Biofuels For the Global Environment

In the search for global climate change solutions, bioethanol has emerged as a promising transportation fuel.

Bioethanol—the Climate-Cool Fuel

The Search for Climate Change Solutions

Growing international concern about the threat of global climate change is increasing momentum behind the search for ways to avoid this potentially devastating phenomenon. Policy makers across the globe are seeking the most effective methods for reducing the buildup of greenhouse gases that may cause global climate change. Carbon dioxide (CO_2) is the most prevalent greenhouse gas, so it is the major focus of domestic and international strategies for controlling greenhouse gases. With the highest CO_2 emissions per capita of any country in the world, the United States places reducing emissions near the top of its policy agenda.

Greenhouse Gases and Global Climate Change

Greenhouse gases are trace gases in the earth's atmosphere—carbon dioxide, ozone, methane, nitrogen oxides, carbon monoxide, and others—that absorb and trap warmth generated by the sun and radiated from the earth's surface. Certain amounts of these gases are necessary to keep our atmosphere at the temperature that sustains life. But according to the global climate change theory, as the amount of greenhouse gases in the atmosphere increases, the heat that is now trapped in our atmosphere will increase, and may change current climate patterns, temperature, and atmospheric processes. Some consequences of this may include melting or shifting polar ice caps and rising sea levels, changing ocean currents and weather patterns, and increased aridity in areas that now support crops.

About one-third of U.S. CO_2 emissions are generated by producing and consuming transportation fuels, which makes these activities an obvious focus for emissions-control efforts. Our dependence on fossil fuels for transportation carries with it the burden of CO_2 emissions with no way to remediate atmospheric buildup. This recognition is driving national research to develop alternatives to fossil fuels for transportation.

The U.S. Department of Energy's (DOE) Office of Fuels Development (OFD) continues to play an important role in national efforts to develop alternatives to fossil fuels. For 20 years, OFD has guided research and development of biomass-based transportation fuels in the United States. Through this research, bioethanol has emerged as a fuel with tremendous potential to reduce CO_2 emissions.

Bioethanol as an Alternative

Bioethanol is alcohol fuel made from cellulosic biomass—renewable resources such as trees, grasses, much of the material in municipal solid waste, and forestry and agricultural residues. Compared to the fossil fuels it will displace, bioethanol contributes little or no net CO_2 to the earth's atmosphere.

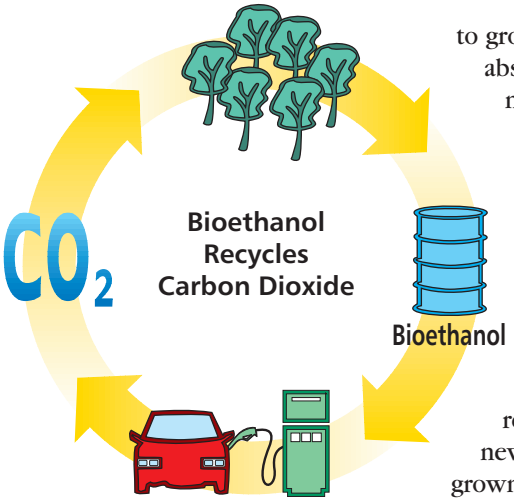
The Carbon Cycle and Fossil Fuels

Carbon dioxide exists naturally in our atmosphere and is part of the Earth's natural carbon cycle. This cycle circulates carbon through the Earth's atmosphere, plants, animals, oceans, soil and rocks, primarily in the form of CO_2. The carbon cycle is a mechanism that maintains a life-sustaining and delicate natural balance between storing, releasing, and recycling carbon.

Since the beginning of the industrial age, our increased use of fossil fuels for energy has released tremendous quantities of CO_2 into the atmosphere, threatening the natural balance of the carbon cycle. CO_2 that was stored in "fossils" for millions of years is now being released quickly with no additional mechanism to recycle the increase. Atmospheric CO_2 concentrations have increased by 25% since preindustrial times, and more than half of this increase has occurred during the past three decades.

The Recycling Effect of Bioethanol

Producing and using bioethanol as a transportation fuel can help reduce CO_2 buildup in two important ways: by displacing the use of fossil fuels, and by recycling the CO_2 that is released when it is combusted as fuel. By using bioethanol instead of fossil fuels, the emissions resulting from fossil fuel use are avoided, and the CO_2 content of fossil fuels is allowed to remain in storage. Further CO_2 reductions occur because the plants and trees that serve as feedstocks for bioethanol require CO_2



to grow, and they absorb what they need from the atmosphere. Thus, much or all of the CO_2 released when biomass is converted into a biofuel and burned in automobile engines is recaptured when new biomass is grown to produce more biofuels.

Carbon Dioxide Reductions

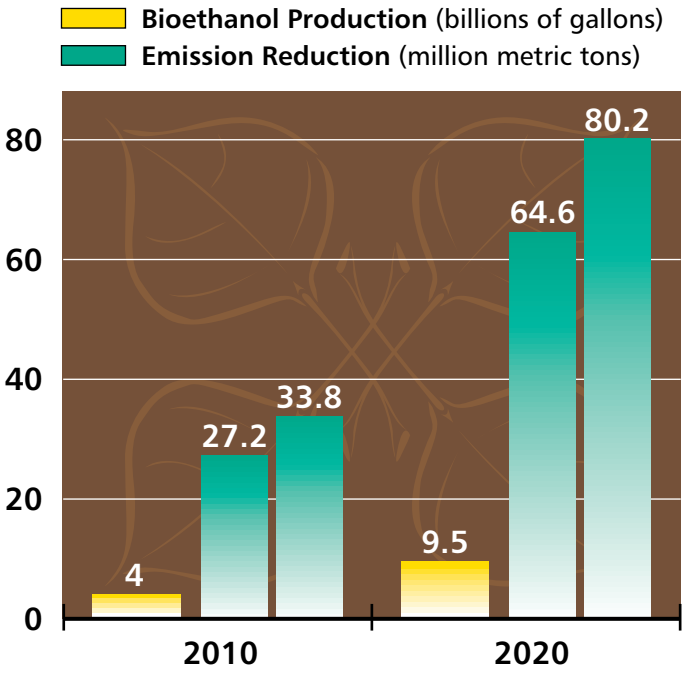
Extensive analysis is required to determine actual CO_2 reductions that can be achieved by replacing fossil fuels with bioethanol for transportation fuel. In order to accurately and objectively predict these reductions, every activity involved in transforming biomass into usable fuel—including planting, growing, harvesting, and transporting biomass feedstocks, as well as converting, distributing, and actually using the final fuel product—needs to be analyzed. Such start-to-finish examination of a fuel is known as fuel cycle analysis.

Researchers at DOE's National Renewable Energy Laboratory (NREL) have used fuel cycle analysis to project CO_2 emissions reductions when bioethanol is used instead of gasoline. The specific types of fuels compared are reformulated gasoline (RFG) and E95. RFG is a traditional blend of gasoline used in most areas of the country now, and E95 is a blend of 95% ethanol and 5% gasoline. Analyses have produced a range of reductions based on various fuel efficiencies of automobiles and various feedstocks used to make bioethanol. Reports are available which break out these values and specify the assumptions used, but the following sums up the results of NREL's analyses.

For every gallon of RFG that is displaced by using bioethanol, 7.3 to 10 kilograms of CO_2 emissions (1.8 to 2.5 kilograms of carbon equivalent) are avoided. Long-term projections are based on these figures and conservative projections for the bioethenol market. According to these, in 2010, based on bioethanol production of 4 billion gallons per year, between 27.2 and 33.8 million metric tons of CO_2 emissions (6.8 to 8.5 million metric tons of carbon equivalent [mmMTCe]) will be avoided each year. By 2020, based on bioethanol production of 9.5 billion gallons per year, between 64.6 and 80.2 million metric tons of CO_2 emissions (16.5 to 20 mmMTCe) will be avoided each year.

Reductions Require Consistent National Investment

With numbers so large, it can be hard to comprehend bioethenol's impact on CO_2 levels. These figures represent the potential for bioethanol to emit 90% less net CO_2 than RFG. This reduction would have a tremendous impact on global CO_2 levels, making bioethanol an important component in U.S. efforts to reduce the threat of global climate change.



Bioethanol Production and CO2 Emission Reduction

Achieving such reductions, though, requires continuing, consistent national investment in research that will improve the competitiveness of bioethanol and propel it into the commercial marketplace.

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