U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

Benefits of Biofuel Production and Use Series—Spotlight on Washington

The U.S. Department of Energy's (DOE's) Bioenergy Technologies Office (BETO) enables the development of technologies that can be used to support state energy priorities. Washington obtains more than 75% of its electricity from renewable resources (2015) and is a national leader in energy conservation and energy efficiency.

Setting the Stage for Biofuels

Drop-in biofuels produced from state biomass resources could use the existing infrastructure and distribution networks to reduce dependence on petroleum-based transportation fuels, stimulate economic development, and reduce harmful emissions.

- **Economy**
  Washington's transportation sector consumed 113 million barrels of petroleum at a cost of almost $12 billion in 2015. In 2013, the state's biobased products industry contributed 41,140 direct jobs (82,640 total jobs) and $3.8 billion in direct value ($7.9 billion in total value).
- **Energy**
  Several large U.S. Air Force and U.S. Navy installations help place Washington as 8th among the top 10 jet fuel–consuming states in the nation. As of 2016, the state's biodiesel production capacity is 105 million gallons, which is ranked as the 5th among the top 10 states.

Washington state–based Alaska Airlines made history flying the first commercial flight using the world's first renewable, alternative jet fuel made from forest residuals, the limbs and branches that remain after the harvesting of managed forests.
Photo credit: Washington State University.

- **Environment**
  In 2014, fossil fuel use in Washington's transportation sector released 41 million metric tons of carbon dioxide. On a life-cycle basis, advanced biofuels can reduce harmful emissions by >50% compared to petroleum—helping to reduce environmental impacts.
- **Feedstocks**
  Estimates indicate 6.9 million dry tons of biomass are currently available in Washington each year. The state can leverage these and other renewable resources to sustainably produce advanced biofuels.

Bringing Technology to Market

Strategic policies and investments help bridge the gap between promising research and large-scale production of advanced biofuels.

- The state provides loans for developing production and distribution facilities for biofuels created from agricultural product wastes from Washington's almost 15 million acres of farmland, as well as for electricity generation from anaerobic digestion.
- DOE has awarded more than $196 million to national laboratory, university, and industrial partners in Washington to research, develop, and demonstrate sustainable biobased fuels and products since 2005. Pacific Northwest National Laboratory (PNNL) has received 90% of this funding.
- PNNL projects include $14.8 million for fungal genomics to produce robust, efficient biocatalysts and bioprocesses for biofuels and bioproducts; $10 million for upgrading of synthesis gas intermediates for liquid fuels production; and $3.5 million for microalgae production and analysis. PNNL also has been conducting biobased fuels and products and bio-oil upgrading research at its Bioproducts, Sciences, and Engineering Laboratory. PNNL's currently active bio-oil upgrading projects, funded by BETO, are valued at $13.8 million.
- BETO provided funding to Forest Concepts (Auburn, Washington) under its Biorefinery Optimization initiative to develop robust feedstock handling modeling and simulation tools based on systematic analysis.
- With funding support from BETO, Lumen Bioscience (Seattle, Washington) will collaborate with the National Renewable Energy Laboratory to engineer algal strains that grow robustly in seawater and resist contamination and predation.

Research at Pacific Northwest National Laboratory

Research and development (R&D) at PNNL is helping supplement petroleum with biobased renewable fuels and products.

- **Biobased fuels**: Researchers are developing the scientific and engineering foundations for converting biomass to biofuels that are compatible with today's infrastructure.

- **Biobased chemicals:** Chemical products offer another way to reduce U.S. dependence on imported oil and improve the economics of U.S. biorefineries.
- **Marine Sciences Laboratory**: The principles of biotechnology are being applied in the quest for renewable energy resources and in the development of biologically inspired technological innovation.

Why Washington?

- ### Biomass Resources

  Washington has the potential to provide an additional 9.2 million dry tons of biomass, for a total of 16.1 million dry tons annually, for biofuel production.

- ### Clean Transportation Fuels

  Biomass resources could supply aviation in Washington with drop-in fuels as sustainable alternatives to petroleum. Seattle-Tacoma International Airport is the first major U.S. airport to set a goal to develop an infrastructure for aviation biofuel use by all its flights.

  Since 2003, Washington State Ferries has been implementing cleaner-burning fuels in its fleet and is now the largest public consumer of biodiesel in the country.

- ### Bioenergy

  Washington is a substantial producer of electricity from wood and wood waste, and it accounts for almost 3% of the nation's net electricity generation from biomass.

- ### Jobs and Economy

  In 2013, the state's biobased products industry contributed 41,140 direct jobs (82,640 total jobs) and $3.81 billion in direct value ($7.87 billion in total value).

DOE has supported R&D at Washington universities. This research improves the productivity of bioenergy feedstocks and maximizes the benefits of biofuels and bioproducts while minimizing negative impacts. ■

BETO Projects with Universities

University	Washington State University[1]	University of Washington[2]	
Research area	Develop an integrated system and related technologies for producing fuels and other valuable chemicals from cyanobacteria that yield high levels of lipids and other products	Design a cookstove for woody and herbaceous biomass fuels	Develop a world-class laboratory for research on producing fuels and high-value chemicals from cellulosic biomass feedstocks[3]
Stage	R&D	R&D	R&D
Primary product	Algal biomass feedstock	Cookstove	N/A
Feedstock	N/A	Woody and herbaceous biomass	Multiple

[1] Both Washington State University and PNNL were partner organizations of the National Advanced Biofuels Consortium (NABC), led by the National Renewable Energy Laboratory. With a $35 million DOE investment under the Recovery Act during 2010–2013, NABC conducted research to develop cost-effective processes to produce drop-in biofuels.

[2] The University of Washington was one of the partner organizations of the National Alliance for Advanced Biofuels and Bioproducts (NAABB). With a $48 million DOE investment under the Recovery Act during 2010–2013, NAABB conducted research to develop technologies with the potential to reduce the cost of algae-based biofuels.

[3] Having this equipment was also instrumental in the University of Washington receiving a $40 million grant from the U.S. Department of Agriculture for biofuels development, as well as other smaller grants.

For more information on Washington's energy portfolio and the economic and environmental benefits of biofuels, visit:

Washington state profile and energy estimates
2016 Billion-Ton Report state biomass resources download tool
U.S. petroleum consumption by sector – 2015
U.S. petroleum expenditures by sector – 2015
Biodiesel production capacity
State carbon dioxide emissions – 2014
Ethanol production capacity and production
Jet fuel consumption
U.S. Department of Agriculture analysis on economic impact of U.S. biobased products industry

For more information on Washington clean energy initiatives, research, and partnerships, visit:

Alternative Fuels Data Center
Washington State Ferries
DOE-BETO
BETO program funding opportunities
PNNL – energy efficiency and renewable energy
PNNL – biobased product research
Renewable Energy in the 50 States: Western Region
"Departments of the Navy, Energy and Agriculture Invest in Construction of Three Biorefineries to Produce Drop-In Biofuel for Military"

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For more information, visit:
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