Centro de Gestão e Estudos Estratégicos
Ciência, Tecnologia e Inovação

Green transformation and competitive advantage: evidence from Brazilian biofuels & bioproducts strategy

Marcelo Poppe

Brasília, DF
2018

Green transformation and competitive advantage: evidence from Brazilian biofuels & bioproducts strategy

Climate change is one of the most relevant issues in the global agenda, since it imposes clear and consistent actions of all countries in order to practically zero global emissions of greenhouse gases (GHG) until the second half of this century and, by doing so, limiting the increase in the average temperature at the Earth's surface under 2ºC. To this end, it is necessary to preserve natural resources and promote an intense decarbonization of the global economy, which, in turn, depends on greater investments in research, development and innovation (RD&I) in the sectors more likely to generate more significant impacts.

In developing countries such as Brazil, where financial resources are scarcer and investments in social and health areas are a priority, stimulus to the formation of public-private partnerships (PPP) to promote innovation in key sectors is an effective strategy to combine national development promotion with measures to face climate change.

The production, transport and use of energy represent the most significant sources of GHG. The shift to renewable, low-carbon sources in the energy sector is crucial, and the role of bioenergy is major (Figure 1).

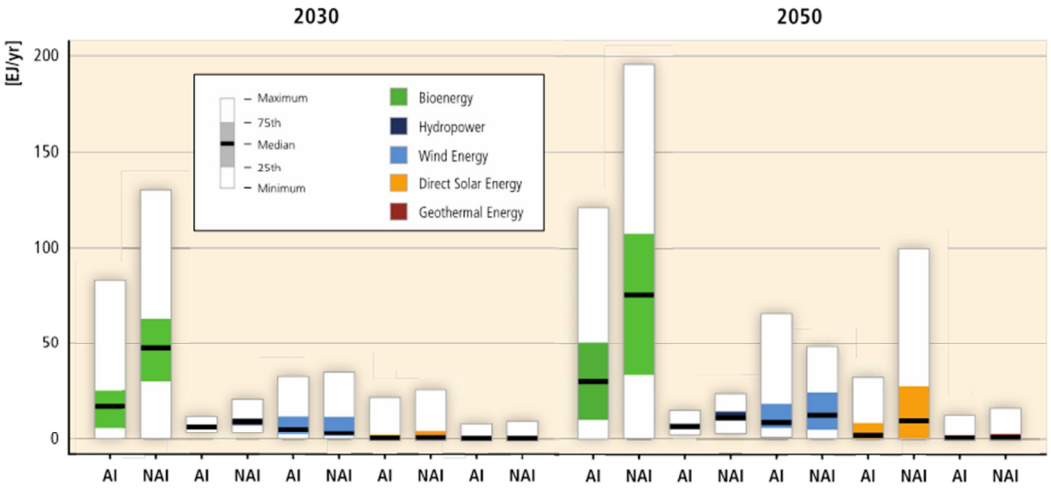

Figure 1. Estimated global renewable primary energy supply by source by 2030 and 2050 in both developed (AI) and developing (NAI) countries (IPCC, 2011)

Emissions associated with the transport sector account for 14% of 2010 global greenhouse gas emission (IPCC, 2014). Though, as over 95% of its energy comes from fossil sources, mainly gasoline and diesel, there is a big chance of reducing these amounts through the use of biofuels and other low-carbon solutions (Figure 2).

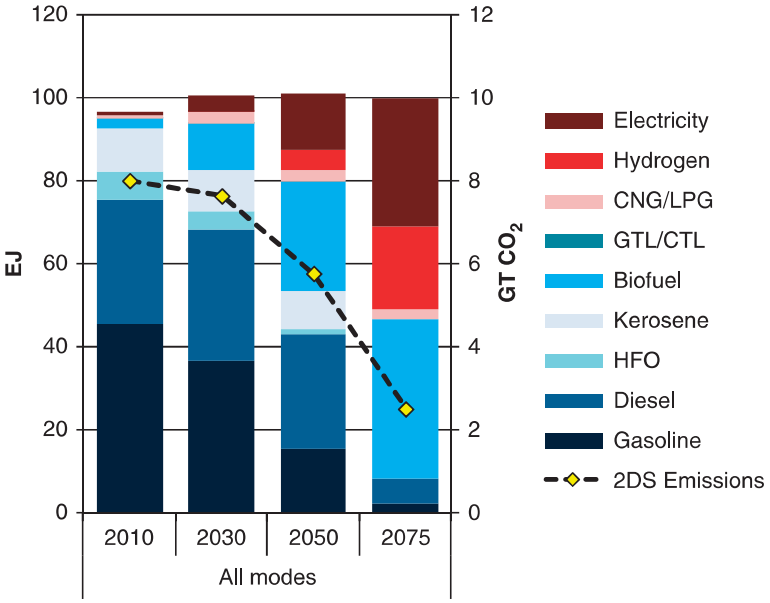

Figure 2. Transport energy use by fuel and year and total CO_2 emissions for limiting the average global temperature increase to 2℃ (2DS) (Fulton *et al.*, 2015)

The United Nations Food and Agriculture Organization (FAO), after broad consultation and analysis of agricultural markets and their constraints, stated that biofuels, whenever produced efficiently, improve the quality of life and food security, promote rural development, and improve the environment (FAO, 2015). Indeed, the evolution of the sugarcane agroenergy has been done in Brazil mostly achieving environmental, economic and social benefits, such as improving soils, integrating production chains, delivering co-products, generating income and jobs (Goldemberg et al., 2008). Introducing innovative feedstock and processes, such as lignocellulosic material and second-generation ethanol (E2G), can reinforce this positive record (NREL, 2013), allowing climate mitigation much more effectively while improving economic performance to accomplish broader societal needs.

The mature experience and consequent legislation promoting biofuels demand in the USA and Brazil offers important references in such direction for other countries. A baseline for these measures is the mechanisms for promoting biofuels in general, that can “pave the road” for stimulating advanced biofuels, creating an adequate logistic and distribution system able to be used either for conventional or advanced biofuels, in a sustainable basis, as well as reducing possible cultural obstacles. In any case blending mandates and quotas specific for advanced biofuels should be considered, as they have been proved to be effective in both cases (Figure 3).

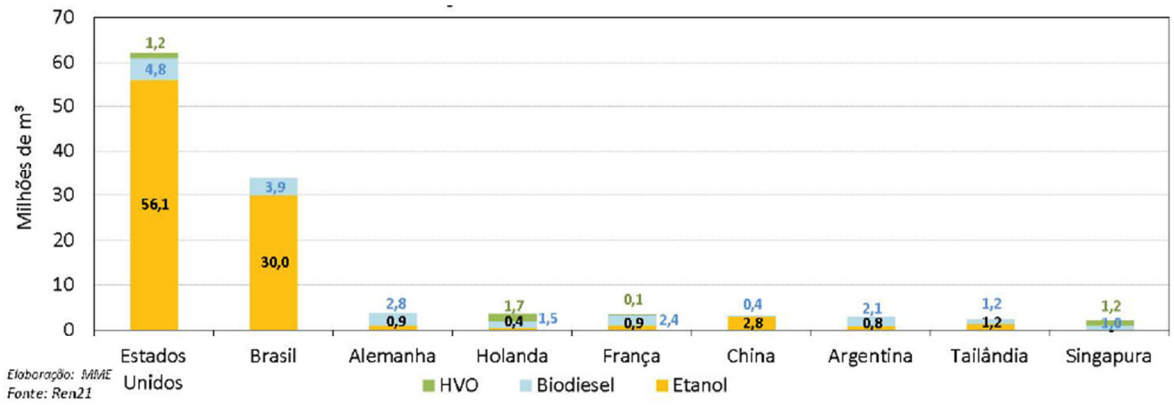

Figure 3. Bioethanol and biodiesel production in selected countries (MME, 2016)

Brazil is one of the countries that make the most use of modern, competitive and sustainable renewable energy sources (Figure 4). Plus, it is using this basis in the process of shifting to a low-carbon economy.

Figure 4. Brazilian energy supply in 2016 (EPE 2017)

Due to its large and pioneering experience in modern liquid biofuels, from feedstock production to modern processing routes, and to its well-developed R&D institutions active in bioenergy, Brazil has a privileged position to endorse these technologies at a global level, being an essential actor to support the transition from fossil sources to renewable sources in other countries, allowing expressive GHG emissions reduction.

Although it already shows good indicators of sustainability, the sugarcane agroindustry still has ample room for improvement in order to achieve greater efficiency and productivity gains (Leal *et al.,* 2012). In addition to marginal gains associated with the gradual dissemination and adoption of best practices and

techniques, the Brazilian agricultural, industrial and management sectors achieve disrupting technologies that are maturing fast, with good efficiency and allowing greater mitigation of GHG emissions (CGEE 2017).

The introduction of new advanced low-carbon technologies, enabling the addition of sugars converted from cellulosic materials (tips, leaves, bagasse), and the breeding and selection of sugarcane varieties with high fiber content (energy cane) has opened a new agro-industrial path (CTBE 2015; Matsuoka *et al.,* 2014). The perspective to improve the potential yield of bioethanol to almost 25,000 liters per hectare is real, from 6,800 today (Figure 5).

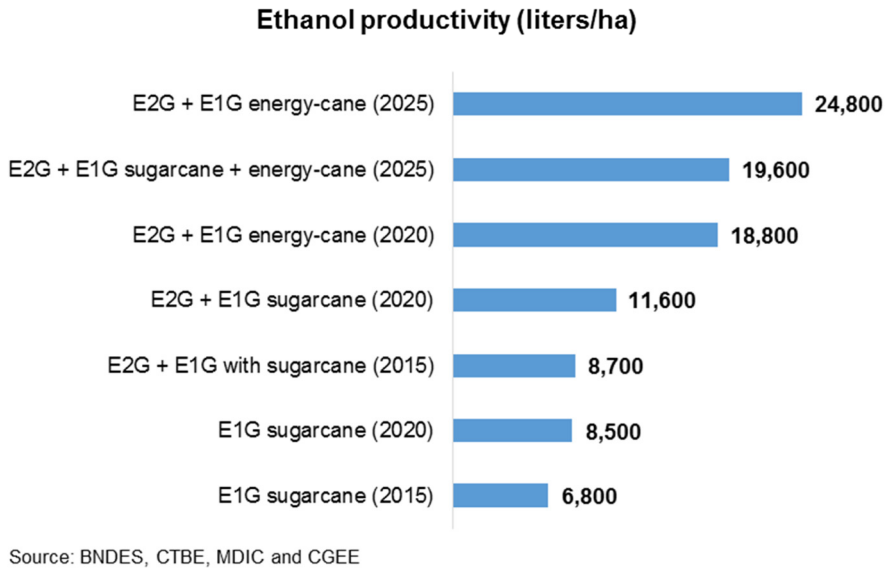

Figure 5 - Bioethanol productivity

The tripod second-generation bioethanol, high-biomass sugarcane (energy cane) and renewable (green) chemistry is under implementation in Brazil throughout strong public-private partnerships. One of its most successful initiative, PAISS[1], has financed several innovation activities involving a number of well-established and start-up companies, as well as prominent science and technology institutions. Given the favorable diagnosis, this plan has invested about US$ 3 billion in PPP projects with focus on RD&I of advanced low-carbon technologies in the areas of second-generation bioenergy and biochemical, and development of energy cane. Positive results are already observed, as the implementation in Brazil of two E2G plants on a commercial scale; their installed capacity is about 140 million liters of bioethanol per year (BNDES 2015). Besides, many energy cane fields are now planted for both fiber and juice supply to industrial uses.

Thus, Brazil has managed to stay in the technological frontier of advanced biofuels industry, making efforts comparable to those observed in the United States, Europe and China, whose installed commercial scale E2G capacity are respectively 305, 80

[1] a government plan to support innovation in the sugar/energy and sugar/chemical sectors, led by the Brazilian Development Bank (BNDES) together with the Research and Innovation Agency (FINEP).

and 65 million liters of cellulosic bioethanol per year.

The expectations about the competitiveness of E2G reinforce the soundness of these investments (Figure 6).

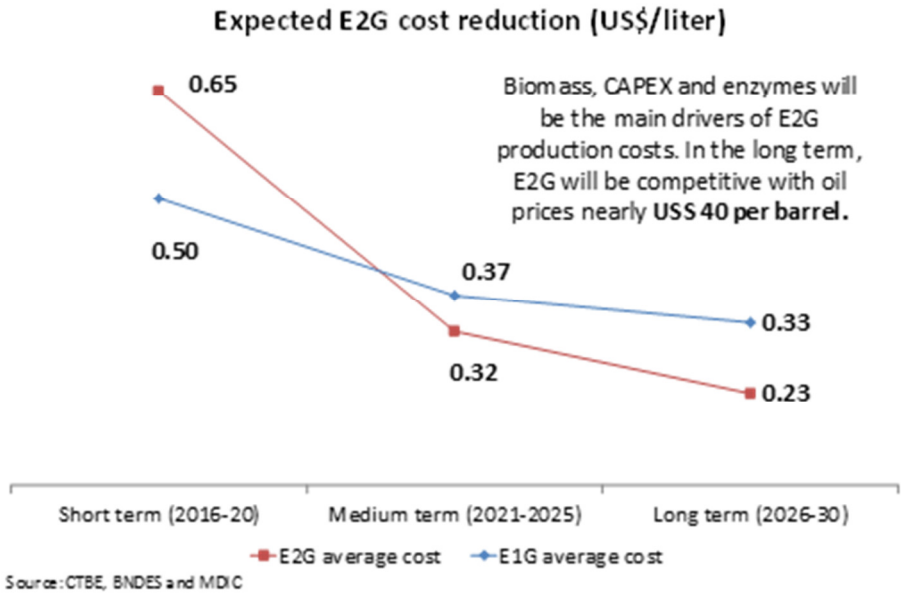

Figure 6. Cost estimates for bioethanol 2G

This new path may notably increase the production of biofuels per unit area, allowing replacing 10% of total gasoline consumed in the world using less than 10 million hectares of land (Figure 7).

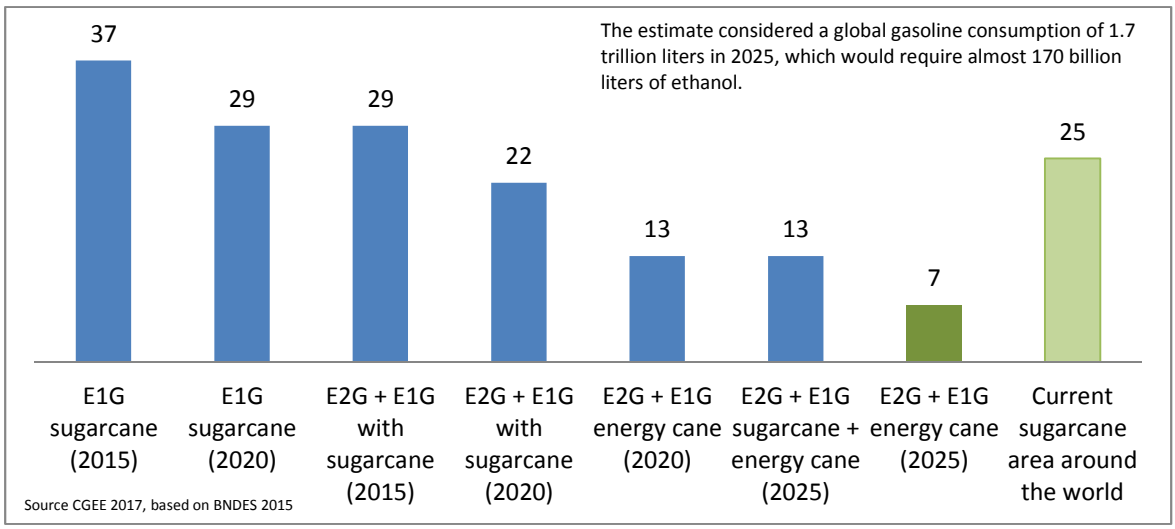

Figure 7 - Agricultural area required for global E10 in 2025 (million hectares)

So, the world would quickly experiment expressive emissions reduction in the transport sector, responsible for one quarter of the total CO_2 emissions (IPCC 2014). Actually, given the best conditions, the ability to mitigate GHG emissions can reach levels greater than 100%, that is, the use of biofuel not only eliminates the emissions from petroleum products that will not be burnt but it also allows, during its production, the generation of renewable power surplus that mitigates emissions from the

electricity sector (Macedo *et al*, 2015), and biogas from copious liquid effluents ("vinasse").

Additionally, diversification in the downstream processes is aggregating numerous bioproducts to the renewable energy output of the mills, improving the overall attractiveness of the business. The sugarcane agroindustry started an important evolution, aggregating advanced technologies and value to some low-cost by-products, becoming more and more a supplier of renewable liquid fuels, electricity, biogas, and opening a broad field of opportunities for producing innovative bioproducts, such as bioplastics and chemical intermediates, nowadays in different stages of development (Figure 8).

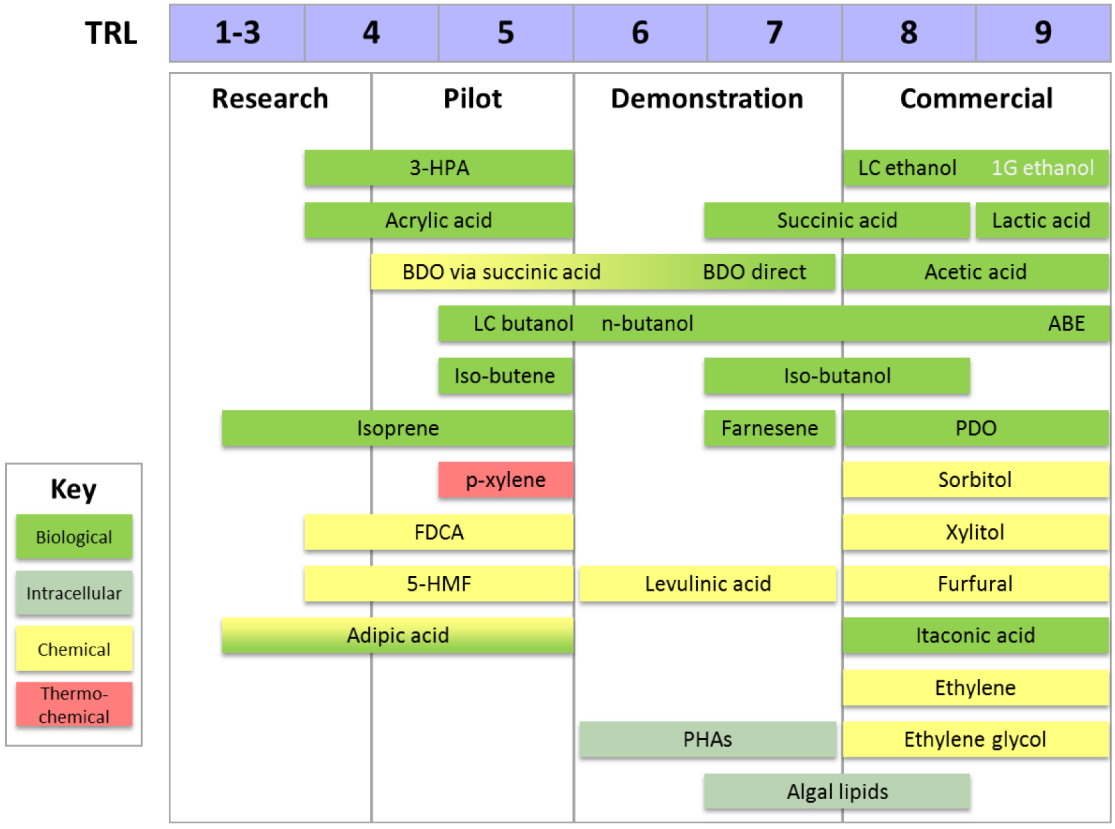

Figure 8. Development stage selected sugar-based platform products, (EC-DGE, 2015)

The current and innovative biomaterials produced in the framework of the emerging sugarcane biorefineries have an expanding local and global market, and creates a new development scenario, with multiple gains: energy, plus economic, social, and environmental benefits.

Nevertheless, its development depends on proper public policies, reducing risk perception and stimulating efficiency. In this direction, the Brazilian case is a good example: the availability of natural resources, the existence of a well-established sugarcane agroindustry and a solid scientific and technology capacity, a proper legislation setting a market for bioenergy, and furthermore, an appropriate financing program, promoting innovation, fostering investment and technological and business

partnerships, represented an important move forward to consolidate a suitable reality, whose first results are appearing. This transformation is starting, with different pathways in evaluation, and learning curves are evolving. But the model is defined, implemented and working. In a few words, it is possible to produce competitive and sustainable renewable energy, as well as customized low-carbon biomaterials, in the required amounts and with the specified quality (Figure 9).

GOOOAAAAL!!!

Figure 9. The new Adidas official soccer ball of the World Cup 2018 “Telstar 18” is made from bio-based product extracted from sugarcane. It reduces over 50% the carbon footprint compared to conventional one. The rubber layer in the soccer ball uses high-tech materials that have impressive performance characteristics and are also sustainable. It is made with the bio-based EPDM (ethylene-propylene-diene monomer) Keltan Eco 6950, produced by Arlanxeo at its Triunfo site in Brazil using ethylene extracted from sugarcane fabricated by Braskem (BiofuelsDigest, December 4, 2017).

To accelerate the maturation and deployment of innovation in bioenergy and biochemicals industry the government’s role is crucial, considering the clear externalities of this route and proportioning a stable environment for new ventures, based on regulatory and financing schemes able to reduce the risk perception and stimulate initiatives with a potential relevant socio-economic-environmental return.

The coordination between technology and environmental policies is crucial and can promote interesting synergies. In this sense, the emission reduction targets announced by Brazil in its National Determined Contributions (NDC) - 37% below 2005 levels, up to 2025, and subsequently 43%, up to 2030, for the economy as a whole -, specify measures as: “increase the share of sustainable bioenergy in the Brazilian energy matrix to approximately 18% by 2030, expanding the consumption of biofuels, increasing the supply of ethanol, including increasing the share of advanced biofuels (second-generation), and increasing the share of biodiesel in the diesel mixture"; among others (Brazil, 2015).

Therefore, with the objective of expanding the internal biofuel market (demand pull action), the Ministry of Mines and Energy (MME) manages a new Program - RenovaBio, and the Ministry of Science, Technology, Innovation and Communication (MCTIC) led the Bioeconomy Action Plan on Science, Technology and Innovation

(technology push act). Besides, the Ministry of Foreign Relations (MRE) runs the Biofuture Platform, joint initiative of twenty nations[2] representing more than half of the world's population that agreed during the COP 23 in Bonn to "develop collective targets prescribing the contribution of sustainable bioenergy to final energy demand and as a percentage of transport fuel use".

This paper shows a major Brazilian contribution, within the framework of the CGEE's project Positive Agenda of Climate Change and Sustainable Development: opportunities of a low-carbon economy. It considers challenges and possible solutions to accelerate the development and dissemination of low-carbon technologies, and based on empirical evidences from Brazilian initiatives on biofuels and biochemicals, addresses recommendations for the formulation of strategies and measures to foster innovation in order to apply the Paris Agreement established at COP 21, under the Climate Change Convention (UNFCCC), and the 2030 Agenda of the UN Sustainable Development Goals.

Conclusively, the paper emphasizes the importance of increasing investments in low-carbon and sustainable development solutions, and strengthening international cooperation, providing reliable foundations for the transition from a fossil based economy to a modern bioeconomy.

[2] Argentina, Brazil, Britain, Canada, China, Denmark, Egypt, Finland, France, India, Indonesia, Italy, Morocco, Mozambique, the Netherlands, Paraguay, Philippines, Sweden, United States and Uruguay.

References

Biofuels Digest, 2017. *ARLANXEO scores a goal with biobased soccer ball for 2018 World Cup*. December 4. Key Biscayne.

BNDES, 2015. *PAISS - BNDES/FINEP Joint Plan to Support Industrial Technology Innovation for the Sugarcane Industry*, by Milanez, A.Y. BNDES Biofuels Department. Rio de Janeiro.

Brazil, 2015. *Nationally Determined Contribution towards achieving the objective of the United Nations Framework Convention on Climate Change*, Brasilia.

CGEE, 2017. *Second Generation Sugarcane Bioenergy & Biochemicals: Advanced low-carbon fuels for transport and industry*. CGEE Center for Strategic Studies and Management. Brasília.

CTBE, 2015. *2G ethanol life cycle assessment*. Executive summary *The contribution of cellulosic ethanol for reducing carbon emissions and fossil energy use in the transportation sector*. Bonomi, A., Cavalett, O., Junqueira, Tassia L. and Chagas, M. F. CTBE National Laboratory of Bioethanol Science and Technology. Campinas.

EC-DGE, 2015. *From the Sugar Platform to biofuels and biochemicals*. Final report for the European Commission Directorate-General Energy, E4Tech, RE-CORD (Consorzio per la Ricerca e la Dimostrazione sulle Energie Rinnovabili), Wageningen University and Research Center, ENER/C2/423-2012/SI2.673791. V2.1. Brussels.

EPA, 2015. *Renewable Fuel Standard Program*, US Environmental Protection Agency, available at http://www.epa.gov/renewable-fuel-standard-program/, November.

EPE, 2017. *National Energy Balance*, EPE Energy Research Company, Rio de Janeiro.

FAO, 2015. *Statement by FAO Director-General at The Global Forum for Food and Agriculture*. Green Week (*The Growing Demand for Food, Raw Materials and Energy: Opportunities for Agriculture, Challenges for Food Security?*), January. Berlin.

Fulton, L.M., Lynd, L.R., Körner, A., Greene, N., Tonachel, R.L., 2015. *The need for biofuels as part of a low carbon energy future*. Biofuels, Bioproducts and Biorefining, Wiley Online Library, DOI: 10.1002/bbb.1559.

Goldemberg, J., Coelho, S.T., Guardabassi, P., 2008. *The sustainability of ethanol production from sugarcane*. Energy Policy, Vol 36.

IEA, 2014. *World Energy Outlook 2014*. IEA International Energy Agency. Paris.

IPCC, 2011. *Special Report on Renewable Energy Sources and Climate Change Mitigation*. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Seyboth, K., Matschoss, P., Kadner, S., Zwickel, T., Eickemeier, P., Hansen, G., Schlömer, S., von Stechow, C. (eds)]. Cambridge University Press, Cambridge.

IPCC, 2014. *Climate Change 2014: Synthesis Report*. Contribution of Working Groups I, II and III to the Fifth Assessment Report [Core Writing Team, Pachauri, R.K. and Meyer, L.A. (eds.)]. IPCC, Geneva.

IRENA, 2014, *REmap 2030: Summary of Findings*. IRENA International Renewable Energy Agency. Abu Dhabi.

Leal, M.R.L., Nogueira, L.A.H., Cortez, L.A.B., 2012. *Land demand for ethanol production*. Applied Energy. Elsevier. Vol. 102.

Macedo, I.C., Nassar, A.M., Cowiec, A.L., Seabra, J.E.A., Marelli, L., Otto, M., Wang, M.Q., Tyner, W.E., 2015. *Greenhouse Gas Emissions from Bioenergy*. Chapter 17, SCOPE *(Bioenergy & Sustainability: bridging the gaps)*. Edited by Souza, G.M., Victoria, R.L., Joly, C.A., Verdade, L.M. Fapesp. São Paulo.

Matsuoka, S., Kennedy, A.J., Santos, E.G.D., Tomazela, A.L., Rubio, L.C.S., 2014. *Energy Cane: Its Concept, Development, Characteristics, and Prospects*. Advances in Botany. Vol. 2014, Article ID 597275.

MME, 2016. Boletim mensal dos combustíveis renováveis. Ed. n°100. June. MME Ministry of Mines and Energy. Brasília.

NREL, 2013. Foust, T., Bratis, A. *Biomass 2013: Cellulosic Technology Advances*. NREL National Renewable Energy Laboratory. Boulder.

Oxiteno, 2012. *Innovation and Green Chemistry in Oxiteno*. Workshop for Sustainable Production of Biopolymers and other Bio-based Products. Fapesp São Paulo Research Foundation. São Paulo.

SCOPE (2015). *Bioenergy & Sustainability: Bridging the gaps* (Vol. 72, p. 779). Souza, G. M., Victoria, R., Joly, C., & Verdade, L. (Eds.). FAPESP/SCOPE Scientific Committee on Problems of the Environment, UNESCO. Paris.