

Bioenergy Technologies Office: Decarbonization of Transportation and Industry

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4/20/2022



Agenda

- **Bioenergy Decarbonization Potential**
- **Biomass Feedstocks: Broad Potential For the U.S.**
- **R&D Programs**
- **Demonstrations and State of the Industry**

Biden Administration Guiding Principles

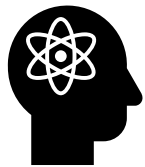
Accelerate the research, development, demonstration, and deployment (RDD&D) of innovative technologies that will transition Americans to a 100% clean energy economy no later than 2050 and ensure the clean energy economy benefits all Americans.

EERE Mission

Keys to Ensure the Greatest Impact



Environmental
Justice and Equity



Diversity in STEM



Workforce
Development



State and Local
Partnerships

EERE Program Priorities

100% decarbonized
electric grid by
2035

Decarbonize
transportation
across all modes

Decarbonize energy
intensive industries

Reduce the carbon
footprint of
buildings

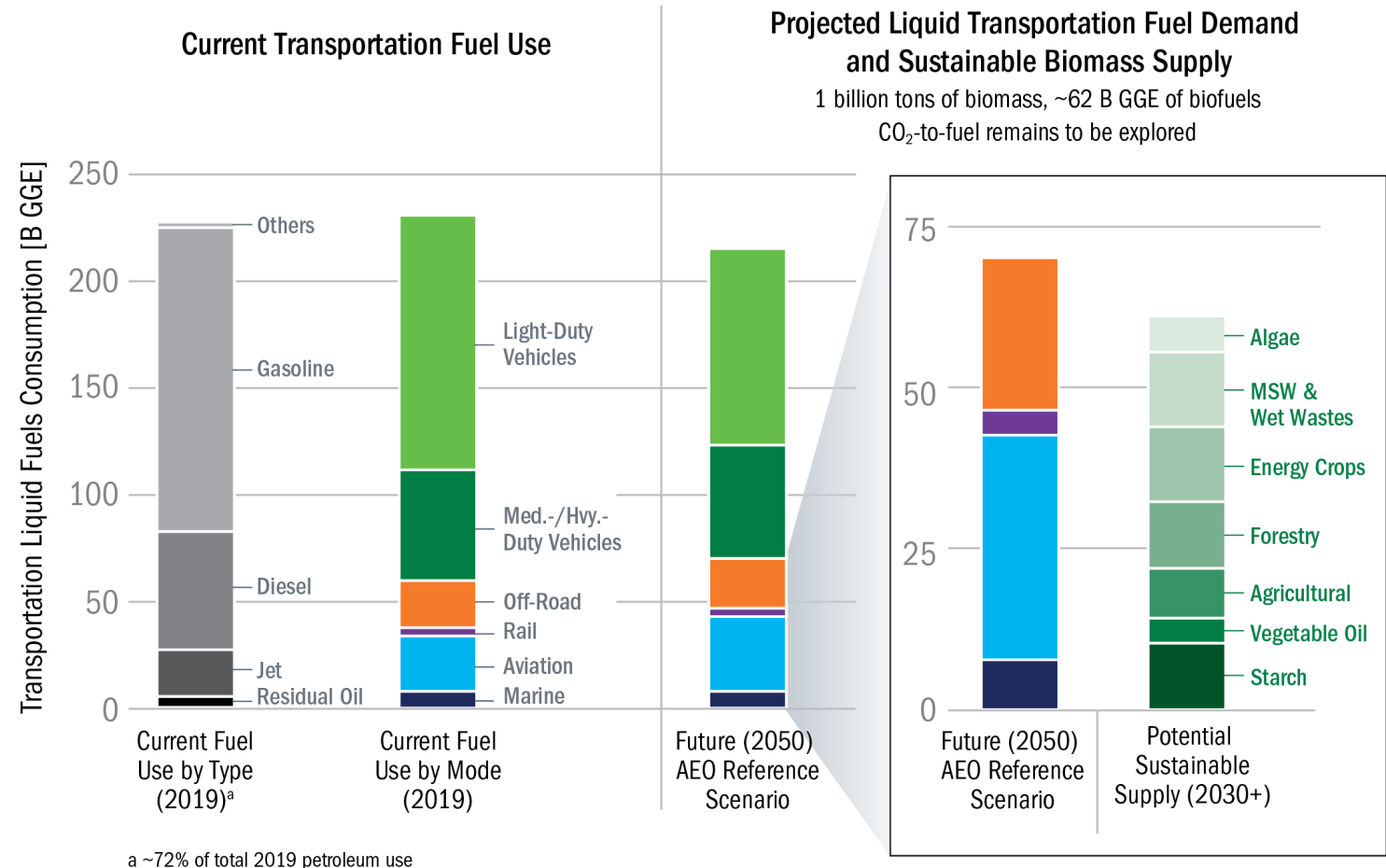
Enable a net-zero
agricultural sector

The Role of Biomass in Sustainable Transportation

- Transportation accounts for 34% of U.S. greenhouse gas (GHG) emissions.
- Biofuels are part of a sustainable transportation fuel strategy to decarbonize all modes.
- U.S. biomass can meet the needs of “hard to electrify” modes, such as aviation, marine and rail.

Focus areas for biofuels:

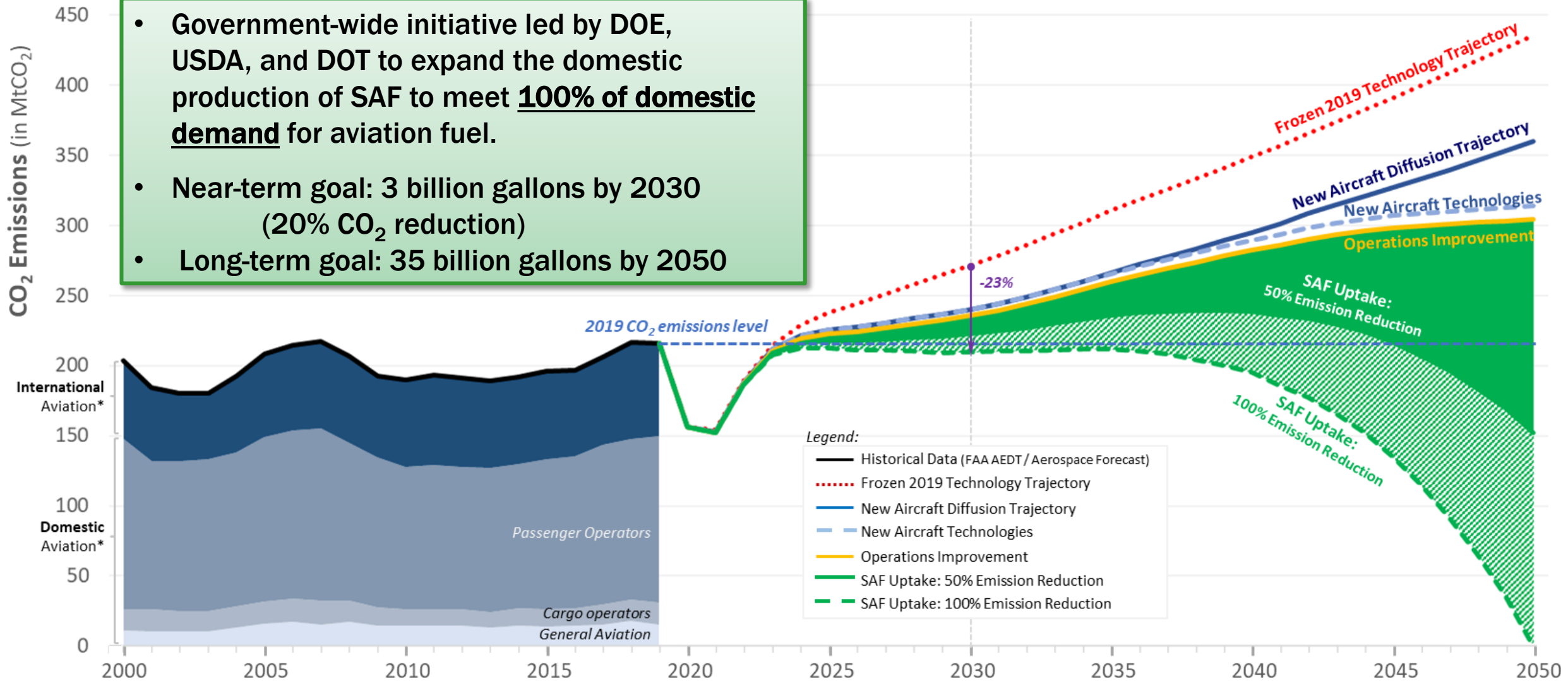
- Ethanol for passenger cars
- “Drop-in” fuels that can use existing infrastructure such as renewable diesel/sustainable aviation fuels



AEO = annual energy outlook | GGE = gasoline gallon equivalent | MSW = municipal solid waste

Sustainable Aviation Fuel (SAF) Grand Challenge

- 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% CO₂ reduction)
- Long-term goal: 35 billion gallons by 2050



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

Marine Biofuels Show Promise

Many feedstocks

- Lignocellulosic (wood, grasses, ag residues)
- **Wet waste and bio-solids**
- MSW

Many fuels

- Hydrocarbon distillates drop ins
 - (renewable diesel, etc)
- Biogas
- Methanol
- **Bio-crudes**
- **Bio-oils**

Vary in cost, quality, volumes, and uses

- Direct diesel replacements
- Residual alternative for ocean going vessels
- Potential for methanol pilot fuel



Hydrothermal Liquefaction Skid at PNNL



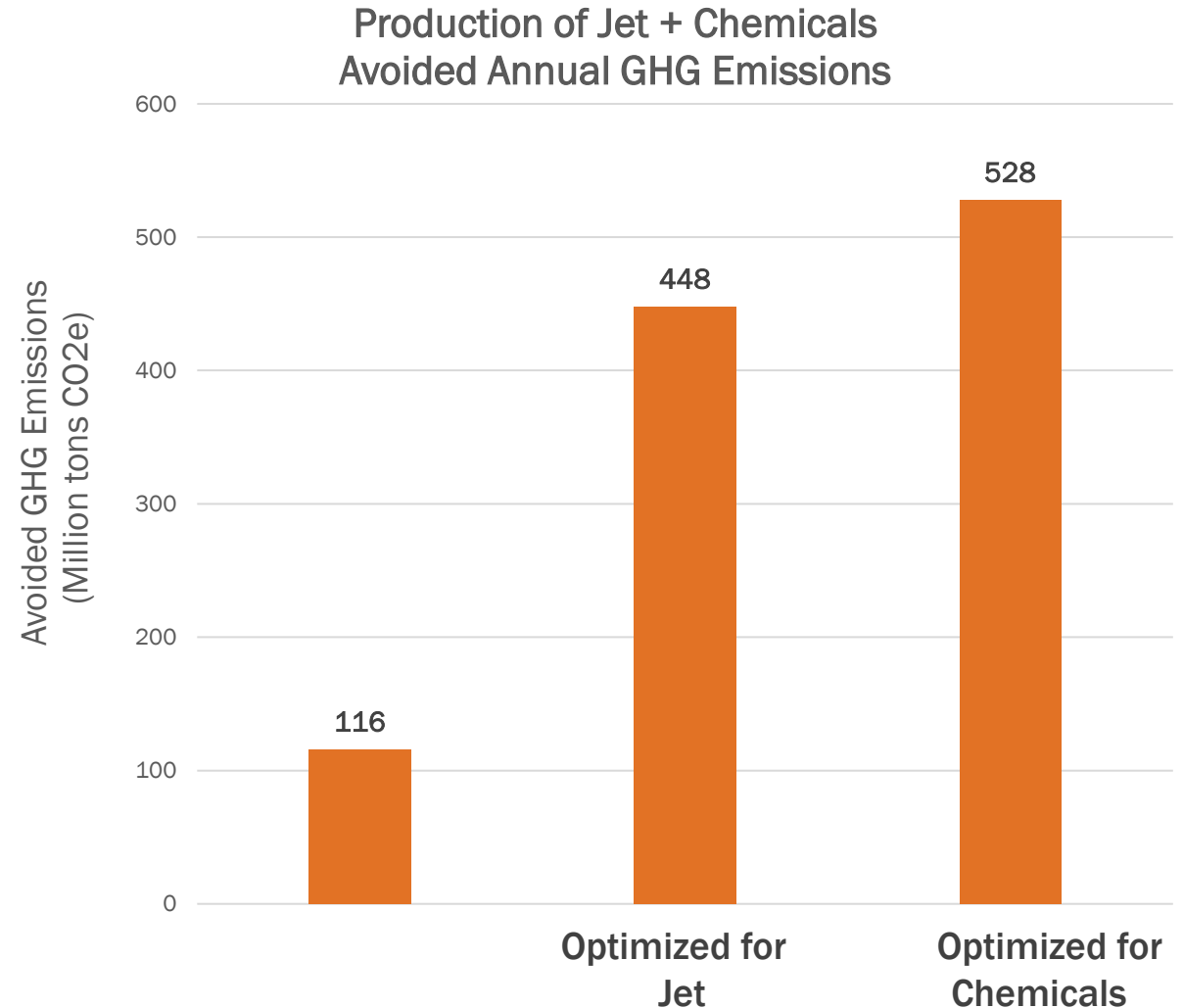
Thermochemical Process Development Unit at NREL

The Role of Biomass in Industry

- Chemical production accounts for 5.5% of U.S. GHG emissions.
- Biomass is the only renewable resource that can replace petroleum to make carbon-based chemicals.
- Biomass-derived chemicals could significantly reduce GHG emissions.

Focus areas

- Drop-in replacements for petro-chemicals
- Performance enhanced biochemicals
- Recyclable on demand

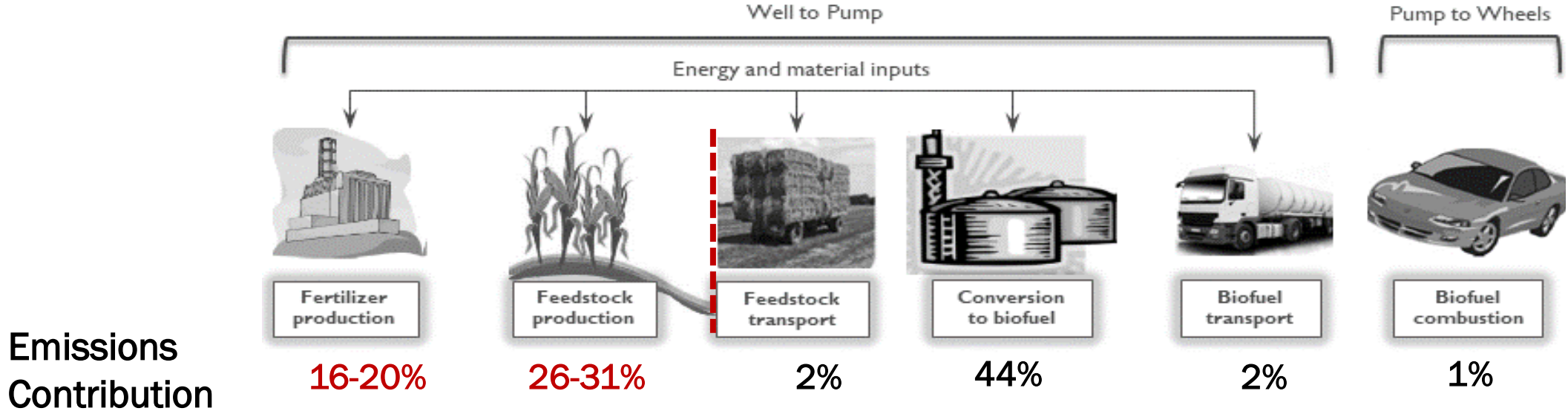


Climate-Smart Agriculture is a Key Enabler

- Agriculture activities serve as sources and sinks for GHGs.
- Decarbonizing transportation/chemicals and decarbonizing agriculture are intrinsically linked.
- By developing tools and strategies to quantify and improve soil carbon sequestration and ecosystem services, we can produce biofuels with a lower carbon intensity.

Focus areas in agriculture:

- Maximize soil CO₂ sequestration by developing healthy, productive soils and regenerating distressed soil.
- Develop climate-smart ag practices.
- Produce clean energy on-site from animal waste.
- Develop wastewater treatment strategies that produce bioenergy feedstocks.



Argonne Final Report to ARPA-E (2019): *Developing a Framework for Lifecycle Analysis of Biofuels on the Farm Level*

Biomass Feedstocks: Broad Potential For the U.S

What Does Making 35 Billion Gallons of SAF Mean?

Major benefits across the United States

- **Create jobs in green industries** – The corn ethanol industry created about 68,000 jobs. SAF will maintain the corn ethanol industry and will be over **11 times larger**.
- **Invest in communities and help manage waste disposal** – Farmers will be able to sustainability produce and collect new crops and residues while ALL communities will have less waste going to landfill.
- **Achieve lasting carbon reductions across our economy** – A variety of SAF conversion technologies will be used to convert biomass and waste to SAF. These feedstock/technologies will reduce CO₂ emissions from 55% to over 165% depending on the combination.
 - CO₂ is removed from the air during biomass growth



Photo courtesy of FDC Enterprises

Agricultural Waste



CAFO Manure



Municipal Solid Waste



Timberland



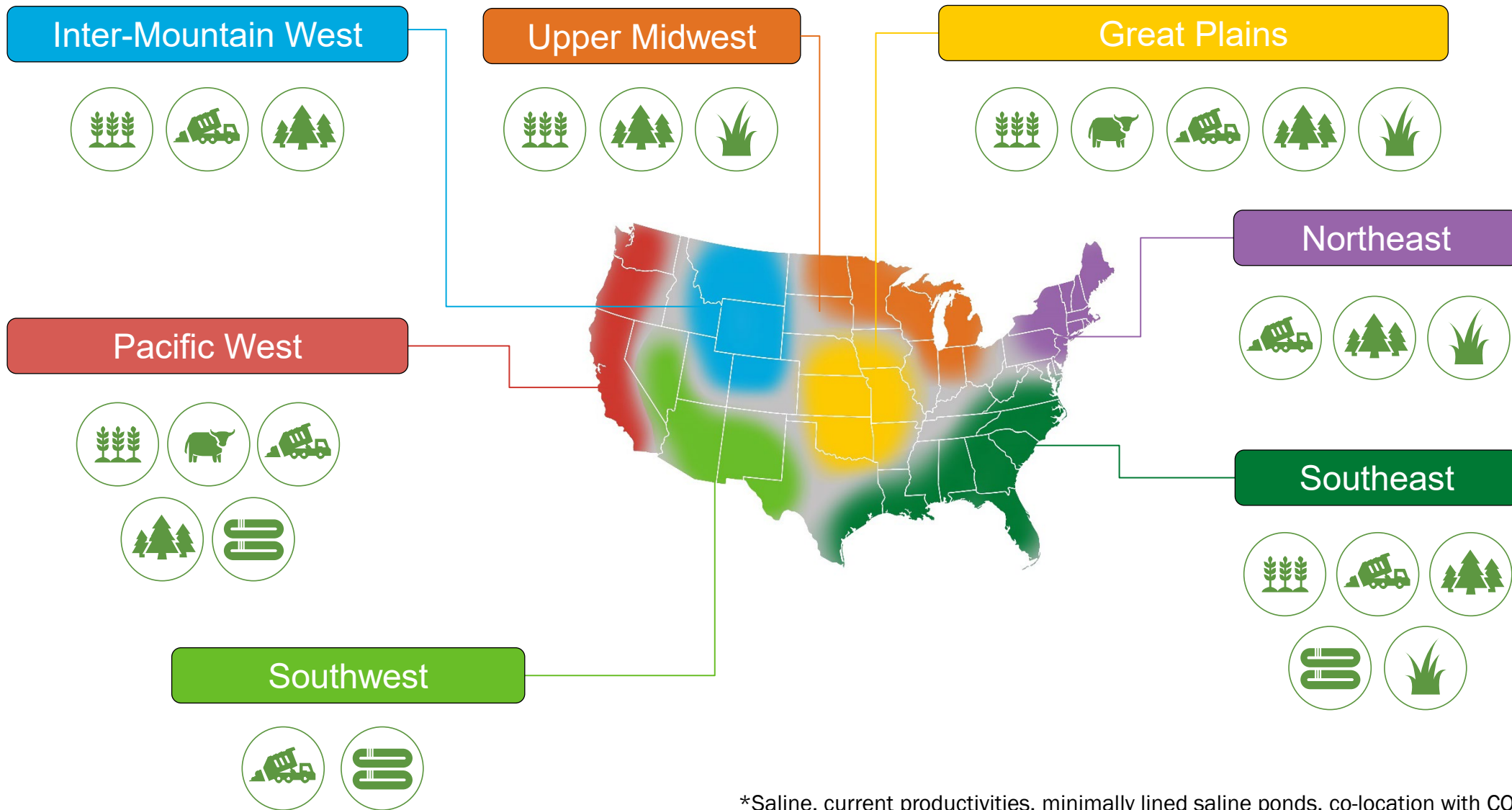
Algae*



Energy Crops**



Feedstock supply will come from regions across the United States



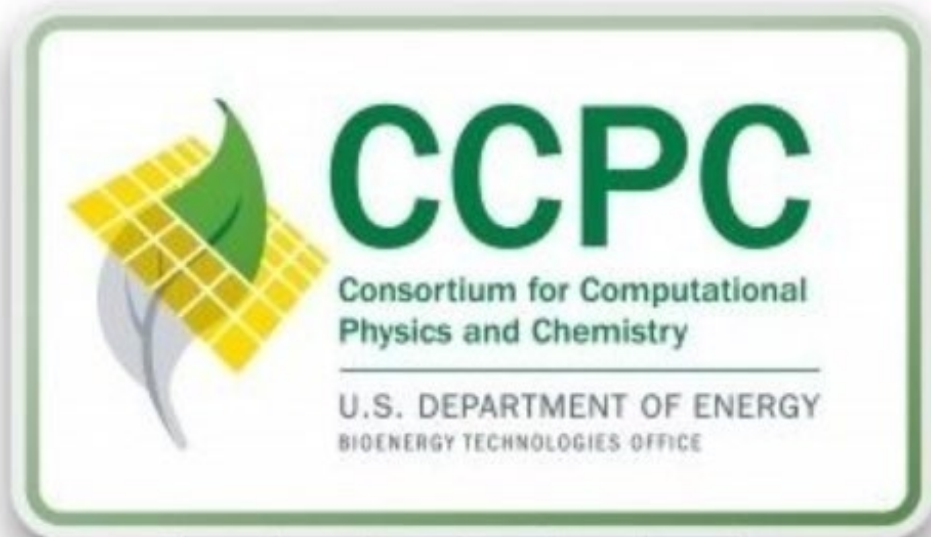
\$60/ton, product density > 50 tons/square mile

*Saline, current productivities, minimally lined saline ponds, co-location with CO₂ from coal, natural gas, and ethanol plants at prices from \$755-\$2,889 per dry ton (\$2014)

**Energy crops derived from 2040 dataset, all other biomass from 2017 dataset

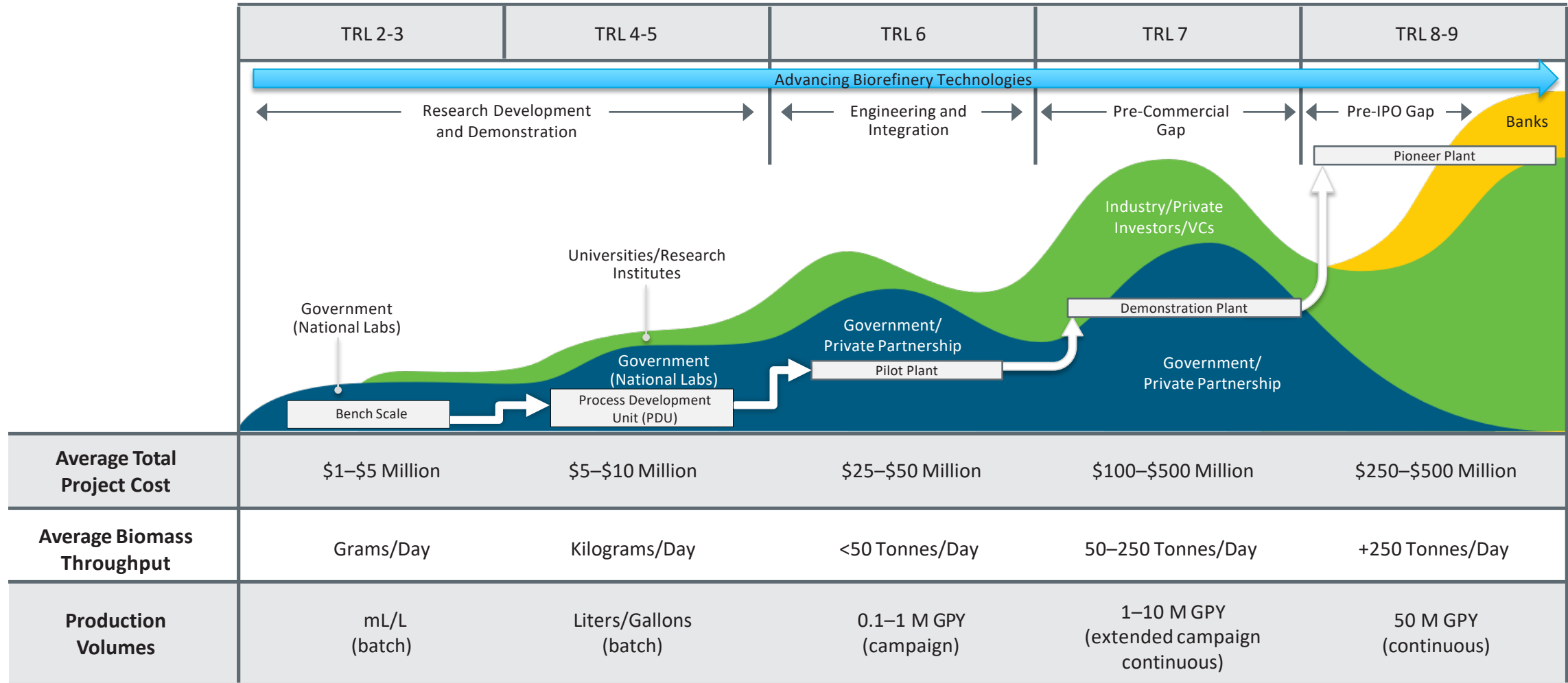
R&D Programs

Select Research Consortia



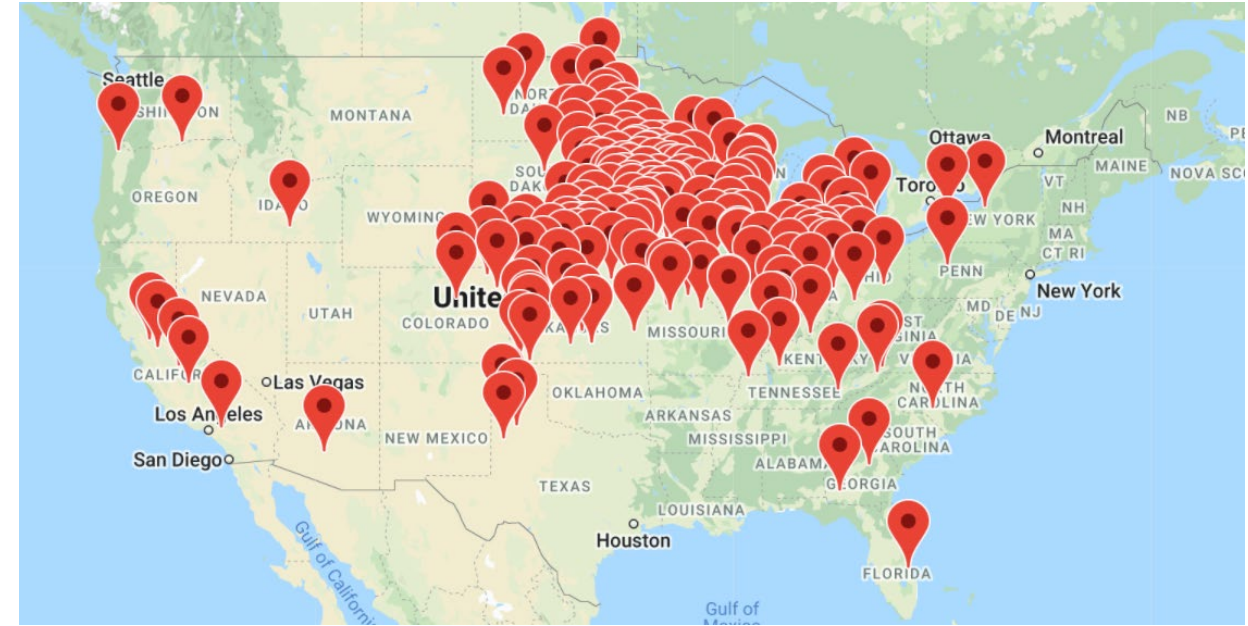
Demonstrations and Building Out the Industry

BETO Invests from Applied R&D to Large-Scale Demonstration



● Government
 ● Project Recipients and Partners
 ● Banks

Doubling the Number of Biorefineries



- To meet the aggressive goals of the SAF grand challenge the US will need
 - By 2030 – 40-45 refineries
 - By 2050 – 400-500 refineries
- Ethanol industry grew from 2B gal/year in 2002 to nearly 16 B gal in 2016
- There are approximately 215 ethanol refineries in the US built over 15 years primary in the Midwest.

WE CAN DO THIS

Are You Interested in Becoming a BETO Reviewer?



Wanted:

Subject matter experts to review research funding applications.

Applying is as easy as 1-2-3.

Fact Sheet:

energy.gov/eere/bioenergy/interested-becoming-beto-project-reviewer

EERE Funding Opportunity Exchange:

eere-exchange.energy.gov/Registration.aspx