Environmental and Energy Study Institute

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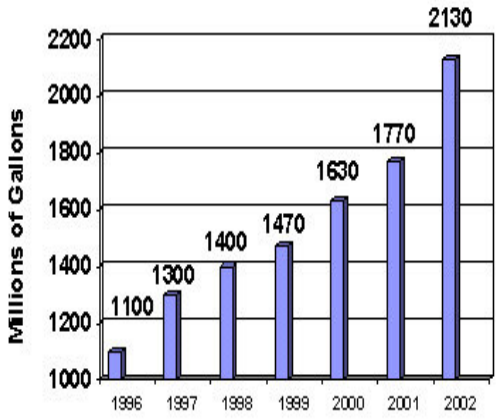
Biofuels: Background

10/03

Background

Biofuels are renewable fuels derived from agricultural crops such as corn, sugarcane, and soybeans, or from biomass resources such as agricultural, wood, animal, and municipal wastes and residues. Ethanol and biodiesel—the predominant biofuels—can substitute for gasoline and diesel or be blended with them in order to reduce greenhouse gas emissions, help communities improve air and water quality by reducing toxins and criteria air pollutants and reusing waste streams, create revenue for the agriculture sector, support rural economies, and increase energy security.

The use of **ethanol** as a transport fuel traces its roots to the 1880's when Henry Ford built his first ethanol-fueled automobile, and continued when Ford built the Model-T in 1908 with a carburetor adjustment that allowed farmers to use ethanol as fuel. Rising taxes on ethanol, combined with a decreasing price of petroleum and an aggressive campaign run by large oil producers kept ethanol out of the mainstream.[1] The use of ethanol as a viable transport fuel was revisited after the oil shortages of the 1970's sparked interest in domestically produced fuels. United States ethanol production has grown to 2.13 billion gallons in 2002[2]. Today, ethanol is primarily blended with conventional gasoline in order to extend the volume of gasoline and as a fuel oxygenate that helps improve air quality.



Rudolf Diesel designed and built the compression ignition engine or "diesel" engine in the 1890's. The basic design has changed little over time. By compressing fuel oil in a chamber, the pressure and temperature of the oil rise to such a degree that it combusts spontaneously, driving the engine pistons and moving the vehicle forward. Diesel engines have been favored for use in buses because they provide the power and fuel efficiency to carry heavy loads of passengers over long distances. Though diesel engines have provided enormous benefits to the nation's transportation needs for a long time, their use has substantial implications for environmental and public health.

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[1] University of Illinois: http://starfire.ne.uiuc.edu/~ne201/1997/richard/history.html
[2] Renewable Fuels Association: www.ethanolrfa.org

When Rudolph Diesel first demonstrated his compression ignition engine in 1898, he used peanut oil as fuel. Producers continued the use of vegetable oils in diesel engines, but eventually made a transition to conventional petroleum diesel because of its relatively lower price, availability, and efficiency.[3] Over the last few years, interest in biodiesel, which offers many environmental advantages over conventional diesel, has been growing steadily. Today, roughly 200 major fleets (public and private) in the United States use biodiesel as a transportation fuel. Examples of users include many metropolitan transit systems, school districts, the US military, and many more. Current dedicated production capacity is estimated to be between 60 and 80 million gallons per year.[4]

⇒ **Starched-based Ethanol** is produced by fermenting and distilling starch crops that have been converted into simple sugars. In the United States, ethanol is most often derived from corn that is dedicated specifically for ethanol production or from the biowaste of corn grown for commercial use. Co-products including high protein animal feeds are developed in this process. Ethanol is typically used in blends with conventional gasoline at blends of 10% (E10), 85% (E85), and 95% (E95).

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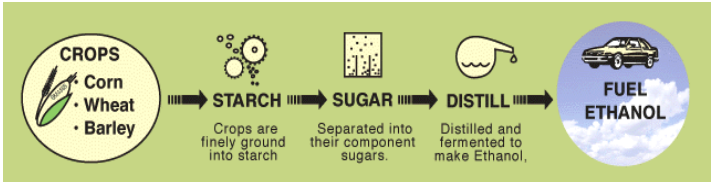

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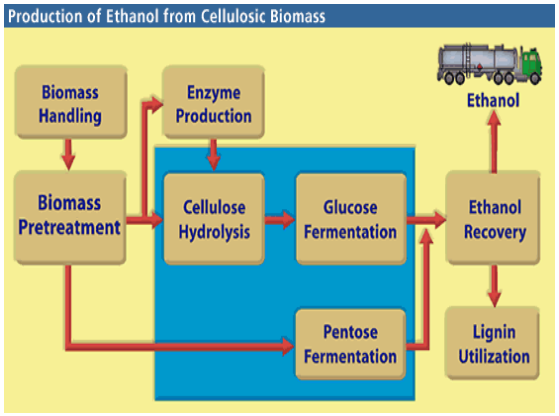

⇒ **Cellulosic ethanol** is the same as starch-based ethanol except that it is derived from renewable, essentially inexhaustible resources because it utilizes the cellulose that is found in all plant matter. Cellulosic ethanol can be derived from fast growing energy crops like willow trees and switchgrass or from waste products like sugar cane bagasse, rice hulls, orchard prumings, wheat straw, and forest thinnings, municipal wastes like as waste paper and yard wastes, and industrial wastes such as pulp/paper and sludge. As with starch-based ethanol, cellulosic ethanol can be blended with gasoline or used as a pure fuel.

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⇒ **Biodiesel** is a renewable alternative to conventional diesel. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to reduce emissions and improve

Biodiesel: The Recipe
- 1 molecule soybean oil
- 3 molecules methanol
- a dash of alkaline catalyst

Yields 3 molecules biodiesel and 1 glycerine

[3] U.S. Department of Energy: http://www.ott.doe.gov/biofuels/history_of_biofuels.html
[4] National Biodiesel Board: www.nbb.org
[5] http://www.ethanol-crfa.ca/
[6] National Renewable Energy Laboratory Diagram via Renewable Fuels Association: www.ethanolrfa.org
[7] EESI Congressional Briefing: John Sheehan, National Renewable Energy Laboratory, 7/31/02.

lubricity. The main feedstocks for biodiesel are agricultural commodities like soybeans and rapeseed (virgin oils), or refined cooking oils and unwanted animal fats (non-virgin oils). Making biodiesel is a relatively simple process of bonding alcohol (normally methanol) to the oils or fats. Biodiesel can be used as a full replacement of diesel fuel (B100), but it is most commonly found mixed at a ratio of 20% biodiesel to 80% normal diesel (B20). At very low blends of 1-2%, it greatly improves the lubricity of low-sulfur diesel.