US Department of Energy's Interest in Soil Carbon and Biochar

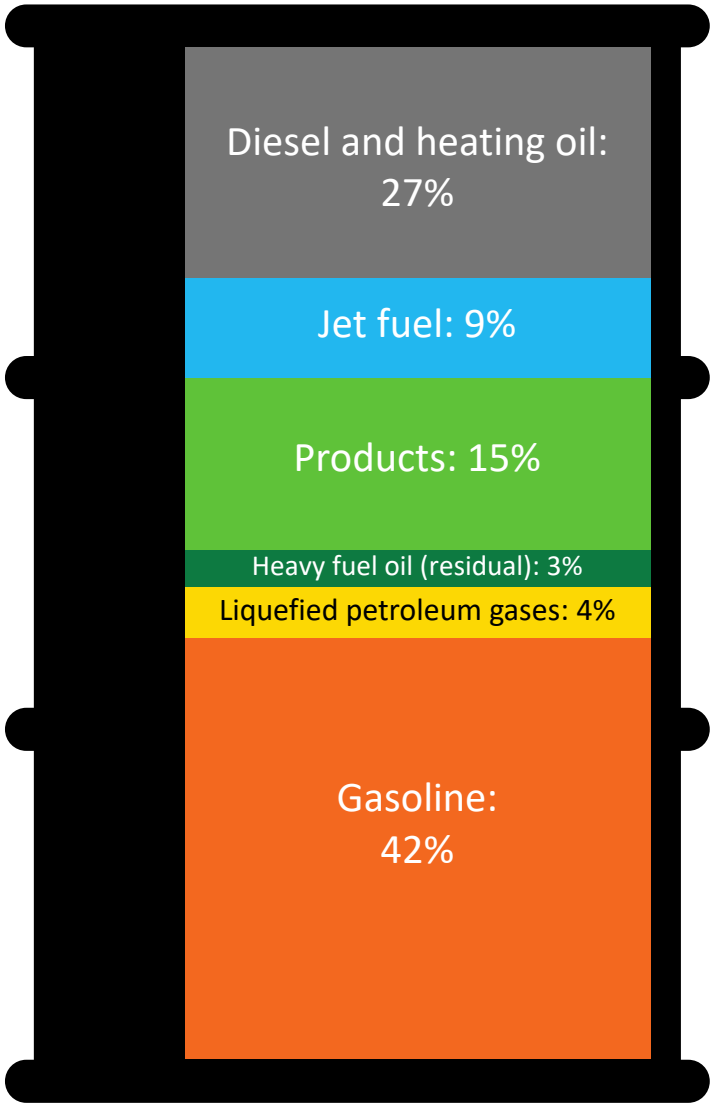
Mark P. Elless, Ph.D.

2024 Biochar Conference

Sacramento, CA

February 15, 2024

Our Economy is Built on Carbon



Photos by iStock

BETO Critical Program Areas

Production and Harvesting

Feedstock Technologies

Lower cost, improve quality, and increase types of renewable carbon feedstock intermediates available for conversion.

Advanced Algal Systems

Increase algae productivity through algal strain improvement and efficient cultivation.

Conversion and Refining

Conversion Technologies

Reduce costs of deconstructing feedstock into intermediate products (such as sugars, intermediate chemicals, bio-oils, or gaseous mixtures)

Upgrading intermediates into liquid biofuels, bioproducts, and biopower

Distribution and End Use

Systems Development and Integration

Systems research to combine tech components, unit operations, or subsystems developed by R&D programs into integrated processes.

Integrated processes tested (pre-pilot to demo scale) to identify further R&D needs or verify readiness for scale-up and commercialization.

Crosscutting

Data, Modeling, and Analysis

Track technology progress and identify opportunities and challenges related to economic/environmental impact of advanced bioenergy systems.

Programmatic Priority Areas - EERE

- **Decarbonizing the Transportation Sector**
  - Across all modes: air, sea, rail, and road
- **Decarbonizing the Industrial Sector**
- **Decarbonizing the Agriculture Sector**
- **Decarbonizing the Electricity Sector**
- **Reducing the Carbon Footprint of Buildings**

Biden Administration Sustainable Aviation Fuels Grand Challenge

- Reduce the cost, enhance the sustainability, and expand the production and use of Sustainable Aviation Fuels (SAF) via a government-wide effort
  - *White House roll-out – September 9, 2021*
  - Minimum of a 50% reduction in lifecycle GHG compared to conventional fuel
    - Near-Term Goal
      - 3B gallons by 2030 (20% CO_2 reduction)
      - Will require doubling of domestic capacity yearly
    - Long-Term Goal
      - 35B gallons by 2050 (sufficient SAF to meet 100% of US aviation fuel demand)

SAF Grand Challenge Fact Sheet: https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/09/fact-sheet-biden-administration-advances-the-future-of-sustainable-fuels-in-american-aviation/

Soil Carbon Workshop

Monday, March 28, 2022

- Welcome & Opening, Valerie Reed, Nichole Fitzgerald, & Mark Elless
- Highlights from Previous Federal Programs on Soil Carbon and Current Agency Perspectives/Directions
- Keynote, Dr. Rattan Lal of Ohio State University
- Mechanisms of Soil Carbon Storage
- Management Strategies to Optimize Soil Carbon Storage
- 3x5 Stakeholder Lightning Talks

Tuesday, March 29, 2022

- Opening, Asmeret Asefaw Berhe, Director of Office of Science
- Agricultural Management Practices to Optimize Soil Carbon Storage
- Forest Management Practices to Optimize Soil Carbon Storage
- R&D Needed to Support Policy for Soil Carbon Storage in Bioenergy
- Tools for Decision Making in Bioenergy and Soil Carbon Storage

Dr. Rattan Lal

Distinguished University Professor of Soil Science and Director of the Carbon Management and Sequestration Center, The Ohio State University

Lightning Talks

Stakeholders with particular focus on Justice 40 Initiative goal and work with communities, small businesses, and disadvantaged groups.

By the Numbers

669 registrants

454 Attendees

Twenty-six academic and expert speakers

Ten 3x5 speakers

Management Practices for Enhancing Soil Carbon (↓ CI)

Biochar

- Produced from wide variety of feedstocks; via pyrolysis or gasification
- Properties of the biochar can be tailored to a specific application by using the appropriate feedstock
- Concerns: LCA issues, Cost, Funding sources of support, C–sequestration potential and residence time, heavy metals in contaminated soils, methods to apply biochar

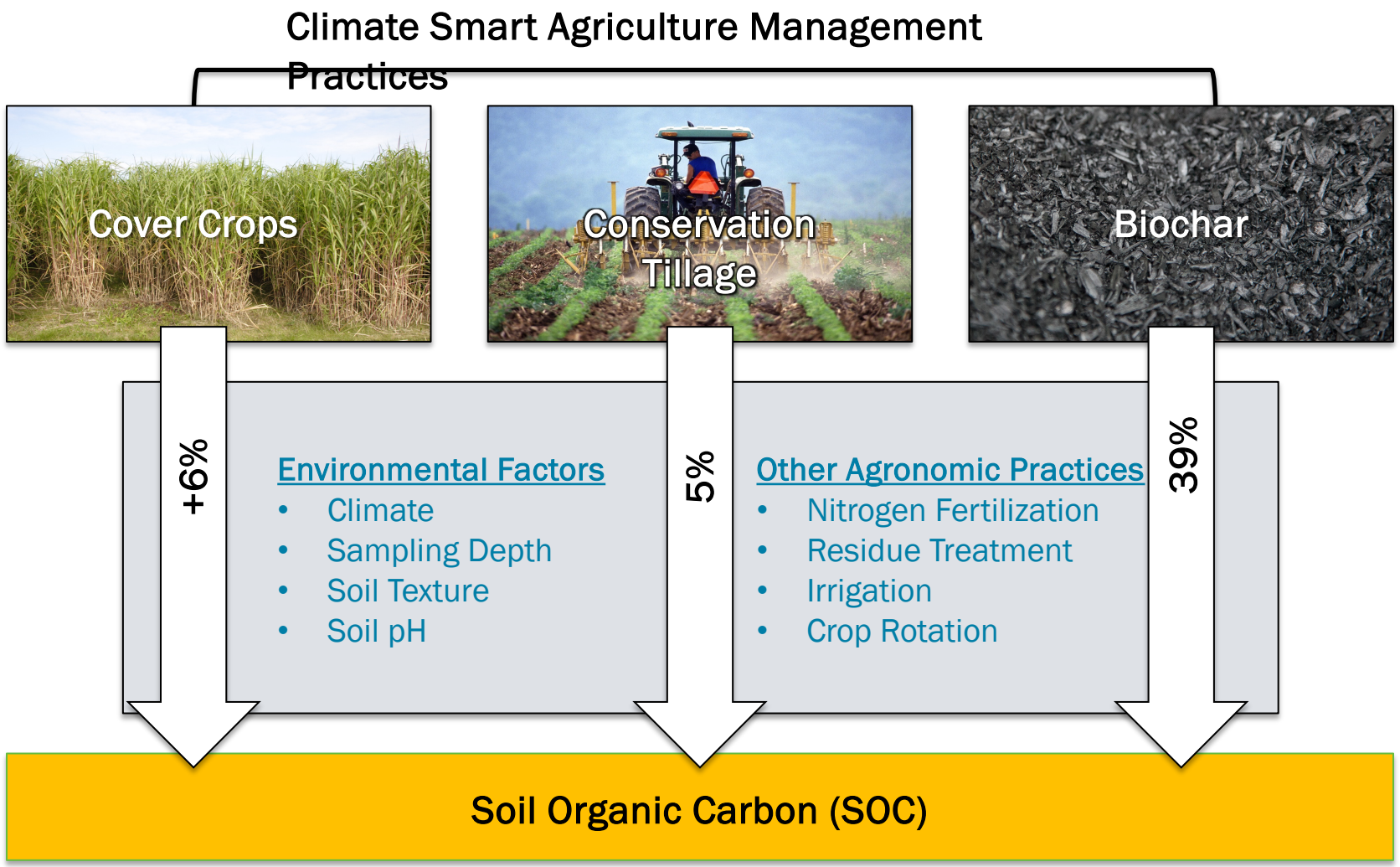
Cover Crops

- Examples include oil seed crops (camelina, pennycress, carinata), clover, etc.
- Benefits: enhance soil carbon levels; reduce erosion
- Concerns: Effect on primary crop; timing of planting/harvesting; harvest at all?

Managed Microbiomes

- Interest in role of microbiome in soil carbon sequestration
- Concerns: Impact of management practices on the microbiome in terms of soil carbon storage; climate change

Climate Smart Agriculture Management Practices Improves SOC



https://doi.org/10.1111/gcb.14658

Reducing Agricultural Carbon Intensity and Protecting Algal Crops (RACIPAC) Funding Opportunity Announcement (FOA) Overview

Topic Area 1a: Climate-Smart Agricultural Practices to Produce Low CI Feedstocks Derived from Agricultural Residues

Topic Area 1b: Biochar Strategies to Increase Soil Carbon Levels and Agronomic Benefits of Crops for Energy Production

Topic Area 2: Algae Crop Protection

Topic Area Number	Topic Area Title	Anticipated Number of Awards	Anticipated Minimum Award Size for Any One Individual Award (Fed Share)	Anticipated Maximum Award Size for Any One Individual Award (Fed Share)	Approximate Total Federal Funding Available for All Awards	Anticipated Period of Performance (months)
1	Climate-Smart Agricultural Practices for Low Carbon Intensity Feedstocks	3-4	$4,000,000	$5,000,000	$15,500,000	Up to 84 months
2	Algae Crop Protection	4-5	$1,000,000	$2,000,000	$10,000,000	Up to 36 months

RACIPAC FOA Selections

Topic Area 1a: Corteva Agrisciences

Project Title: Feedstocks for Advanced Biofuels from Perennial Ground Cover Systems

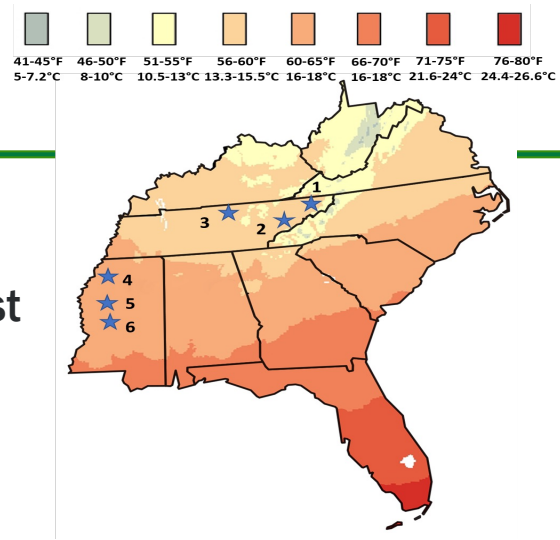
Total Project Costs: $5,000,000

Location: Johnston, Iowa

Summary: Led by Corteva Agrisciences, in collaboration with partners Iowa State University, University of Missouri, University of Nebraska, University of Wisconsin, The Land Institute, consultants C. Bartle, LLC, and POET, this project seeks to reduce the CI of corn stover by growing perennial groundcover crops in between the rows of corn, thereby decreasing N_2O emissions and increasing soil carbon storage. This multi-state (KS, NE, IA, MO, and WI), seven-year project will combine actual field trials with modeling to estimate the carbon intensity reduction as well as the cost of the PGC system of the project. When fully developed, documented, and demonstrated at scale with Iowa farmers, this corn stover PGC system is expected to enhance farmer adoption of this novel system.

Applicant	Climate-Smart Practice	Agricultural Residue	CI Reduction Metric
Corteva Agrisciences	Growing perennial groundcover crops (Kentucky Bluegrass) in between corn rows	Corn Stover (may require soy rotation)	30-50%

RACIPAC FOA Selections



Topic Area 1b: University of Tennessee: Knoxville

Project Title: Biochar Enhanced Ecosystem Services for Energy Crop Systems in the Southeast

Total Project Costs: $5,960,000

Location: Knoxville, Tennessee

Summary: Led by The University of Tennessee Knoxville, in collaboration with partners Tennessee State University, Mississippi State University, ORNL, Kolmar-America, and Genera, Inc., this project seeks to reduce the fertilizer requirement for growing two bioenergy crops (miscanthus and biomass sorghum) in six locations in the southeast U.S. via application of biochar and poultry litter, which itself will help to trap additional soil carbon, lower N_2O emissions, and reduce the overall carbon intensity of this feedstock supply chain. The agronomic benefit of deploying these amendments for each of these feedstocks will be measured and the relationship between these factors will be elucidated via machine learning and process modeling.

Applicant	Biochar Feedstock(s)	Agricultural Crop	Soil Carbon Durability Metric
University of Tennessee	Various – 100+ samples from commercial biochar producers – in combination with poultry litter	Miscanthus and Biomass sorghum	7% (sorghum) and 15% (miscanthus) relative to baseline

RACIPAC FOA Selections

Topic Area 1b: Washington State University

Project Title: **Yardsticking the Impact of Biochar Formulations on Soil Carbon Durability and Agronomic Performance in Hemp-based Crop Rotation Systems**

Total Project Costs: $6,250,000

Location: Pullman, Washington


Yard Stick Probe

Summary: Led by Washington State University, in collaboration with partners at the University of Connecticut, Myno Carbon Corporation, and Yardstick PBC, this project seeks to develop **optimal biochar products, a novel device for measuring soil carbon in seconds, and a method to improve yields of commodity crops with hemp rotations. The project will take place largely with growers from several Tribes in Washington State. The project's key concept is that a combination of biochar application and hemp rotation can increase crop yield, soil health, and grower profits, while reducing GHG emissions. The goals of the project are to increase crop yield by durable soil carbon by up to 20% in the top 45 cm of soil, increase the hemp and commodity crop yield, and reduce the carbon intensity (including GHG emissions) of the system by >15%, at costs within 10% of current practices.**

Applicant	Biochar Feedstock(s)	Agricultural Crop	Soil Carbon Durability Metric
Washington State University	High-carbon feedstocks (e.g., wood, nut shells)	Hemp and rotational crops (e.g., wheat and corn)	Increase up to 20% in top 45 cm relative to baseline

Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR): America's Seed Fund

AMERICA'S SEED FUND
SBIR·STTR

SBIR/STTR are federally funded contracts & grants designed to stimulate the commercialization of technological innovation using small businesses

Problems we are solving:

Fertilizer Needs in Hawaii:

- Costs 40-60% more than U.S. average
- Rose 157% in cost in 2022-23
- Is >97% imported
- Is >90% made from fossil fuels

Landscape Needs in Hawaii:

- Overrun with invasive plants
- Wildfires increased 4X between 1980s & 2020
- Depleted of nutrients from sugar era

The solution we are offering…

Accomplishments to date:

- Feedstock sampling, processing, proximate & elemental analysis
- 48 hour continuous gasification test on invasive greenwaste with University of North Dakota, EERC
- Biochar ash analysis
- 1st round of fertilizer formulation & mixing

Processing invasive greenwaste biomass

Gasification testing at Univ. North Dakota -

Takachar

SBIR Phase II Award - $1,150,000

Project Period 8/2022 – 8/2024

Benefits of the MiniTorr

Supports Rural Communities

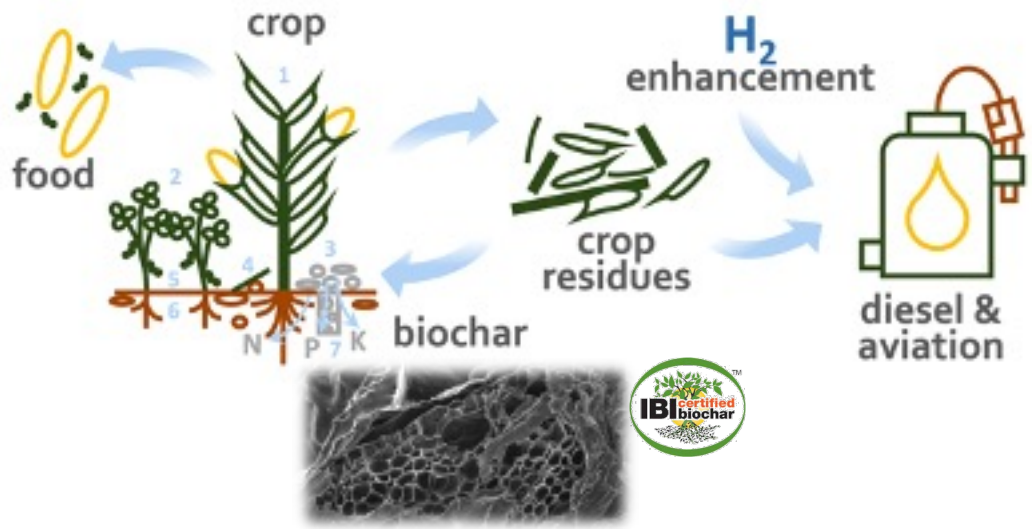
- Economical solution compared to larger units
- Accessibility
- Low purchase price (utilization)
- Generate new jobs in underserved rural areas
- Reduces fire risk by removing unwanted fuels
- Environmentally friendly alternative to open burning

Field Demonstrations and Testing

- Portable prototype has been built
- Unit deployed to three areas of Tribal Nations in Canada
  - Learning their design requirements
  - Analyzing char characteristics

Advancing Farm Soil Sequestration with Biofuel

WeNeW Carbology
Fueling Your Community



Enhance biofuel synthesis for **lower costs**

Collaborate via community-scale **biorefineries**

Advance soil quality with **biofuel revenue**

Support farms with **equipment & services**

DOE Funding Assistance: DE-SC0023795

 | MattMerrill@WeNeWC.com

FOAs often follow from a workshop on the same topic

2020

- Algae
  - Direct Air Capture ($14M)
  - Algae Waste Water Treatment ($4M)
- Feedstocks
  - Advanced Fractionation and Decontam-ination of MSW ($13M)

2021

- Algae
  - Algae Productivity ($20M)
- Feedstocks
  - Character-ization of MSW ($15M)

2022

- Algae
  - Carbon Utilization ($9M)
  - Scale-up ($15M)
- Feedstocks
  - MSW Pre-processing and co-products ($13M)

2023

- Algae
  - Crop Protection ($10M)
- Feedstocks
  - Climate Smart Ag Practices ($15.5M)

Turning the carbon we have into the carbon we need

Responsive FOA Application: Quick Tips

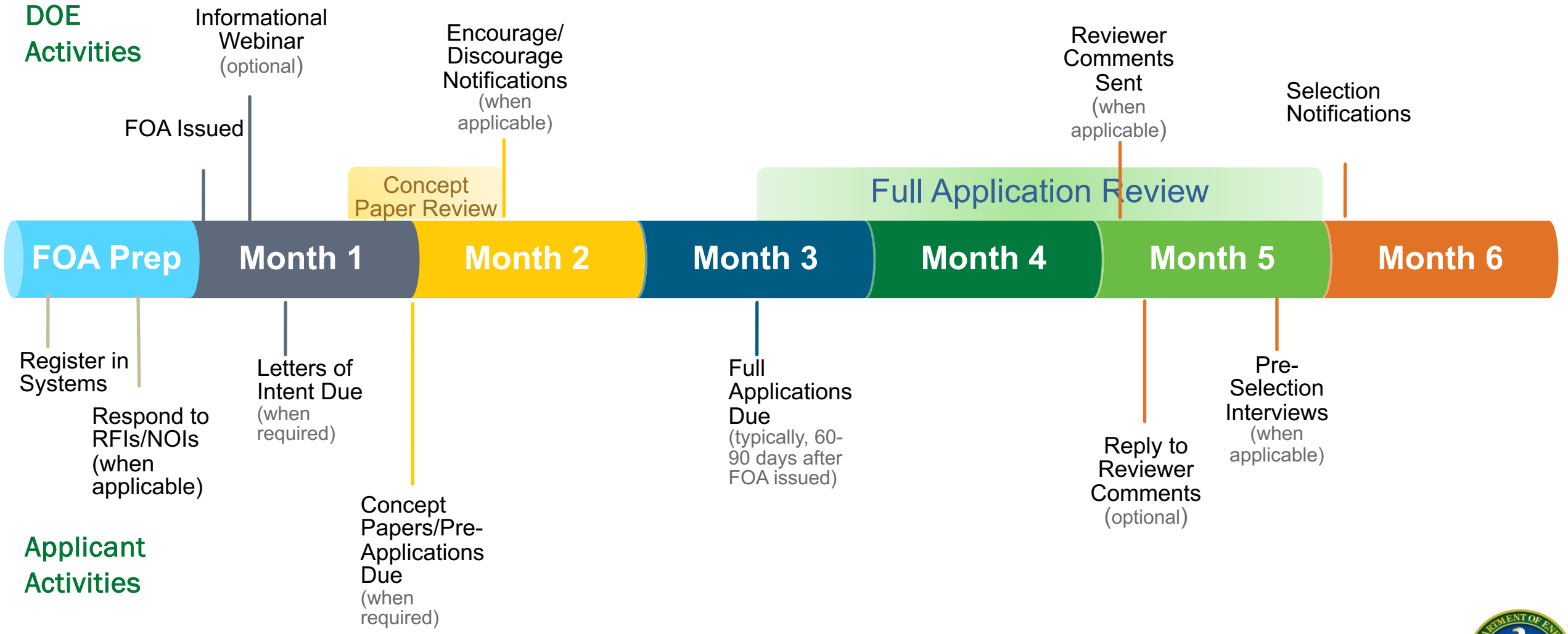
Start Early! Before the FOA is issued:

- First-time applicants should register in SAM and Grants.gov as soon as possible.
- Previous applicants should ensure that their account is active and up-to-date.
- Familiarize yourself with prior FOAs from the office and look at recipients' projects.
- Familiarize yourself with newest strategic documents released by the office.
- Teaming takes time! Begin exploring potential partners and cost share providers early.

Once FOA is issued:

- Clearly address ALL requirements, use same terminology and units used in the FOA.
- Pay attention to heavily-weighted criteria.
- Aim to submit your application before the deadline stated in the FOA. Build in time for system glitches or delays especially close to deadlines.

DOE FOA Process with Sample Schedule *



** Schedule is for reference purposes only. Actual schedules are posted on the first page of the FOA.*

Reviewing helps to see the process from the inside, and it's paid!

Interested in Becoming a BETO Project Reviewer?

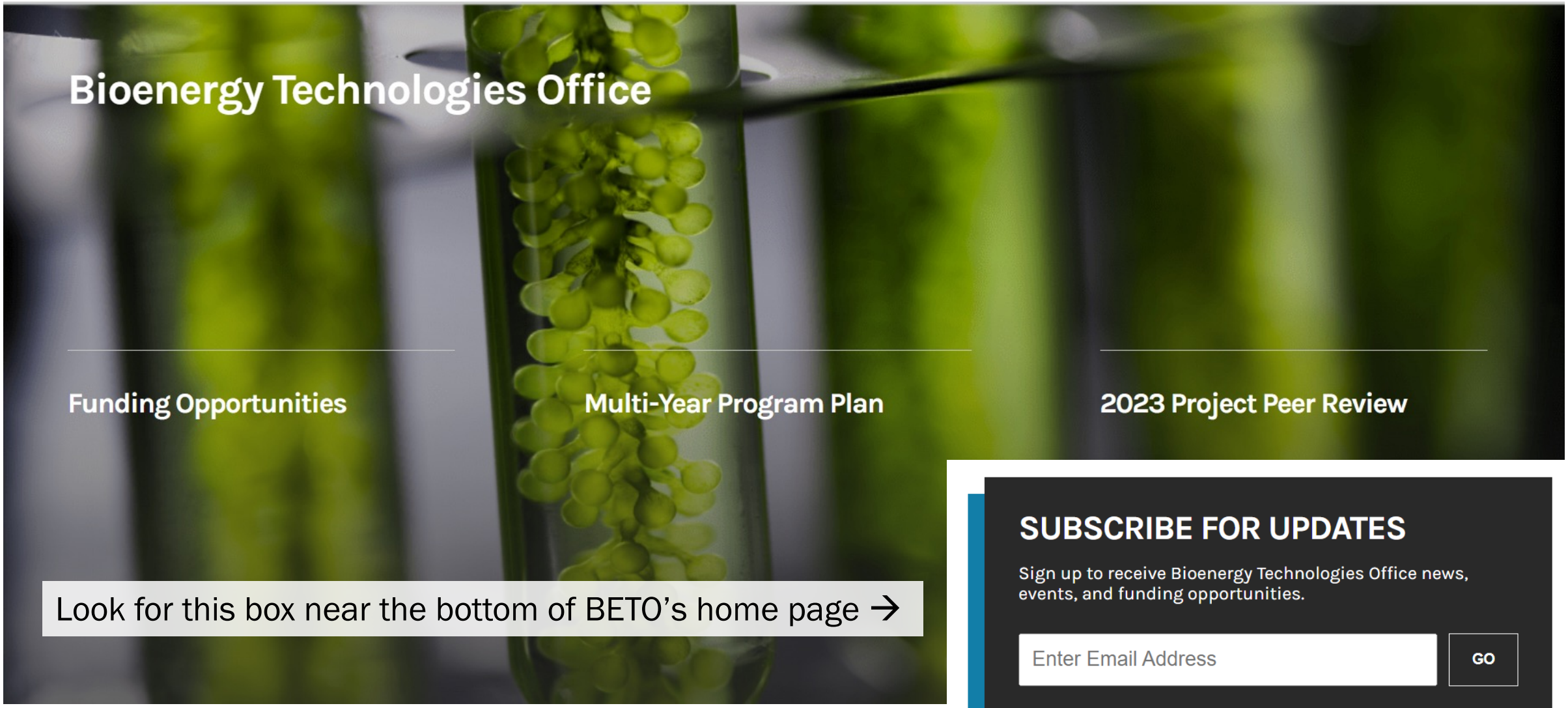
Bioenergy Technologies Office

Bioenergy Technologies Office » Interested in Becoming a BETO Project Reviewer?

The U.S. Department of Energy (DOE) Bioenergy Technologies Office (BETO) relies on subject matter experts to review applications for federal funding opportunities and active projects. BETO is looking for skill sets including, but not limited to:

- Diversity, equity, and inclusion
- Chemical engineering
- Process engineering

Join BETO's mailing list to hear about FOAs and other news



Deploying Purpose-Grown Energy Crops for SAF Workshop

Workshop Summary

- June 6-7, 2023 in Kansas City, MO
- 117 Attendees
  - Federal Agencies
  - Industry
  - National Labs
  - Universities
- Promise of Purpose-Grown Energy Crops moderated panel
- Resource Considerations presentations
- 20, 3x5 Lightning Talks
- Expanding the Network for Energy Crop Deployment

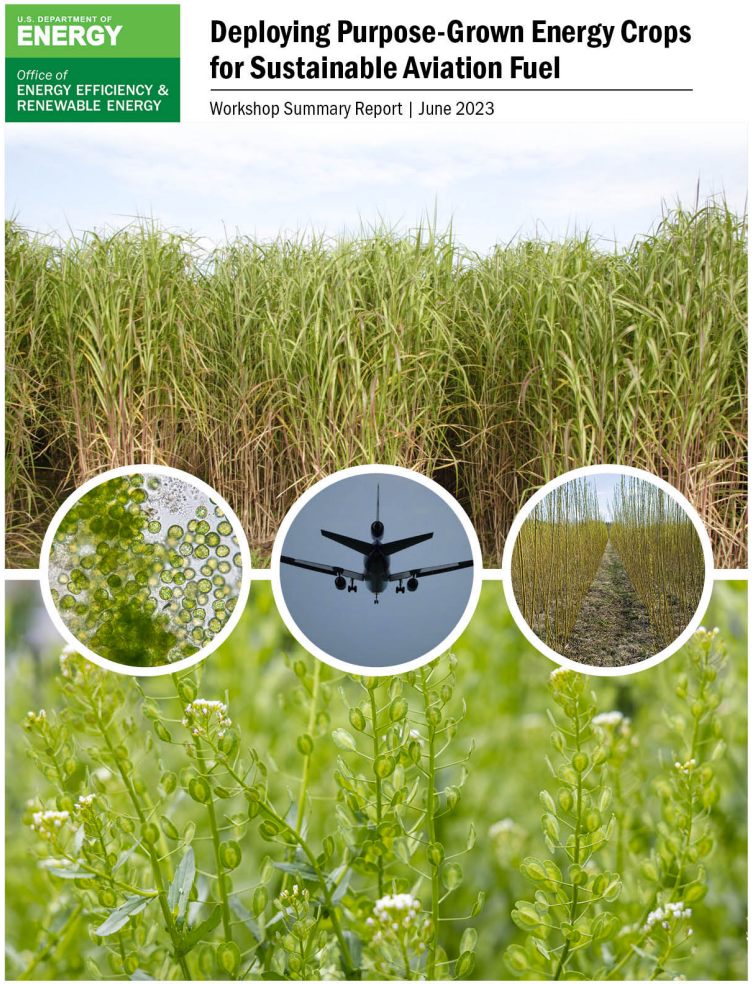
Feedstock Specific Breakout Sessions

- Identifying Knowledge Gaps
- Ideas and Strategies for Addressing Knowledge Gaps
- Innovative Solutions for Successful Deployment

Deploying Purpose-Grown Energy Crops for SAF Workshop

Summary Report

- **Four breakout groups:**
  - Algae
  - Herbaceous Energy Crops
  - Overwintering/Secondary Energy Crops
  - Short-Rotation Woody Crops
- **Knowledge gaps common to at least 3 groups:**
  - Investment in large-scale demonstrations
  - Preprocessing/fractionation and downstream processing/logistics
  - Consistent carbon accounting



https://www.energy.gov/eere/bioenergy/articles/deploying-purpose-grown-energy-crops-sustainable-aviation-fuel-workshop

FOA: Regional Resource Hubs for Purpose-Grown Energy Crops

FOA Number: DE-FOA-0003209

Objective: Enable the mobilization of low carbon intensity, purpose-grown energy crops across varied agronomic and geographic landscapes through the generation of data and research findings.

- **Topic Area 1: Purpose-Grown Energy Crops**
  - Subtopic 1a: Algae (e.g., microalgae, macroalgae, cyanobacteria)
  - Subtopic 1b: Herbaceous Energy Crops (e.g., switchgrass, miscanthus, energycane)
  - Subtopic 1c: Intermediate Energy Crops (e.g., carinata, camelina, pennycress)
  - Subtopic 1d: Short-Rotation Woody Crops (e.g., hybrid poplar, shrub willow)
- **Concept papers due 3/14/2024**
- **Full applications due 6/13/2024**

https://eere-exchange.energy.gov/Default.aspx#Foaldfa6037d3-eece-432b-a59f-6b3cf8fce87a

SBIR/STTR Funding Opportunities

Mark your calendars for FY 2025 Phase I Release 1 & 2!

SBIR FY 2025 | U.S. DOE Office of Science(SC) (osti.gov)

2025

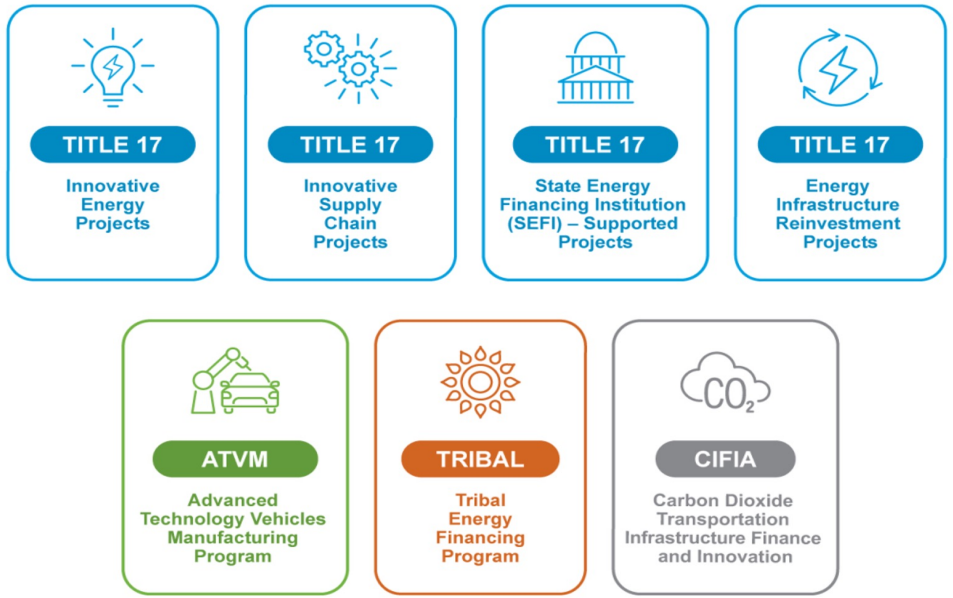
Phase I	Release 1	Release 2
Topics Issued	Monday, July 15, 2024	Tuesday, November 12, 2024
Document		
Phase 0 Application Assistance (free for first time applicants) starts	Monday, July 15, 2024	Tuesday, November 12, 2024
Topic Webinar, week of	Monday, July 22, 2024	Monday, November 18, 2024
FOA Issued	Monday, August 12, 2024	Monday, December 16, 2024

DOE's Loan Programs Office (LPO)

LPO is...

the **premier public financing partner** accelerating high-impact energy and manufacturing investments to advance America's economic future.

How do we do it?



- ✓ By **providing attractive debt financing** for high-impact, large-scale ($100M+) energy infrastructure projects in the U.S.
- ✓ With **tens of billions of dollars** in available loan and loan guarantee authority.
- ✓ Via **seven loan programs & project categories** supporting both innovative and commercial technologies.

Thank You!

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