

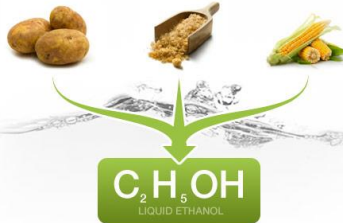
## What is Bioethanol?

A renewable energy source made by fermenting sugar and starch components of plant by-products using yeast.

It is blended with petrol to make a sustainable fuel used in transportation.

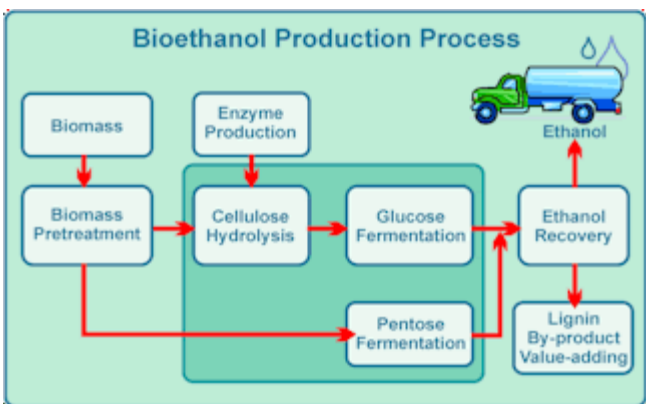
## Possible Source Crops:

corn (maize), sugar cane, sugar, beets, palm oil, sorghum, soy beans, wheat



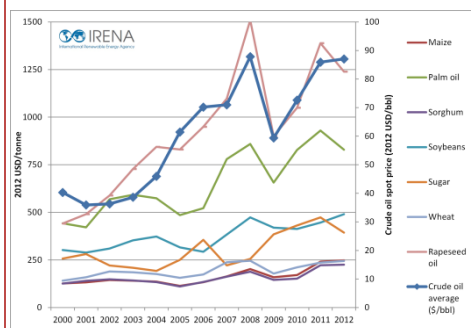
## Process/ Production

Conventional Production consists of enzymatic conversion of starchy biomass into sugars, and/or fermentation of 6-carbon sugars with final distillation of ethanol to fuel grade.



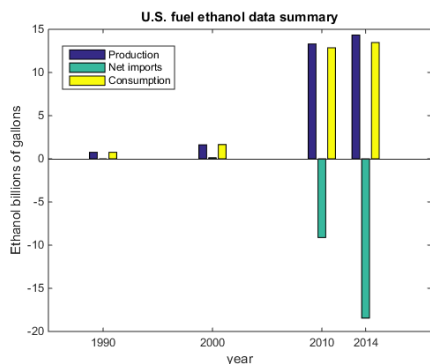
## General Process Steps

1. Milling
2. Dilution
3. Hydrolysis for starch
4. Fermentation with yeast and enzymes
5. CO<sub>2</sub> storage and ethanol recapture
6. Evaporation
7. Distillation
8. Waste Water treatment
9. Fuel Storage



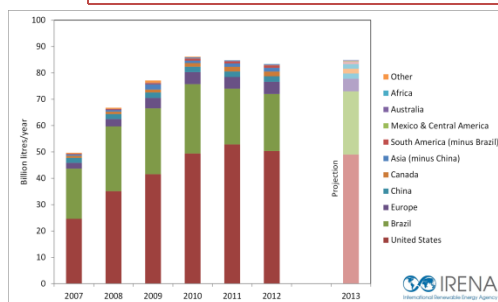
## Emissions

Ethanol well-to-wheels CO<sub>2</sub> emissions can be as low as 0.2-0.3 kgCO<sub>2</sub>/liter ethanol compared with 2.8 kg CO<sub>2</sub>/liter for conventional gasoline (90% reduction)



## Uses

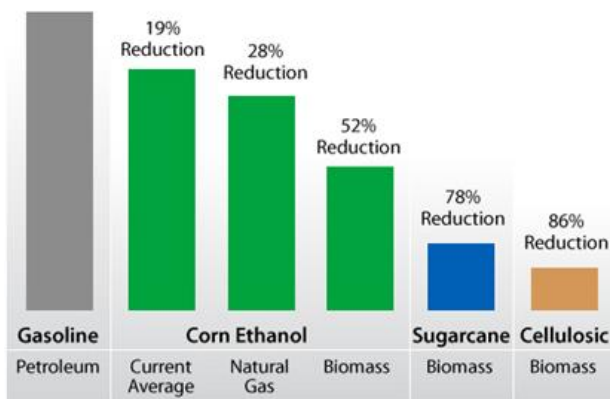
Ethanol is used in low 5%-10% blends with gasoline (E5, E10) but also as E-85 in flex-fuel vehicles.



## Advantages

- Renewable Energy Source
- Similar to fossil fuels: can be distributed with only minor modifications to existing infrastructure.
- Combustible in SIE's with minor modifications for high octane mixtures
- Bioethanol in older engines can reduce carbon monoxide emissions
- Ethanol from maize may displace petroleum use by up to 95%
- Production crops offset CO<sub>2</sub> admissions by taking up the gas during growth that is produced when the fuel is burned.

## Greenhouse Gas Emissions of Transportation Fuels By Type of Energy Used Processing



### What is Bioethanol?

"What Is Bioethanol." *What Is Bioethanol*. University of Strathclyde Glasgow, 1 Jan. 2002. Web. 20 Apr. 2015.

<[http://www.esru.strath.ac.uk/EandE/Web\\_sites/02-03/biofuels/what\\_bioethanol.htm](http://www.esru.strath.ac.uk/EandE/Web_sites/02-03/biofuels/what_bioethanol.htm)>. (7)

### Possible Source Crops

Simblotti, Giorgio. "Biofuel Production." *www.iea.org*. IEA.org/publications, 1 Jan. 2007. Web. 20 Apr. 2015.

<<https://www.iea.org/publications/freepublications/publication/essentials2.pdf>>. (6)

### Process/Production

U.S fuel ethanol data summary figure created in MatLAB using data from:

"How Much Ethanol Is Produced, Imported, and Consumed in the United States?" *U.S Energy Information Administration*. U.S Department of Energy, 7 Apr. 2015. Web. 20 Apr. 2015.

<<http://www.eia.gov/tools/faqs/faq.cfm?id=90&t=4>>. (5)

### General Process Steps

"Bioethanol Production and Use." *Www.erec.org*. Supported by the European Commission - FP6, 2 July 2007. Web. 21 Apr. 2015.

<[http://www.erec.org/fileadmin/erec\\_docs/Project\\_Documents/RESTMAC/Brochure5\\_Bioethanol\\_low\\_res.pdf](http://www.erec.org/fileadmin/erec_docs/Project_Documents/RESTMAC/Brochure5_Bioethanol_low_res.pdf)>. (3)

- Process diagram taken from: Zafar, Salman. *Bioethanol Production Process*. Digital image. *Www.Bioenergyconsult.com*. 2 June 2014. Web. (8)

Bar Graph depicts international bioethanol production taken from: "Bioethanol." *Bioethanol*. IRENA, 1 Jan. 2014. Web. 21 Apr. 2015. <<http://costing.irena.org/charts/bioethanol.aspx>>. (2)

### Emissions

- Simblotti, Giorgio. "Biofuel Production." *www.iea.org*. IEA.org/publications, 1 Jan. 2007. Web. 20 Apr. 2015.

<<https://www.iea.org/publications/freepublications/publication/essentials2.pdf>>. (6)

### Advantages

- "Advantages of Biofuels." *Biofuels - The Fuel of The Future*. Biofuel.org.uk, 1 Jan. 2010. Web. 20 Apr. 2015. <<http://biofuel.org.uk/advantages-of-biofuels.html>>. (1)

- Figure taken from "Ethanol Vehicle Emissions." *Alternative Fuels Data Center*. U.S Department of Energy, 16 Dec. 2014. Web. 21 Apr. 2015. <[http://www.afdc.energy.gov/vehicles/flexible\\_fuel\\_emissions.html](http://www.afdc.energy.gov/vehicles/flexible_fuel_emissions.html)>. (4)