

## U.S. Department of Energy - Energy Efficiency and Renewable Energy Biomass Program

### Environmental Benefits

Tens of millions of Americans live in areas that don't meet at least one federal air quality standard. In 1990, Congress passed the Clean Air Act Amendments to combat high emission levels of carbon monoxide and the creation of ground-level ozone by petroleum-based transportation fuels. This Act specifically required the use of oxygenated fuels during winter months in areas exceeding standards for carbon monoxide and "reformulated gasoline" in areas exceeding standards for ground-level ozone. In order to fulfill the oxygenate requirement, ethanol is now blended with gasoline in nearly all the carbon monoxide non-attainment areas and is added to a modest but growing portion of reformulated gasoline (RFG).

Although diesel fuel regulations don't require the use of oxygenates per se, oxygen-containing renewable diesel alternatives such as biodiesel (fatty-acid methyl ester made from vegetable oil or animal fat) and e-diesel (ethanol blended with diesel) can dramatically reduce emissions from diesel engines. Biodiesel used straight or in a typical 20 percent blend with petroleum diesel reduces visible smoke, odor, and toxic emissions as follows:

Emission	B100	B20
Carbon Monoxide	-47%*	-12%*
Hydrocarbons	-67%*	-20%*
Particulates	-48%*	-12%*
Nitrogen oxides	+10%*	+2%*
Air Toxics	-60%-90%	-12%-20%
Mutagenicity	-80%-90%	-20%

\* Figure ES-A Environmental Protection Agency Draft Technical Report EPA420-P-02-001 "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions" ([PDF 765 KB](#)) [Download Adobe Reader](#).

Biofuels are essentially nontoxic and biodegrade readily. Every gallon of biofuels used reduces the hazard of toxic petroleum product spills from oil tankers and pipeline leaks (average of 12 million gallons per year, more than what spilled from the Exxon Valdez, according to the U.S. Department of Transportation). In addition, using biofuels reduces the risk of groundwater contamination from underground gasoline storage tanks (more than 46 million gallons per year from 16,000 small oil spills, according to the General Accounting Office), and runoff of vehicle engine oil and fuel.

The U.S. transportation sector is responsible for one-third of our country's carbon dioxide (CO<sub>2</sub>) emissions, the principal greenhouse gas contributing to global warming. Combustion of biofuels also releases CO<sub>2</sub>, but because biofuels are made from plants that just recently captured that CO<sub>2</sub> from the atmosphere—rather than billions of years ago—that release is largely balanced by CO<sub>2</sub> uptake for the plants' growth. The CO<sub>2</sub> released when biomass is converted into biofuels and burned in truck or automobile engines is recaptured when new biomass is grown to produce more biofuels. Depending upon how much fossil energy is used to grow and process the biomass feedstock, this results in substantially reduced net greenhouse gas

emissions. Modern, high-yield corn production is relatively energy intense, but the net greenhouse gas emission reduction from making ethanol from corn grain is still about 20%. Making biodiesel from soybeans reduces net emissions nearly 80%. Producing ethanol from cellulosic material also involves generating electricity by combusting the non-fermentable lignin. The combination of reducing both gasoline use and fossil electrical production can mean a greater than 100% net greenhouse gas emission reduction.

For more information about biofuels and global climate change, read [Biofuels-A Solution for Climate Change: Our Changing Earth, Our Changing Climate \(PDF 651 KB\)](#) or [Bioethanol-The Climate-Cool Fuel \(PDF 358 KB\)](#) [Download Adobe Reader](#).

### **Environmental Benefits of BioPower**

Biomass electricity is typically generated through boiler/steam turbine plants, but with three key differences: the fuel is renewable, there is less than 0.1% sulfur (an acid rain ingredient) in biomass fuels, and less air pollutants are produced. More specific environmental benefits for biomass power are:

#### **Reduced Sulfur Dioxide Emissions**

Most forms of biomass contain very small amounts of sulfur, therefore a biomass power plant emits very little sulfur dioxide (SO<sub>2</sub>), an acid rain precursor. Coal, however, usually contains up to 5% sulfur. Biomass mixed with coal can significantly reduce the power plant's SO<sub>2</sub> emissions compared to a coal-only operation.

#### **Reduced Nitrogen Oxide Emissions**

Recent biomass tests at several coal-fired power plants in the U.S. have demonstrated that NO<sub>x</sub> emissions can be reduced relative to coal-only operations. By carefully adjusting the combustion process, NO<sub>x</sub> reductions at twice the rate of biomass heat input have been documented.

#### **Reduced Carbon Emissions**

Plants absorb CO<sub>2</sub> during their growth cycle when managed in a sustainable cycle, like raising energy crops or replanting harvested areas. Biomass Power generation can be viewed as a way to recycle carbon. Thus, Biomass Power generation can be considered a carbon-neutral power generation option.

#### **Reducing Other Emissions**

Landfills produce methane (CH<sub>4</sub>) from decomposing biomass materials. Decomposing animal manure, whether it is land-applied or left uncovered in a lagoon also generates methane. Methane, which is the main component of natural gas, is normally discharged directly into the air, but it can be captured and used as a fuel to generate electricity and heat.

#### **Reduced Odors**

Using animal manure and landfill gas for energy production can reduce odors associated with conventional disposal or land applications.

### **Environmental Benefits of Biobased Products**

Many of the products now made from petroleum (e.g., petrochemicals) could be made from renewable biomass. The basic molecules in petrochemicals are hydrocarbons. In plant resources, the basic molecules are carbohydrates, proteins, and plant oils. Both plant and petroleum molecules can be processed to create building blocks for industry to manufacture a wide variety of consumer goods,

including plastics, solvents, paints, adhesives, and drugs.

During the last century hydrocarbon feedstocks have dominated as industrial inputs. However, reserves of petroleum are finite and, while expected to last well into the next century, could be significantly depleted as the world population grows and standards of living improve in developing countries. Renewable plant resources will be one way to supplement hydrocarbon resources and meet increasing worldwide needs for consumer goods. We are currently witnessing the emergence of new biobased commercial and industrial chemicals, pharmaceuticals, and products. Utilization of these products on a larger scale has the potential to make an impact on reducing U.S. reliance on fossil fuels and sequestering carbon, both of which benefit the environment.

### **For Further Reading**

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