

Country Report

United States

October 2014



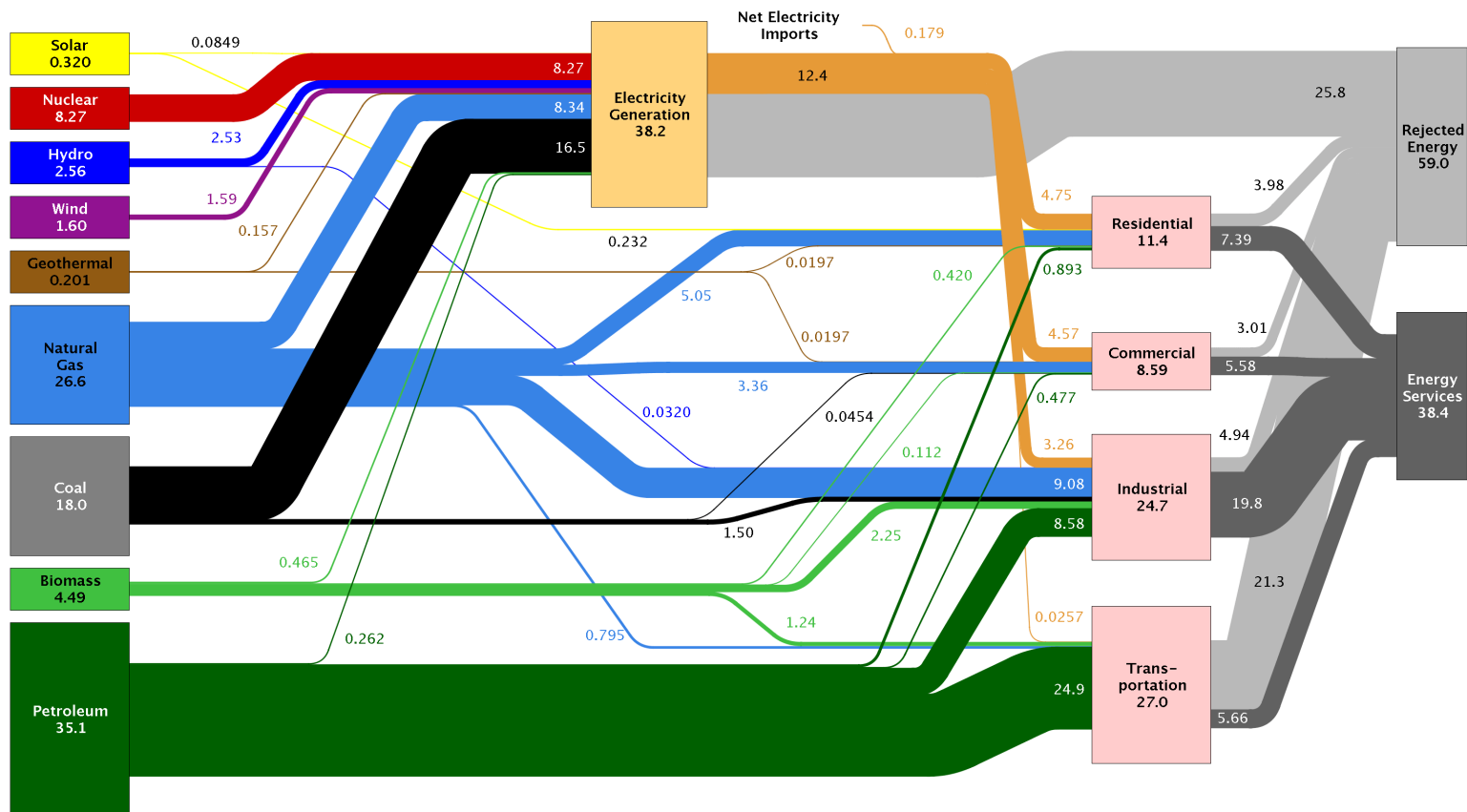
Jim Spaeth, U.S Department of Energy

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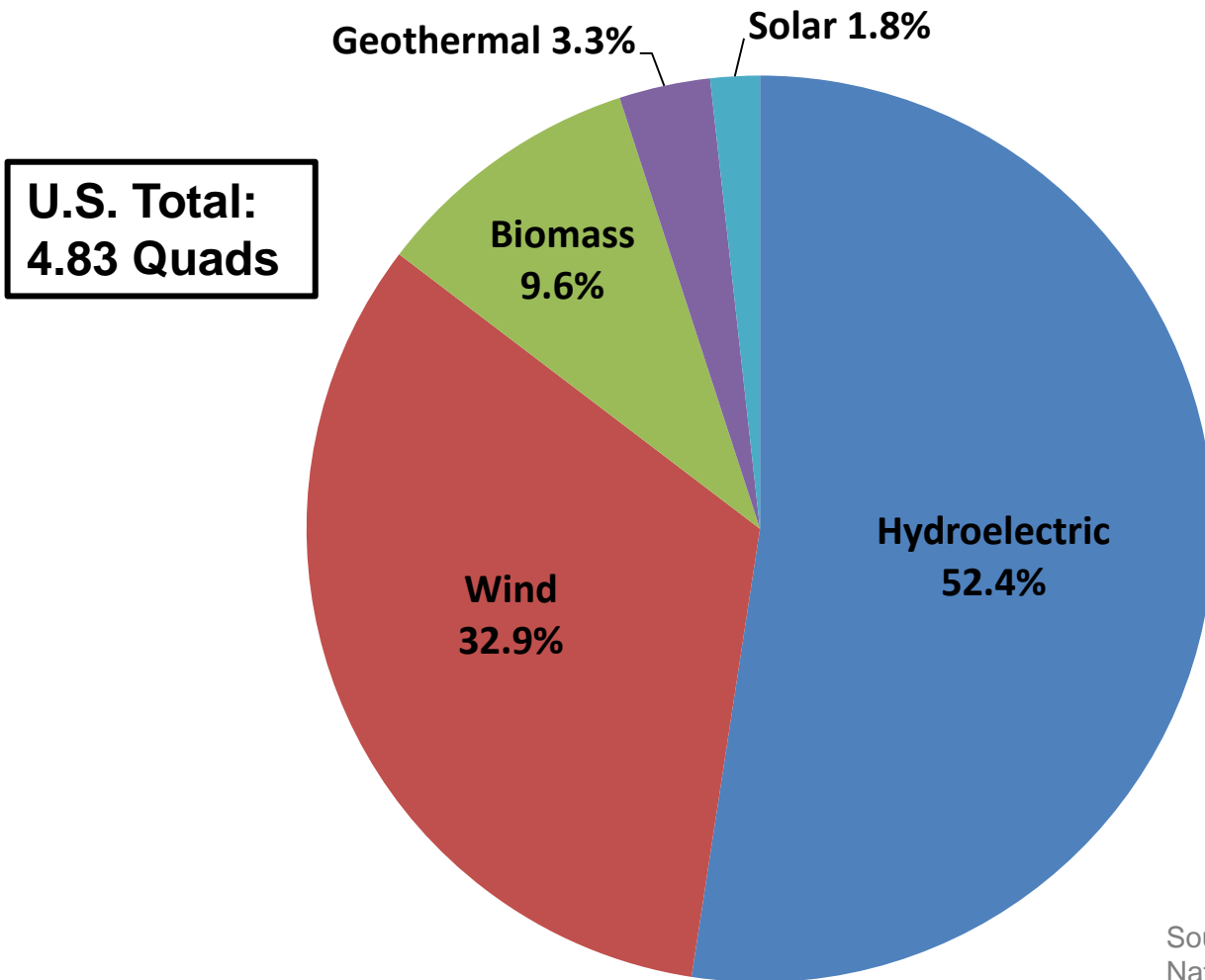
U.S. Primary Energy Consumption

Estimated U.S. Energy Use in 2013: ~97.4 Quads



Source: LLNL 2014. Data is based on DOE/EIA-0035(2014-03), March, 2014. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant "heat rate." The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential and commercial sectors 80% for the industrial sector, and 21% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

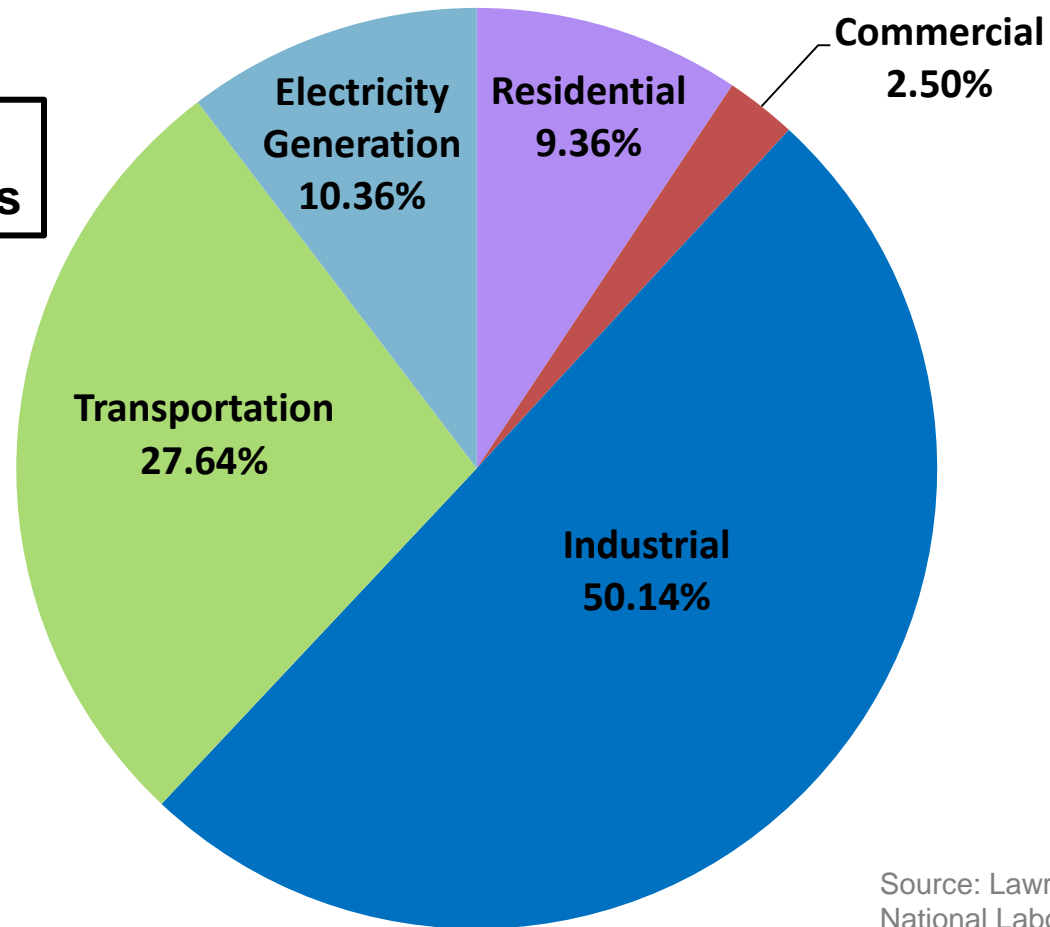
U.S Renewable Electricity Generation – 2013



Source: Lawrence Livermore National Laboratory and U.S. Department of Energy

U.S. Biomass Consumption by End-use Sector – 2013

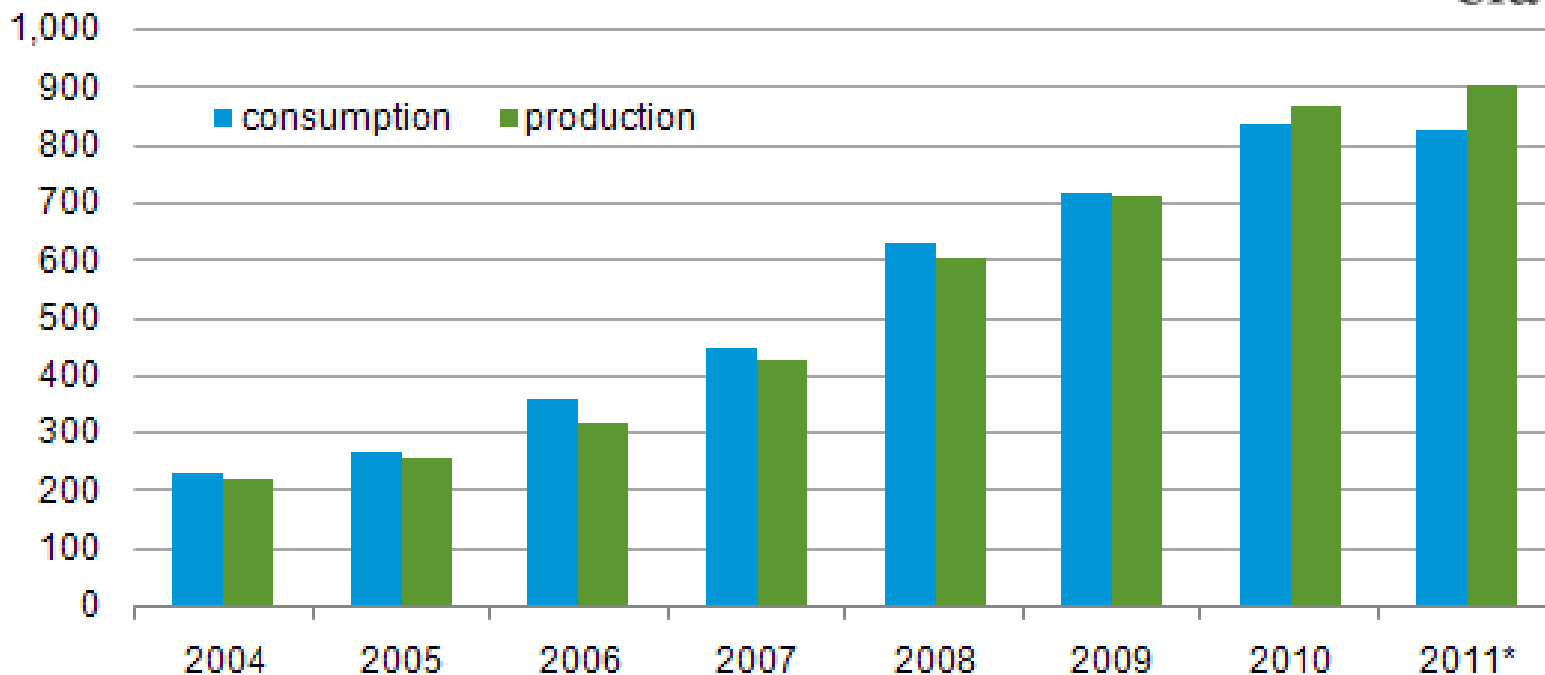
**U.S. Biomass
Total: 4.49 Quads**



Source: Lawrence Livermore
National Laboratory and U.S.
Department of Energy

U.S. Annual Ethanol Production vs Consumption

Annual U.S. ethanol production and consumption
thousand barrels per day

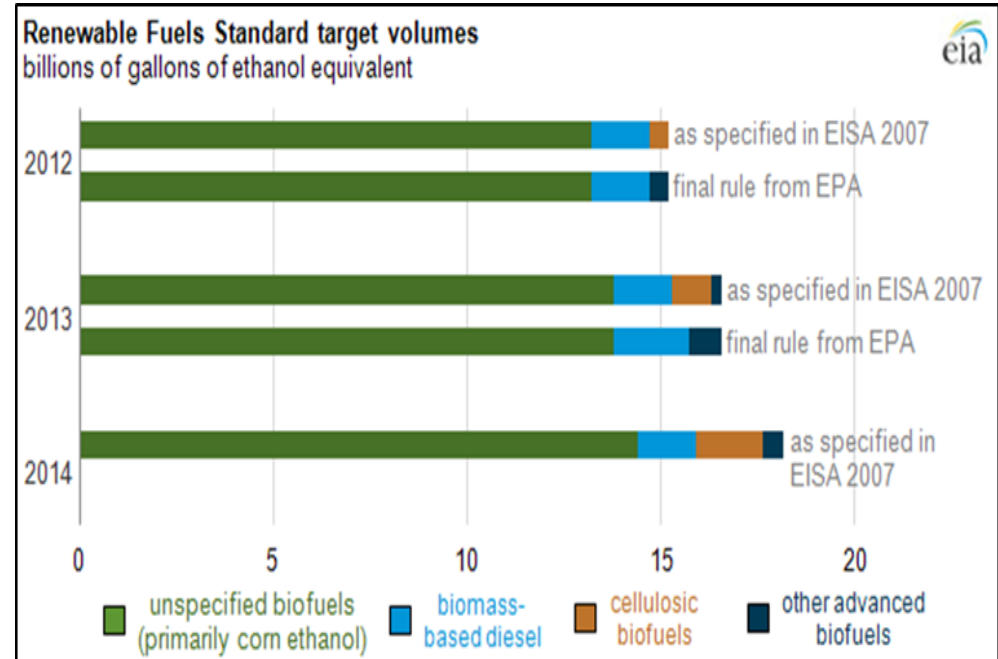


*January-May average

Source: U.S. Energy Information Administration

Biomass Related National Policy Issues

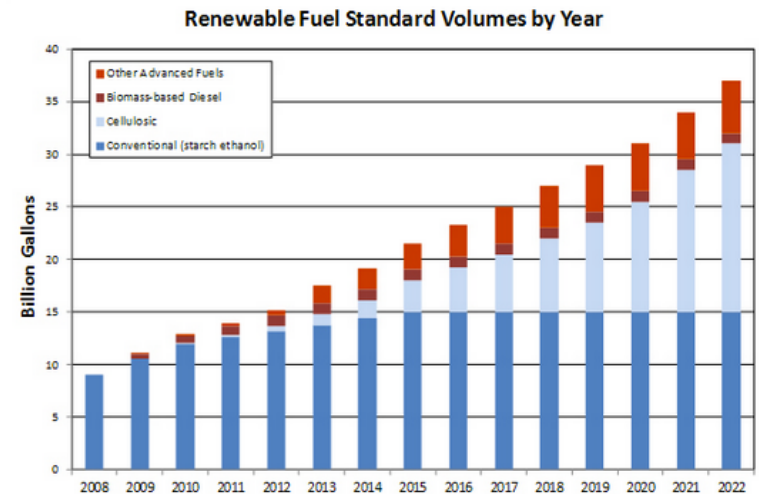
- ❑ The Renewable Fuels Standard (RFS) is a federally mandated program that was created under the Energy Policy Act (EPAAct) of 2005, and was expanded and extended by the Energy Independence and Security Act of 2007 (EISA)
- ❑ The RFS established the first renewable fuel volume mandate in the United States. Producers are assured a market uptake to production benchmarks; fuel marketers are required to purchase and sell renewable fuels to customers.
 - Under EPAAct, the original RFS program required 7.5 billion gallons of renewable- fuel to be blended into gasoline by 2012



Source: U.S. Energy Information Administration

Biomass Related National Policy Issues

- ❑ Under the Energy Independence and Security Act (EISA) of 2007, the RFS program was expanded (RSF2) in several key ways.
 - RFS2 included diesel, in addition to gasoline.
 - RFS2 increased the volume of renewable fuel required to be blended into transportation fuel from 9 billion gallons in 2008 to 36 billion gallons by 2022.
 - EISA established new categories of renewable fuels, and set separate volume requirements for each one.
 - EISA required EPA to apply lifecycle greenhouse gas performance threshold standards to ensure that each category of renewable fuel emits fewer greenhouse gases than the petroleum fuel it replaces.
 - U.S EPA is delaying finalization of 2014 Renewable Fuel Standard Renewable Volume Obligations until 2015
 - The 2015 compliance deadline will also be moved into 2015



Source: U.S. Department of Energy – Alternative Fuels Data Center

Biomass Related National Policy Issues

- ❑ The development of a national bioeconomy has emerged as a Presidential priority with a main driver being the support of U.S energy security
 - [National Bioeconomy Blueprint](#)
 - [Unleashing the Power of the Bio-economy](#)
 - [The Bioeconomy and Agricultural Research Summary](#)
- ❑ Program plans and technology roadmaps provide guidance for the adoption of bioenergy technologies
 - [Bioenergy Technologies Office Multi-Year Program Plan](#)
 - [Roadmap for Biomass Technologies in the United States](#)
 - [National Algal Biofuels Technology Roadmap](#)



Source: U.S. Department of Energy – Alternative Fuels Data Center

Biomass Related Sustainability Aspects

Objective: to understand and promote the positive economic, social, and environmental effects and reduce the potential negative impacts of bioenergy production activities.



Biomass Related Sustainability Aspects

Objective: Through targeted Research, Development, and Demonstration (RD&D), enable sustainable, nationwide production of advanced biofuels that will displace a share of petroleum-derived fuels, mitigate climate change, create American jobs, and increase U.S. energy security.

Research, Development, and Demonstration at Increasing Scale

Feedstock Supply

Develop sustainable and affordable feedstock supply and efficient logistics systems.



Conversion R&D

Develop commercially viable technologies for converting feedstocks into liquid transportation fuels and products.



Demonstration at Increasing Scale

Validate integrated technologies at cost-shared pilot, demonstration, and pioneer scale facilities.



Cross Cutting

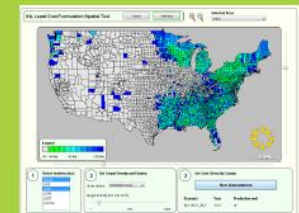
Sustainability

Promote the positive economic, social, and environmental effects of bioenergy.

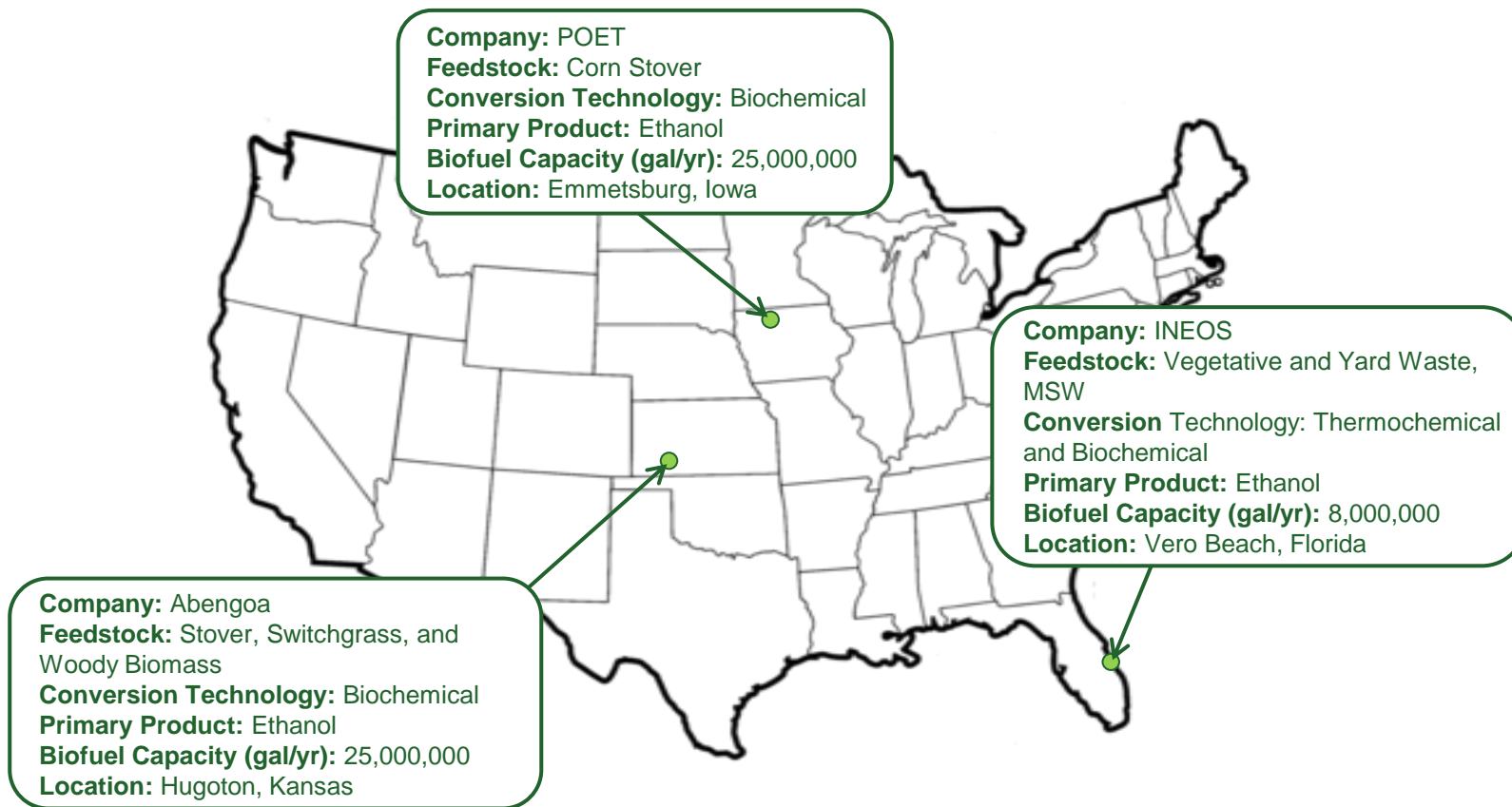


Strategic Analysis

Conduct market, policy, environmental, and other analyses to inform planning and decisions.



Running Commercial Biorefineries



Biorefinery Demonstration and Pilot Plants

Project (State)	Feedstock	Product	Scale	MGY
Algenol (FL)	Carbon Dioxide, Algae, Sunlight	Ethanol	Pilot	0.1
API (MI)	Woody Biomass	Ethanol, Potassium Acetate	Pilot	0.8
Bioprocess Algae (IA)	Carbon Dioxide, Algae, Sunlight	Algae Oil to Jet A	iPilots	TBD
Frontline (IA)	Carbon Dioxide, Algae, Sunlight	Jet Fuel and Diesel Fuel	iPilots	0.02
Haldor Topsoe (IL)	Wood Pellets	Renewable Gasoline	Pilot	0.345
ICM (MO)	Corn Fiber, Switchgrass, Energy Sorghum	Cellulosic Ethanol	Pilot	0.26
Mercurius (WA)	Carbon Dioxide, Algae, Sunlight	Ethyl Levulinate	iPilots	0.25
Myriant (MI)	Non-Food Cellulosic Feedstock	Bio-succinic Acid	Pilot/ Demonstration	30 MM lb/year
Sapphire (NM)	Carbon Dioxide, Algae, Sunlight	Jet Fuel and Diesel Fuel	Demonstration	0.5
Solazyme (IL)	Sucrose (From cane), Municipal Green Waste, and Switchgrass	Biodiesel and Renewable Diesel from Purified Algal Oil	Pilot	0.001
UOP (HI)	Agricultural and forestry residue, wood, energy crops, and algae	Gasoline, Diesel, and Jet Fuels	Pilot	0.01
Zechem (OR)	Woody Biomass and other Cellulosic Feedstocks	Ethanol and Intermediate Chemicals	Pilot	0.25

Interagency Coordination on Bioenergy R&D

Biomass Research and Development Board



- Established by the Biomass Research and Development Act of 2000
- Composed of senior decision-makers from federal agencies and the White House
- Coordinates federal government bioenergy R&D efforts.

Biomass Research and Development Technical Advisory Committee (TAC)

Approximately 30 representatives from industry, academia, research institutions, state and local agencies, and nongovernmental organizations.

- Provides recommendations on the implementation of awards and the overall scope and focus of federal bioenergy R&D.




Interagency Coordination: Defense Production Act (DPA) Initiative

In July 2011, the Secretaries of Agriculture, Energy, and Navy signed a Memorandum of Understanding to commit \$510 M (\$170 M from each agency) to produce hydrocarbon jet and diesel biofuels in the near term. This initiative sought to achieve:

- Multiple, commercial-scale integrated biorefineries.
- Cost-competitive biofuel with conventional petroleum (without subsidies).
- Domestically produced fuels from non-food feedstocks.
- Drop-in, fully compatible, MILSPEC fuels (F-76, JP-5, JP8).
- Help meet the Navy's demand for 1.26 billion gallons of fuel per year.
- Contribute to the Navy's goal of launching the "Great Green Fleet" in 2016.
- Demonstration of the production and use of more than 100 million gallons per year will dramatically reduce risk for drop-in biofuels production and adoption.

On September 19th, three projects were selected for construction and commissioning:



Company	Location	Feedstock	Conversion Pathway	Capacity (MMgpy)
 EMERALD BIOFUELS	Gulf Coast	Fats, Oils, and Greases	Hydroprocessed Esters and Fatty Acids (HEFA)	82.0
 Fulcrum BIOENERGY	McCarran, NV	Municipal Solid Waste	Gasification – Fischer Tröpsch (FT)	10.0
 Red Rock Biofuels	Lakeview, OR	Woody Biomass	Gasification – Fischer Tröpsch (FT)	12.0

Interagency Coordination: Additional DPA Developments

- Cathay Pacific Airways has become an investor in Fulcrum and has negotiated a 10 year supply agreement for 375 million gallons of jet fuel.
- Southwest Airlines has signed a fuel purchase agreement with Red Rock for 3 million gallons/year of jet fuel. Blended product will be used at Southwest's Bay Area operations.
- USDA has awarded Fulcrum a \$105 million Biorefinery Assistance Program loan guarantee through Bank of America for construction of their facility.



Accomplishments/Milestones

The Commercial Alternative Aviation Fuels Initiative (CAAFI) has set a goal of 1 billion gallons per year of alternative jet fuel by 2018 (the commercial aviation market currently 20 billion gallons per year), and DOE is playing an active role by providing technical expertise in various high-level aviation activities, including:

- Becoming the latest partner agency for Farm to Fly 2.0, joining the aviation sector as well as Department of Agriculture (USDA) and Federal Aviation Administration (FAA) in an agreement to enable commercially viable and sustainable jet fuels in the U.S.
- Serving on CAAFI Steering Group and as a co-host with the FAA for the Aviation Biofuels Techno-Economic Analysis Workshop, November 2012.
- Working with FAA to develop a National Alternative Jet Fuels Strategy Roadmap (December 2014).
- Supporting FAA's newly established Center of Excellence in alternative jet fuels led by Washington State University/MIT, and supported by National Renewable Energy Laboratory and Pacific Northwest National Laboratory.
- Increasing technical work at National Laboratories to enable achievement of alternative jet fuel goals.



Bioenergy Research, Development, and Deployment Success

The Office of Energy Efficiency and Renewable Energy's (EERE) successes in developing sustainable, cost-competitive biofuels, bioproducts, and biopower translate into clean, affordable fuels for the cars and trucks of today and tomorrow, and products and power that can help reduce dependence on fossil fuels.

- ❑ [Ionic Liquid Pretreatment Process for Biomass Is Successfully Implemented at Larger Scale](#)
- ❑ [DOE-Funded Research on Bacterial Enzyme Could Lead to Cheaper Biofuel](#)
- ❑ [California: Breakthrough in Algae Biology](#)
- ❑ [Washington, D.C. and Tennessee: Bioenergy Technologies Office Announces Launch of New and Improved KDF](#)
- ❑ [California and New Mexico: Sapphire Energy Advances the Commercialization of Algae Crude Oil](#)
- ❑ [Nationwide: The Nation's First Commercial-Scale Biorefineries](#)
- ❑ [Washington: Enabling the Successful Transition of Microalgae from Lab to Pond](#)
- ❑ [California: Agricultural Residues Produce Renewable Fuel](#)
- ❑ [California: Cutting-Edge Biofuels Research and Entrepreneurship Provide a Proving Ground](#)
- ❑ [Louisiana: Verenium Cellulosic Ethanol Demonstration Facility](#)
- ❑ [Refining Bio-Oil alongside Petroleum](#)

Major National Stakeholders Involved in Biorefining

Companies	Research & Development	Government	NGOs
<u>POET</u>	<u>NREL</u>	<u>Department of Energy</u>	<u>American Coalition of Ethanol</u>
<u>Abengoa</u>	<u>ANL</u>	<u>Department of Agriculture</u>	<u>Energy Future Coalition</u>
<u>Solazyme</u>	<u>INL</u>	<u>Department of Defense</u>	<u>American Council on Renewable Energy</u>
<u>INEOS Bio</u>	<u>ORNL</u>	<u>Department of Transportation</u>	<u>Renewable Fuels Association</u>
<u>DuPont</u>	<u>PNNL</u>	<u>Environmental Protection Agency</u>	<u>Biotechnology Industry Organization</u>
<u>Novozymes</u>	<u>LBNL</u>	<u>National Institute of Standards and Technology</u>	<u>Algae Biomass Organization</u>
<u>Sapphire Energy</u>			

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