



Biofuels

A Solution for Climate Change



OUR CHANGING

Earth

OUR CHANGING

Climate

“We want to see... the efficient production and use of energy, so that the products we produce and the way we produce them pose no threat to the world’s natural environment[,... economic development... so that more and more of the world’s population can enjoy... the things which the energy industry supplies... [and] a society in which ideas and knowledge move freely...”

John Browne, Group Chief Executive, British Petroleum Company, presentation to the Council of Foreign Relations, New York, November 13, 1997

The weather affects our work and play; climate change can affect our survival

Our lives are linked to weather and climate, and to energy use. Our search for and use of fossil fuels—primarily coal and oil—could warm the atmosphere enough to contribute to ever more destructive floods, serious and sustained droughts, and relentless snowfalls. One way to slow these trends is to increase energy efficiency and develop and use clean, sustainable energy sources. Political and business leaders throughout the world recognize that global climate change is real, and are taking steps to reduce fossil fuel emissions.

The U.S. government advocates environmental sustainability

The United States has less than 5% of the world’s population and consumes about 25% of the world’s petroleum (more than 18 million barrels each day for transportation and other uses). The U.S. transportation sector presents significant opportunities for improvement, as it is responsible for about 27% of U.S. energy consumption and 35% of U.S. greenhouse gas emissions.

The Clinton Administration disclosed a \$6.3-billion package for tax incentives and research to spur

Why not turn up the heat?

The greenhouse effect—the natural phenomenon by which the Earth’s atmosphere traps and holds warmth from the sun—is vital to our survival. Without it, the Earth’s surface temperature would be about 90°F (33°C) cooler and unable to support life as we know it. Trace gases (carbon dioxide [CO₂]), ozone, methane, nitrogen oxides, and others) in the atmosphere absorb and retain radiated heat before it escapes into space. Because CO₂ exists in the atmosphere in far larger quantities than other trace gases, it is responsible for more than half the greenhouse effect.


But too much of this good thing can cause global climate change. If the amounts of CO₂ and other trace greenhouse gases in the atmosphere are increased, more heat will be trapped. This could change climate patterns, temperature, and atmospheric processes.

development of ultra fuel-efficient automobiles and other energy-saving technologies. A cornerstone of the program would give tax credits of \$3,000 to \$4,000 to buyers of the next generation of fuel-efficient cars to boost development of the vehicles expected to be up to three times as fuel efficient as today’s models.

A tax credit of \$3,000 would apply to vehicles that get double the current mileage for their class. For example, a midsize car that now gets 25 mpg would have to achieve 50 mpg to qualify. The credit would later be expanded to \$4,000 for vehicles with three times the gasoline mileage of current models.

Problem solving is big business, and big business is working to solve environmental problems

Many energy-intensive industries are responding to the climate change challenge. Some oil companies are using their best expertise and talent to find better ways to extract, ship, and refine coal, natural gas, and petroleum to minimize their effects on the environment. Additionally, some are finding ways to use their own waste products to produce energy and other useful coproducts;



“Weather is what happens outside your home this morning. Climate is what you can expect to happen outside during your 30-year mortgage.”

Curt Suplee, “Untangling the Science of Climate,” *National Geographic* 193(5):50, 1998.

“We [the Administration] see the need to sit down with energy intensive industries to see if they will reduce energy use or use renewable sources. . . . If we can do for renewable energy what we have done for recycled copying paper we can really make an impact.”

Dan Reicher, Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy, as quoted by Marc Benjamin in *The Bakersfield Californian*, April 29, 1998

others are looking at possibilities associated with alternative energy sources.

Many auto makers have said they plan to have cars in showrooms that run 50 to 70 miles on a gallon of gasoline. They are also exploring fuel cells, hybrid electric vehicle technologies, and the use of alternative fuels such as ethanol. They manufacture flexible-fuel vehicles that can operate on gasoline or any blend of ethanol in gasoline as high as 85%.

These vehicles have been used in government fleets for several years, and now the manufacturers are offering them for no additional cost to consumers.

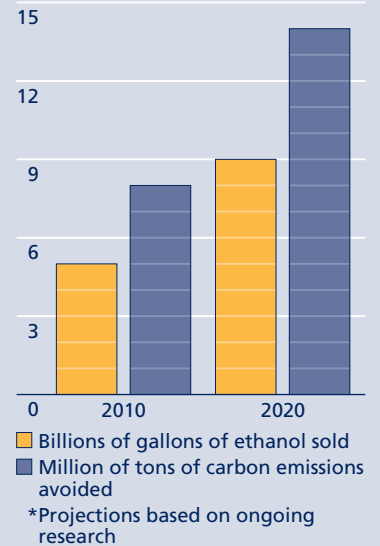
Biofuels can be part of the solution

Biofuels such as bioethanol contribute little or no CO₂ to the buildup of greenhouse gas emissions. Bioethanol is a versatile fuel that can be mixed with gasoline in 10% blends (E10), and potentially in 20% and 22% blends, known as E20 and E22, respectively. It can also be used to manufacture ethyl tertiary butyl ether (ETBE), an octane-enhancing fuel additive, to produce a more efficient and relatively clean-burning fuel that

What is biomass?

The term *biomass* encompasses a wide spectrum of plant materials that range from agricultural and forestry wastes to municipal wastes to crops grown specifically to make *biofuels*, such as bioethanol and biodiesel. The technologies used to convert these biomass feedstocks vary, and the alternative fuels produce similarly low amounts of greenhouse gas when combusted. But by using alternative fuels, we can offset the use of petroleum products. So if we use, for example, ethanol produced from plant material (which is made from atmospheric carbon) we are not releasing carbon that has been trapped as oil for millions of years into the air.

Projected Fuel Ethanol Sales and Associated Carbon Savings*



requires no engine modifications. Higher-level blends (such as 85%, known as E85) can be used in flexible-fuel vehicles.

Biofuels reduce greenhouse gas emissions

Converting biomass feedstocks to biofuels is an environmentally friendly process. So is using biofuels for transportation. When we use bioethanol instead of gasoline, we help reduce atmospheric CO₂ in three ways: (1) we avoid the emissions associated with gasoline; (2) we allow the CO₂ content of the fossil fuels to remain in storage; and (3) we provide a mechanism for CO₂ absorption by growing new biomass for fuels. Because of their compatibility with the natural carbon cycle, biofuels offer the most beneficial alternative for reducing greenhouse gases from the transportation sector.

Our nation’s biomass resource base is extensive (about 200 million dry tons of various waste feedstocks are available annually). Using a fraction of this resource could probably supply the equivalent of 350,000 barrels of oil in 2010, or 3.6% of the projected light-duty vehicle energy demand. Increasing biomass use would accelerate the displacement of fossil fuels and the reduction of transportation greenhouse gas emissions.



Bus that runs on ethanol

Greater Peoria Mass Transit District/PIX03320

“Despite the many remaining uncertainties about the nature and the risks of the process [climate change], I believe that there is now sufficient evidence to support prudent precautionary action.”

Cor Herkströter, Senior Managing Director, Shell Oil

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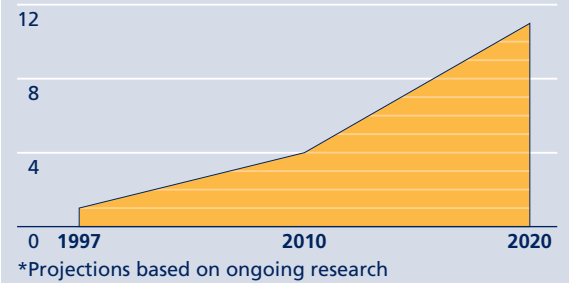
DOE offers alternatives

Since the late 1970s, the U.S. Department of Energy (DOE) has invested in research and technology related to global climate change. DOE’s Office of Fuels Development (OFD) manages the National Biofuels Program and is the lead technical advisor on the development of biofuels technologies in the United States. Together with industry and other stakeholders, the program seeks to establish a major biofuels industry that can provide a significant fraction of the nation’s transportation fuels. Its goals are to develop and commercialize technologies for producing sustainable, domestic, environmentally beneficial, and economically viable fuels from dedicated biomass feedstocks.

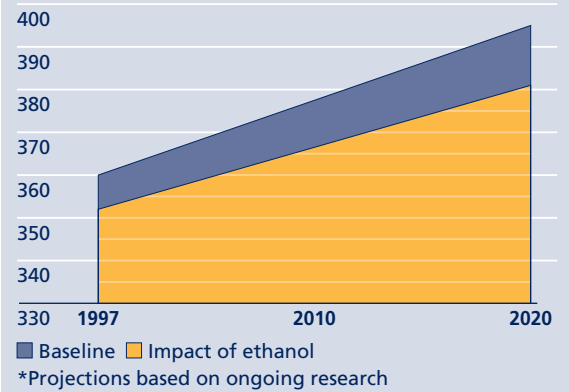
National laboratories work to support biofuels

Several national laboratories—primarily Oak Ridge National Laboratory (ORNL) and the National Renewable Energy Laboratory (NREL)—are working to expand the potential of biofuels technologies in mitigating CO₂. In addition to employing world-class researchers to conduct work in house, these laboratories work with numerous subcontractors from universities, the private sector, and other research institutes to improve and commercialize biofuels technologies. Through ORNL, OFD is

Projected Use of Bioethanol (in billions of gallons)*



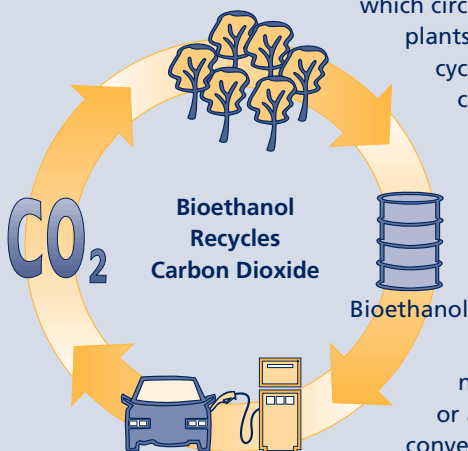
Projected Carbon Emissions from Light-Duty Vehicles: Impact of Bioethanol Development (in millions of metric tons per year)*



The carbon cycle and biofuels

CO₂ is part of the Earth’s natural carbon cycle, which circulates carbon through the atmosphere, plants, animals, oceans, soil, and rocks. This cycle maintains a life-sustaining and delicate natural balance between storing, releasing, and recycling carbon.

By using biofuels such as bioethanol and biodiesel for transportation, we can help restore the natural balance of CO₂ in the atmosphere. Besides displacing fossil fuels, the feedstocks used to make biofuels require CO₂ to grow, and they absorb what they need from the atmosphere. Thus, much or all of the CO₂ released when biomass is converted into a biofuel and burned in automobile engines is recaptured when new biomass is grown to produce more biofuels.



setting up several feedstock R&D centers to support a greater variety of energy crops for the widespread use of biofuels. These crops include switchgrass, willow, and hybrid poplars.

At NREL, in-house engineers work with subcontractors to increase vehicle fuel efficiency, test alternative fuels, and find alternatives to the internal combustion engine. These strategies will help reduce CO₂ emissions in the transportation sector. Biofuels research focuses on reducing the cost of biomass-to-biofuels conversion technology and transferring this technology to the commercial sector. OFD has established an Alternative Fuels User Facility at NREL, which helps industry develop cost-competitive renewable transportation fuels from biomass. The heart of this facility is the Process Development Unit, which engineers and scientists use to gather data about promising biofuels technologies. It houses fermenters, distillation columns, and centrifuges that take biomass through the steps to become a fuel. NREL also leads projects to improve the efficiency of ethanol-producing microorganisms and to lower the cost of cellulose enzymes.

(Continued page 5)



From left to right:
 Farmer and scientist examine switchgrass, a dedicated energy crop for ethanol production
 PDU biomass-to-ethanol 9000-liter fermentors
 BCI biomass-to-ethanol plant in Jennings, Louisiana, scheduled for operation in the near future

Continued from inside

Government and industry cooperate to support biofuels

OFD is working to improve government/industry cooperation with efforts to facilitate industry access to the Biofuels Program’s technologies, resources, and facilities. For example, it is collaborating with BC International to construct a biomass-to-ethanol plant in Jennings, Louisiana. The primary feedstock will be bagasse, the waste product of sugar production from sugarcane. Also, OFD is working with Arkenol, which plans to produce ethanol by converting rice straw in California’s Sacramento Valley, and with Masada Resources Group, which is planning a municipal solid waste-to-ethanol plant in New York State.

We can make a difference

Some naysayers argue that the cost of reducing greenhouse gas emissions is too high and that we should not move too fast. But “environmental visionaries” have historically proven this kind of negative thinking to be false. Here are a few examples:

- From 1975 to 1994 the average gas mileage of U.S. automobiles improved by 50%.
- During the same period, the U.S. chemical industry reduced its energy use per unit of output by 40%.
- Solar, wind, and biomass energy technologies, which were in their infancy 20 years ago, are now approaching commercialization in many areas.

Reducing our CO₂ emissions to eliminate the threat of global warming requires tremendous commitment to changing the way we use energy and the energy sources we use. Part of this commitment must be to continue national investment in research that will improve the competitiveness of biofuels and propel them into the commercial marketplace.

We Americans have proven that we can respond to crises. Now we need to respond to a crisis that may seem a little less real than an oil embargo or a flash flood or a deadly tornado. But if these things are all intertwined—and the evidence that they are is steadily mounting—we will gladly do what is needed to protect ourselves, our future generations, and our planet.

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 Warren Gretz, NREL/PIX00305; Warren Gretz, NREL/PIX00945; Air Bear Aerial Photography, Lake Charles, LA

“I do not underestimate the difficulty of the challenge that global climate change presents to us. It will take a significant effort and the best talent and technology we have to solve the problem.”

Former DOE Secretary Federico Peña, Address to Carnegie Mellon University, September 15, 1997

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