



BECOOL

Brazil-EU Cooperation for Development
of Advanced Lignocellulosic Biofuels

SUSTAINABLE VALUE CHAINS FOR LIGNOCELLULOSIC ADVANCED BIOFUELS

Newsletter February 2020

**BECOOL - BIOVALUE Meeting in Brazil | Innovative Cropping Systems |
Thermochemical Conversion | Upcoming Events | Reports**



BECool is a Horizon 2020 research and innovation project to foster the cooperation between the European Union and Brazil, for the development of advanced lignocellulosic biofuels, from sustainable agricultural value chains. Launched in June 2017 and ending in 2022, the project is carried out by a consortium of twelve partners from seven countries, coordinated by the University of Bologna.

We are glad to share with you some of the latest results and activities of the project.

Synergies and opportunities from joint activities in BECOOL and BIOVALUE can drive innovation in advanced biofuels

International cooperation for the development of advanced lignocellulosic biofuels is one of the main features of BECOOL. The activities of BECOOL are aligned with those of BioVALUE, a twin project funded by five State Foundations and five industrial companies in Brazil, which started in 2019. The two projects adopt a synergistic work programme that is based upon three common pillars: biomass production and feedstock diversification, biomass logistics and optimization of conversion processes.



BECool and BIOVALUE teams at the joint meeting in Recife, Dec. 2019

The first BECOOL-BioValue joint meeting was held in Recife (Brazil) in December 2019, hosted by Universidade Federal de Pernambuco. On this occasion, partners from both Europe and Brazil engaged into parallel panel discussions about **how to exploit all the synergies and complementarities between the two projects**. Combining together the large expertise of this two consortia can deliver significant innovations and indeed many ideas and opportunities emerged from the spontaneous talks among the partners during the meeting. Some examples:

- Technologies developed by SME manufactures of agricultural machineries in Europe could help to increase the **efficiency of harvesting sugar cane straw**, an abundant but still challenging feedstock for second generation biofuels in Brazil;

- The experiences in the cultivation of Sunn hemp (*Crotalaria juncea*) by LNBR in Brazil could benefit to the development of sunn hemp cultivation as a summer cover crop in rotation with cereals in Greece, Italy and Spain, especially with regard to the identification of new varieties and cropping schemes;
- Several ongoing projects and research initiatives both in the EU and in Brazil were identified, that can feed their results and provide complementarity to BECOOL and BIOVALUE;
- A wide range of in-depth tests on feedstock characterization, gasification, pyrolysis and gas cleaning, (for example on sugarcane bagasse) can be implemented by combining and aligning the **analytical capabilities** already available at European and Brazilian laboratories;
- Significant improvements could be achieved in the **modelling of conversion processes** and in the development of cost estimations by sharing and harmonizing the data and the results of the different models available in the EU and Brazil.

On the last day of the project meeting, BECOOL partners had a study tour to the sugar and ethanol factory [Usina Petribù S/A in Lagoa do Itaenga - Pernambuco](#). The agricultural unit of the company manages over 21,000 hectares of sugarcane, while the sugar cane mill has an installed capacity of 160,000 tons of sugar per cropping season and can produce up to 200,000 litres of ethanol per day.



BECool coordinator Prof. Andrea Monti (University of Bologna) and BioValue coordinator Antonio Bonomi (Brazilian Biorenewables National Laboratory) at the joint project meeting in Recife

International cooperation discussed during BIOVALUE partners visits to Europe

In November 2019, Prof. Ricardo Soares Universidade Federal de Uberlândia (Brazil), spent some weeks in Europe visiting several BECOOL partners including the University of Bologna and RE-CORD in Italy, BTG and ECN/TNO in The Netherlands and VTT in Finland, to discuss the alignment of the research methods and experimental plans of the BioValue project on thermochemical conversion with the work of BECOOL. In February 2020, BioValue partners Prof. Fabio Toniolo, (COPPE Universidade Federal de Rio De Janeiro, Brazil) and Dr. Thalita Peixoto Basso, (ESALQ

Universidade San Paolo, Brazil) visited RE-CORD in Italy. Prof. Toniolo presented itsr work on catalysis for the upgrading of bioethanol to bioproducts and the catalytic upgrading of syngas to remove tars. Dr. Basso presented his work on optimized yeast strains for lignocellulosic ethanol production. RE-CORD showed the experimental facilities where BECOOL prototypes are working to produce bio-intermediates (i.e. pyrolysis products) and the team discussed about potential collaboration within BECOOL-BioValue and parallel activities.

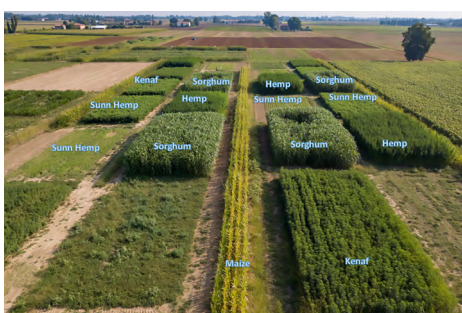
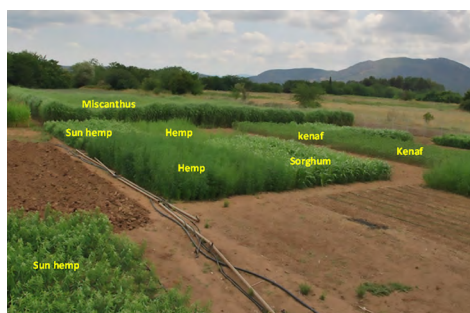
Integrated food-and-fuel farming systems: a sustainable solution for a a more efficient use of agricultural land

In 2019, the work on integrated food-energy crop rotations schemes of BECOOL entered in the third year of evaluation. The feasibility and the sustainability of growing annual lignocellulosic crops integrated in conventional maize-wheat rotations were assessed. The preliminary results indicate that introducing those crops into traditional rotation schemes **has no negative effects on cereal grain yields**, while it can **increase the overall biomass production** per hectare and **improve soil conditions**.

The cumulative results from the first three years of the rotation cycle (2017-2019) indicate that **grain yields were not affected** by previous crops in any of the different rotations and environments, while **biomass yields per hectare increased** when the energy/industrial crops were included in the rotation

scheme. The rotation “maize-biomass sorghum-wheat-sunn hemp” provided ds the highest biomass yields in Italy and Greece, whereas in Spain the most productive rotation was “maize-kenaf-wheat-sunn hemp”.

The experimental trials carried out in Italy by the University of Bologna indicate that it is possible to increase the production of biomass by **double cropping an energy crop in the summer after wheat harvesting**. Wheat was sown in November 2018 following the common farmers practices at the study site, sunn hemp was sown in July 2019 Immediately after the cereal harvest. The double cropping of sunn hemp after wheat provided an average of 6 Mg ha⁻¹ of additional dry lignocellulosic feedstock compared to the food control rotation, potentially eligible for advanced biofuel conversion.



“Integrated food-energy-crop schemes can be a sustainable solution”

Pictures from the crops' rotations in Italy: harvest of wheat (left upper side), harvest of sunn hemp (right upper side), view of field trials in Greece (2018, left lower side) and view of field trials in Bologna (2018, right lower side)

Long-term experiments confirm the potential of perennial lignocellulosic plantations on marginal land

In this task BECOOL partners CRES, University of Bologna and CIEMAT assess the long-term potential productivity of perennial lignocellulosic crops (giant reed, miscanthus, switchgrass, tall wheatgrass) and eucalyptus, grown on marginal and idle land. In Bologna (Italy), plantations of giant reed and switchgrass were established in 2003 on a reclaimed marginal land and grown with low input management. Harvest is carried out annually at the end of the winter. After 15 years these two plantations can still produce over 10t/ha of dry biomass every year (up to 14 t/ha last year).

In Greece, field trials with perennial grasses



Mechanical harvest of giant reed and switchgrass in Bologna, Italy.

(switchgrass, giant reed and miscanthus) were established on both marginal and medium fertility areas, with a lifetime varied from five to nineteen years. The average yield of switchgrass over 20 years ranges between 11 and 12 t/ha.

In the Spanish region of Extremadura, a switchgrass trial was established in 2013 on a land with low organic matter content with sprinkle irrigation and medium-low inputs conditions. The biomass productivity was assessed yearly from the beginning

of the trial up to now, yielding around 12 t/ha year in the period 2014-2019. This average productivity suggests a quite good potential for this perennial crop as lignocellulosic feedstock source in the tested region.

CIEMAT team has recently prepared an article on Tall wheatgrass (*Thinopyrum ponticum* (Podp)) as an alternative energy crop to rye (*Secale cereale* L.) cultivation in marginal areas of real farms and performance at energy, environmental and economic level. More information on this will be available in the next months!

A review of agricultural, forest and process residues for advanced biofuels in Europe and Brazil

An extensive review of available data about lignocellulosic feedstocks for advanced biofuels in Europe and in Brazil is being conducted by partners CRES and CIEMAT. Feedstocks include cereal residues, pruning and forest residues, bagasse, lignin-rich residues and other types of biomass. The review considered the availability of biomass, the analytical characteristics, harvesting and logistic options, market prices, cost and supply curves. The inventory covers Southern EU regions, a related work from Brazilian partners of the BioValue will be also included.

In addition to literature review, the [BIORAISE](#) tool is being used in this task to assess the resource potential and availability of agri-forest residues for Southern EU. BIORAISE is a web-based GIS tool developed by CIEMAT which provides data about agricultural and forest field biomass resources availability for energy use, including harvest and transport costs, existing biomass producers and bioenergy market stakeholders in Croatia, France, Greece, Italy, Portugal, Slovenia, Spain and Turkey. The review is an advanced stage of development and a complete report including also information from Brazil will be published by Spring 2020.

Learn more in this report: [D.1.1 – Setup of Assessment Tools and Literature Review.](#)

Tall wheat grass plantations in Spain. Source CIEMAT



Efficient harvesting and storage of lignocellulosic biomass

Another task of BECOOL is focused on improving harvesting logistics, recovering agricultural residues from cereals and reducing biomass loss from the harvesting of perennial crops and Eucalyptus. Residues such as **maize cobs**, **wheat chaff** and olive tree prunings are abundant and still untapped resources. Harvesting operations represent one of the most critical bottlenecks in the sustainability of these supply chains. In 2019, BECOOL partner CREA-IT performed harvesting tests of maize cobs and wheat chaff with innovative systems, in order to understand their advantages and restrictions in comparison with traditional ones.

Learn more in this report: [D1.3 - Definition of best harvesting logistics for agricultural residues, and for specialist annual and perennial lignocellulosic crops](#)



Recovery of wheat chaff with innovative Thievin System. Source CREA-IT.

While the harvesting operations of these crops are well known, storage is another essential step of the supply chain that is still critical and presents several drawbacks. An effective storage system can help significantly to decrease the initial moisture content of these types of biomass. For this reason, storage tests were performed by CREA-IT to monitor the evolution of moisture and dry matter of giant reed, Eucalyptus and fiber sorghum.



Storage test of giant reed (at CREA-IT)

In light of the strengthened cooperation with Brazilian BIOVALUE project, in November 2019 CREA-IT had the opportunity to visit sugarcane plantations in the North of Brazil. The purpose was studying the existing value chain of **sugarcane straw harvesting** and to improve it by reducing the ash content of straw bales, actually used to produce bioenergy (2G ethanol or electricity) alone or in combination with bagasse.



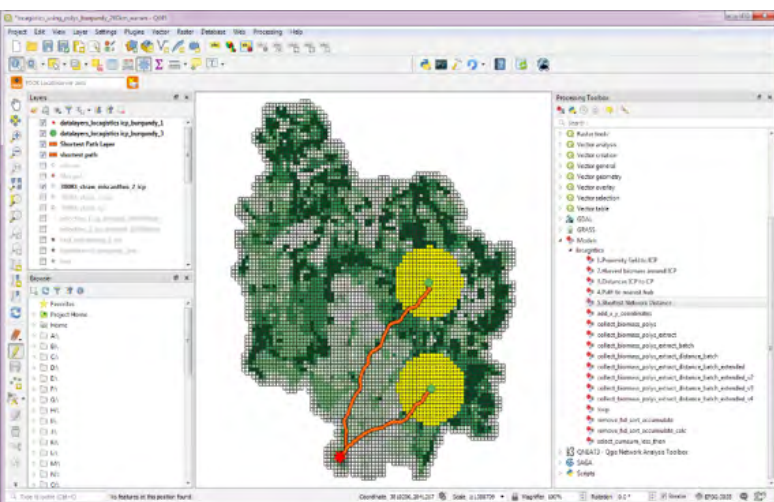
CREA-IT team visit at sugarcane straw harvesting sites in Brazil in December 2019 (up); storage of sugar cane straw (down)

Machine harvesting of sugarcane in North East Brazil, Dec 2019. Source CREA-IT



Optimization of biomass logistics

One of the initial activities in BECOOL was the description of various types of biomass logistic chains for advanced lignocellulosic biofuels varying for different feedstocks, regions and conditions.



This task is performed with available software tools which have been already used effectively in the past, for example in the S2Biom project. The tools are [LocaGistics](#), [BeWhere](#), BioloCo and BECOOL partners Wageningen University of Research (WUR) and IIASA are developing new versions of them. The updated tools will help to design and evaluate innovative, cost-effective logistic chains for advanced lignocellulosic biofuels in different regional conditions in Europe. They will also be used to adapt the supply of biomass to the requirements of standardized industrial conversion processes.

In 2019 the database feeding the three tools has been redesigned and is being completed with additional logistical components and data collected from literature. Furthermore, intensive work was carried out to link the BeWhere tool with the GLOBIOM model for the assessment of the sustainability of the BECOOL value chains.

The assessments of the different logistical concepts are now being evaluated by BECOOL partners WUR, IIASA and DBFZ. The value chain designs have been developed in detail and every step in the chains will be tested for fast and slow pyrolysis as well as gasification. Together with the Brazilian partners of the BIOVALUE project, a collaboration plan has been elaborated so to exchange information and deliver joint products.

Learn more in the report: [“D2.1- Description of full biomass supply chains”](#)

Recent experimental work on thermochemical conversion processes

Following the extensive project work plan for the optimization of biomass conversion processes, in 2019 a series of tests was carried out for the gasification and the pyrolysis of a wide range of feedstock and Aspen modelling was started.

Batches of a **slurry made with fast pyrolysis bio-oil (FPBO) and slow pyrolysis charcoal** were prepared by RE-CORD and feeding trials in an experimental gasifier were conducted by TNO. A mix of 10 wt% (weight percent) char-in-bio-oil was considered as the best solution, with good slurry capacity and an increased energy content compared to the pure FPBO. This solution has the potential to significantly reduce transportation costs when the slurry is moved from the pyrolysis plants to a central advanced biofuels production site. Gasification tests have been performed at TNO and the results were presented at the 27th EUBCE (May 2019) in Lisbon (P) and at TCBIomassPlus2019 Conference (September 2019) in Chicago (USA). Find slides at page 9.



In addition, TNO performed extensive testing on the **gasification of both pyrolysis oil and slurry**, for the conversion of these feedstocks into gas, for a potential Fischer-Tropsch supply chain.

In collaboration with VTT, the Aspen modelling was started in order to define economically viable value chains. At present two value chains have been defined and the results of gasification trials are used as input for the final calculations. The results of the gasification and the modelling work were presented at the European Biomass Conference and Exhibition (EUBCE) 2019 in Lisbon, Portugal. **Find the slides at page 9.** At VTT in Finland, batches of FPBO were produced from biomass samples of giant reed, eucalyptus and fibre sorghum. The FPBO will be used for gasification trials in a bench-scale test unit recently built by BTG in The Netherlands, where experimental work on the **fast pyrolysis of lignin-rich residues from biorefineries** is also ongoing.

REPORTS

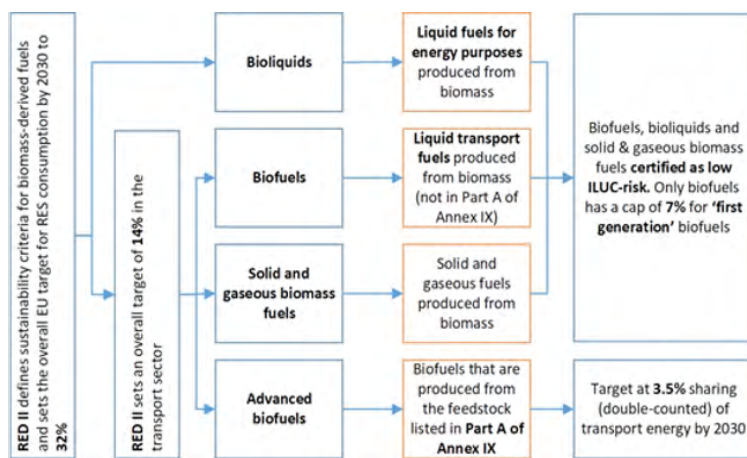
Regulatory framework, economic and social perspective of advanced biofuels and sustainable aviation fuels

A report on “Norms and standards for advanced biofuels” was prepared by RE-CORD.

The report provides a thorough overview of the EU legislative framework for the period 2020-2030 focusing on RED II and the related delegated acts.

The RED II Directive entered into force on 1st December 2018 and will be effective from 1st July 2021; Member States shall transpose it into National laws, regulations and administrative provisions by 30th June 2021.

Learn more in the report: [D3.4 Norms and Standards for Advanced Biofuels](#)



RED II targets for bioliquids, biomass and advanced biofuels.

Integrated market and value chain sustainability assessment

Market framework for advanced biofuels from lignocellulosic feedstock

Prepared by DBFZ, this report outlines the potential EU market for the types of advanced biofuels considered in BECOOL and provides a focus on the existing framework influencing the use of advanced fuels in different sectors and applications. Potential markets are described with regards to incentives and promotion mechanisms, market size the potential for future development and possible competitors.

Full report: [D5.2 Market Framework Description for Biofuels](#)

Ref. Ares(2019)1045652 - 20/02/2019




Project acronym: BECOOL

Project full title: Brazil-EU Cooperation for Development of Advanced Lignocellulosic Biofuels
Grant Agreement Number: 744821

Project start date: 01.06.2017

Deliverable 5.2

Title: MARKET FRAMEWORK DESCRIPTION FOR LIQUID BIOFUELS IN ROAD TRANSPORTATION AND AVIATION	
Author(s):	Stefan Majer, Katja Oehmichen, Daniela Thrän (DBFZ)
Reviewers	UNIBO
Date:	2019/02/19

Impact and strategy for liquid biofuels

This second report written by DBFZ defines the process for the market framework assessment in order to present the impact and strategy for liquid biofuels in road transportation and aviation. The core of the document is an overview of current market actors which were categorised. This is crucial to later analyse the different market dynamics through the Porter's Five Forces analysis (e.g. rivalry, buyer and supplier power).

Full report: [D5.4 Impact Strategy for Liquid Biofuels in Road Transport and in Aviation](#)

Ref. Ares(2019)4949002 - 29/07/2019




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Grant Agreement Number: 744821

Project start date: 01.06.2017

Deliverable 5.4

Title: IMPACT AND STRATEGY FOR LIQUID BIOFUELS IN ROAD TRANSPORTATION AND AVIATION	
Author(s):	Alexandra Pfeiffer, Katja Oehmichen, Linda König, Stefan Majer, Daniela Thrän (DBFZ)
Reviewers	UNIBO
Date:	29/07/2019

Upcoming Events

BECOOL project to be presented at BBEST-Biofuture conference 2020 in São Paulo

BECOOL will be presented at the [Biofuture Summit II and the Brazilian Bioenergy Science And Technology Conference BBEST 2020](#), which will take place on 30th March – 1st April 2020 in São Paulo (Brazil). The BBEST Science Conference and the 2020 Biofuture Platform multilateral initiative have joined forces to bring the world's very best in policies, innovation, science and market outlook in the bioenergy and bioeconomy sectors to Brazil. [Find agenda here](#)



Meet BECOOL at the European Biomass Conference 2020

Like in the past years, also in 2020 the BECOOL project will be presented extensively at the [European Biomass Conference and Exhibition \(EUBCE\)](#) which will be held in Marseille, France from the 27th to 30th April.

A workshop **Brazil-EU Cooperation for Development of Advanced Lignocellulosic Biofuels** will be organized jointly with the BIOVALUE project on the 29th of April afternoon as a side event of the conference.

In addition, the different aspects of the project will be discussed in nine presentations spreading across the entire conference programme:

- [Is Sunn hemp \(*Crotalaria juncea* L.\) a valid biomass feedstock alternative in temperate climates?](#)
W. Zegada-Lizarazu, A. Parenti, A. Monti
- [Agronomic performance of dedicated lignocellulosic feedstocks in a double cropping system following a cereal food crop](#)
A. Parenti; W. Zegada-Lizarazu; A. Borghesi; A. Monti
- Life Cycle Assessment of kenaf grown as feedstock for bio-products and power generation within a crop rotation with food crops in south-west Spain.
Carlos M. Sastre, J. Carrasco, R. Barro, J. Cabanillas, L. Royano, A. Parralejo, J. González, P. Ciria
- [Agricultural/forest residues for advanced biofuels](#)
M. Christou, J. Carrasco, C.M. Sastre, P. Ciria, P. Perez
- Effect of Wood Debranching on Eucalyptus Storage Performance
L. Pari, S. Bergonzoli, A. Suardi, et al.
- Giant Reed Storage, Assessment of Comminuted Biomass Behaviour
L. Pari, S. Bergonzoli, A. Suardi et al.
- [Fast pyrolysis of hydrolysis of lignin in fluidized bed](#)
E. Pienhäkkinen, C. Lindfors, T. Ohra-aho, A. Oasmaa, T. Granström, M. Yamamoto.
- [Towards advanced biofuels production from energy crops: Gasification and gas cleaning](#)
E. Boymans, B. Vreugdenhil

Check the conference programme at eubce.com



EUBCE 2020 *Transition to a Bioeconomy*
28th European Biomass Conference & Exhibition
27 - 30 April | Marseille - France | Marseille Chanot Convention and Exhibition Centre



Join us in Marseille!

Recent presentations and publications

On the 8th of October 2019, part of the activities of BECOOL related to pyrolysis were presented by Marco Buffi, RE-CORD at the conference TCI Biomass in Chicago (USA).

Slides: [A Study of Slurries Produced from Pyrolysis Products from Alternative Lignocellulosic Biomass Characterization and Use](#)

A thorough presentation of the agronomic aspects and initial results of BECOOL was presented by University of Bologna on the 20th of November 2019 at the 9th Stakeholder Plenary Meeting of ETIP Bioenergy

Slides: Lignocellulosic biomass and food crops: sustainable intensification of agriculture in the framework of the BECOOL project

Recent papers

- [Intercropping Dedicated Grass and Legume Crops for Advanced Biofuel Production](#)
A. Parenti, W. Zegada-Lizarazu, A. Monti
- Building Value Chains for Large Scale FT Production
B.J. Vreugdenhil, E.H. Boymans, P.M.R. Abelha, M. Buffi, D. Chiaramonti
- [Sustainable Biomass Feedstock Options for](#)

Advanced Biofuels

M. Christou, E. Alexopoulou, A. Monti, W. Zegada-Lizarazu, A. Parenti, J. Carrasco, C.M. Sastre

- [Comparable studies on four annual herbaceous lignocellulosic crops as feedstock for advanced biofuels](#)
E. Alexopoulou, W. Zegada-Lizarazu, M. Christou, A. Monti
- [Innovative Lignocellulosic Crop Rotation Systems as a Source of Feedstock for Biofuels Production](#)
W. Zegada-Lizarazu, A. Parenti, C. Martin-Sastre, J. Carrasco, M. Cristou, E. Alexopoulou, A. Monti
- [Fractional Condensation of Slow Oxidative and Intermediate Pyrolysis Vapors from Lignocellulosic Biomass: Pilot Unit Design and Testing](#)
M. Buffi, S. Dell'Orco, A. M. Rizzo, D. Chiaramonti
- [A Value Chain for Large Scale FT Production: the Case of Pyrolysis Oil-char Slurry Gasification](#)
E. H. Boymans, B. J. Vreugdenhil, P.M.R. Abelha, M. Buffi, D. Chiaramonti

Partners



<http://www.becoolproject.eu>



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