Technology Fact Sheet

Bio-ethanol from sugar and starch based crops[i] /http://climatetechwiki.org/technology/ethanol/

General description

Liquid bio-fuels for transport have to a certain extent been in use for a very long time. In recent years however, they are enjoying renewed interest in both developed and developing countries as a result of the need to curb rising emissions from the transport sector, reduce dependence on increasingly expensive fossil oil imports and increase farm incomes. An important advantage of bio-fuels is that they can easily be integrated into the existing transport infrastructure, thus avoiding the significant investment costs associated with other renewable options for the transport sector. (Source: climatetechwiki.org).

Depending on the feedstock and conversion route, we can distinguish 1st and 2nd generation bio-ethanol. 1st generation bio-ethanol, also known as carbohydrate ethanol, can be produced from sugar or starch based crops. When replacing gasoline in transport, it can lead to substantial reduction in $CO2$ emission. The main countries producing 1st generation bio-ethanol are the US and Brazil.

Bio-ethanol is mixed with gasoline in proportions varying from 5 to 85%. The lower blends are compatible with conventional gasoline engines. Blends above 10% ethanol content are only suitable for use in modified engines. The least complicated way to produce ethanol is to use biomass that contains so-called six-carbon sugars that can be fermented directly to ethanol. If producing ethanol from starch based crops another processing step is required.

Production of ethanol from sugars starts by grinding up the feedstock to extract the sugar, which is then added to yeast for the fermentation process. In a closed anaerobic chamber, the yeast secretes enzymes that digest the sugar, yielding several products, including lactic acid, hydrogen, carbon dioxide and ethanol (WWI, 2007). The most common feedstock include sugarcane, sugar beets, sweet sorghum and other sugar containing plants.

Producing ethanol from starch-based crops requires another step in the process called saccharification, which entails breaking the large starch molecules into simpler sugars. There are two main methods for refining starches into sugars, primarily differing in the pre-treatment of feedstock. In the “wet milling” process the grains are soaked in water, usually with a sulphurous acid, to separate the starch-rich endosperm from the high-protein germ and high-fiber husks. In addition to ethanol, the process results in a number of high-value co-products, such as grain oil, gluten feed, germ meal, starches, dextrin and sweeteners. (WWI, 2006) The simpler “dry milling process” entails grinding the unprocessed heterogeneous seed into granules. Compared to wet mills, dry mills are less capital intensive and produce fewer co-products.

Implementation

Production of ethanol through biological fermentation of sugars extracted from sugar and starch crops is a technically mature and commercially available process. Bio-fuels are generally not yet competitive with fossil fuels, therefore many governments around the world offer special incentives for non-fossil based fuels. In Brazil, the successful implementation of ethanol program resulted in bio-ethanol contributing some 50% of fuel consumption in the gasoline market from sugar-cane ethanol (Pelkmans et al., 2009). Similar program is underway and a number of other countries worldwide. Over 50% of global bio-ethanol production is concentrated in the U.S.A.

Implementation of bio-ethanol technologies is part of the commitment of the Republic of Moldova to mitigate emissions in transport sector, one of the measures being to accomplish a 20% share of bio-fuel in conventional fuels mix.

Implementation barriers

- Production of bio-ethanol depends mainly on sufficient provision of economical biomass used as feedstock. The production of 1st generation bio-ethanol is limited by the availability of suitable land and water resources and crop yields.
- The production of bio-ethanol involves moving and storing large amount of feedstock. Therefore a bio-ethanol production plant should be located close to the source of feedstock or in (or very close to) a logistical hub, such as a harbor, if the biomass needs to be imported.
- The specific properties of biomass: low energy density, often requiring drying and densification; seasonal availability and problematic storage requiring further pre-treatment.

- Factors limiting the supply: availability and appropriateness of mechanized equipment; and inadequate infrastructure to access conversion facilities and markets.

GHG emissions reduction (megatons CO_2 equivalent) – 175 thousand tons CO_2 in 2030.

Impact on development priorities:

a) Social

- Job creation in the agriculture and forestry sectors, which is particularly relevant for developing countries with significant unused land resources and a large pool of unskilled workers;
- Job creation in the industrial sector (e.g. a 125 million liter ethanol plant would employ cca 270 people (Gnansounou et al., 2005);
- Increasing farm incomes: provided the additional income is distributed equitably, increasing the income in the primary sector, which employs the majority of the workforce, can support rural development and significantly improve living standards;
- Increasing inclusion in the economic system: well-organized farmers unions can gain access to energy markets.

b) Economic

- Increasing energy security by producing and using bio-fuels locally, thus reducing the dependence on imported fossil oil;
- Saving foreign currency by displacing fossil oil imports;
- Earning foreign currency by producing bio-fuels for export.
- Diversifying the industrial sector.

c) Environmental

- GHG emissions reduction: most bio-fuels offer a net GHG savings compared to fossil fuels, unless forest land area is cleared to make way for bio-fuel feedstock plantations.

d) other

Investments

Depending on the feedstock used and scale of the plant, production costs can differ significantly. Because of lower average costs, larger plants (of capacity greater than 200 million liters per year) have dominated among new installation. Production costs vary from US$0.31/l to US$0.87/l (IEA Bioenergy, 2009). For a plant with a production capacity of 250 million liters / year investment is $ 53.6 million.

Operation and maintenance costs are estimated at 0,02 $/liter or, taking into account the plant capacity of 250 million liters/year, of $5.0 million /year.

GHG reduction cost – 334 $/ton CO_2.

Technology lifetime – 50 years.

Other

Source: http://climatetechwiki.org/technology/ethanol

[i] This fact sheet has been extracted from TNA Report - Technology Needs Assessment for climate change mitigation - Republic of Moldova. You can access the complete report from the TNA project website **http://tech-action.org/**