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Potential feedstock for renewable aviation fuel in Brazil

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ABSTRACT

The aviation industry worldwide is committed to reduce CO_2 emissions. The present goal is towards Carbon Neutral Growth (CNG) by 2020 and 50% reduction in net CO_2 emissions over 2005 levels by 2050. There are not easy alternatives to liquid fuels for airplanes; therefore, biofuels are necessarily part of the solution. However, the specifications for jet biofuel rule out ethanol and biodiesel, the most common biofuels in the market. There are several routes for the production of aviation biofuel allowing the use of a wide range of biomasses. The conversion and refining technology pathways will be determinant for the choice of feedstock. At present, most jet biofuel tested in airplanes are derived from oils, but not taking into account conversion technologies, the best options to start an aviation biofuel industry in Brazil are sugarcane, eucalyptus, and soybean, of the sugar, cellulose, and oil crop groups. The main reasons are the established production chains, high yields, competitive prices, and possibility of greenhouse gases abatement. Other crops may be feasible options depending on specific regional conditions, further agronomic improvements, and cost reduction. Taking as reference the energy content of ethanol, around 30 Mha of land would be necessary to supply sugarcane to meet 50% of the present global consumption of jet fuel. This is less than the 64 Mha of land suitable for sugarcane in Brazil, mostly replacing pasture and

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without using environmentally sensitive areas. This area may be less as biomass yields increase and the energy of other plant parts is more efficiently used. The opportunity costs of final products derived from the biomass feedstock may place the price of the energy of jet biofuel above that of the fossil jet fuel. Appropriate public policies and tax treatment may be necessary to stimulate an emerging aviation biofuel industry.

1. Biofuels and the aviation industry

The aviation industry consumes around 1.5 billion barrels of jet fuel annually, by 1397 airlines companies, operating a fleet of 25,000 aircraft, serving 3864 airports through a network of several million kilometers (ATAG, 2014).

Aviation depends on liquid fuels because there are no alternative sources of energy in site for aircrafts flying long distances. Jet fuels are mostly derived from fossil oil. In 2012, 253 Mm^3 of jet fuel were produced, or 6.5% of all the oil refined worldwide (IEA, 2014). Brazil accounts for only 2.8% of the world consumption, approximately 7 Mm^3 in 2011 (ANP, 2012). The demand for jet fuel is foreseen to continue to expand by 3–3.5% globally (ICAO, 2013), but more strongly (5%) in emergent markets such as Brazil (EPE, 2011).

The environmental impact associated with the utilization of fossil fuel is of concern for the aviation industry. Nowadays, the aviation industry contributes 2% of global anthropogenic CO_2 emissions and fuels represent on average 33% of operating costs (IATA, 2010). Aiming to reduce these impacts, this industry has set goals to reduce fuel consumption not only to lower costs but also to reduce greenhouse gases (GHG) emissions and take part of the effort to mitigate global warming (OAG, 2012). The aviation industry plans to have carbon neutral growth by 2020 and a 50% reduction in net CO_2 emission in 2050, taking as reference the 2005 (IATA, 2013). The actions to reach these targets include improving fuel efficiency by 2% per year and the use of renewable fuels (ICAO, 2013).

Jet fuels must follow stringent regulations according to international standards (ASTM, 2013) for safety reasons and because aircrafts fly over and are refueled in different countries. Any alternative jet fuel, including biofuels, must comply with the same performance standards of the conventional jet fuels. In this way, jet biofuels must have properties that characterize them as "drop in" i.e. have to be completely interchangeable or blended with conventional jet fuels, so that no adaptations of current aircraft engines are necessary (ASTM, 2009). This poses limitations and adds complexity to jet biofuels production. For instance, ethanol or biodiesel – the most common biofuels used nowadays for transportation – cannot be considered options without further processing, although ethanol is used in small scale in small airplanes (SNA, 2014).

Large quantities of biofuel and, therefore, biomass, will have to be generated in order to meet the 2020 and 2050 aviation industry goals. As Brazil is a country with great potential for increasing biomass production because of land availability and favorable climate conditions the objective of this paper is to discuss the options and limitations of feedstock to support a new aviation biofuel industry.

2. Feedstock for jet biofuel

There is a wide range of organic materials from different sources that can be used to produce biofuels through various biomass converting technologies, which include gasification of carbonaceous materials, fast pyrolysis of biomass into liquid products, liquefaction, enzymatic hydrolysis, fermentation of sugar and starches to alcohols, and production of lipids from carbohydrates (Schuchardt et al., 2014; Hari et al., 2015). Further processing of the products of the above conversion processes are required in order to meet the specifications of drop in jet biofuels (Cortez et al., 2014; Schuchardt et al., 2014) and will not be discussed in the present text.