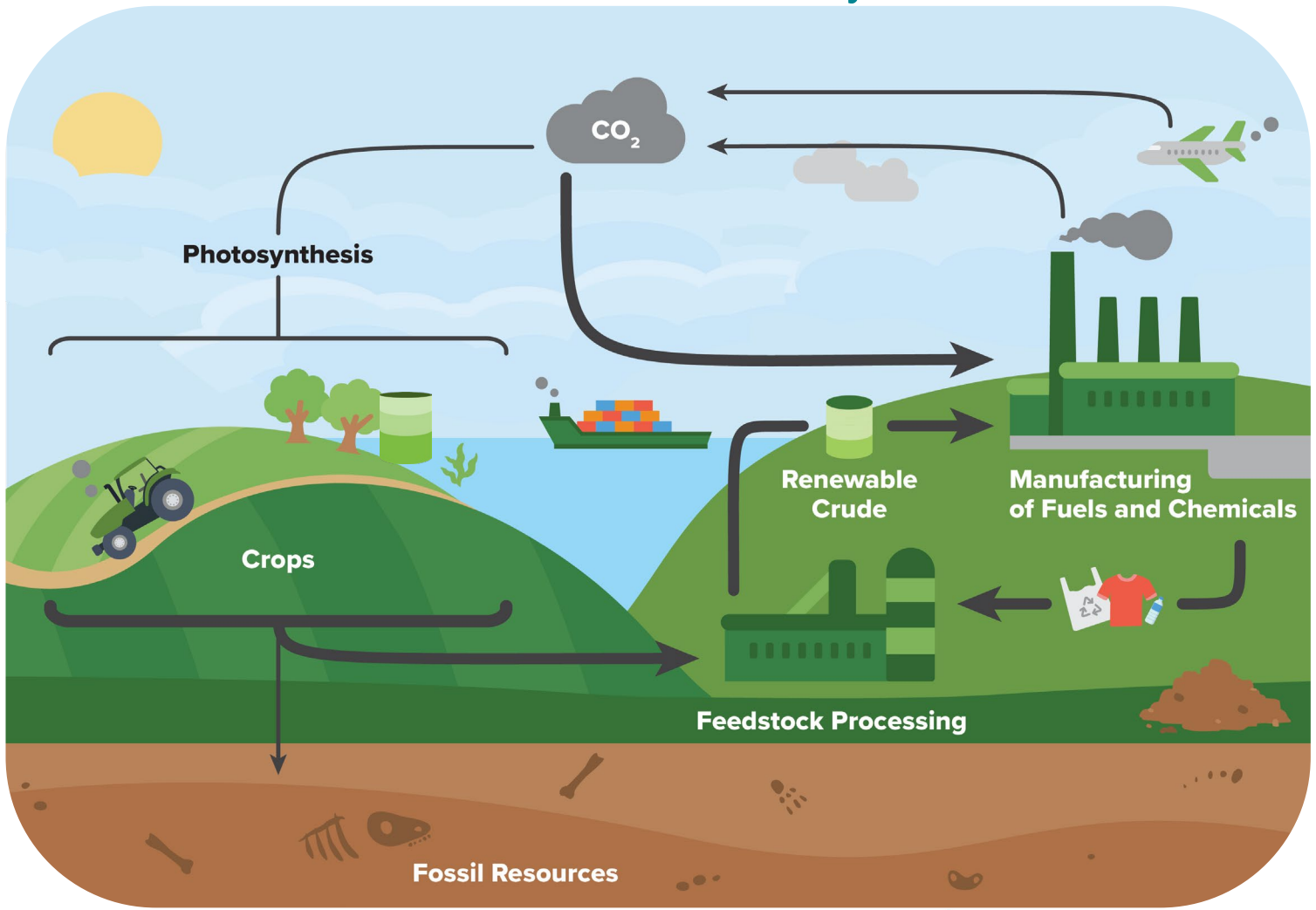
Rebalance the Carbon Cycle

- Develop renewable resources such as plant biomass and wastes as the feedstocks for fuels, chemicals and materials
- Use CO2 directly from the air or other emissions and convert to products
- Dramatically reduce reliance on fossil resources
- Shift the carbon cycle balance from a situation of net increase CO2 to the atmosphere to a net decrease in CO2 from the atmosphere

Clean Fuels & Products Earthshot

Solution: Shift the Carbon Cycle



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Clean Fuels & Products Earthshot

Clean Fuels & Products Shot™
Decarbonize the fuel and chemical industry through alternative sources of carbon to advance cost-effective technologies.

Utilize the >1000 MMT of sustainable biomass and waste feedstocks that can be harvested and collected annually in the U.S. plus an additional 450MMT CO2 directly to meet the growing demand for renewable fuels, chemicals and materials without impacting food production. (*Source: Billion Ton Report)*

Convert those renewable feedstocks to offset fossil resource demand in some of the most difficult economic sectors to decarbonize to achieve a net-zero economy by 2050.

- **Aviation fuel demand** – meet 100% of demand with renewable resources
- **Marine fuel demand** – meet 50%
- **Rail fuel demand** – meet 50%
- **Off-road fuel demand** – meet 50%
- **Hydrocarbon chemicals** – meet 50%

The Impact? A reduction of over 650MMT of CO2 to the atmosphere annually.

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Pillars/Core Research Areas

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Societal Considerations/Impacts	• Energy equity impacts and differentiated regional strategies • Cradle to grave life-cycle analysis and sustainability modeling to prioritize the most impactful R&D
Resource/Feedstock Mobilization	• New technologies to enable low cost, low-emissions feedstocks at scale • Increased carbon incorporation into biomass
Carbon-Efficient Conversion Processes	• New carbon-efficient conversion technologies • Innovation to improve CO_2 catalytic conversion efficiency • Solar fuels • Processes using green electricity and hydrogen
Technology Scaling & Demonstration	• Integrated pilot and demonstration scale facilities to de-risk technology for rapid industry adoption

Introductory Remarks

THE HONORABLE
JULIA BROWNLEY
U.S. REPRESENTATIVE,
CALIFORNIA'S 26TH DISTRICT

THE HONORABLE
JIM PILLEN
GOVERNOR OF NEBRASKA

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DOE Office Overviews

A continuum of RDD&D effort

Clean Fuels & Products: Crosscutting All-hands-on-deck Effort

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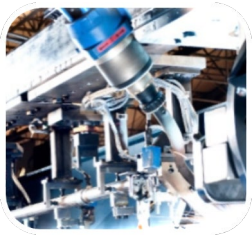
Foundational Research | **Applied Technology Research, Development, & Demonstration** | **Demonstration & Deployment**








SC-BER | SC-BES | SC-ASCR | ARPA-E | AMMTO | HFTO | FECM | BETO | IEDO | OCED

Basic research advancing biological, chemical, and computational systems:

- Catalysis
- Genomic Modification and Design
- Chemical/Physical Separations
- Materials Science
- Advanced AI, ML, and Data Science Methods

Leverage scientific user facilities

Technology transition across:

- Biomass/Waste/CO_2 Conversion to Fuels/Chemicals
- Sustainable Supply Chains, Processing, and Manufacturing
- Efficient Processes, Circularity, and Environmental Co-benefits
- Decarbonization of Chemical Manufacturing
- Clean H_2 Production, Storage, and Delivery
- Point Source/Direct Air Carbon Capture

Leverage LCA/TEA modelling

Demo projects:

- De-risk Technologies,
- Approaches, and Business Models to Enable Adoption, Replication and Scaling

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Lead DOE Office Overviews

- Dr. Todd Anderson | Office of Science
- Dr. Jay Fitzgerald | Bioenergy Technologies Office
- Emily Connor | Office of Fossil Energy and Carbon Management
- Dr. Felicia Lucci | Industrial Efficiency and Decarbonization Office

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Office of Science (SC)

Dr. Todd Anderson

Director Biological Systems Science Division

U.S. DEPARTMENT OF ENERGY | Office of Science

SC Mission:

Delivery of scientific discoveries and major scientific tools to transform our understanding of nature and advance the energy, economic, and national security of the United States.

More than **29,000** Researchers supported at more than **300** Institutions and **17** DOE Labs

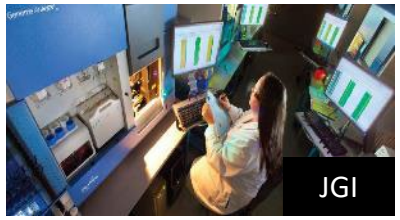
Steward **10** of the 17 DOE National labs

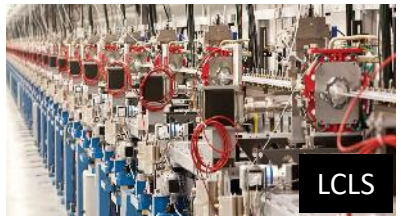
More than **37,000** Users of **28** SC Scientific Facilities

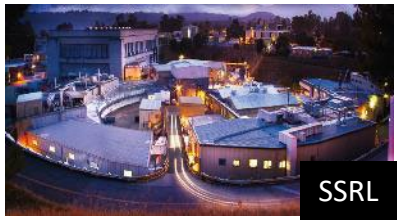
$8.1B
(FY 23 enacted)

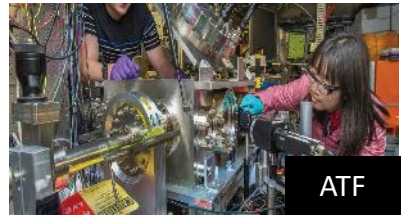
Office of Science User Facilities

FY 2023
28 scientific
user facilities
>37,000 users









U.S. DEPARTMENT OF ENERGY
Office of Science

Basic Science Supporting the Clean Fuels & Products Shot

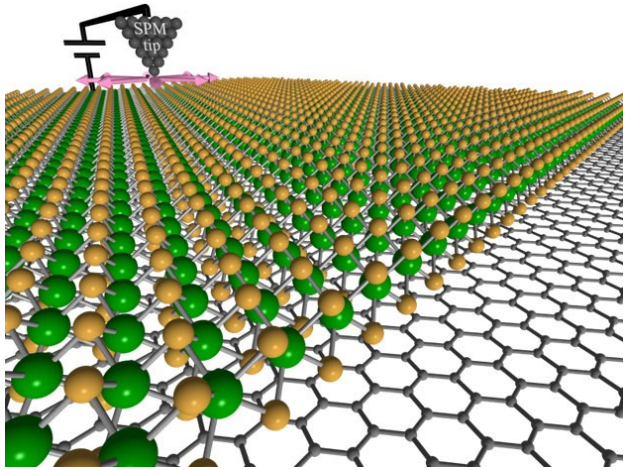
Office of Science Research Portfolio

Advanced Scientific Computing Research	• Delivering world leading computational and networking capabilities to extend the frontiers of science and technology
Basic Energy Sciences	• Understanding, predicting, and ultimately controlling matter and energy flow at the electronic, atomic, and molecular levels
Biological and Environmental Research	• Understanding complex biological, earth, and environmental systems
Fusion Energy Sciences	• Supporting the development of a fusion energy source and supporting research in plasma science
High Energy Physics	• Understanding how the universe works at its most fundamental level
Nuclear Physics	• Discovering, exploring, and understanding all forms of nuclear matter
Isotope R&D and Production	• Supporting isotope research, development, production, processing and distribution to meet the needs of the Nation
Accelerator R&D and Production	• Supporting new technologies for use in SC's scientific facilities and in commercial products

Computational Science Supporting a Broader Bioeconomy

Basic research that lays the groundwork for scientific discoveries

- **Applied Mathematics and Computer Science foundations** to advance the understanding of natural and engineered systems and to reveal scientific insight from high end simulations, models, and data.
- **Advanced Computing** to prepare for the future of science based on emerging advanced computing technologies, artificial intelligence and microelectronics.



Advanced computing for autonomous investigations

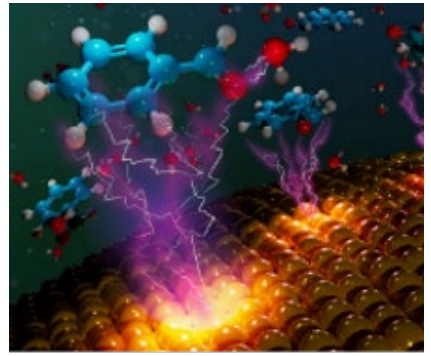
Strategic partnerships that enable scientific breakthroughs and advance America's economic competitiveness

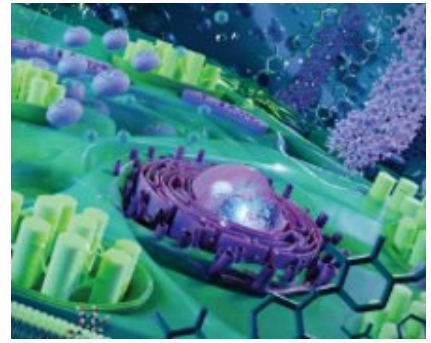
- World-leading programs in **interdisciplinary research** like SciDAC enable scientific applications including sustainable chemistry take full advantage of computing and networking capabilities that push the frontiers.
- Unique models of partnerships accelerate the competitiveness of **American computing technologies, advanced manufacturing,** and **high-tech companies** - large and small.

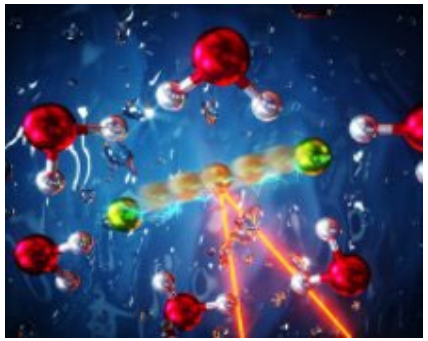
Fundamental Chemical and Materials Science

Basic research for discovery, design, and understanding of materials and, chemical and biochemical processes underpinning a broader bioeconomy

- **Mechanistic understanding the biochemistry, chemistry, and biophysics of energy capture,** conversion, and storage can reveal principles that underlie pathways for the production of specific molecules and the design of structures with specific architectures and capabilities such as self-repair.
    - **Insights into mechanisms of light harvesting and energy transport in natural photosynthesis** and of redox and active site protein chemistry controlling energy and molecular conversions by enzymes could inspire new bio-based strategies for energy capture, and conversion, and storage.
    - **Research on energy and molecular conversion processes** (e.g. catalysis and photochemistry) can help provide a foundation for development of bio-inspired, biohybrid and biomimetic systems.
- **Understanding of biomolecular materials** can guide the creation of robust and scalable materials and systems that take advantage of the extraordinary processes of biology.





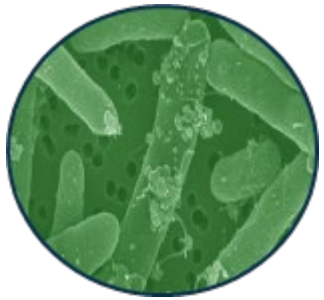


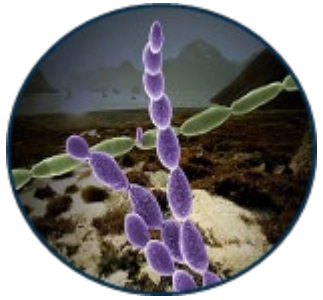
Fundamental Biological and Environmental Research

Basic science to understand, predict, manipulate and design biological processes forming the basis for innovations in bioenergy and bioproduct production

Harnessing the power of genomics to explore new concepts for:

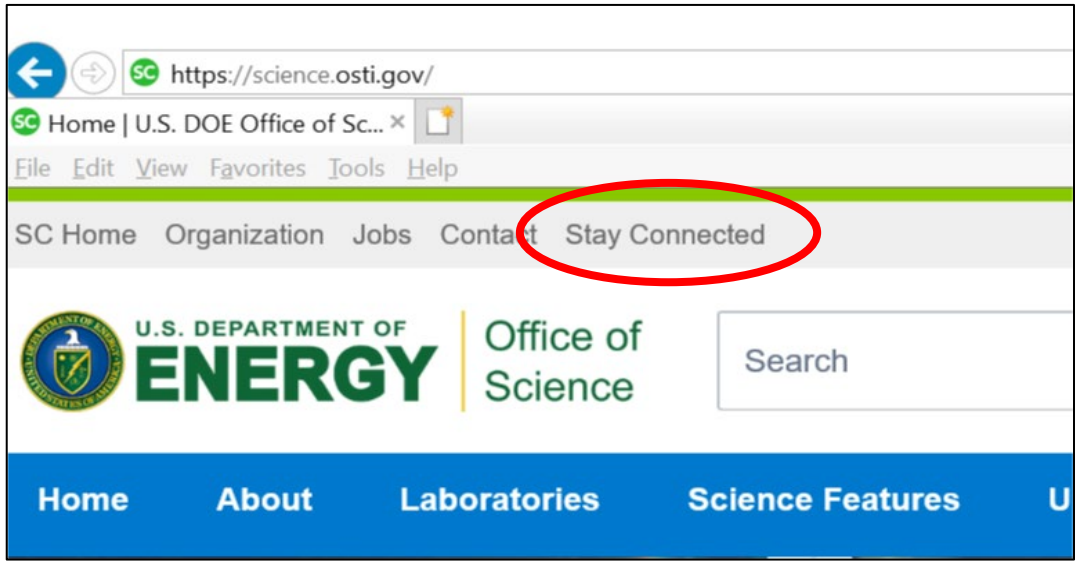
- **Plant Biology** – developing a range of dedicated and resilient bioenergy crops for use as feedstocks fueling a larger bio-based economy
- **Microbial Biology** – broadening the range of microbial species that can be designed/tailored for specific processes or to produce specific products at scale.
- **Resilient and Sustainable Bioenergy Crop Production** – understanding key plant-microbe-soil interactions needed for resilient bioenergy/bioproduct crop production.
- **Biosystems Design** - exploring new concepts to tailor microorganisms and plants for desired and beneficial purposes





Office of Science Activities and Resources

- Computational Research
- Fuels from Sunlight Hubs
- Energy Frontier Research Centers
- Catalysis, Separations Science
- Bioenergy Research Centers
- User Facilities:
  - National Energy Research Supercomputing Center (NERSC)
  - Synchrotron Light and Neutron Sources
  - Nanoscience Centers
  - Joint Genome Institute
  - Environmental Molecular Science Laboratory



Receive Office of Science news by email or text
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- FOAs
- Press releases
- Meetings
- Scientific topics
- Program office news

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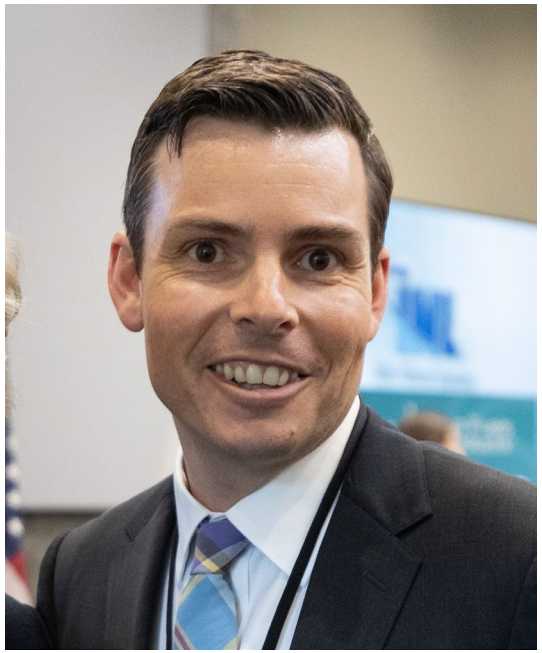
Bioenergy Technologies Office (BETO)

Dr. Jay Fitzgerald

Chief Scientist and Program Manager



BETO STRATEGIC GOALS – 2023 MULTI-YEAR PROGRAM PLAN

Decarbonize Transportation

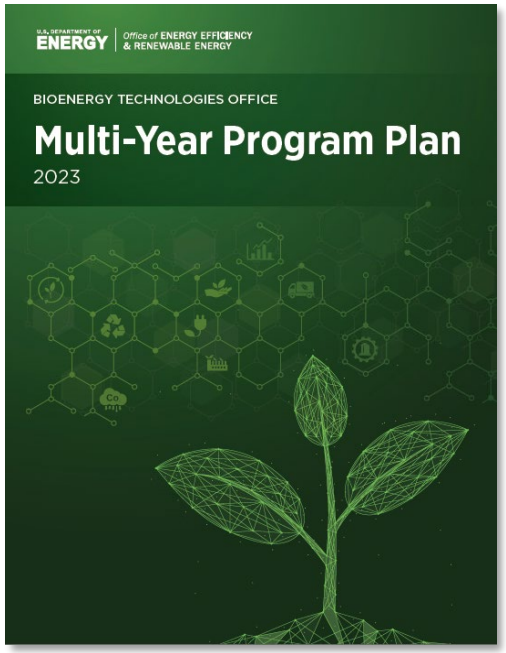
Decarbonize the sector through R&D to produce cost effective **sustainable aviation** and other **strategic fuels**

Decarbonize Industry

Decarbonize the sector through R&D to produce cost effective **sustainable chemicals, materials and processes** utilizing biomass and waste resources

Decarbonize Communities

Develop **cost-effective, sustainable biomass and waste utilization technologies** and innovative approached contributing to the **decarbonization of agricultural** sector, generating **carbon negative power**, developing **carbon drawdown strategies** or other beneficial uses



Applied R&D	Pilot R&D	Demonstration
TRL 2-5	TRL 4-7	TRL 7-8

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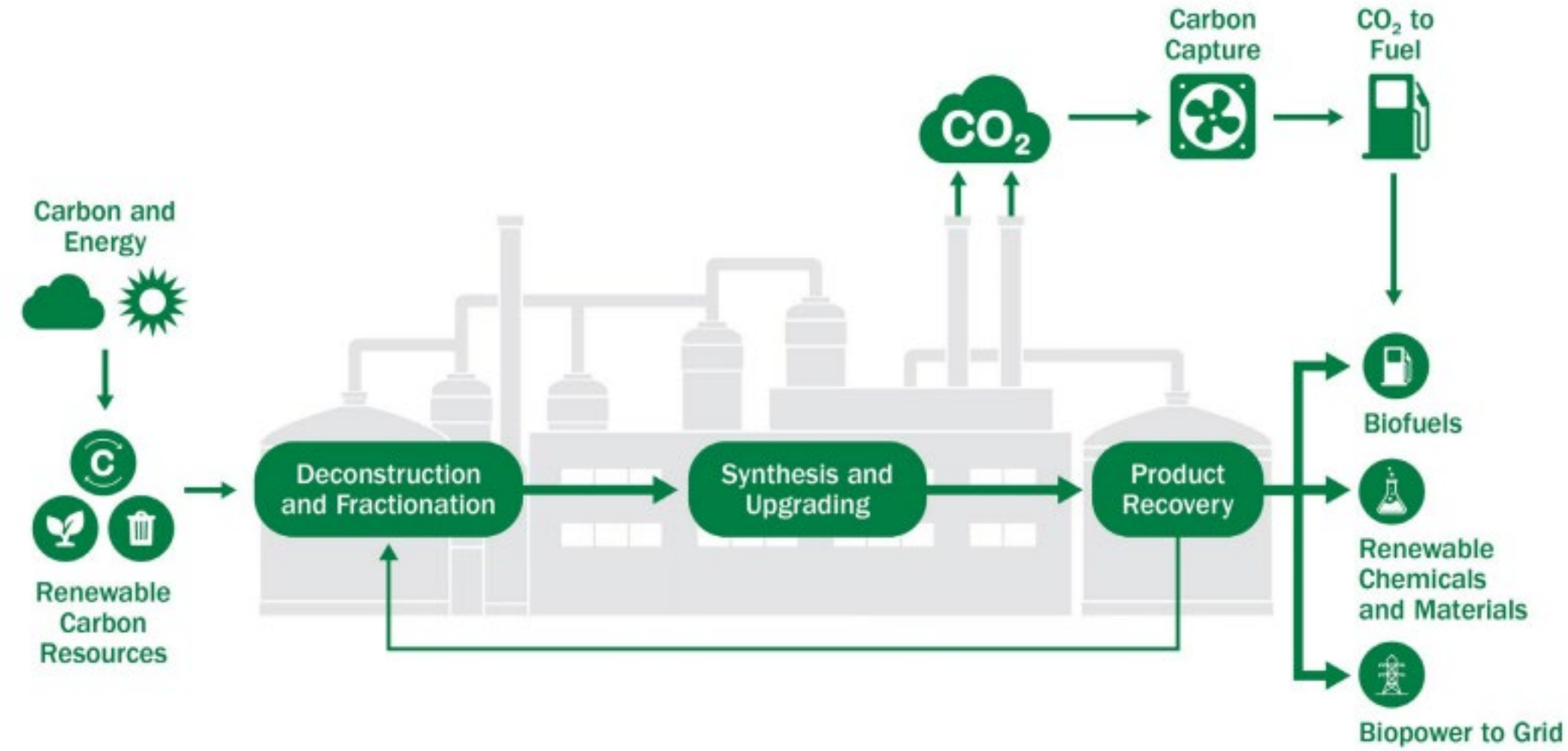
TRANSFORMING RENEWABLE CARBON RESOURCES



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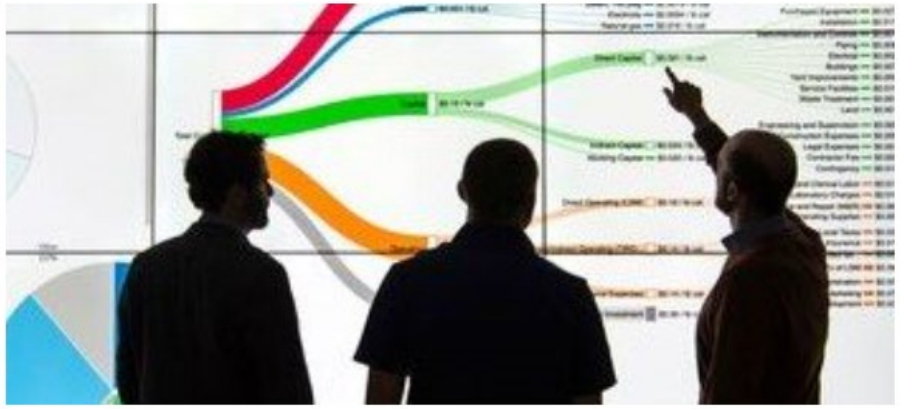
BETO TEAMS & FOCUS

RENEWABLE CARBON RESOURCES

DATA, MODELING, & ANALYSIS



CONVERSION TECHNOLOGIES

SYSTEMS DEVELOPMENT & INTEGRATION

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BIOENERGY TECHNOLOGIES OFFICE NATIONAL LAB INFRASTRUCTURE

Agile BioFoundry

Robust platform for faster, cheaper biological engineering

ABPDU

Rapid bioprocess development

DISCOVR

DEVELOPMENT OF INTEGRATED SCREENING, CULTIVAR OPTIMIZATION, AND VERIFICATION RESEARCH

Outdoor algae test beds

ChemCatBio

Chemical Catalysis for Bioenergy

Catalyst development

bottle

changing the way we recycle™

U.S. DEPARTMENT OF ENERGY

Plastic redesign and upcycling

BIOPROCESSING SEPARATIONS CONSORTIUM

Cost-effective bio separations

CCPC

Consortium for Computational Physics and Chemistry

U.S. DEPARTMENT OF ENERGY

BIOENERGY TECHNOLOGIES OFFICE

Computational modeling

CO_2RUe

U.S. DEPARTMENT OF ENERGY

Low temperature CO_2 electrolysis and upgrading

Pilot plant with preprocessing and fermentation. Major planned upgrades.

fcic

FEEDSTOCK-CONVERSION INTERFACE CONSORTIUM

U.S. DEPARTMENT OF ENERGY

Feedstock and preprocessing

ATEC

Algae Technology Education Consortium

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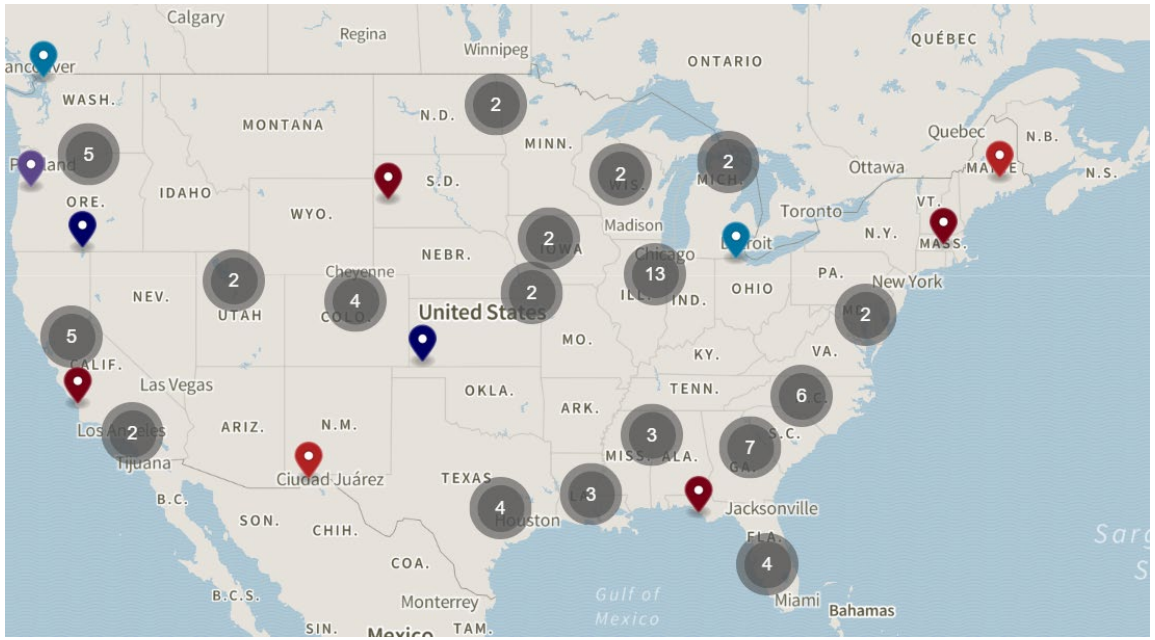
Bioenergy Consortia | Department of Energy

TRACK PRE-PILOT, PILOT, AND DEMONSTRATION SCALE PROJECTS



FINAL TECHNOLOGY READINESS LEVEL (TRL)

- [x] TRL 3: Bench Scale
- [x] TRL 4: Engineering Scale
- [x] TRL 5: Industrially Relevant Scale/ Pre-Pilot
- [x] TRL 6: Pilot Scale
- [x] TRL 7: Demonstration Scale
- [x] TRL 8: Commercial Scale
- [x] Modeling/Analysis

STATUS

All

FEEDSTOCK

- [x] Agricultural Residue
- [x] Algae
- [x] Bio-Crude
- [x] Biogas
- [x] By-Product
- [x] Cellulosic Sugars
- [x] Chemical Intermediate
- [x] Corn Stover
- [x] Energy Crops
- [x] Ethanol
- [x] Fats
- [x] Food Waste
- [x] Greases
- [x] Industrial Off Gas
- [x] Landfill Gas

https://www.energy.gov/eere/bioenergy/integrated-biorefineries

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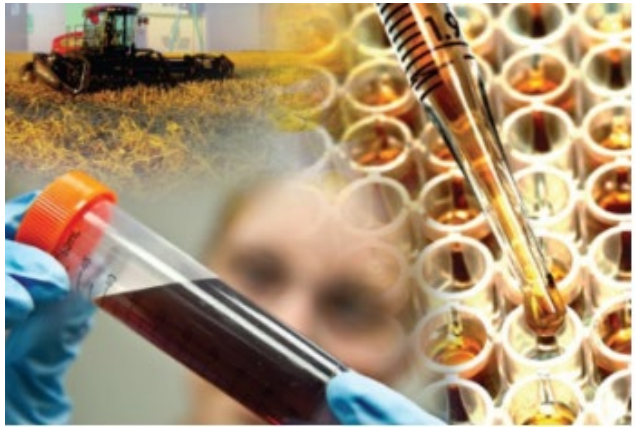
BETO FY24 FUNDING OPPORTUNITIES



- **Renewable Resource Hubs:** $29 Million to Drive Feedstock Innovation for Clean Energy Production
- **Scale Up:** $9.4 Million to Spur Development of Advanced Biofuels (IRA funding Joint with EPA)
- **Community Funding:** Waste-to-Energy Technical Assistance
- **Conversion:** Notice of Intent to Fund Mixed Algae and Wet Waste Feedstocks R&D for Biofuels and Bioproducts (Joint BETO/FECM)
- **Conversion:** Notice of Intent to Fund Research for Waste-to-Energy Community Solutions and Advance the U.S. Bioeconomy (Joint BETO/VTO)
- **Small Business Innovative Research:** Bio-based Materials, Alternative Uses of Commercial Equipment

https://www.energy.gov/eere/bioenergy/bioenergy-technologies-office-funding-opportunities

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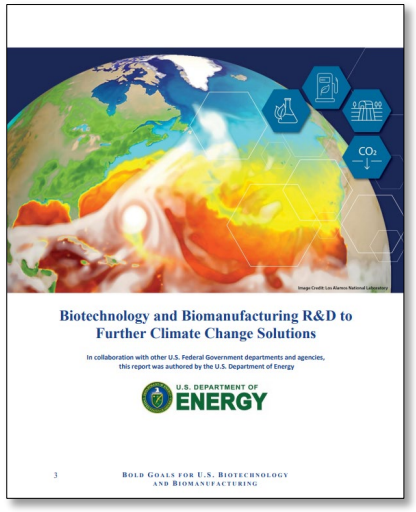
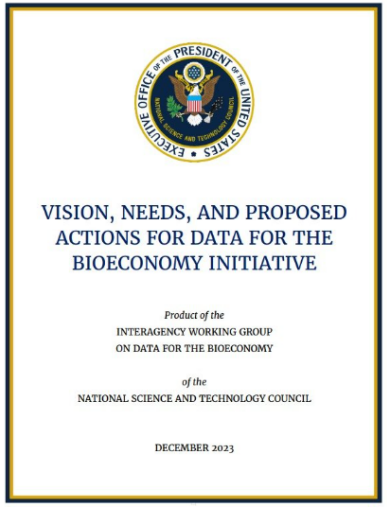
THE TIME IS RIGHT TO DESIGN THE BIOECONOMY FOR DECARBONIZATION





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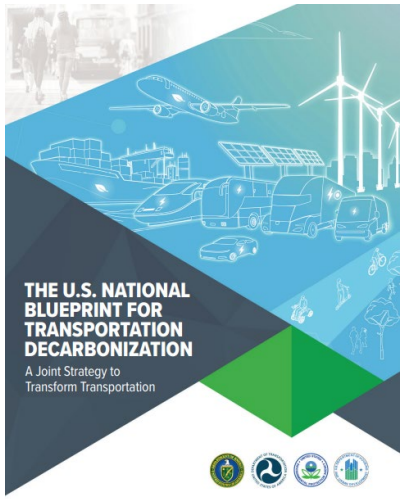
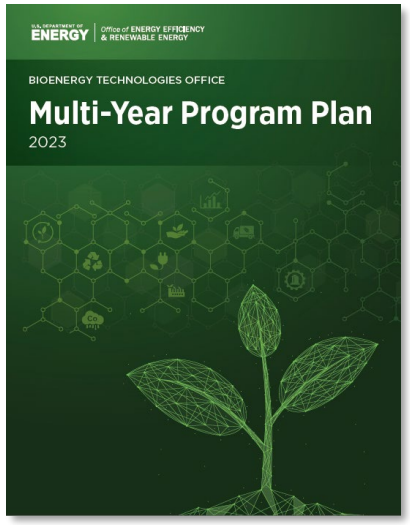
Clean Fuels & Products Shot





45Q Carbon Oxide

45Y, 48E Clean Electricity

45V Clean Hydrogen

45Z Clean Fuel

48C Energy Property

40B SAF

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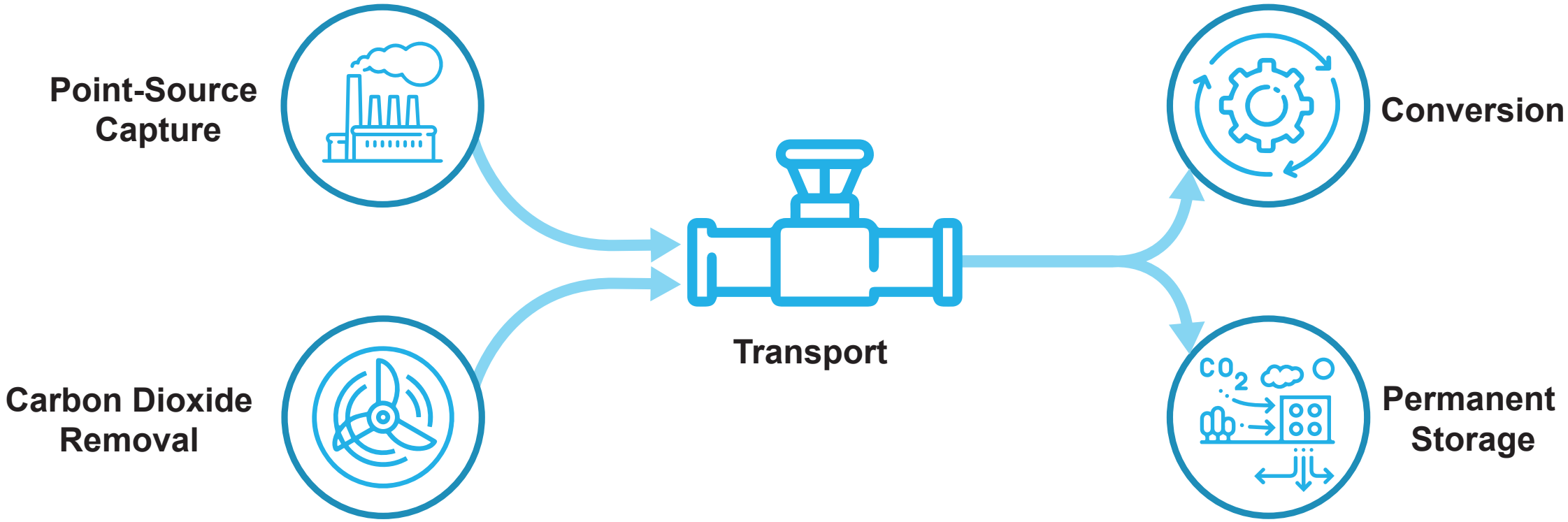
Office of Fossil Energy & Carbon Management (FECM)

Emily Connor

Acting Division Director/Program Manager

WHAT IS CARBON MANAGEMENT?



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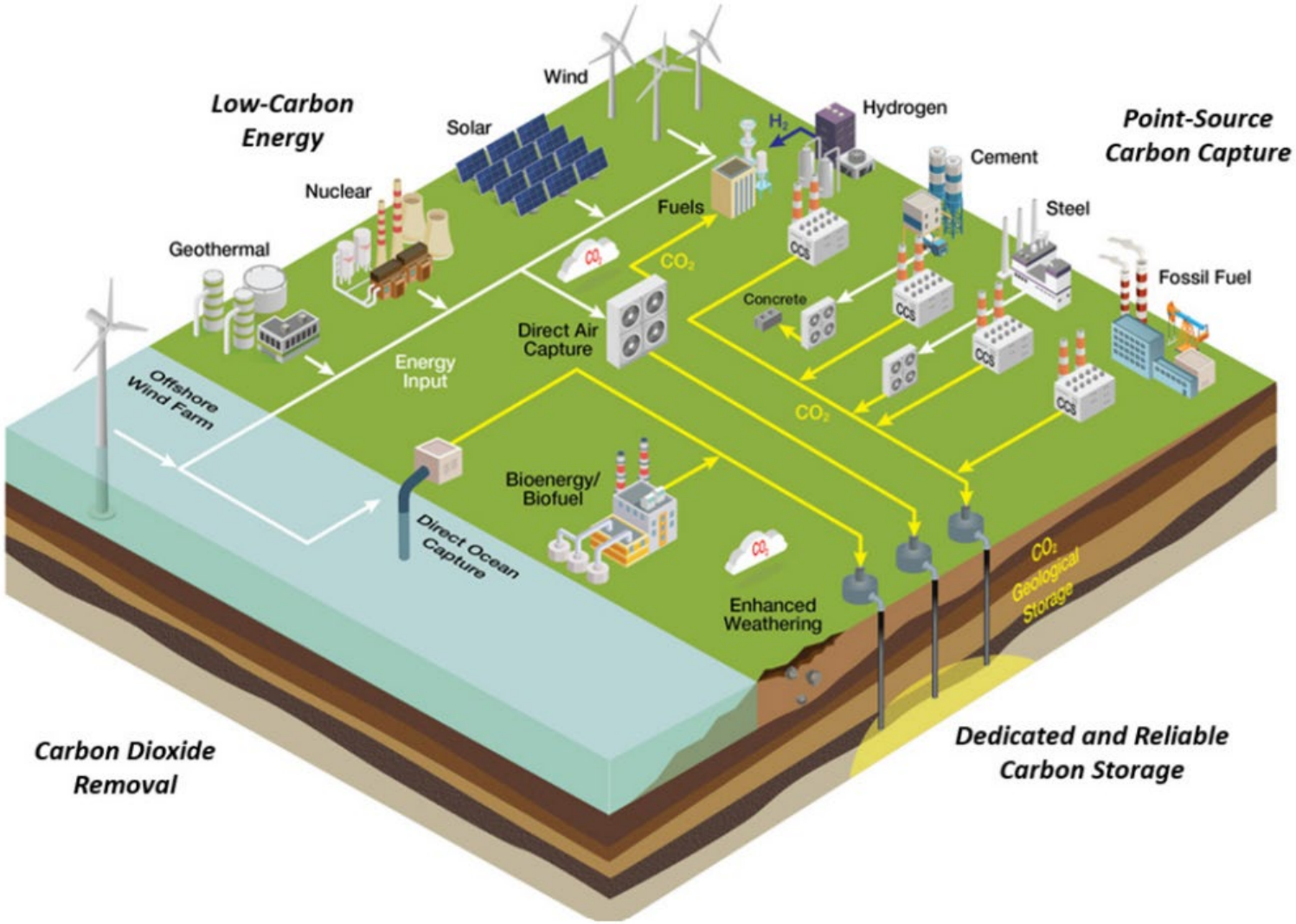
CARBON MANAGEMENT IS KEY FOR NET-ZERO...



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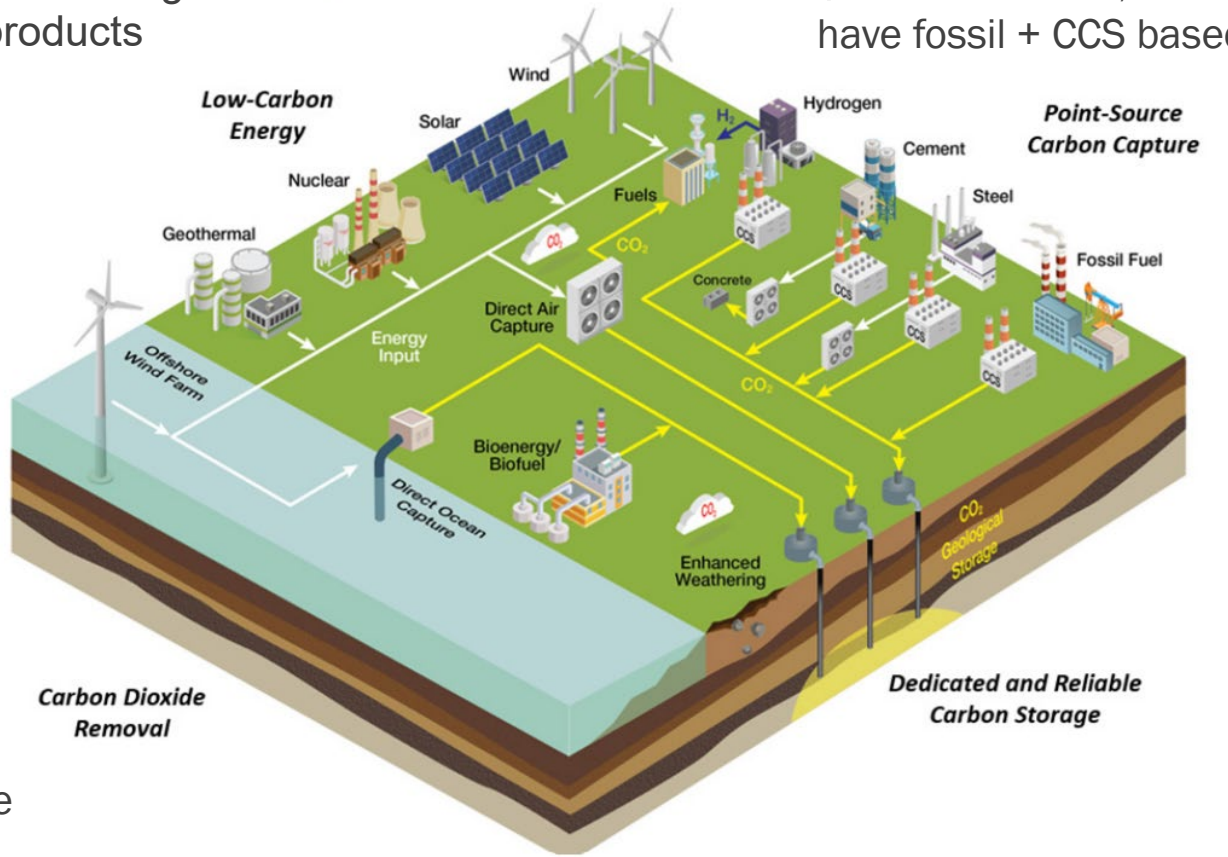
BIPARTISAN INFRASTRUCTURE LAW FUNDING

$300M for CO2 conversion grants for low embodied carbon products

$8B for H2 Hubs, of which at least one will have fossil + CCS based H2 production

$2.5B for CO2 transportation loan support via CIFIA program

$100M for CO2 transportation engineering studies



$2.5B for commercial CCS demonstrations

$1B for small CCS pilots

$2.5B for expanding DOE's CarbonSAFE storage characterization and buildout initiative

$3.5B for Direct Air Capture Hubs
$115M for Direct Air Capture Technology Prizes

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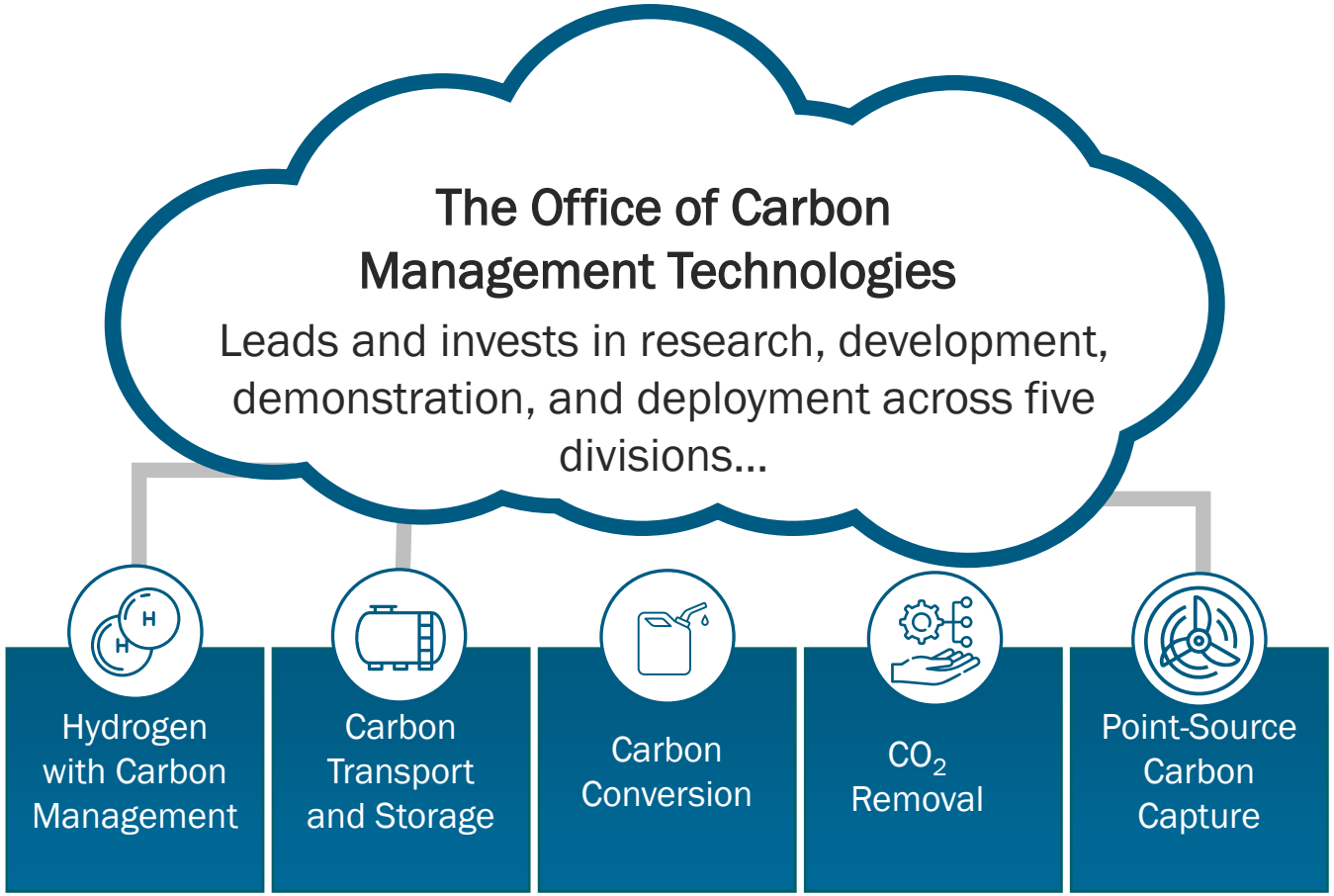
FECM MISSION: OFFICE OF CARBON MANAGEMENT



Focused on minimizing the environmental and climate impacts of fossil fuels and industrial processes, while working to achieve net-zero GHG across our economy

Enacting Justice and Supporting Legacy Communities

- Good-paying jobs
- Job growth acceleration
- Healthy economic transitions
- Improve community conditions

Address hardest-to-decarbonize applications in the electricity & industrial sectors

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U.S. POLICY ENABLES FULL RANGE OF PROJECTS

Policy Lever	**Updated 45Q tax credits** *(Inflation Reduction Act)*	**Pilot and demo funding** *(Bipartisan Infrastructure Law + Inflation Reduction Act)*	**Carbon credits + Buy Clean** *(voluntary corporate + state/ local governments)*
Expected Project Impacts	Higher concentration point sources near pipelines and/or storage 100Ms t/y by 2030	Lower concentration point sources and novel capture technologies 10Ms t/y by 2030	Carbon dioxide removal and conversion demonstrations Ms t/y by 2030

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SOCIAL & ENVIRONMENTAL IMPACTS ESSENTIAL TO SUCCESS

DOE includes community, workforce, and environmental criteria in funding opportunities (up to 20% on major demos)

DOE supports community and stakeholder engagement activities

DOE requires monitoring and data collection to inform life cycle analysis, including non-CO_2 emissions and water usage impacts

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FECM ALIGNMENT WITH ENERGY EARTHSHOTS

- Supporting catalytic R&D including catalytic conversion of CO_2
- CO_2 conversion to fuels and chemicals
- Point source carbon capture and direct air capture
- H_2 with CCS and through gasification

Additional synergies with projects developed under the Carbon Negative Earthshot & FECM Areas efforts in CDR:

- Biomass with Carbon Removal and Storage
- Direct Air Capture (DAC)
- Direct Ocean Capture (DOC)
- Accelerated Weathering and Mineralization

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Industrial Efficiency and Decarbonization Office (IEDO)

Dr. Felicia Lucci

Technology Manager

IEDO Focus on Energy Intensive Manufacturing Subsectors

Mission: Accelerate the innovation and adoption of cost-effective technologies to increase energy efficiency and reduce greenhouse gas (GHG) emissions in the U.S. industrial sector.

Major Economic Impact

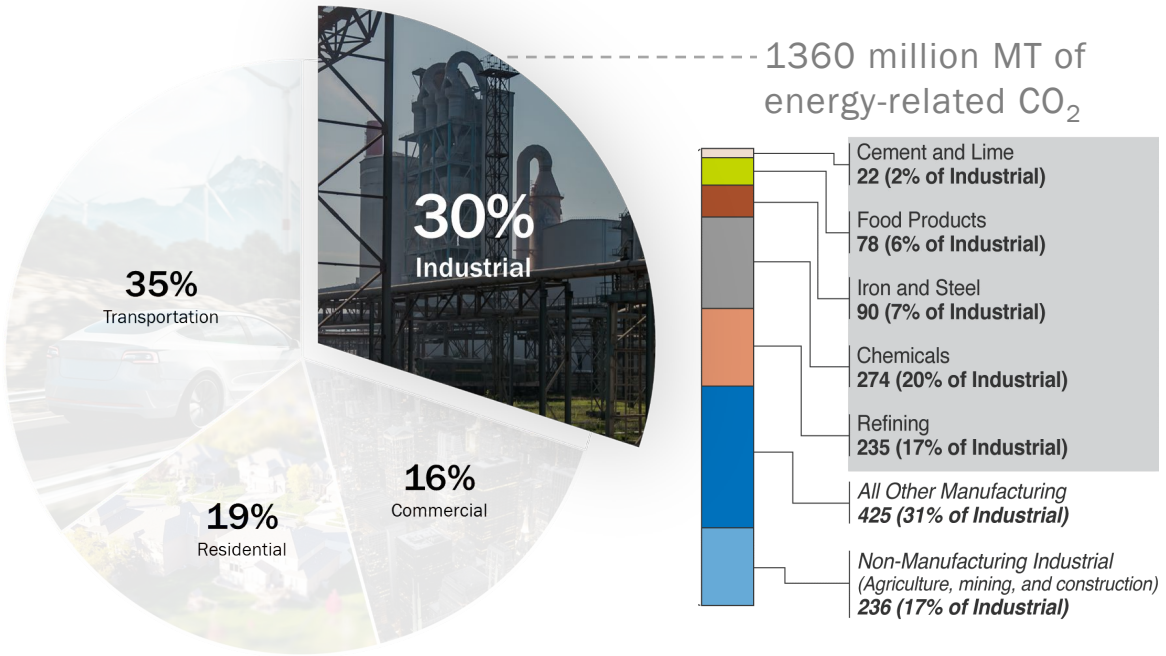
GROW
a robust
economy

While working to
DECREASE
CO_2 emissions

U.S. manufacturing subsector…

- CONTRIBUTES $2.35 trillion to the U.S. Economy
- GENERATES 11% of U.S. GDP
- CREATES 11.4 million jobs

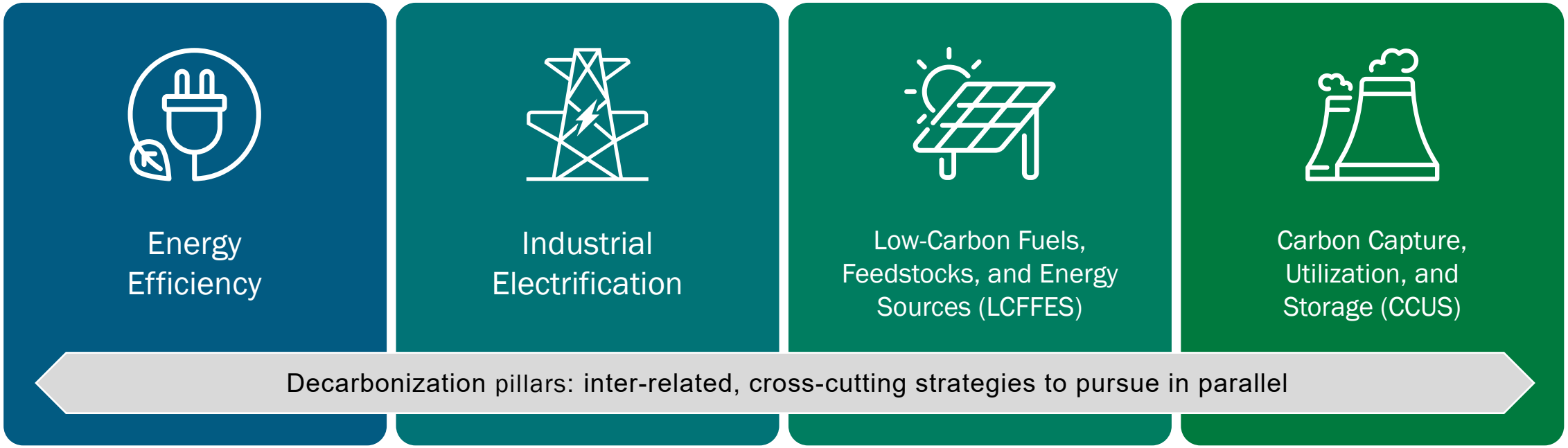
CO_2 Emissions Across U.S. Industry



Data source: Energy Information Administration (EIA) *Annual Energy Outlook 2021 with Projections to 2050* and other EIA and EPA source

DOE Industrial Decarbonization Roadmap

Industrial Decarbonization Pillars




Iron & Steel


Chemicals


Food & Beverage


Petroleum Refining


Cement

www.energy.gov/eere/doe-industrial-decarbonization-roadmap

IEDO Invests in Sector-specific & Cross-cutting Technologies

ENERGY- AND EMISSIONS-INTENSIVE INDUSTRIES (EEII)

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

Chemicals & Fuels | Iron & Steel| Cement, Concrete, Asphalt, Glass| Forest Products | Food & Beverage

CROSS-SECTOR TECHNOLOGIES (CST)

Accelerates the readiness of energy- and emissions-reducing components, systems, and operational technologies, across a broad range of industries.

Thermal Process & Systems| Low-Carbon Fuels, Feedstocks, & Energy Sources |Emerging Efficiency | Water & Wastewater Treatment

TECHNICAL ASSISTANCE AND WORKFORCE DEVELOPMENT (TAWD)

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.

ONSITE ENERGY | PROGRAM 50001 | READY & SEP 50001 | WORKFORCE DEVELOPMENT

Fostering Emerging Technologies Through RD&D

IEDO Funding Opportunity Announcements: Awarded $314M and announced $121M in R&D funding in the last two years for cross-cutting decarbonization technologies and technologies within energy-and-emission-intensive industries.

EPIX
ELECTRIFIED PROCESSES FOR INDUSTRY WITHOUT CARBON

EPIXC: New $70M DOE Clean Energy Manufacturing Innovation Institute focused on electrifying process heating and decarbonize the industrial sector.

RAPID
Transforming Process Industries

RAPID: DOE Clean Energy Manufacturing Innovation Institute focused on re-designing industrial processes to optimize production and increase sustainability within the chemicals and fuels industries.

Adopting Technologies through Technical Assistance

Public /private partnerships to help manufacturers and industrial organizations set and achieve long-term energy intensity reduction goals

Better Climate CHALLENGE
U.S. DEPARTMENT OF ENERGY

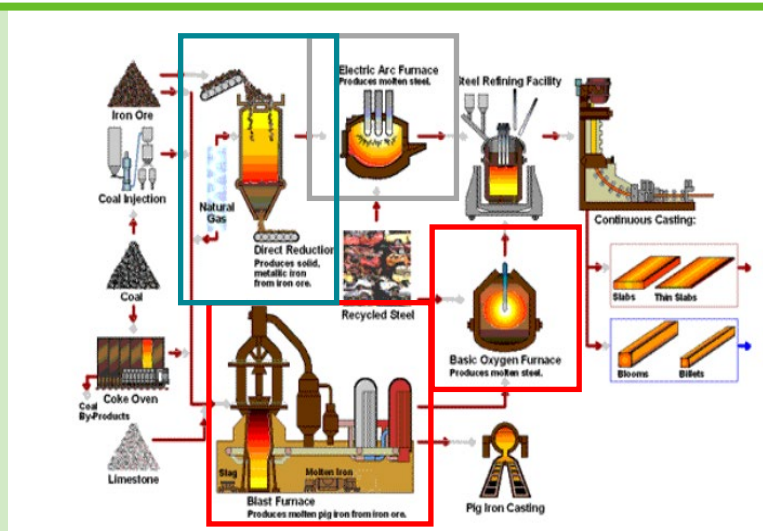
50001 Ready
U.S. DEPARTMENT OF ENERGY

Better Plants®
U.S. DEPARTMENT OF ENERGY

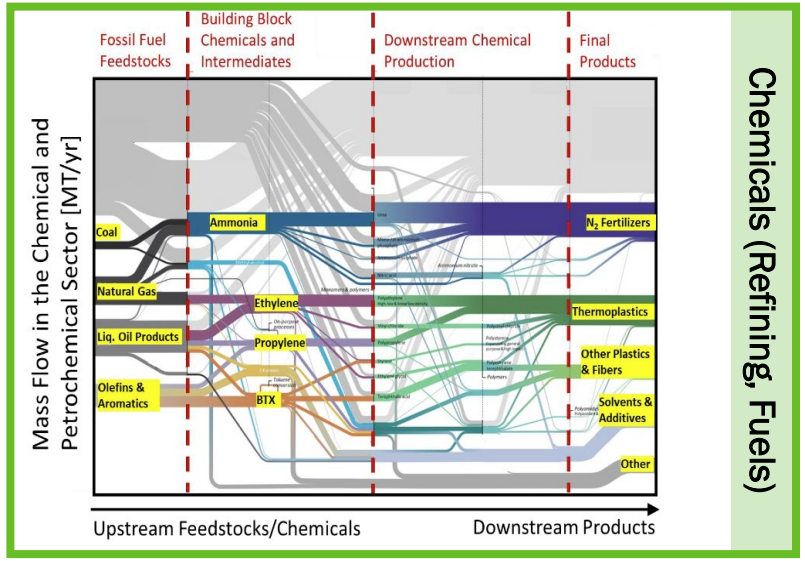
Superior Energy Performance®
U.S. DEPARTMENT OF ENERGY

Sector Value Chains: Raw Materials, Process, Final Products

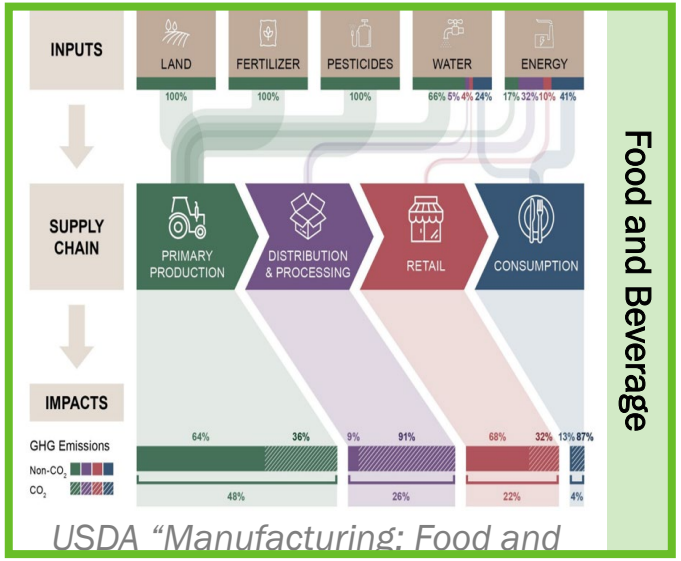
Iron and Steel



Chemicals (Refining, Fuels)

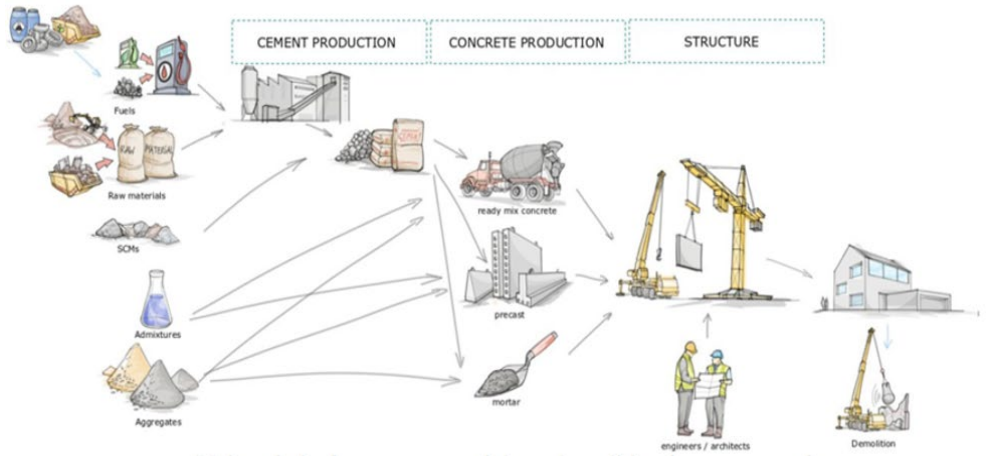


Food and Beverage

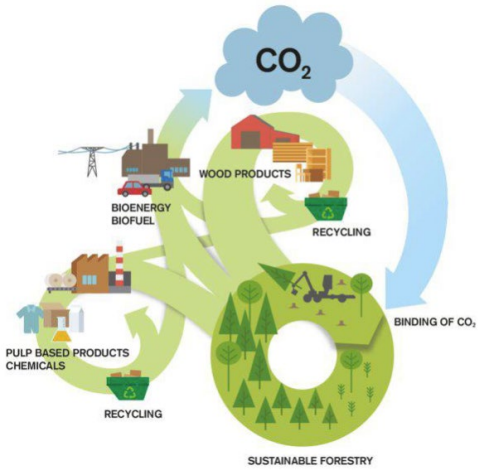


USDA "Manufacturing: Food and Beverage Manufacturing"

Cement and Concrete



Paper and forest product



American Forest & Paper Association https://www.afandpa.org/about-afpa data from Bureau of Economic Analysis

Leverage Industrial Bi-products and Waste for Value-Added Products

Industrial Biproducts

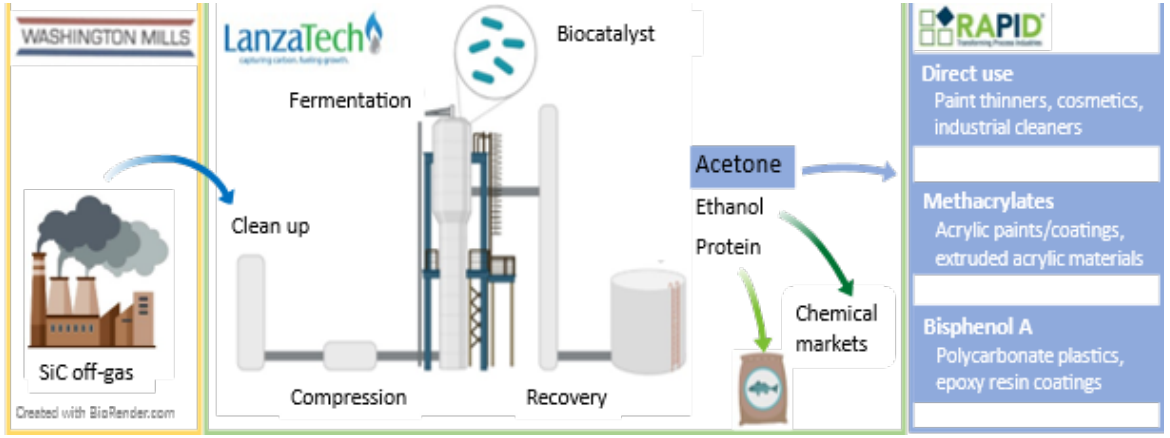
Industrial Waste Gases

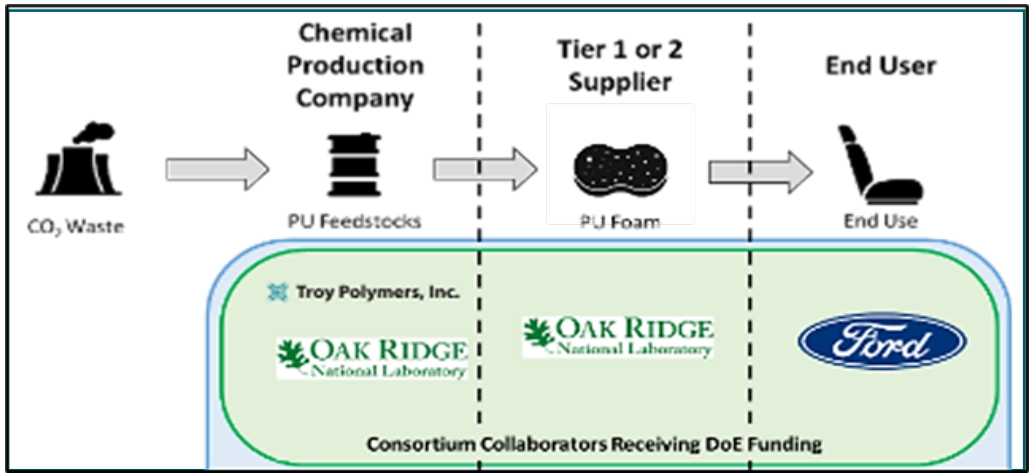
Food Waste

Forest Products

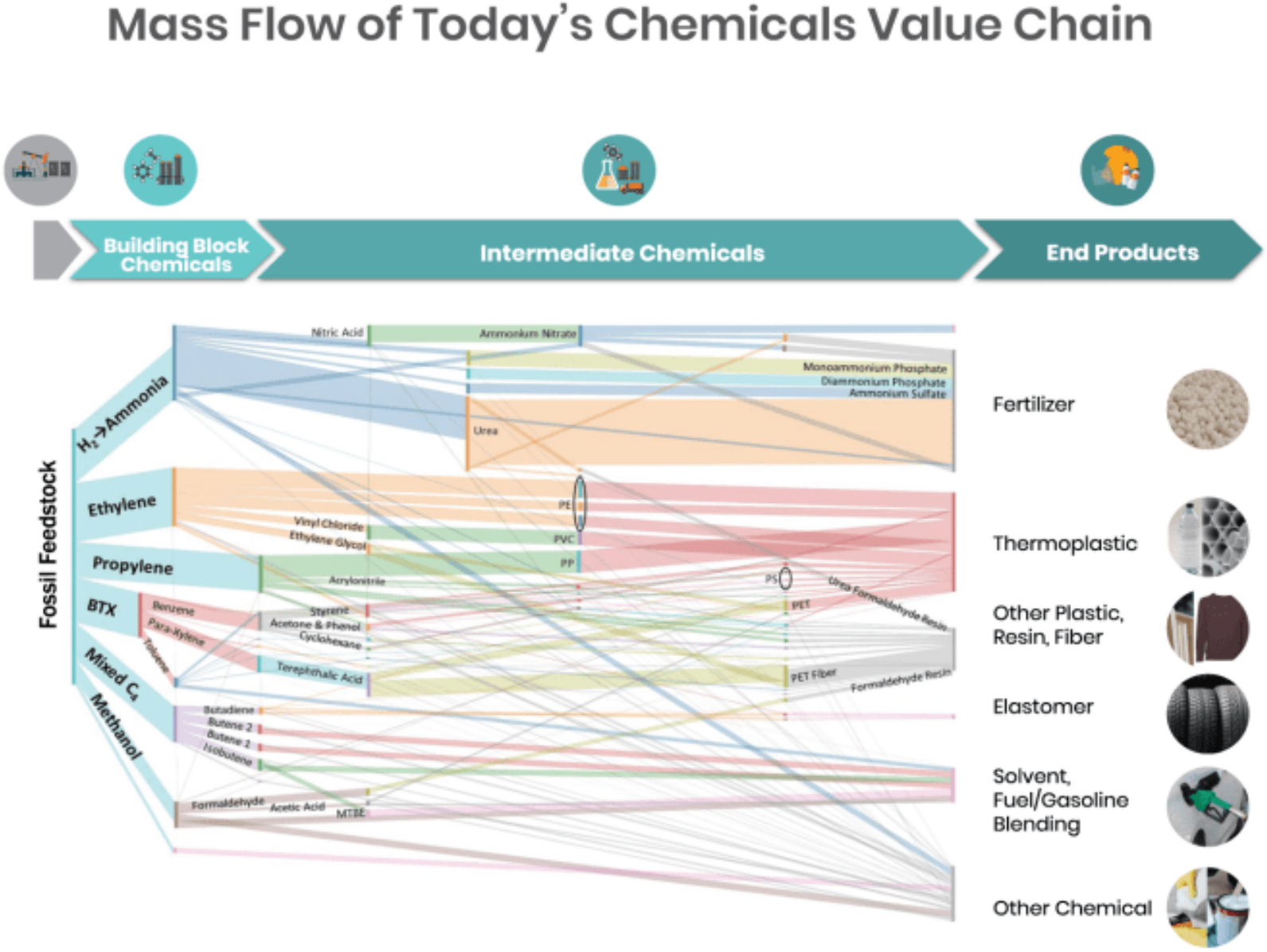
Discarded Building Products

IEDO Supported Projects

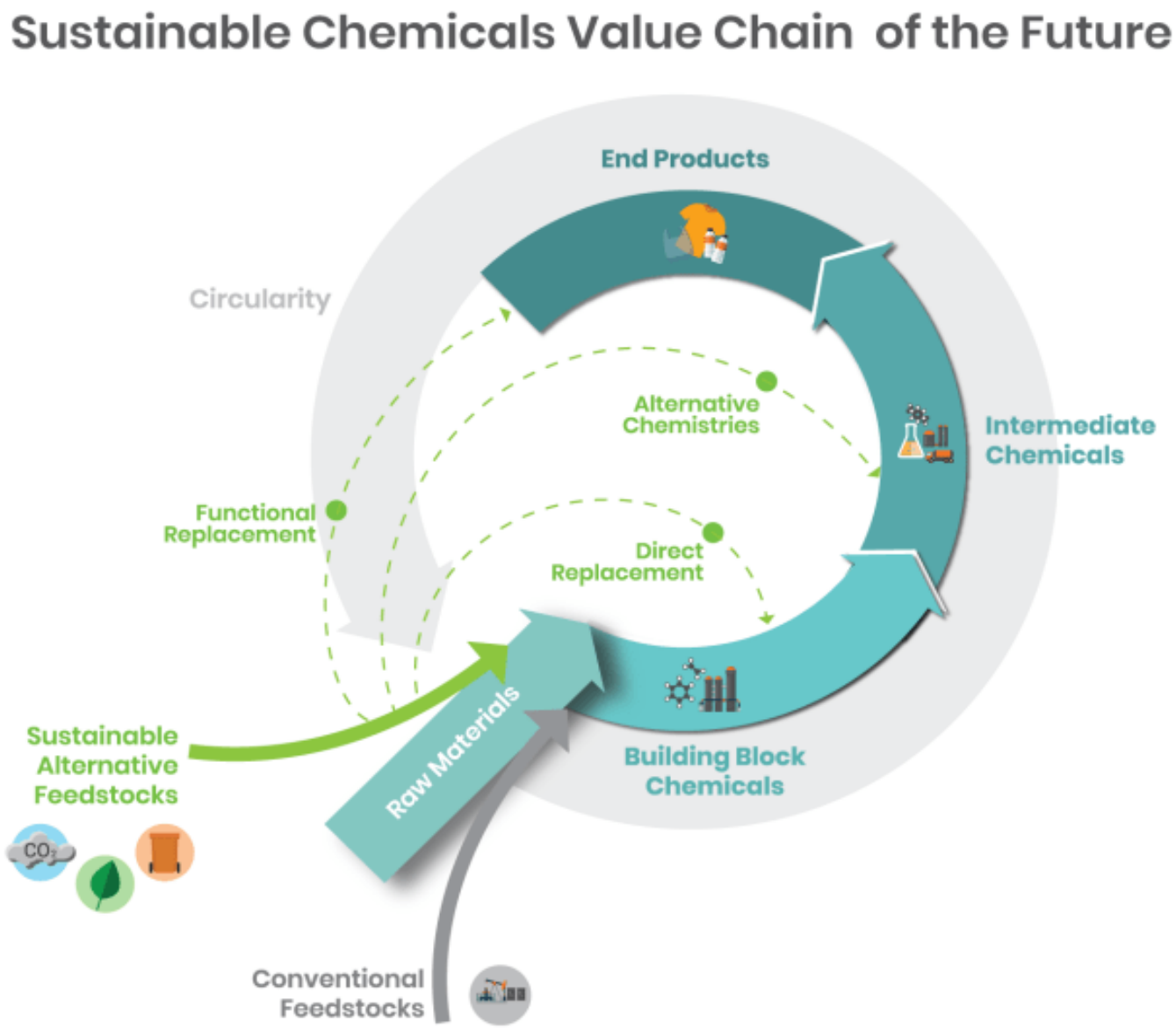




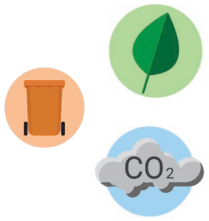
Sustainable Feedstocks Key to Transforming from a Linear to Circular Economy



Sustainable Feedstocks Key to Transforming from a Linear to Circular Economy



IEDO $150M+ Chemicals & Fuels Portfolio



Sustainable Feedstocks

- CO_2
- CO
- Bio methane
- Waste biomass
- Waste tires
- Waste plastic
- Waste concrete

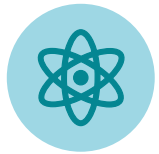
Process Innovations

- Reactor development
- Modularity
- Catalysts
- Membranes
- Electrochemical and Non-contact heating

Chemical Products

- Ethylene
- Propylene
- Methane
- Methanol
- Ethylene glycol
- Acrylonitrile
- Ammonia
- Acetone
- Ethanol
- Acetic acid
- Polyurethane
- FDCA
- Butadiene
- Rubber

Sustainable Chemistry



Energy & Material Efficiency

Save the Date: Workshop to inform DOE's Industrial Decarbonization Strategies

When: May 14-15, 2024

Where: D.C. Region

The U.S. Department of Energy (DOE) will host a workshop to solicit input to inform a new DOE analysis, *Transforming Industry: Strategies for Decarbonization.*

This effort will consider the technical, economic, workforce, and supply chain challenges associated with the scale and pace of an industrial transformation, and present informed strategies for overcoming these barriers.

More details about the in-person and virtual options for the workshop and additional engagement opportunities coming soon.

Looking Forward:
DOE's Industrial Efficiency & Decarbonization Office

Stay up-to-date on stakeholder engagement:

- Requests for Information
- Workshops
- Webinars
- Funding Opportunity Announcements

Subscribe:
www.energy.gov/eere/iedo/subscribe-iedonewsletter

Email: felicia.lucci@ee.doe.gov

IEDO is Hiring!

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

Introduction to Sessions

Session Organization
Pillars/Core Research Areas Cont'd

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Societal Considerations/Impacts	• Energy equity impacts and differentiated regional strategies • Cradle to grave life-cycle analysis and sustainability modeling to prioritize the most impactful R&D
Resource/Feedstock Mobilization	• New technologies to enable low cost, low-emissions feedstocks at scale • Increased carbon incorporation into biomass
Carbon-Efficient Conversion Processes	• New carbon-efficient conversion technologies • Innovation to improve CO_2 catalytic conversion efficiency • Solar fuels • Processes using green electricity and hydrogen
Technology Scaling & Demonstration	• Integrated pilot and demonstration scale facilities to de-risk technology for rapid industry adoption

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Session 1

Societal Considerations and Impacts

Pillar Overview

Social Considerations and Impacts

Social & Technological Systems Integration:
Using cradle to grave life-cycle analysis, sustainability modeling, and social science integration to prioritize the most impactful R&D that considers energy equity, social impacts, and differentiated regional strategies

Pillar Includes:
Life cycle analysis (including social LCA), Sustainability modeling and analysis, Economic analysis, Social acceptability, Social license to operate, Consent-based siting, Co-production, Distributional impacts of energy production and use

Examples:
Health-focused toxicity modeling, Cumulative impacts assessments, Equity indicator development, Social impact analysis, Social impact assessments throughout project design and deployment, Community Benefits Plans/Agreements, Early and ongoing community engagement, Technical assistance

Basic & Foundational Science

Applied Research & Development

Session Agenda

PRESENTATION	SPEAKER
U.S. Department of Energy Updates	Andrea Bailey, Technology Manager, DOE BETO
	Dr. Felicia Lucci, Technology Manager, DOE IEDO
	Rebecca Erwin, Technical Project Officer, DOE HFTO
Keynotes	Ugbaad Kosar, Director of Environmental Justice, Carbon180
	Dr. Kristi Pullen Fedinick, Assistant Director of Environmental Justice Science & Technology, White House OSTP
Research Panel	Dr. Lis Blanco, Social Science Researcher, NREL
	Dr. Taylor Uekert, Circular Economy Research Analyst, NREL
	Dr. Rebecca Efroymson, Distinguished Scientist, Environmental Sciences Division, ORNL
	Dr. Shruti Khadka Mishra, Senior Member of Technical Staff, Economics of Energy and Environment, SNL

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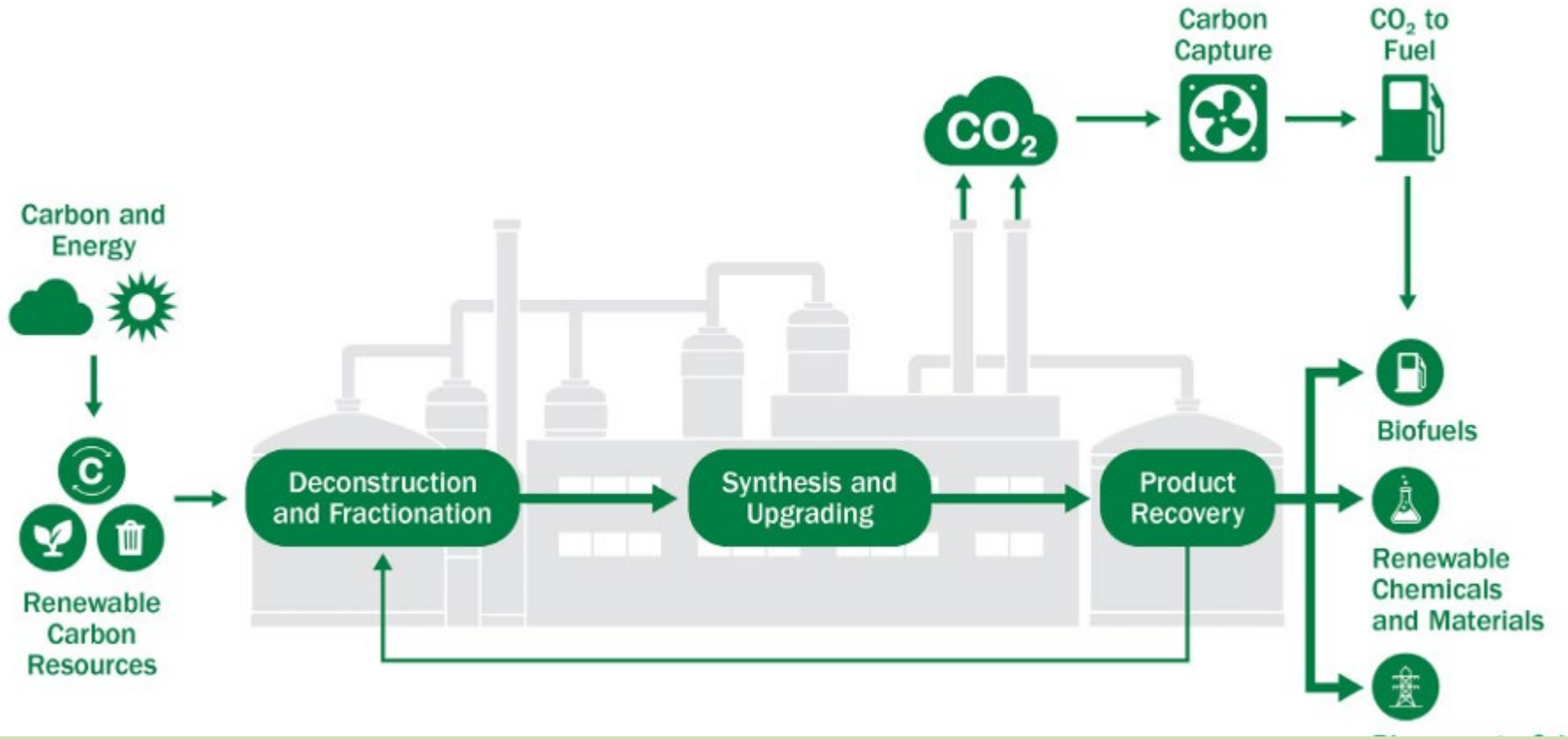
Bioenergy Technologies Office (BETO)

Andrea Bailey

Technology Manager

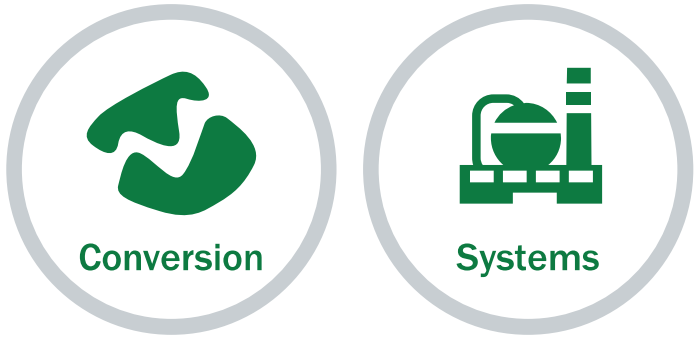
Equity Analysis Considerations Across the Bioenergy Supply Chain



Overarching Questions

- What are systems-level versus local-level tradeoff scenarios for energy equity?
- How can we integrate diverse indicators to provide a holistic model for energy equity in bioenergy scenarios?
- What are long-term outcomes on energy equity for various bioenergy scenarios?

Equity Analysis Considerations Across the Bioenergy Supply Chain



Feedstock Questions

- How do feedstock production and collection affect communities/landscapes?
- What ecosystem services are provided by these feedstocks?
- What are potential conflicts of using these feedstocks (i.e., food vs. fuel, waste hierarchy)?
- How do these feedstocks fit into various programs and emerging opportunities advancing sustainable practices?

Technology & Infrastructure Questions

- What emissions are avoided and/or created from the processes? What are the impacts?
- Where is infrastructure sited, historically and in the future? What are the impacts?
- What are the social & environmental impacts of new biobased products and fuels? How does this affect national and global supply chains and labor conditions?

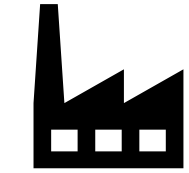
Social Sustainability Questions

- What jobs and careers are available for various technological scenarios? Access to training? Advancement opportunities?
- What benefits do communities directly and indirectly receive? How?
- To what degree are communities impacted by technologies involved as co-developers in the process?
- When is equity appropriate, and when is justice (i.e., fair/equal access versus preferential access based on historic barriers)?

Example: Waste-to-Energy Technical Assistance Program

Objectives:

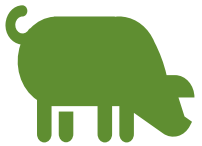
- Deploy the analyses that have been developed for a variety of energy/resource recovery strategies
- Provide data to local decision-makers
- Foster local public-private partnerships.



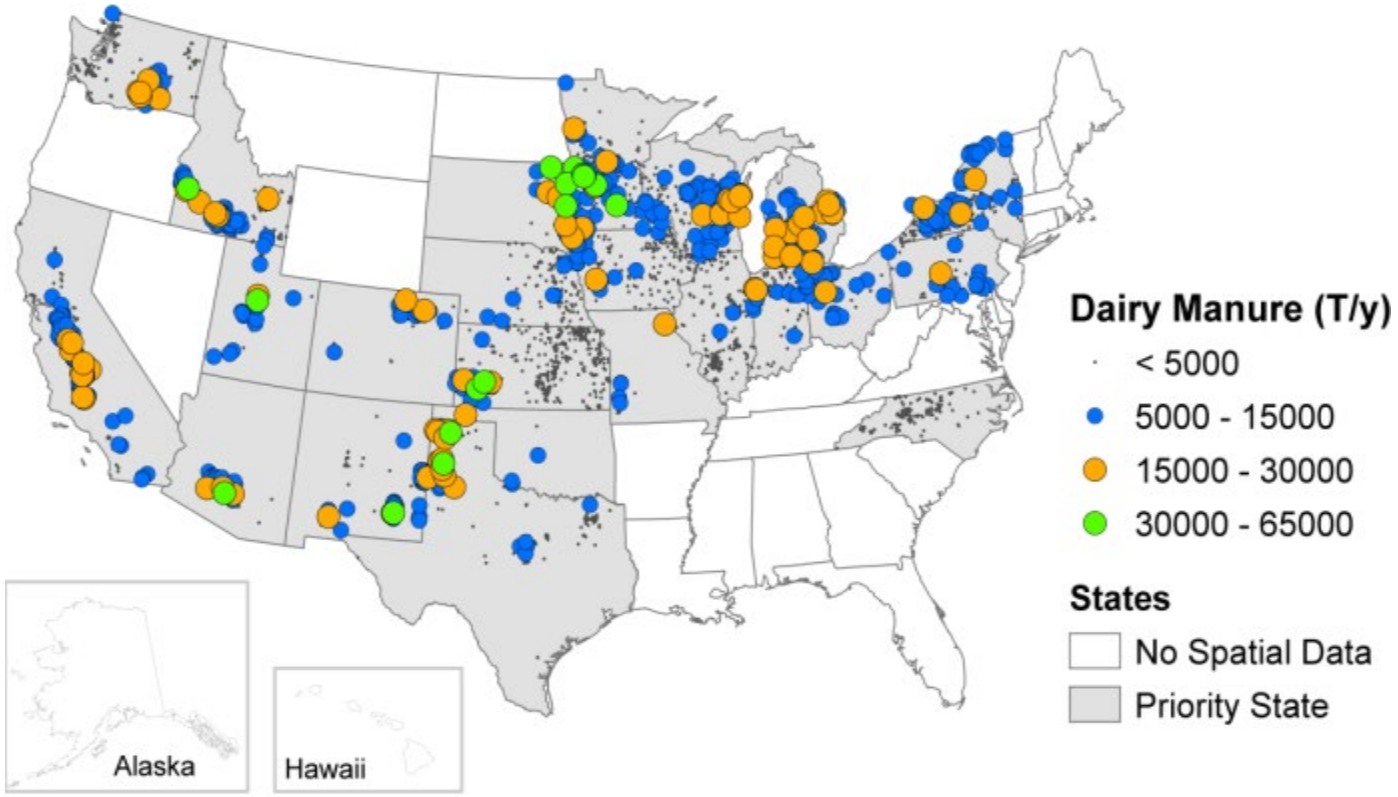
Wastewater Sludge

Food Waste

Animal Manure



Inedible Fats, Oils, and Greases



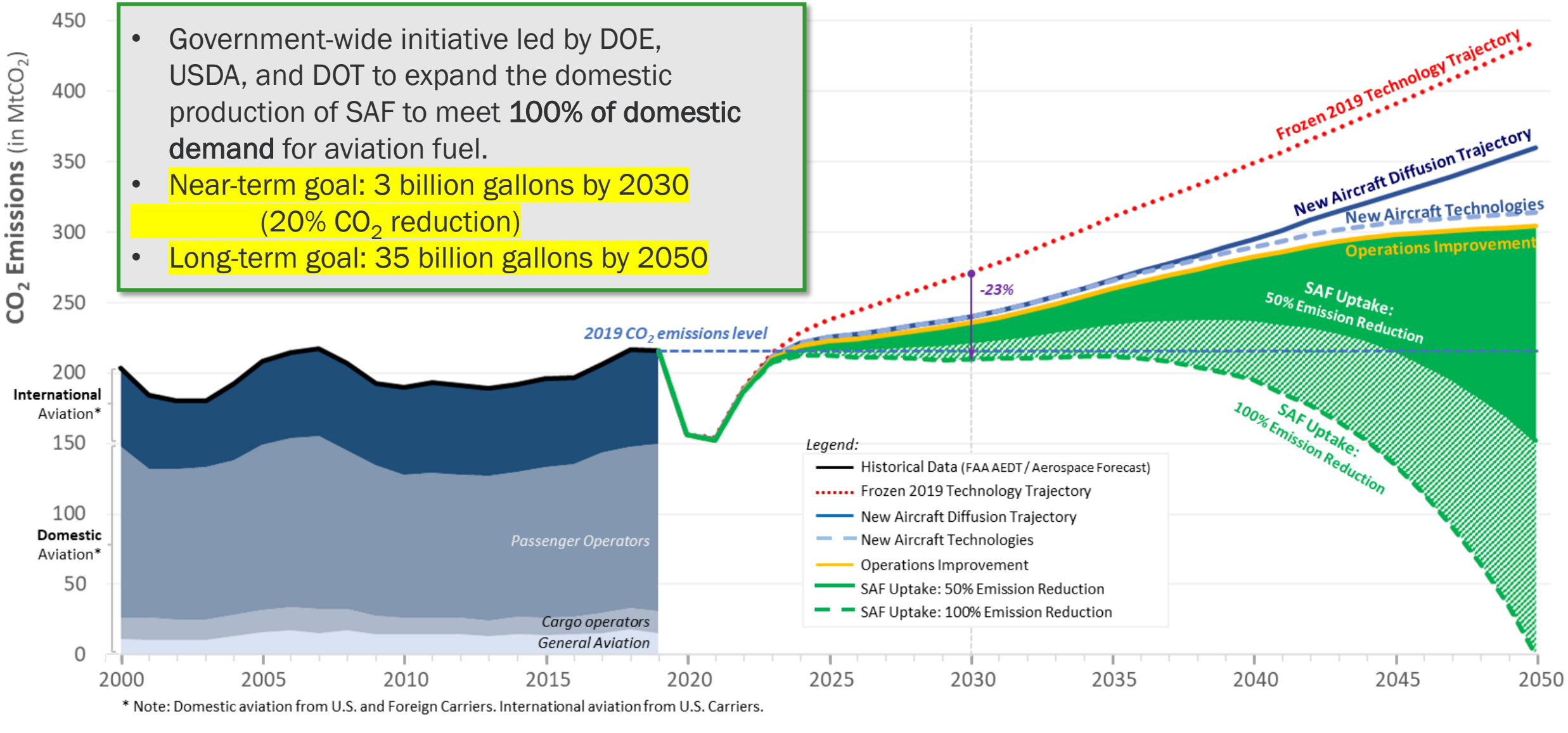
Based on this example, consider:

- Audience/users
- Accessibility
- Utility (i.e., what questions do people need answered to make informed decisions?)
- Integrating local information into models
- Replicability

FY24 solicitation announced March 4

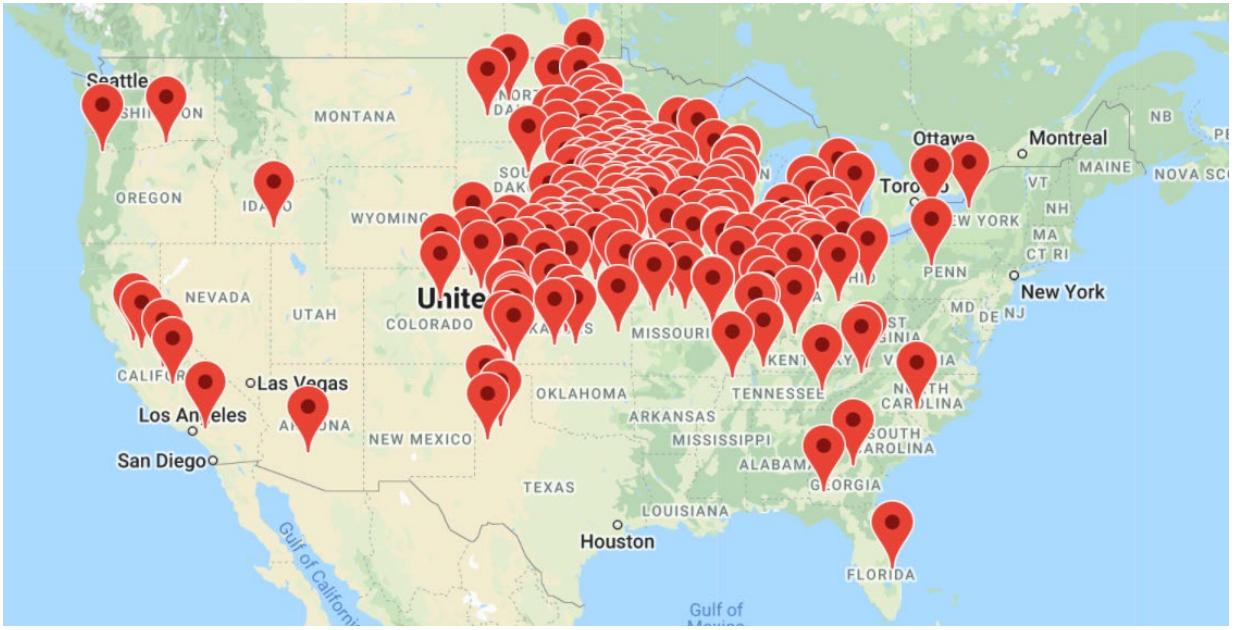
SAF Grand Challenge: Considerations for the Future of Bioenergy

- Government-wide initiative led by DOE, USDA, and DOT to expand the domestic production of SAF to meet **100% of domestic demand** for aviation fuel.
- Near-term goal: 3 billion gallons by 2030 (20% CO_2 reduction)
- Long-term goal: 35 billion gallons by 2050



* Note: Domestic aviation from U.S. and Foreign Carriers. International aviation from U.S. Carriers.

Hitting SAF GC Goals: Considerations for the Future of Bioenergy



- Ethanol industry grew from 2 billion gallons/year in 2002 to nearly 16 billion gallons in 2016.
- There were about 215 ethanol refineries in the U.S. built over 15 years, primarily in the Midwest.
- To hit SAF Grand Challenge volumetric goals, the U.S. will need:
  - 40–45 refineries by 2030
  - 400–500 refineries by 2050

It will be important to invest in research that considers the impacts of these facilities and promotes responsible development at pre-commercial scales.

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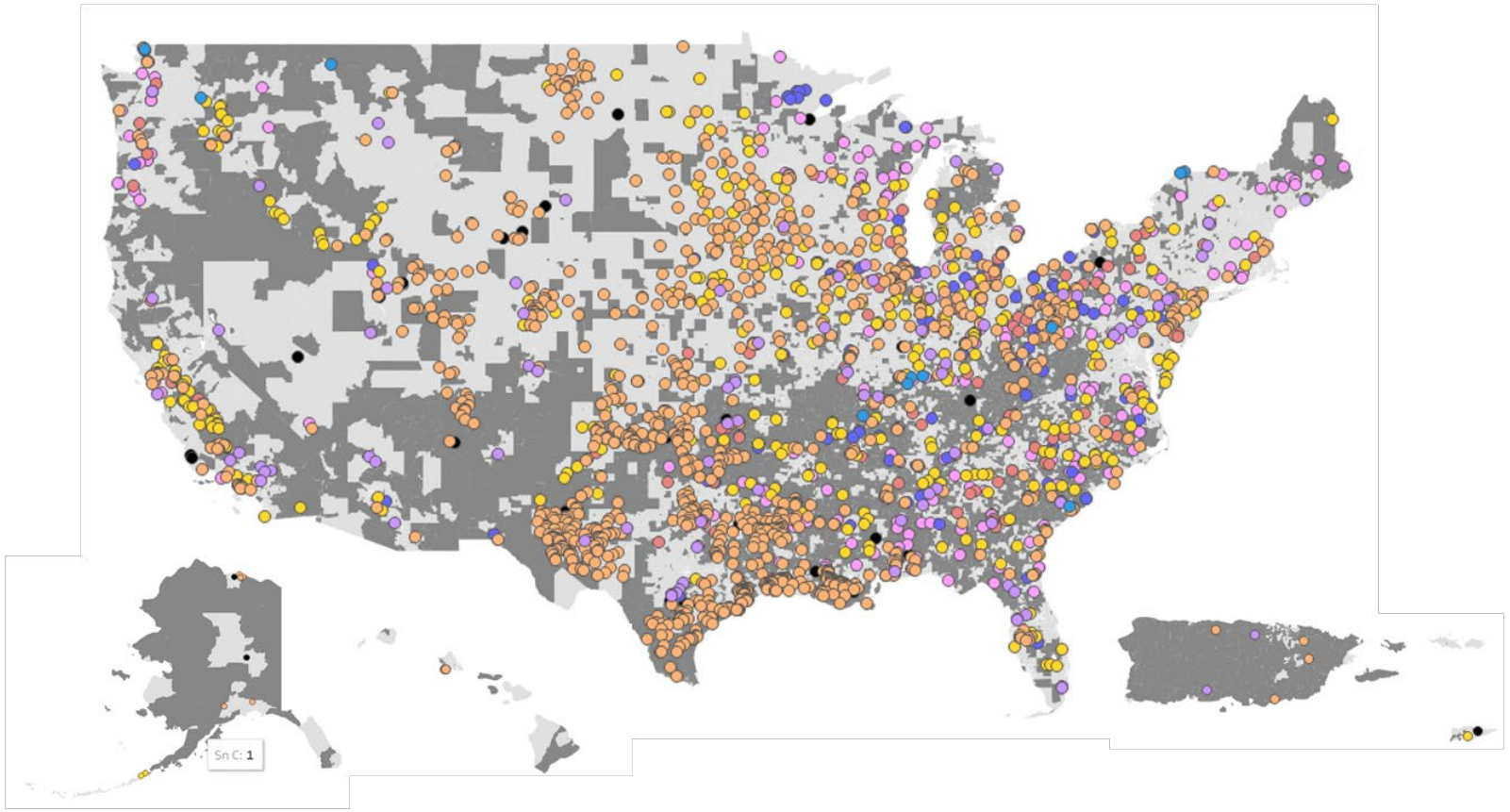
Industrial Efficiency and Decarbonization Office (IEDO)

Dr. Felicia Lucci

Technology Manager

Industrial Facilities are Located across the U.S., Often in Disadvantaged Communities

Map of select U.S. point source CO_2 emissions and US Disadvantaged Communities, 2021



Sectors: Cement, Chemicals, Pulp & Paper, Refining, Aluminum, Iron & Steel, Glass, Food & Beverage

Non-DAC Community, DAC Community

Source: EPA Flight, Climate and Economic Justice Screening Tool

2,500+

Industrial facilities in sectors of focus

1,145+

Studied sectors' industrial facilities located within U.S. disadvantaged communities

Leveraging Sustainable Chemistry to Advance Decarbonization and Environmental Justice

Stakeholder Engagement

Scaling Sustainable Chemistry for an Industrial Transformation Workshop

- Summer 2024 – Washington, D.C. Metro Area
- Evaluate the technologies, policy and regulatory reforms, and collaborations needed to scale sustainable chemistry from the lab to the market

IEDO Technical Assistance & Workforce Development Increase Adoption of Technologies Ready Today

Public /private partnerships to help manufacturers and industrial organizations set and achieve long-term 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

TA work products include: Energy Assessments | Peer-to-Peer Networking | Tools & Training | Technology Screening | Project Profiles

Manufacturing, Materials, and Life Cycle Energy Tools

IEDO's manufacturing, materials, and life cycle energy tools and resources use a cross-sector and prospective life cycle assessment (LCA) approach that anticipates future benefits and impacts.

- Life Cycle Assessment and Techno-Economic Analysis Training
- Environmentally Extended Input-Output for Industrial Decarbonization Analysis (EEIO-IDA) Tool
- Techno-Economic Energy and Carbon Heuristic Tool for Early-State Technologies (TECHTEST) Tool
- Materials Flows through Industry (MFI) Tool
- Life Cycle Greenhouse Gas, Technology, and Energy through the Use Phase (LIGHTEnUP) Tool
- Plant Water Profiler Tool – Excel, Beta Version (PWPEx v. 0.1)
- Manufacturing Energy and Carbon Footprints

www.energy.gov/eere/iedo/iedo-strategic-analysis-team-manufacturing-materials-and-life-cycle-energy-tools

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Hydrogen and Fuel Cell Technologies Office (HFTO)

Rebecca Erwin

Technical Project Officer

HFTO Environmental Justice Strategy (Draft)

I. Listening, Engaging, and Increasing Transparency

II. Prioritizing Safety and Positive Impacts

III. Lowering Barriers

IV. Supporting DEIA

V. Building Capacity and Skills

VI. Embedding Environmental Justice in Permitting and Siting

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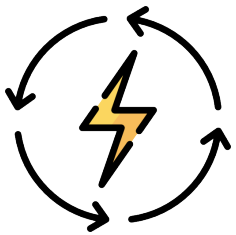
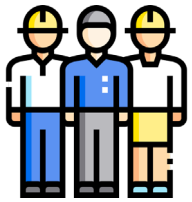
R&D Community Benefits Plan (CBP): Three Priorities

1. **Diversity, Equity, Inclusion, and Accessibility**
    - Equitable access to wealth-building opportunities (teaming, access to good jobs, business and contracting opportunities, etc.)



2. **Energy Equity**
    - How research will drive benefits to frontline communities and historically under-resourced groups (DACs)



3. **Workforce**
    - Consideration of long-term workforce impacts and opportunities of research
        - Create/retain high-quality jobs
        - Attract, train, and retain skilled workers

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Equitable Hydrogen Technology Community Engagement FOA Topic (FY24)

Developing Resources for Effective Hydrogen CBPs

- **Issue:** CBPs and hydrogen technologies are relatively new; community engagement is necessary to support effective CBPs
- **Overview:** Create and implement a community engagement plan that:
  - provides education to communities about hydrogen technologies;
  - engages community around CBPs; and
  - solicits priority benefits from communities about CBPs
- **Deliverable:** Report detailing results of community engagement, best practices for R&D and D&D CBPs, and community engagement resources
- **Funding:** Up to $3M, 3–9 awards

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CBPs in Negotiation

Hydrogen and Fuel Cell Technologies Office Funding Opportunity Announcement in Support of Hydrogen Shot (FY23)

16 projects

The selected projects aim to lower technology costs, enhance hydrogen infrastructure, and improve the performance of hydrogen fuel cells

$58.4 million

Including $10.7 million in cost share

13 states

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CBPs in Negotiation: BIL FOA

Bipartisan Infrastructure Law: Clean Hydrogen Electrolysis, Manufacturing, and Recycling

52 Projects

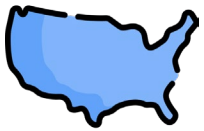
RD&D and manufacturing for domestic supply chain

Enables $2/kg H_2 by 2026 and $80/kW fuel cells by 2030

$1.6B

Total Project Costs

Including ~ **$850M** in cost share



24 States

Benefiting 32 disadvantaged communities across the U.S. with initiatives in workforce development, energy equity, and DEIA

1,500+

Direct jobs created

Plus, thousands of indirect jobs across the U.S.

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CBPs in Negotiation: BIL FOA

> $35M Committed to CBPs

Workforce

9

Certificate programs

- Support automation and manufacturing training for local community
- Engagement with technical high schools, community colleges
- Hundreds of internships with industry partners

DEIA

9

Unique MSI/HBCU Partners

- MSI/HBCU subrecipients support R&D, life cycle, and techno-economic analysis
- Job-matching programs for disabled workers
- Translation of work materials into Spanish

Energy Equity

40+

Community partners

Community partners will facilitate project activities, including:

- Community advisory boards
- Improving local transportation
- Providing onsite food services
- Impact analyses

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Building Internal Capacity & Skills: Office Education

At least one member of the EJ subcommittee in each subprogram

- CBP workshops
  - Guide staff in reviewing and negotiating CBPs
- Staff meeting updates
- Environmental Justice Offsite
  - Continue to develop and deepen staff understanding of environmental and energy justice
  - Support staff in understanding how to embed EEJ into their work and understand challenges

Ugbaad Kosar

Director of Environmental Justice
Carbon180

SESSION 1 KEYNOTE

Dr. Kristi Pullen Fedinick

Assistant Director of Environmental Justice
Science & Technology
White House Office of Science and Technology Policy

SESSION 1 KEYNOTE

Dr. Shruti Khadka Mishra, Sandia National Laboratories

Dr. Taylor Uekert, National Renewable Energy Laboratory

Dr. Rebecca Efroymson, Oak Ridge National Laboratory

Dr. Lis Blanco, National Renewable Energy Laboratory

RESEARCH PANEL

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Closing Comments – Day 1

Adjourn Day 1

See you tomorrow

April 9, 2024
11:00AM – 4:00PM (ET)