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FACTSHEET: BIOFUELS

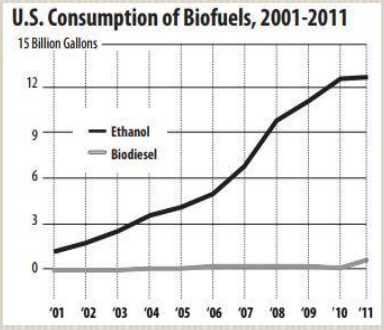
BIOMASS TO BIOFUEL: DOMESTIC RENEWABLE ENERGY

Preethy Thangaraj, David Zilberman, Gal Hochman* &

Biofuel is energy produced from organic matter, primarily found in the form of living plants or waste. Different biomasses are composed of different chemistry, but all consist majorly of carbon and water.

How is biomass converted into biofuel?

1. **Combustion** is the process where the biomass is burned in the presence of air to release heat. For example, when starting a campfire wood is used to sustain the fire.
2. **Gasification** is the process of using heat, pressure, and partial combustion to convert biomass into a combustible gas mixture called syngas. This gas may be used in place of natural gas for heating and electricity purposes.
3. **Pyrolysis** is the process of heating biomass at high temperatures in the absence of oxygen; since no O2 is present the mass does not combust, rather the mass decomposes into biooil (liquid), bio-char (solid), and syngas.
4. **Anaerobic digestion** or **bio-digestion** is the process by which bacteria breaks down organic material in the biomass in the absence of air to create a biogas; the biogas is captured and then burned to produce energy. The remaining byproduct of this process results in a fertilizer.
5. **Fermentation** is the process of converting a plant's glucose into an alcohol, known as ethanol, through the application of yeast. Ethanol is a liquid fuel most commonly known to be used as an automotive fuel.

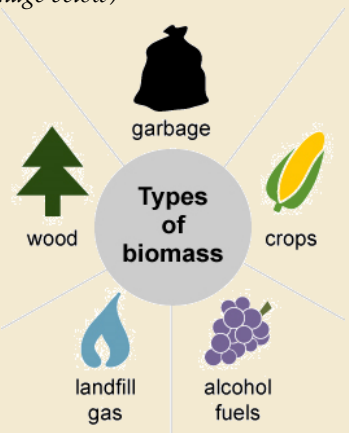


In 2011, just under 13 billion gallons of ethanol were consumed in the U.S. In that same year, just 1 billion gallons of biodiesel were consumed.[5]

However, the problem of excessive greenhouse gas emissions remains unresolved; the transportation sector emits 27% of all greenhouse gas emissions in 2013. In that same year, the power and energy sector accounted for 31%.[6]

WHAT ROLE DOES BIFUELS PLAY?

Biomass was a primary source of energy before industrialization, but now only comprises a small percentage of world energy use. Technology and globalization, however, have changed the ways in which products are produced and consumed for the better. More developed science and globalization allow for better integration of industries. *(EIA image below)*



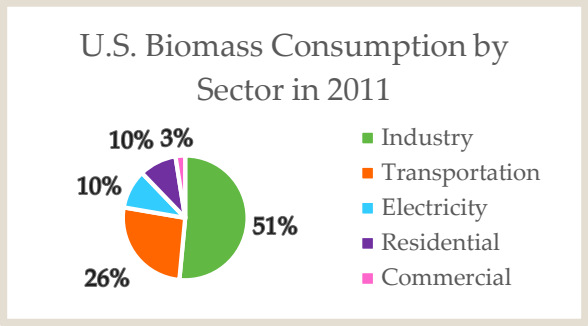
Biofuels hold the potential to mitigate the effects of climate change and combat the depletion of fossil fuel resources. Access and availability to energy and natural resources have become finite; this can infringe on domestic energy stability and raise energy security concerns.

* Preethy Thangaraj is a research Assistance in the agricultural food and resource economics department at Rutgers University. David Zilberman is a professor in the agricultural and resource economics department at University of California Berkeley. Gal Hochman is an associate professor in the agricultural food and resource economics department at Rutgers University.

& **Corresponding author:** Gal Hochman (gal.hochman@rutgers.edu). The authors thank NIFA award # 2016-670023-24751, the USDA Office of Energy Policy and New Uses by cooperative agreement #58-0111-15-007, Department of Agricultural, Food, and Resource Economics, and the Rutgers Energy Institute for financial support.

U.S. CONSUMPTION OF BIOFUELS

Biofuels: Ethanol and Biodiesel: In 2011, U.S. biomass consumption consisted of 51.5% by the industrial sector and 26. 2% by the transportation sector; manufacturing and electricity production will soon have to rely on renewable energy sources.[1] The effects of biofuel on food and fuel prices are moderate, but aggregate welfare gains outweigh losses. A recent meta-analysis study argued that despite almost a 20% increase in agriculture commodity price due to the adoption of corn ethanol, there was a correlating 5% decrease in gas prices.[2]



What do we gain from biofuels? Many industries already use biomass energy to fuel their power, such as: paper industry like *Old Town Fuel and Fiber* and power plants like *Vattenfall* and *Lockheed Martin*.[3],[4]

- Biomass will evolve the energy industry to create jobs in manufacturing, engineering, tech industries, and agriculture; long-term benefits of biomass energy usage due to increased overall welfare will further create more employment opportunities in other sectors like real estate, food, and finance.
- Biologically, biomass crops may vary based on its chemical composition, duration of sprouting and growth period, resistance to harsh climates, nutrient and water intake, and best method of conversion into biofuel. This creates a spectrum of possibilities for biomass to bioenergy.
- Biomass is geographically diversified; locally grown biomass crops encourage domestic production and serve as an abundant resource for energy. Sustainable biomass can help wane U.S. dependency on foreign fuel and improve energy security.
- An increase in the usage of biofuels will alter supply chain development; the improvement of alternative fuel usage and increased research and development of biofuel usage will result in a large shift from fossil fuel consumption
- Advanced biofuels will lead to the abatement of co_2 emissions to produce cleaner air, increase demand and competitiveness in bio-economy markets; the process of biofuel generation is a carbon-neutral cycle
- *Vattenfall*, an energy retailer and a member of the Sustainable Biomass Partnership, monitors biomass production and conversion through the course of its supply chain. Most of their operations are powered by biofuel.[3]
- Supporting biofuel development and implementation further substantiates development of advanced biofuels which are synthesized from a non-edible biomass, for example excrement, and can be produced in cell cultures by reproducing enzymes and bacteria from other sources. By harnessing waste, biofuels take something with no use and generate economic value. To make a significant impact on climate change, R&D must be directed towards this new generation of biofuels.

*The biomass Vattenfall uses typically leads to more than **80%** CO2 emissions reduction*

[1] *Independent Statistics and Analysis U.S. Energy and Information Administration*, U.S. Department of Energy, 16 May 2017, www.eia.gov/energyexplained/?page=biomass_home.
[2] Hochman, Gal. Draft, pp. 1–33, *Corn-Ethanol and US Biofuel Policy 10 Years Later: A Quantitative Assessment*.
[3] "Biomass Plant – How It Works." *Vattenfall*, Vattenfall AB. VAT, 12 May 2017, corporate.vattenfall.com/about-energy/renewable-energy-sources/biomass/how-it-works/.
[4] Dalton, Andrew. "Lockheed Martin's Bioenergy Plant Turns Waste Into Clean Power."*Engadget*, Oath Inc., 22 Sept. 2016, www.engadget.com/2016/09/22/lockheed-martin-bioenergy-plant-waste-clean-power/.
[5]"Switch Energy Project – Biomass." *Switch Energy Project Documentary Film and Energy Expert Video Series*, Arcos FIlms, 2013, www.switchenergyproject.com/.
[6]EPA. *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. Environmental Protection Agency, 1990, pp. 18–23, *Inventory of U.S. Greenhouse Gas Emissions and Sinks*.

FAST FACTS

14%

Biomass makes up 14% of the world's energy supply

9.9%

Corn ethanol made up 9.9% of motor gasoline in 2015. [5]

Balance of Trade

26%

The U.S. exported more than one billion gallons of ethanol in 2016, which was 26% more than in 2015. [5]

60%

The U.S. imported about 36 million gallons of ethanol in 2016, which was 60% less than in 2015. [7]

To achieve full displacement of carbonized energy, the availability of bioenergy resources needs to be accounted for. In the United States, just agriculture residue like corn stalks and leaves account for up to 155 million dry tons of biomass. (UCSUSA) By using the residue, the accessibility of food and land used to grow the crop are not diminished nor depleted.

Social, Economic, and Environmental Supply Chain Shortcomings: Challenges in the logistics of biofuel production and conversion serve to inhibit aspects of the biofuel supply chain. Conditions for optimal biofuel supply chain management can be achieved by combatting these issues:

1. **Creating the biomass:** Although a sustainable form of energy resource, certain biomass yields are diminutive in colder seasons; because of seasonal changes and land availability, biomass crops, for example soybean, are not harvested at a high rate. Competition with food crops also contributes to a lower yield for energy crops. Experts are exploring options with perennial plants, like switchgrass. Fear of overharvesting and nutrient-depletion in soil remains a deterrent.
2. **Converting the biomass:** It is a challenge to establish an efficient supply chain between biomass production and biofuel production to assure overall efficiency. The U.S. has centered biofuel development around cultivating the biomass feedstock, instead of advancing conversion technology. Europe is doing the opposite. Inefficiencies in the supply chain will inhibit the ability to meet growing demand for biofuels and constrain efforts to find the most cost-effective methods of harvesting, processing, and transporting.
3. **Social implications:** Impacts to the agriculture sector due to biofuel production will result in the increase of rural employment rate, but moderate increase in prices of agriculture commodities. [5]

[6] Hochman, Gal. Draft, pp. 1–33, *Corn-Ethanol and US Biofuel Policy 10 Years Later: A Quantitative Assessment*.
[7] Hanson, Steve, and Sean Hill. "Biofuels: 2016 U.S. Ethanol Exports Rise 2nd Highest Level on Record." *AgFax*, Allegro, 16 Mar. 2017.