



SECOND GENERATION BIOFUEL MARKETS:

STATE OF PLAY,
TRADE AND DEVELOPING
COUNTRY PERSPECTIVES



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Acronyms

2G	Second-generation biofuels
ABPP	Africa Biogas Partnership Programme
BCAP	Biomass Crop Assistance Program
BETO	Bioenergy Technologies Office
BIP	Biofuel Infrastructure Partnership
BMELV	German Federal Ministry of Food, Agriculture and Consumer Protection
BNDES	Brazilian Development Bank
CNG	Compressed Natural Gas
CTBE	Brazilian Bioethanol Science and Technology Lab
CWC	Cellulosic Waiver Credit
DoD	United States Department of Defense
DOE	United States Department of Energy
EC	European Commission
EISA	United States Energy Independence and Security Act
EJ	Exajoule
EMTS	United States Environmental Protection Agency Moderated Transaction System
EPA	United States Environmental Protection Agency
EU	European Union
Fapesp	São Paulo State Research Foundation
Finep	Brazilian Innovation Agency
FTA	Free Trade Agreements
GATT	General Agreement on Tariffs and Trade in Goods
GBEP	Global Bioenergy Partnership
GHG	Greenhouse Gas
IEA	International Energy Agency
IIASA	International Institute for Applied Systems Analysis
iLUC	Indirect Land-Use Change
IRENA	International Renewable Energy Agency
ISCC	International Sustainability and Carbon Certification
ISO	International Organization for Standardization
LCFS	Low Carbon Fuel Standard
LDCs	Least Developed Countries
LIIB	Low Indirect Impact Biofuels
LNG	Liquefied Natural Gas
MFN	Most-favoured nation
MSW	Municipal Solid Waste
NABC	National Advanced Biofuels Consortium
NBP	National Biogas Programme
NREL	United States National Renewable Energy Laboratory
Norad	Norwegian Agency for Development Cooperation
PAISS	Joint Plan for the Industrial Technological Innovation of the Energy and Chemical Sugarcane-based Industries
RDIF	Renewable Drop-In Fuels
RED	Renewable Energy Directive
RFA	Renewable Fuels Association
RFS	Renewable Fuel Standard
RIN	Renewable Identification Numbers
RSB	Roundtable on Sustainable Biomaterials
RVOs	Renewable Volume Obligations
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
SNG	Synthetic Natural Gas
TBT	Technical Barriers to Trade
TRS	Total Recovery Sugars
UCO	Used Cooking Oil
US	United States of America
USDA	United States Department of Agriculture
WTO	World Trade Organization
WWF	World Wide Fund for Nature

EXECUTIVE SUMMARY

UNCTAD's first report on the state of biofuel technologies in 2007 highlighted a sector with great potential, but at the time that was a long way off from markets. In 2015, countries made commitments toward a more environmentally balanced future through the Sustainable Development Goals (SDGs), and now seek to expand policies for low-carbon development after the agreement reached in Paris at COP21. The year also marked a milestone in the bioeconomy, as the point in time when the production of second-generation biofuels (2G) finally took off at commercial scale. Developing countries now face a new set of market opportunities and policy dilemmas to enhance their usage of biomass, which can now be transformed into more valuable products. This report focuses on how these market opportunities can be capitalized on and how to promote technology transfer for developing countries interested in engaging in advanced biofuel markets for the attainment of the SDGs, and as an instrument to meet their commitments under COP21. By carrying out a non-exhaustive mapping of cellulosic ethanol projects and recent policy lessons around the globe, this report seeks to provide public and private practitioners with a macro-picture of the advanced biofuels sector, with a specific focus on cellulosic ethanol as of 2015-2016.

Second-generation biofuels can be classified either by: process type, estimated greenhouse gas (GHG) emissions reductions compared to the fossil-fuel equivalent, or feedstock type. This report primarily looks at feedstock choice, which concerns fuels made from non-edible feedstocks, partially in reaction to the food versus fuel debate. Nevertheless, process improvements have been a key factor in decreasing costs for the industry and allowing market expansion. Historically, the United States of America (US) has had the largest installed capacity for cellulosic ethanol production of deployed second-generation biofuel facilities, followed by China, Canada, European Union (EU) and Brazil, respectively. Projects in these countries vary significantly in their technological approaches and feedstocks used for fuel production, including the use of corn stover, sugarcane bagasse, municipal solid waste, and forestry residues, among others. One common trait is that companies that possess technology and knowledge in the European Union and the United States engage in partnerships to deploy advanced ethanol facilities abroad, for example, the Fuyang project, which is a cooperation between Italy-based Beta Renewables and Guozhen Group in China. While the African continent and the entire Latin American region (excluding Brazil) have no cellulosic ethanol projects as of 2015, progress has been made in bagasse-fired electricity cogeneration and biomass cook stoves in these regions.

The policy instrument that has provided the greatest traction to advanced biofuels has been the market-segmentation strategy in conventional / advanced / cellulosic biofuels used in the United States market, albeit by granting price premiums for the production of cellulosic ethanol. Low interest rates and a venture capital culture have also been touted for advancing the deployment of second-generation biofuels in United States market forward. Furthermore, the rapid growth of China in the advanced cellulosic ethanol industry, as well as strong support to the sector by the National Development Bank in Brazil, all illustrate the multiple supply and demand pull mechanisms, which have given traction to the industry globally.

While installed capacities have been scaled-up over the past three years, interviews carried out during the preparation of this report suggest that actual production is much smaller than nominal capacities. This could be explained by several factors including feedstock costs, process costs, a lack of domestic regulatory frameworks favourable to advanced biofuels, risk avoidance, and blend walls in major markets. While this report has mapped production capacities, the availability of actual production data is limited as such information is treated confidentially by the industry. In the case of the United States, the expected

utilization of cellulosic fuels in the market Renewable Volume Obligations (RVOs) for 2015 corresponds to 400 million litres, or about 80 per cent of the installed United States capacity as of 2015 as surveyed in this report. Based on the limited data available, actual production data in 2014 corresponded to a utilization rate of 25 per cent of the United States installed capacity for cellulosic fuel. Indicating an optimistic stance, the United States Environmental Protection Agency (EPA) has issued obligations that nearly double the cellulosic ethanol requirements for the United States market in 2016, calling for imports to meet the likely shortfall in domestic capacity.

Trade opportunities might exist in advanced biofuel markets, particularly as recent limits on conventional biofuels in Europe, together with the European Union's growing self-sufficiency in conventional biofuels, suggest that imports of advanced biofuels will most likely be made if domestic producers fail to deliver their expected output. The United States is also likely to begin cellulosic ethanol imports in the years ahead, as its own official statistics suggest. Depending on future rules on advanced biofuels in important markets, potential World Trade Organization (WTO) outcomes could be similar to those raised for first-generation biofuels, which led to special sustainability requirements for biomass, and may work as indirect barriers to trade.

The report concludes with five suggestions for the responsible development of the second-generation biofuels industry:

- Create regulatory frameworks for advanced bioenergy tailored to national circumstances, which do not necessarily focus on the type of supply but instead on the existing local demands. The fulfilment of such regulation is most likely to meet domestic development strategies in line with the SDGs.
- Promote cooperation between domestic organizations and foreign companies for joint ventures by means of investment agreements in order to facilitate technology transfer. This is important to avoid the emergence of a large technological gap between first-generation, land-intensive feedstocks and second-generation, capital-intensive biofuels in developed and developing countries.
- Consider the broader aspects of bioeconomy sectors, including biomaterials, in ways that avoid locking industrial development paths into specific sectors or technologies. This would provide flexibility for market players that operate biorefineries as they could target multiple markets, including materials, feed, food, and energy - both domestically and internationally.
- Incorporate lessons from sustainability criteria applied for first-generation biofuels into near and mid-term sustainability provisions or labels for advanced biofuels.
- Continuously promote technical dialogue among different production regions of advanced fuels in order to ensure compatible standards for feedstock and promote trade in advanced biofuels.

Advanced biofuels are an important tool to be considered in national policies in the coming decades. They are a renewable energy option with great potential to help decarbonize transportation and other systems in developing countries. Advanced biofuels consequently relate to numerous SDGs and national commitments to limit climate change to tolerable levels. Their responsible development in the coming years should take into account lessons from first-generation biofuels (and other renewable energy technologies), which have received intense scrutiny in recent years. In particular, rules on trade and the sustainability aspects of advanced biofuels should be applied coherently with other regulations, both domestically and internationally.



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