



2019 PROJECT PEER REVIEW

U.S. DEPARTMENT OF ENERGY
BIOENERGY TECHNOLOGIES OFFICE

**Bioeconomy Initiative: Implementation
Framework, Interagency and Intra-
agency Collaborations**

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BETO Focus on Collaboration and Coordination

- Interagency
 - Biomass R&D Board, USDA, Interagency Working Groups
- Within DOE
 - Office of Science
 - Fossil Energy
 - ARPA-E
 - Other EERE Offices
 - Advance Manufacturing Office
 - Fuel Cell Technologies Office
 - Vehicle Technologies Office



- The Biomass Research and Development Act of 2000 established the Interagency **Biomass R&D Board**, the **Technical Advisory Committee**, and the **Biomass R&D Initiative (BRDi)**.
- The BR&D Board facilitates coordination among federal government agencies that affect the research, development, and deployment of biofuels and bioproducts.

Membership

Senate-confirmed sub-cabinet officials from 8 executive branch agencies



Co-chair



Co-chair



Biomass R&D Breakdown

- Senior federal officials from 8 agencies
- Chaired by USDA and DOE
- Coordinates R&D activities relating to biofuels and biobased products
- Provides recommendations to the points of contact concerning administration of the BRDi
- Eight interagency working groups

Biomass R&D Board



- ~30 members from academia, industry, and nonprofit organizations
- Advises the Secretaries of Energy and Agriculture on the technical focus and direction of the BRDi RFPs and procedures for reviewing and evaluating the proposal
- Evaluates and performs strategic planning on BRDi activities

Technical Advisory Committee



- Administered by appointees from the Secretaries of Agriculture and Energy
- Awards competitive grants to projects that integrate science and engineering research in the following three areas: feedstock development; biofuels and biobased products development; and biofuels development analysis

Biomass R&D Initiative (BRDi)

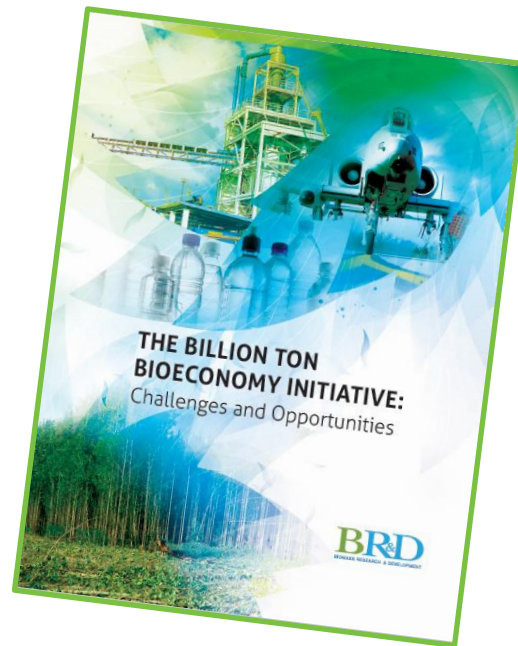


Interagency Working Groups (IWGs)



The Framework serves as a guiding document for BR&D Board member agencies to implement the multi-agency Bioeconomy Initiative while:

1. Increasing government accountability and efficiency
2. Maximizing interagency coordination on research and other activities
3. Accelerating innovative and sustainable technologies that harness the nation's biomass resources.



Challenges

- Major technical hurdles for development and scale
- Steep competition from traditional petroleum-derived resources
- A lack of necessary infrastructure
- Access to capital for large financial investments
- Uncertainties about sustainability—understanding environmental, social, and economic outcomes
- Growth instability and increased investment risk caused by policy uncertainty
- The need for a capable workforce
- Lack of access to knowledge, data, and tools to understand impacts of the bioeconomy*
- Lack of a formal, collaborative mechanism for sharing knowledge, deploying technology, and developing cooperative activities with stakeholders*

Opportunities

- Develop feedstock and fundamental innovations that reduce cost and technology uncertainty in the supply chain
- Seek opportunities to utilize low-cost waste resources
- Quantify, communicate, and enhance beneficial effects and minimize negative impacts
- Increase public education on biomass-derived products in a bioeconomy
- Develop bioproducts that can accelerate biofuel production
- Enable the testing and approval of new biofuels and bioproducts
- Expand the market potential for biomass
- Encourage private-sector financing
- Support analysis as a foundation for stable, long-term policies
- Ensure a ready workforce to meet the needs of the bioeconomy

Examples of Knowledge & Technology Gaps

- Limited ways to densify feedstocks and manage their variability, low yield, inaccessibility, and high cost
- Insufficient feedstock collection, harvest, transport, storage, preprocessing, and distribution technologies, and inefficient supply and distribution systems
- Recalcitrance of feedstocks and need to improve separation/purification processes for conversion to competitive products
- Limited transfer of knowledge and demonstration of technology as a catalyst for expansion of the bioeconomy
- Lack of resilient crops that are highly productive in marginal environments where water and nutrients are limited and under stress conditions such as heat, high salinity, and pests



Critical Research Areas

- Develop superior feedstock crop plants with improved yields and quality and less recalcitrance to deconstruction
- Improve enzyme and catalyst effectiveness, efficiency, and regeneration
- Improve catalytic and separations processes
- Develop new products, co-products, and robust processes
- Advance industrial efficiency through a more complete understanding of cellulosic breakdown and reformulation
- Understand and model materials characteristics and handling



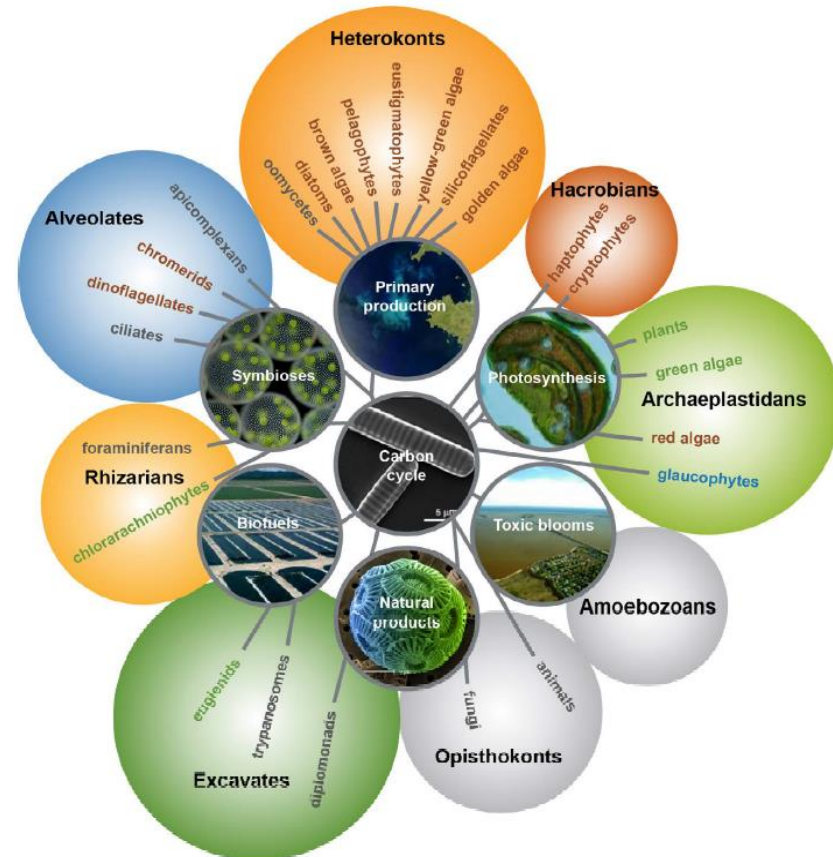
Examples of Interagency Working Group Goals

- **Algae:** Leverage high-value bioproducts to develop algae industry infrastructure
- **Genetic Improvement:** Provide science-based information on the impacts of GMOs and biotechnology to support sound decision-making, regulations, and education efforts
- **Feedstock Logistics:** Provide easily accessible nationwide data on feedstock characteristics and attributes with management applications
- **Conversion:** Remove barriers to biointermediate refining and upgrading via existing infrastructure
- **Transportation:** Facilitate end-user market expansion by streamlining testing and certification of novel fuels for use in existing surface vehicles, vessels, and aircraft



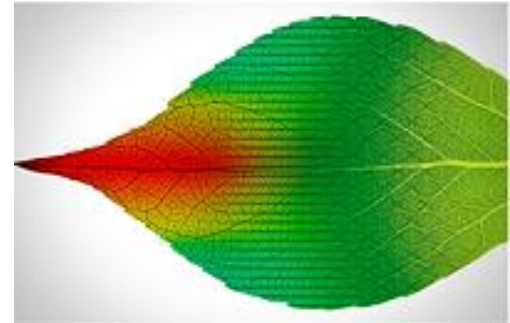
Algae Inter/Intra-agency Collaboration

- OSTP's *National Strategic Plan for Federal Aquaculture Research 2020-2024*
 - Leading development in the Emerging Areas section on algae
 - Focus:
 - Intentionally cultivated cyanobacteria, microalgae, and macroalgae in terrestrial and marine systems, mitigation
 - Reporting of harmful algal blooms.
- Algae Genome Science Partnership
 - Collaboration between BETO, BER, JGI, and LANL
 - Purpose: Gain knowledge of the cellular and ecological processes that contribute to their biochemical composition and growth performance (BER value add); foundational knowledge that can be applied to improve productivity and stability (BETO value add).
 - Process: Collect and disseminate genomics data on a diverse collection of industrially-, environmentally-, evolutionarily-relevant algal strains.

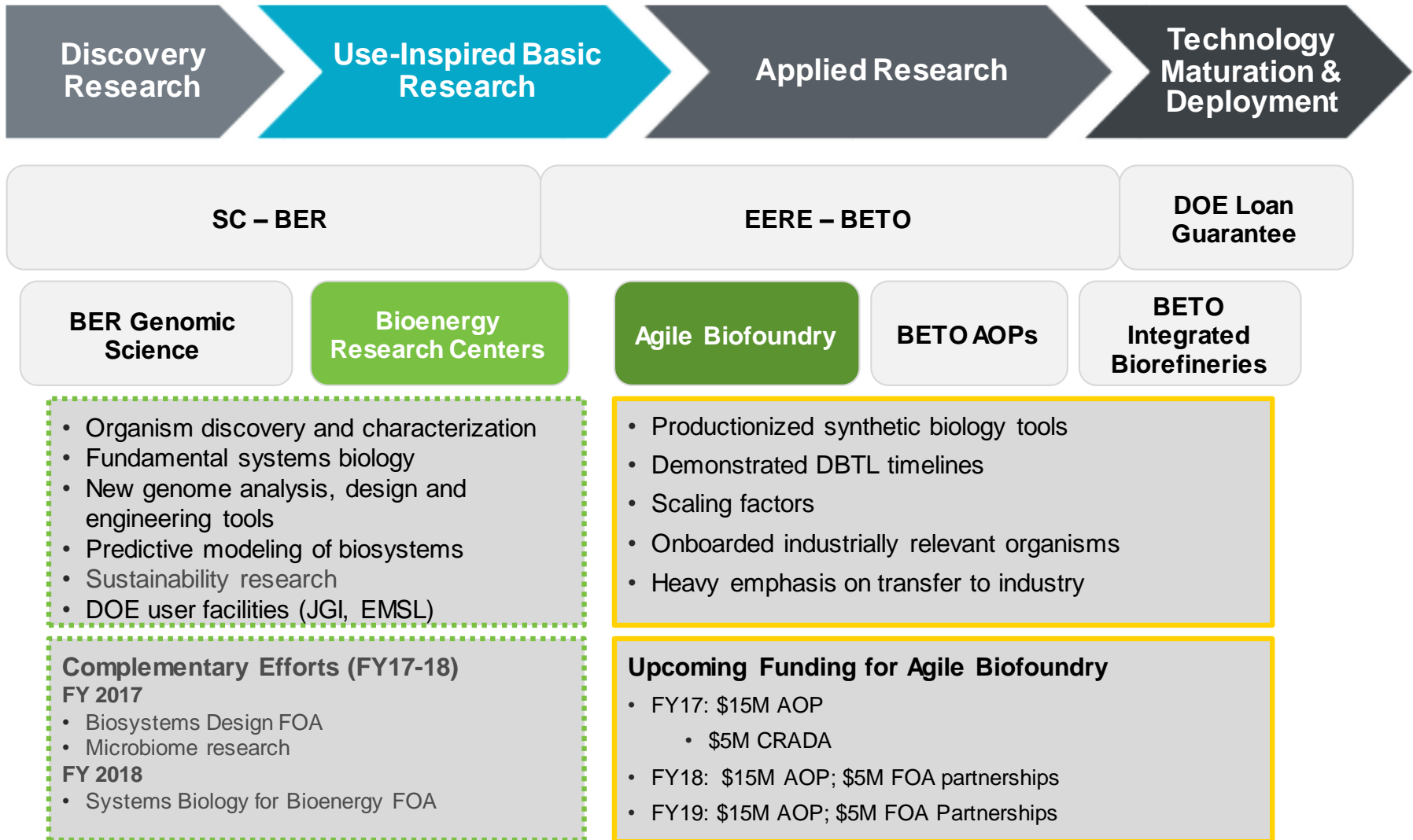


Collaboration within Department of Energy

- Engagement with Office of Science due to related R&D areas of interest—energy crops (BER), sustainability (BER), photosynthesis (BES)
 - BER Bioenergy Research Centers, particularly GLBRC (Great Lakes Bioenergy Research Center) with a thrust area in sustainability
- Engagement with ARPA-E through TERRA (Transportation Energy Resources from Renewable Agriculture) and ROOTS (Rhizosphere Observations Optimizing Terrestrial Sequestration)
 - Participate in review panels, connect through DOE Intra-agency quarterly meetings, and USDA REE engagement



BioDesign Research across Office of Science and BETO



Fossil Energy Computational Capabilities Leveraged

Fossil Energy (FE) Capabilities Being Leveraged

- Decades of FE investment and application/reactor experience
- Open-source computational fluid dynamics (CFD) code: MFiX (Multiphase Flow with Interphase eXchanges)
- Unique experimental techniques (cold flow reactors) for verification and drag correlation development of multiphase flow

Bioenergy Technologies Office (BETO) Applications

- CCPC-NETL/FE reactor models enable scaling of ChemCatBio catalyst innovations to industry-relevant scales and support critical verification of BETO pathways
- CCPC, FCIC-NETL elucidates drag and multiphase flow for vastly complex array of biomass feedstocks and their behavior in a wide range of reactor systems and processes (e.g. enabling use of forest pine residues in place of clean pine for techno-economic benefit)

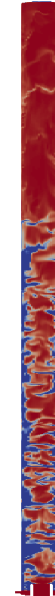
Emerging Growth Areas

- New BETO BioPower project incorporates existing FE and BETO capabilities across ORNL, NETL, and NREL teams and supports crosscutting industry in biopower
- MFiX-exa (Office of Science) development ongoing to enable MFiX applications in Exascale computing systems (benefits both FE and BETO)

BETO's Consortium for Computational Physics and Chemistry



www.cpcbiomass.org



mfix.netl.doe.gov

Left: BETO Thermochemical Process Development Unit at NREL for converting biomass to fuel

Right: MFiX model of riser section

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

Collaboration across EERE

- **AMO**

- BETO serves on the RAPID Institute Governing Board and Technical Advisory Panel(s) coordinating modeling efforts with CCPC and assisting with revisions to metrics task
- Collaborating on the Biobased Additive Manufacturing Prize on Freelancer.com
- Assisting on a new Additive Manufacturing Institute on nanocellulose-reinforced thermoplastic composites
- BETO TM detailed to AMO for ~4 months
 - Negotiated new awards for Emerging R&D FOA
 - Implemented best practices for starting lab-led FOA awards



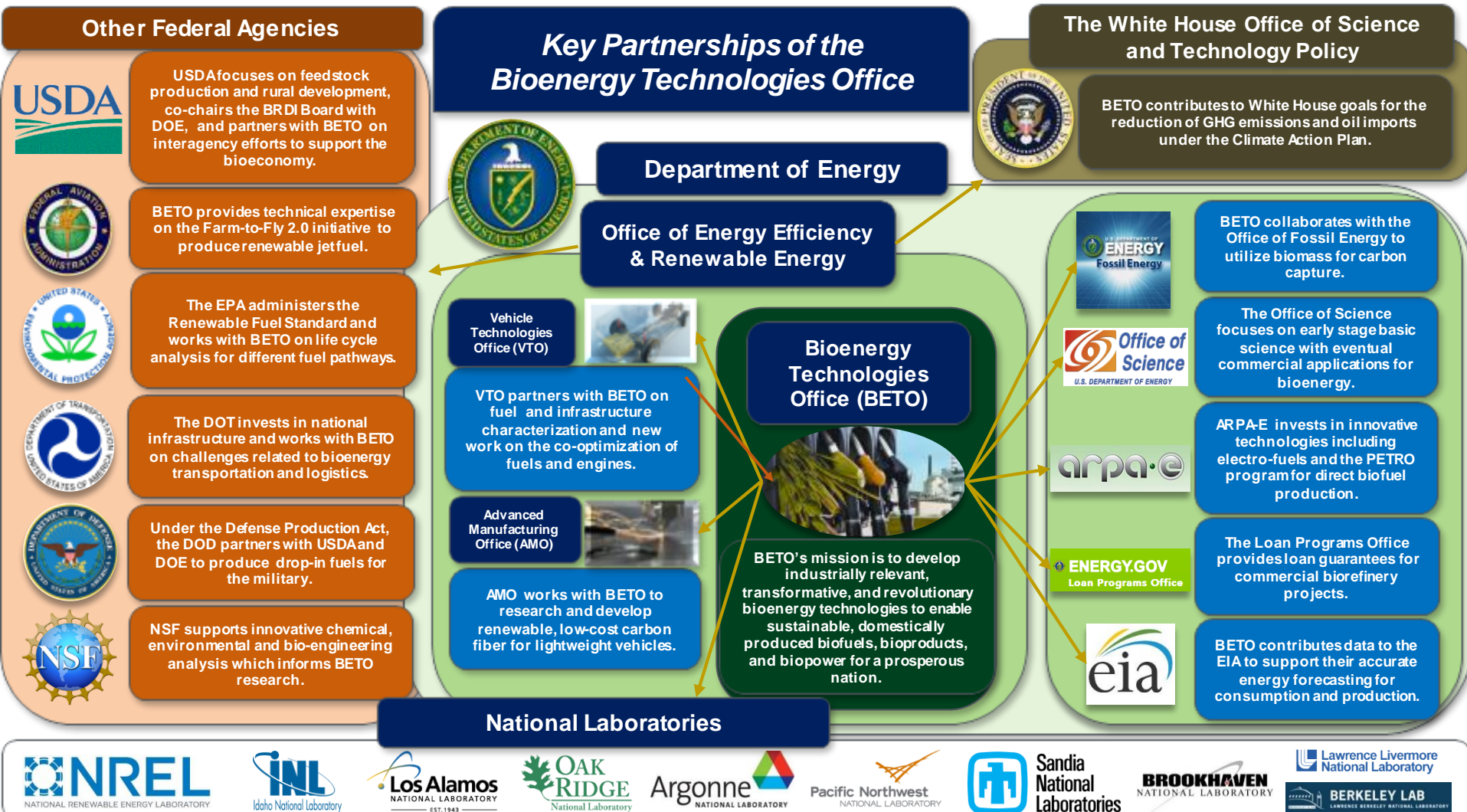
- **VTO**

- Multi-year collaboration on Co-Optima
- BETO contributed \$5M towards the multi-office TRUCK FOA to support electrification and natural gas fueled medium- and heavy-duty vehicles.

- **FCTO**

- Jointly support of research into advanced energy storage technologies in the form of renewable natural gas. FCTO has funded work at NREL to lower the cost of electrolysis with BETO supporting developing of organisms and gas fermentation technology that biologically convert the resulting hydrogen and CO₂ into methane.
- Co-funding an effort to determine the optimal design for commercial-scale CO₂ electrolysis cells at NREL

Collaboration and Key Partnerships



BETO partners with other DOE Offices, other Federal agencies, and the national labs to achieve U.S. goals on bioenergy