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# The Fall of Oil Prices and the Effects on Biofuels

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**This analysis is focused on the effect of the abrupt decline of oil prices on biofuels, particularly second-generation ethanol. The efforts to decrease the production costs of biofuels, especially cellulosic ethanol (CE), will be greatly threatened if current oil prices remain low, especially since production is not slowing. Only huge state subsidies could alleviate this threat, but the challenge is to persuade citizens that this sacrifice is worthwhile.**

## The Viability of CE

Ethanol is a strategically important transportation fuel that has been adopted worldwide (Table 1). Brazil's ethanol relies almost exclusively on sugarcane whereas the USA has a long tradition of ethanol production from corn kernel. By contrast, in Europe the most commonly used feedstocks in ethanol production are wheat, maize, and sugar beet, which represent approximately 90% of raw materials used [1] beyond the use of barley, rye, and triticale. The role of wastes and residues in current production is irrelevant, although the approval in April 2015 of the 'iLUC Directive' by the European Parliament put great emphasis on the production of advanced biofuels from waste feedstocks while establishing a cap of 7% on the contribution of biofuels produced from crops, to meet the target of 10% for renewables in transport fuels by 2020.

Table 1. The World's Main Ethanol Producers (in Billion Liters), 2013 Data

| | Production Capacity | Production | Consumption | Imports | Exports |
|---|---|---|---|---|---|
| USA | 56 | 51 | 50 | 1.6 | 2.9 |
| Brazil | 40.7 | 23.5 | 20.9 | 0.3 | 3.6 |
| EU | 8.8 | 6.7 | 7.9 | 1.2 | 0.1 |

Data from [1].

If all of the wastes and residues that are sustainably available in the EU were converted into advanced biofuels, this could supply 16% of road transport fuel in 2030, thus reducing the carbon intensity of transport fuels without significant impacts on food commodity markets or land resources (http://europeanclimate.org/wp-content/uploads/2014/02/WASTED-final.pdf). Estimates suggest that by 2030 approximately 220 million tonnes (Mt) of residues from agriculture (139 Mt), forestry (40 Mt), and municipalities (44 Mt) will be available for ethanol production, creating up to 300 000 jobs in Europe (http://europeanclimate.org/wp-content/uploads/2014/02/WASTED-final.pdf) and thus optimizing resource efficiency and boosting the rural economy beyond the greenhouse gas (GHG) savings and the reduction of EU oil imports. Additionally, dedicated biofuel crops grown on marginal land fallow, such as herbaceous switchgrass (*Panicum virgatum* L.) and *Miscanthus* spp., can be converted into CE. Both practices (use of residues and/or biofuel crops) are important to implement the Renewable Energy Directive and the EU climate and energy targets for 2020, known as the 20%–20%–20% targets.

In this context, both the USA and Europe are now entering a new phase to bring CE into the promising future of renewable energy. The US Renewable Fuel Standard (RFS) program requires renewable fuel to be blended into transportation fuel in increasing amounts each year, reaching 36 billion gallons (b.g.) by 2022. In 2014, US fuel ethanol production reached a maximum of 14.3 b.g. of ethanol mainly derived from corn (http://www.eia.gov/todayinenergy/detail.cfm?id=21212), a value close the plateau of 15 b.g. defined by the RFS. Thus, the challenge for the ethanol industry is to meet the 16 b.g target for CE in 2022, maintaining the quota of 15 b.g. of corn ethanol. The European Commission agrees that ethanol is the most cost-effective and readily available means of substantially decarbonizing Europe's transport sector [1] responsible for over a quarter of the EU total GHG emissions.

CE production is expensive due to both capital and operational costs, with biomass pretreatment the most expensive processing operation due to so-called 'biomass recalcitrance' [2]; that is, the natural resistance of plant cell walls to microbial and enzymatic deconstruction.

Estimates put the production cost of CE at US$3.4 per gallon (in 2012, NREL and its industry partners claimed to produce CE at a minimum selling price of $2.15 per gallon through thermochemical and biochemical process modeling; http://www.nrel.gov/docs/fy14osti/60663.pdf), compared with US corn and Brazilian sugarcane ethanol production costs, which are in the range US$1.14–1.51 per gallon [3]. Thus, CE is far from competitive for blending purposes and is threatened by current oil prices; predictions for 2015 average prices were: US$2.23 per gallon for wholesale ethanol versus US$2.39 per gallon for motor gasoline [4].

Although positive blending margins were more common (when ethanol prices are below the price of wholesale gasoline) and 1.0 was accepted as the breakeven ethanol/gasoline price ratio [5], occasionally negative blending margins may occur. If that happens, the expected response would be higher Renewable Identification Numbers (RINs), a tradable commodity created by US Environmental Protection Agency (EPA) to enforce biofuel mandates.

The benefits of CE (reduction of oil imports and carbon footprint, among others) lead some authors to claim for strong public investment in R&D, subsidies, and other support policy decisions [2,3]. Ethanol producers are also encouraged to switch from corn kernel to dedicated cultures or agroforestry wastes. Nevertheless, it must be emphasized that considerable variations in GHG emissions and the production costs of CE were observed, depending on the feedstock and location, mostly due to soil proprieties and differences in yield [6]. Compared with gasoline, the GHG savings from *Miscanthus*-based ethanol ranged between 130% and 156% and from switchgrass between 97% and 135%, whereas those from corn stover were 57–95% [6].

Despite a strong belief that the ethanol market is already saturated, the ability to absorb more ethanol in the future depends on the raising of the blend wall. E10 has become the maximum feasible blend adopted for all car models and years in the USA and Europe, although in 2012 the US EPA approved E15 for use in vehicles from the 2001 model year to date [7]. If CE production is unable to advance rapidly enough to meet the RFS mandate (36 b.g. by 2022), other unexpected biofuels sources may be forced to step in and fill the void [7].

## The Viability of CE in the Face of Low Oil Prices

The abrupt decline of oil prices in the world market (from approximately US$100 per barrel in August 2014 to near US$50 in January 2015, a price that still remains in November this year) will have consequences at various levels, especially in the implementation and success of ethanol production from renewable sources. The US Energy Information Administration forecasts that Brent crude oil prices will average US$54 per barrel in 2015 and US $59 per barrel in 2016 [8], suggesting that the price of crude oil will remain relatively low. Regarding ethanol, high oil prices per barrel favor its competitiveness, as claimed by Tyner [9] ('If oil stays above $100 per barrel, corn ethanol under normal conditions will be viable simply because of the energy demand for it as a substitute for gasoline'), who also claimed that government subsidies and mandates could be abolished. This threshold was also assumed by other scholars [10,11] or may fall within the

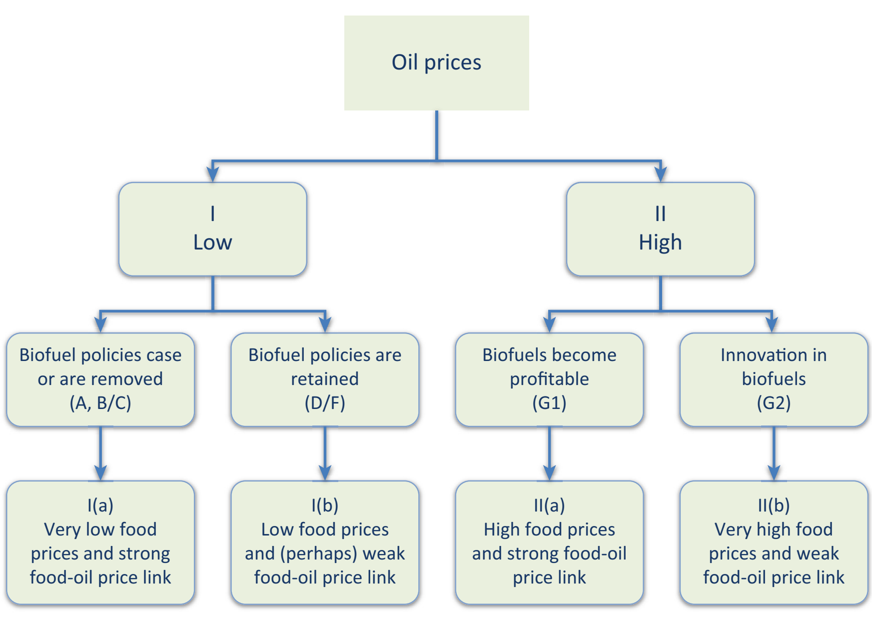


Figure 1. Food Prices Under Low and High Oil Prices. Reproduced from [10] with permission of Elsevier.