Activity Group 8 – Advanced liquid biofuels

Best practices and experiences in advanced liquid biofuels

Brazil

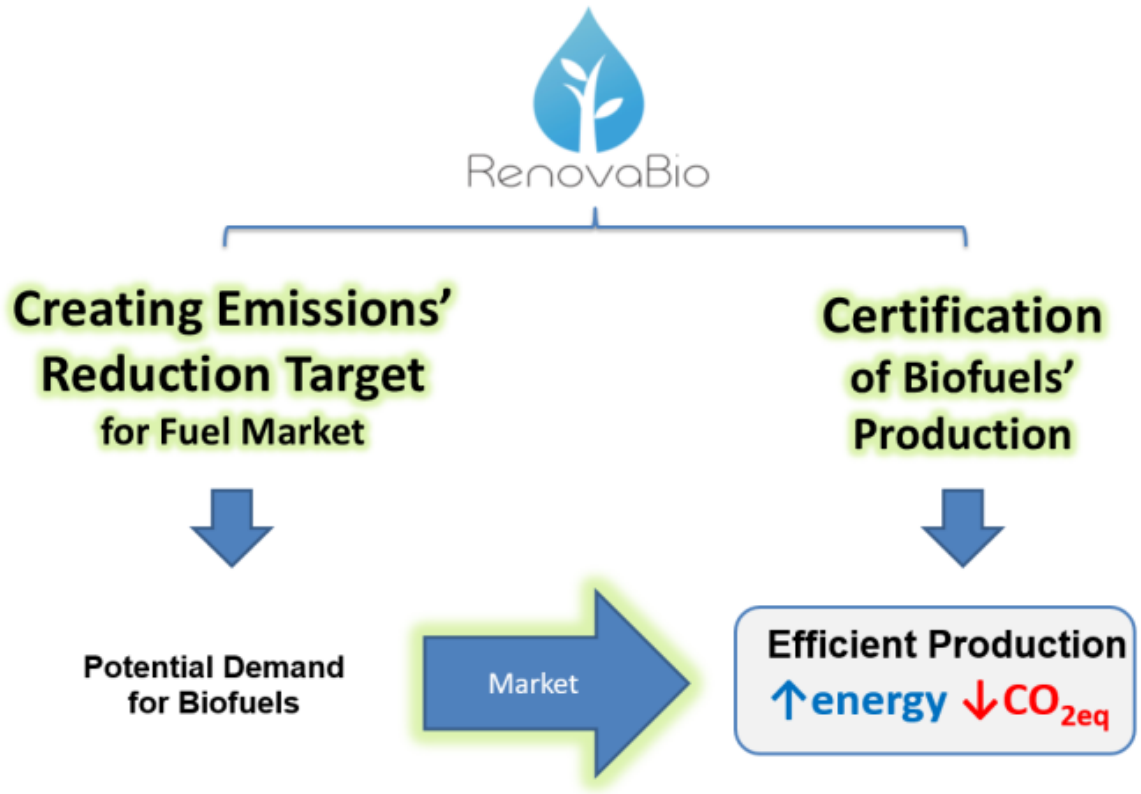
Brazilian National Biofuels Policy (RenovaBio)

RenovaBio, Brazil's new National Biofuels Policy, aims to reduce the carbon footprint of the national fuel mix as well as ensuring a long-term demand for low carbon fuels in the country. The program aims specifically to:

- *Promote the reduction of greenhouse gases (GHG) emissions by the fuel mix, in accordance with the ambitious commitments established under Paris Agreement in December 2015 - 21st Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change;*
- Contribute to the security of domestic fuel supply by encouraging biofuels production and use.

The core of Brazil's new National Biofuels Policy (RenovaBio) is to create a market-based mechanism that incentives the search for better energy efficiency together with the reduction of the carbon footprint. To accomplish its objectives, RenovaBio is founded on three pillars:

- *Annual decarbonization targets set by the government for a minimum 10-year period;*
- *Issuance of GHG emissions reduction certificates, named "CBio" in Portuguese (an acronym for "Crédito de Descarbonização" – Decarbonization Credit);*
- Biofuels production certification through life cycle analysis.



Introduction

Geographic location: Brazil

Type of example: policy and regulatory framework.

Investment: N/A

Linkage of conventional (CBs) and advanced biofuels (ABs): *RenovaBio's is expected to incentivize advanced, second generation biofuels due to the program's qualification of biofuels according to their respective levels of energy-environmental efficiency, through and individual certification process and life cycle assessment.*

Status: *Law n. 13.576 (December 26, 2017) established RenovaBio. Further regulations have been approved throughout 2018 and 2019, defining the rules of accreditation of inspection firms eligible to certify producers, as well as the carbon intensity reduction targets. By late 2019, the regulations concerning the emissions reduction certificates (CBio) market are expected to be published. RenovaBio is expected to become operational by 2020.*

Drivers, benefits, challenges and prospects

Reasons or main drivers: *RenovaBio aims to reduce the carbon intensity of the national fuel mix as well as ensuring a long-term demand for low carbon fuels in the country.*

Key enabling factors: *N/A*

Technology transfer: *N/A*

Benefits: *Since individual certification of producers is a core element of RenovaBio, as well as the qualification of the different biofuels according to the energy-environmental efficiency score, the program will promote environmental benefits in the transport fuels sector. Incentives to the biofuels industry will spur regional development and create jobs and wealth in rural areas.*

Main challenges encountered: *N/A*

Indicators: *The process through which the "energy &environment efficiency score" is calculated counts biofuels carbon intensity (in g CO2 eq./MJ) and compares it to its fossil fuel equivalent. The combination of this score and the volume of biofuels produced results in a specific amount of tradable certificates. The whole policy relies on fully measurable targets and certificates. The decarbonization target set for the cycle 2020-2029 will lead to an emission reduction of 686 million tons of CO2eq in 10 years.*

Potential for scaling-up and replicability: *Overall, RenovaBio will establish a robust framework that combines certification standards, government regulations and market-based incentives to super investments that will help decarbonize the transportation energy mix. It is a one-of-a-kind policy model for the transport sector, benefitting from lessons learned from similar programs in the US (California) and Europe, and introducing new and smart policy design. It is already a priority in Brazil´s energy policy planning, and since it is fully measurable, results will be highly visible and hopefully inspire others to follow suit.*

References and additional information

Contact name, Affiliation/Organisation:

Miguel Ivan Lacerda de Oliveira – Director, Biofuels Department (DBIO), Ministry of Mines and Energy

(bio@mme.gov.br)

Renato Domith Godinho – Head, Division for Energy Progress (DEN), Ministry of Foreign Affairs

(den@itamaraty.gov.br)

Further relevant details, e.g. organization description, size and type of investment (i.e. public, private or public/private):

N/A

Link with information about the example (if available):

http://biofutureplatform.org/wp-content/uploads/2018/06/RenovaBio-Mechanism-Policy-and-Instruments.pdf

Publications (if available):

Grassi, M.C.B.; Pereira, G.A.G. (2018). Energy-cane and RenovaBio: Brazilian vectors to boost the development of Biofuels. *Industrial Crops & Products 129 (2019)* 201-205, early online version. DOI: 10.1016/j.indcrop.2018.12.006

Japan

Title of the example

Development of Production Technologies for Biojet Fuels.

Introduction

The introduction of biofuels is important not only for CO2 reduction and diversification of energy sources as a fossil alternative fuel, but also from the viewpoint of creating new industries. In this project, research and development (R&D) is conducted for the reducing costs and practical application of biojet fuel that do not compete with food.

For bio-jet fuels, pilot-scale verification tests are being conducted to build an integrated manufacturing process based technologies such as biomass gasification / liquefaction and microalgae culture technology.

NEDO (New Energy and Industrial Technology Development Organization) has been conducting this projects from FY2017 to FY2020.

Drivers, benefits, challenges and prospects

The Aim of this project is to establish at least two integrated manufacturing processes that are expected to be commercialized by around 2030.

First, in the production of biojet fuel from microalgae, a plant containing a cultivation pond in the scale of 10,000 m² is built in Thailand (Saraburi Province), for pilot-scale test employing fast-breeding Botryococcus braunii. Additionally, issues involved in industrialization with greater efficiency and their solutions are examined for verification into the feasibility of stable, long-term and continuous operation, reduction of production cost, etc. This technology development participants are IHI Corporation and Kobe University and plant place property owned by Siam Cement Group.

Second, demonstration project is conducted by a pilot plant which converts woody and herbaceous biomass into hydrogen and carbon monoxide gas and reforms the purified gas into biojet fuel by catalyst. This project participants are Mitsubishi Hitachi Power Systems, Ltd., Chubu Electric Power Co., Inc., Toyo Engineering Corporation, JAXA (The Japan Aerospace Exploration Agency), Mitsubishi Heavy Industries Group and AIST (National Institute of Advanced Industrial Science and Technology).

References and additional information

Kosuke Yanagida, Agency for Natural Resources and Energy / Ministry of Economy, Trade and Industry

USA

Integrated Biorefineries

Lessons learned were compiled from direct experience with over 40 projects throughout the United States and over the course of approximately 10 years.

Introduction

Under the Renewable Fuel Standard, the United States has outlined a goal to produce 21 billion gallons of advanced biofuels by 2022. This creates an urgent need to bridge the gap between promising research and commercial, largescale production of advanced liquid biofuels to decrease greenhouse gas emissions as well as to displace gasoline utilization in the transportation sector.

The development of the integrated biorefinery was identified as crucial part of achieving alternative fuel production goals. Throughout its stages of development, the integrated biorefinery will utilize input from all of the other platforms as well as the existing biofuels industry. The research and development of feedstocks and the biochemical and thermochemical conversion platforms will allow the integrated biorefinery to continually increase its diversity and complexity further increasing effectiveness, efficiency, and productivity.

The process of developing an integrated biorefinery is unique because of the new technologies involved as well as the integration and bundling of these technologies. A detailed and realistic project scope and expectations is critical to the successful deployment of an integrated biorefinery.

Even though there are a few integrated biorefineries in the early stages of commissioning, startup, shakedown and/or commercial production, large scale implementation of highly-efficient integrated biorefinery facilities is still a goal yet to be realized. This is caused by a variety of non-technical and technical barriers.

Drivers, benefits, challenges and prospects

The U.S. Department of energy assessed the market deployment aspects for integrated biorefineries, as well as the technical and non-technical critical success factors.

The major critical success factors and barriers, both non-technical and technical, can be grouped into three broad categories: policy, financial, and technical. In both the United States and the European Union, biofuel and bioenergy policies are under evaluation for potential change. For early biorefineries, assured markets are typically tied to mandated volumetric production or greenhouse gas saving levels. With these levels facing an uncertain future, the commercial viability of biorefineries is endangered. Given the significant and widespread industry, academic, and industry attention currently focused on bioenergy policy study and evaluation, this paper will not delve further into the realm of policy debate.

Financial barriers are among the most challenging aspects of biorefinery deployment. Lenders of project financing will not consider federal incentives and subsidies as income in the consideration of loan applications if it is perceived that federal (and provincial or local) policies and financial support mechanisms are uncertain. If a project developer does not have a strong and established financial performance record, obtaining debt (and/or equity) financing in the current uncertain policy environment can be nearly impossible. In addition, capital costs for commercially viable facilities are relatively high, and securing capital for an unproven technology is extremely difficult. Lenders are hesitant to provide debt financing for first-of-a-kind facilities where the process performance cannot be adequately guaranteed. In order to reduce technical risks, government financial assistance in projects aimed at proving performance at the pilot, demonstration, and pioneer scales can be a key enabler. And for those companies that cannot obtain financing, government financial assistance in the form of grants, subsidies, or loan guarantees can be critical to enhance lender confidence to invest in facility construction and replication at the commercial scale.

Additional technical success factors barriers include: End-to-End Process Integration, Risk of First-of-a-Kind Technology; Technical Risk of Scaling; Stages of Scaling; and cost of Production.

Market Challenges and Barriers include: Inadequate Supply Chain Infrastructure; Offtake Agreements; Biofuels Distribution Infrastructure; Codes, Standards, and Approval for Use; and Lack of Acceptance and Awareness of Biofuels.

Other key lessons learned and recommendations:

• Great emphasis needs to be placed on scale-up risks, for which data validation and piloting efforts should be seriously considered prior to design of an integrated facility.
• Early-stage and emerging technology projects should be driven and have their progress measured by technical accomplishments and milestones and not by schedule, entrepreneurial goals, or political expediencies.
• Projects that demonstrate poor project management practices, including mismanaging the budget or schedule or making multiple, major, high-level change requests (especially those indicating the technology is not as mature as proclaimed by the project) should be coached into compliance or considered for termination.
• Demonstration-scale and commercial-scale deployment projects must not be allowed to proceed to award or into detailed design and engineering without the validation of the requisite data at the preceding scale. Projects should be required to verify/validate any supporting bench-, pilot-, or demonstration-scale data prior to receiving an approval.
• Overaggressive schedules mask risks and could result in years of delay.
• "Commercially available" equipment adapted for a new function or scale needs to be treated as new technology.
• The more new technology process steps, the higher the risk to successfully executing the project.
• Well balanced, diverse project teams are vital to the project success.
• The appropriate team and requisite skills mix varies depending on the stage of development.
• Adopting formal project management and change control best practices improves the chances of success:
• Invoking a formal Risk Mitigation Plan results in disciplined, cost effective risk management and application of contingency.
• Projects should consider additional contingency during commissioning/startup to address risks and unknowns associated with starting up first of a kind units.
• Oversight of long lead equipment manufacturers is important including.
• Performing an independent, third-party pre-award risk assessment is a good management practice that successfully identifies risk, project deficiencies, and true commercialization readiness level.
• Utilizing an independent engineer throughout the life of a project is good management practice to successfully identify technical risk and potential project design deficiencies.
• Project location weather and climate should be considered in the plant design and construction.

References and additional information

Emily Marthaler, International Trade Specialist, U.S. Department Agriculture, Foreign Agricultural Service Emily.marthaler@usda.gov

Kristen Johnson, Bioenergy Technologies Office, U.S. Department of Energy (DOE), Energy Efficiency and Renewable Energy Kristen.johnson@ee.doe.gov

https://www.energy.gov/eere/bioenergy/development-integrated-biorefineries

https://www.nrel.gov/bioenergy/ibrf.html

Recent funding was announced in September 2017 by the DOE, which selected eight projects to negotiate for up to $15 million in total DOE funding to optimize integrated biorefineries. These projects are working to solve critical research and development challenges encountered for the successful scale-up and reliable operations of integrated biorefineries, decrease capital and operational expenses, and focus on the manufacture of advanced or cellulosic biofuels and higher-value bioproducts.

IRENA

Title of the example

The result of the survey conducted by IRENA with the aim to identify the currently prevailing and most pressing factors explaining the stagnating investment activity in advanced biofuels showed that regulatory uncertainty stands out as the most important impediments to investments. Investors send a clear message to policy makers calling for a more stable and predictable investment environment for biofuels.

Introduction

Geographic location: *The questionnaire was sent to companies doing business on the production and sale of advanced biofuels during the second half of 2018. The feedback was received from 14 major advanced biofuel companies from North America, Brazil, China and Europe.*

Type of example: *The questionnaire includes statements evaluated on a five-point agreement scale (Likert Scale) under the five following groups:*

1. Feedstock (8 statements)
2. Technology and financing (7 statements)
3. Markets through mandates and targets (16 statements)
4. Trends in consumer demand (12 statements)
5. Environmental and social concerns (11 statements)

Investment: *N/A*

Linkage of conventional (CBs) and advanced biofuels (ABs): *N/A*

Status: *A new report "Advanced biofuels – what holds them back?" will be released by IRENA this year.*

Drivers, benefits, challenges and prospects

Reasons or main drivers: *Investments in biofuels started to decline after the peak year of 2007 for the conventional biofuels and 2011 for the advanced biofuels. When observing such a continuing decrease in liquid biofuel production investments at a time when investments in other forms of renewable energy are growing and becoming immensely popular, it became clear that an analysis of the barriers to investment was needed.*

Key enabling factors: *N/A*

Technology transfer: *N/A*

Benefits: *N/A*

Main challenges encountered: *N/A*

Indicators: *N/A*

Potential for scaling-up and replicability: *discuss whether and under which conditions the Example could be potentially scaled-up and replicated elsewhere and under which circumstances*

References and additional information

Contact name, Affiliation/Organisation: *Toshimasa Masuyama, International Renewable Energy Agency (IRENA)*

Further relevant details, e.g. organization description, size and type of investment (i.e. public, private or public/private): *IRENA is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy.*

Link with information about the example (if available): *https://www.irena.org/*

Publications (if available): *N/A*

National and regional policies

Brazil

Implementing Agency/Ministry		Ministry of Mines and Energy
Policy/Activity Name		RenovaBio
Legal and regulatory instruments	Policy/Activity Type	National biofuels policy
	Existing Legislation	Law 13.576/2017
	Policy/ Activity Target Area	Transport fuels
Impact on bioenergy	Direct	RenovaBio will promote production and use of biofuels for transport by means of carbon intensity reduction targets applied to fuel distributors.
	Indirect	RenovaBio will indirectly promote sectors and activities that have synergistic outcomes with bioenergy systems, promoting enhancements in agricultural practices and land use.
Impact on Production Stream	Production	RenovaBio will indirectly promote developments throughout the biofuels value chain and production stream, from agricultural producers to biorefineries, which will seek to improve their efficiency and sustainability to achieve a higher energy-environmental efficiency score.
	Conversion	RenovaBio will indirectly promote developments throughout the biofuels value chain and production stream, from agricultural producers to biorefineries, which will seek to improve their efficiency and sustainability to achieve a higher energy-environmental efficiency score.
	Use	Fuel for transport. RenovaBio is also expected to indirectly incentivize biomass cogeneration of electricity in biorefineries.
Funding Mechanism		N/A
Progress/results		RenovaBio is expected to becomeoperational by 2020.
Comments		

Japan

Implementing Agency/Ministry		New Energy and Industrial Technology Development Organization, Japan
Policy/Activity Name		Development of Production Technologies for Biojet Fuels
Legal and regulatory instruments	Policy/Activity Type	—
	Existing Legislation	"The 5th Basic Energy Plan" released on 2018 describes that biofuels will continue to be a significant means of diversifying energy sources and lowering carbon emissions in the transportation sector.
	Policy/ Activity Target Area	—
Impact on bioenergy	Direct	—
	Indirect	—
Impact on Production Stream	Production	—
	Conversion	—
	Use	—
Funding Mechanism		R&D commission fee from METI（Ministry of Economy, Trade and Industry）
Progress/results		On going
Comments		—

USA

Implementing Agency/Ministry		U.S. Department of Energy, U.S. Department of Agriculture and the U.S. Environmental Protection Agency.
Policy/Activity Name		Renewable Fuels Standard (RFS)
Legal and regulatory instruments	Policy/Activity Type	
	Existing Legislation	Energy Independence and Security Act of 2007
	Policy/ Activity Target Area	
Impact on bioenergy	Direct	Yes
	Indirect	
Impact on Production Stream	Production	
	Conversion	
	Use	
Funding Mechanism		Integrated Biorefinery Optimization funding opportunity is coordinated and supported jointly between DOE's Bioenergy Technologies Office and the U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA)
Progress/results		
Comments		

For the purposes of this table:

"Policy" is considered to be law created through interpretation and regulatory guidelines put forth by the implementing agency(ies). "Policy Type" is considered to identify the type of law and the goals of the mandate. "Activity Type" is defined in two categories: International (binding or non-binding - bilateral or multilateral) agreements and collaborations, or non-binding/voluntary recommendations/programmes that advance the implementation of bioenergy, biofuels, and renewable energy into the energy stream. "Legislation" is defined as national or state (sub-national political boundaries) legislative mandates. "Target Area" is defined as the sector on which the policy's/activity's goals and objectives are focused - the area of most direct impact and engagement. (e.g industry, bioenergy producers. bioenergy suppliers, farmers, educational institutions).

"Direct" is defined as policies or activities that directly impact the energy sector. These items may include policies or activities that promote national/state bioenergy action plans; production and use of biofuels for transport (including blend mandate, type of fuel, market segment, target flexibility, enforcement provision); electricity generation from biomass (including market penetration targets, target flexibility, enforcement provision, and heat generation from biomass including targets, target flexibility, enforcement provision). "Indirect" is defined as policies or activities that impact the energy sector by influencing

activities in other sectors - affecting bioenergy deployment both directly and indirectly. Policies and activities from the following sectors should be considered: agriculture/land use, environment, trade/industry, forestry, waste management, poverty reduction, rural development, and employment.

"Production" relates to feedstock, farming practices, land use, or other aspects associated with the production of bioenergy agricultural crops (raw materials). “Conversion" refers to the practices (processing, refining, etc...) and energy efficiency methodologies used in the conversion of raw bioenergy materials into end-use products. "Use" refers to end-use (i.e. electricity, heat, fuel for transport, etc...). In this section of the table, we asked each country to show what part of the production stream would be affected by the listed policies and activities (i.e. Production, Conversion, Use).