EERA European Energy Research Alliance BIOENERGY

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Joint Programme Coordinator's corner

Dr. Juan Carrasco
EERA Bioenergy Coordinator

Dear participants in EERA Bioenergy Joint Programme (JP), dear eebionews readers,

It is a pleasure for me, as EERA Bioenergy JP Coordinator, to be in this section once more at the end of this annual exercise, in order to make the presentation of the most relevant activities and achievements in 2017 and the perspectives for the next coming months and beyond.

As foreseen, **during this year most significant part of the activity in the JP has been focused on the elaboration of the JP DoW, which will contain the structure and research priorities of the JP for the three coming years.** With this purpose, during 2017 several well attended meetings and workshops have been organized and co-organized by the ad hoc JP working groups (WG), and particularly by WG1, WG2 and WG5. In these events, often with participation of external entities, **the discussions to align the opinions and facts towards priorities in Bioenergy research have been combined with a strong orientation to promote the collaboration in future proposals.** Moreover, synergies and horizontal activities among present Subprogrammes, a relevant issue to achieve the targeted objectives of the new DoW, have been also explored. At the time of this communication, the first strategy papers elaborated by the WGs are almost ready and the rest are expected by the first months of 2018. Their conclusion will involve a further assessment by stakeholders and JP participants and altogether will allow the definition of the JP new DoW.

In addition to the described technical activities, the Management Board has also been working on the **new JP Governance, adapting the present one to the related requirements contained in the EERA AISBL internal rules** document recently approved, and updating it, according to the JP new structure and needs for the management of the JP new DoW. The elaboration of a procedure of EERA quality label projects, whose approval was finally ratified by the JP Steering Committee last June is a relevant example and result of this work, given **the importance the EERA quality label is expected to have as a tool to select and manage projects that will address the priority activities contained in the new DoW.**

Adapting the present one to the related requirements contained in the EERA AISBL internal rules

Relationships and collaboration in the context of EERA and with relevant external stakeholders, another of the key actions highlighted in the strategy of JP, have also been enhanced and strengthen during 2017. Within EERA, to highlight the recent contribution from the EERA Bioenergy JP in response to an internal call with two proposals that hopefully will form part of the **Missions that EERA will propose for further consideration in the future FP9.**

With external stakeholders, the increased collaboration has been evident in the co-organization and participation in different events, in particular with the ETIP Bioenergy in which Steering Committee is represented the EERA Bioenergy JP through its Coordinator, while the JP Steering Committee meetings are attended by one representative of ETIP Bioenergy Secretariat. In 2017, in the context of the European Bioenergy Conference and Exhibition, EERA Bioenergy JP has collaborated in the organization and participated in a side Conference event organized by ETIP Bioenergy to discuss about strategies to bring the research results into the Bioenergy market. The event was attended by more than 50 participants, including CE representatives, research organizations, bioenergy companies and other stakeholders. EERA Bioenergy JP has also participated in the elaboration of the ETIP Bioenergy position regarding the biofuels objectives contained in the proposal of the new Renewables Energy Directive, **claiming for more relevant and accurate criteria for biofuels objectives in the RED II.**

In the context of **collaboration with external organizations,** also to point out the participation on a meeting organized by IEA Task42 and attended by representatives of IEA Bioenergy, FAO, ETIP Bioenergy, IRENA, EC DG JRC and DOE where the views of the

assisting organizations regarding the **role of Bioenergy and biorefineries in the context of Circular Economy** was discussed, and the set of a more stable framework for cooperation was also examined, being identified some joint opportunities that will be tried to put in practice in the next year. More detailed information from this meeting and from the before mentioned workshops is on JP web page (www.eera-bioenergy.eu, section "Publications"), and one article regarding one of the workshops can be found in this newsletter, signed by Francisco Girio ("News in brief" section).

On the side of bioenergy research assessment, particularly to SET-Plan (one of the main aims of EERA Bioenergy JP), and as a continuation of the inputs to the Issues paper on SET-Plan Action number 8 in 2016, an important activity has been initiated this year within the Temporary Working Group launched by the SET-Plan in October 2017. The objective of the TWG is to define an Implementation Plan which identify priority R&I activities covering short, mid and long-term actions to be carried out by several actors (SET-Plan countries, stakeholders and/or the EC within its mandate) to achieve the targets set in the DoI elaborated by the Task Force on Renewable Fuels and Bioenergy in 2016, for the SET-Plan Priority Action number 8 ("Renewable Fuels and Bioenergy"). In this framework, in addition to other research actions to promote the use of advanced biofuels, particularly in the fields of aviation, shipping and long-haul transport as well as in CHP (hybrid RES) plants, from the EERA Bioenergy JP it is being stressed the **importance to develop sustainable feedstock production and supply chains according to the demand requirements of the expected commercial plants with new technologies in advanced biofuels, to explore and develop the real potential of advanced biofuels in Europe.**

Finally, I would like to finish the review on the most important activities carried out in the year, making a mention to the PAD issues. In addition to this newsletter that was launched last year, in 2017 the new JP website with a new design, as well as other actualized PAD materials are now available (see on the web page section "Publications"). All of them form part of the set of tools designed to **improve and professionalize the image of the JP.**

To sum up, it can be concluded that the JP has progressing well during 2017 towards the main objectives and actions that compose the strategy designed in 2016, conducting EERA Bioenergy JP to become a robust tool to assess and accelerate the achievement of the SET-Plan priorities on Bioenergy while creating a high added value for its participants. As I did last year, **I would like to ask for renewed efforts to all members of the JP to actively participate in the JP activities and, in first term, in those related to the definition of the new DoW coming in the next months.**

I wish you a relaxing Merry Christmas time and Happy New Year 2018.

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Bioenergy news in brief

SP1 AND SP2 JOINT WORKSHOP ON PROPOSALS GENERATION FOR H2020 2018-2020

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Last October 27th, 2017, in Brussels, it was held a joint Workshop organized by the Subprogram 1 and Subprogram 2 of EERA-Bioenergy to pitch proposals ideas for next H2020 EU Calls on Renewables in the Transportation sector.

The Workshop was attended by 18 participants from CIEMAT, CSIC, IMDEA-Energy and CENER (Spain), University of Padua, University of Perugia, University of Torino and University of Modena and Regio Emilia (Italy), IFK Stuttgart and Karlsruhe Institute of Technology (Germany), University of Aalborg (Denmark), LNEG (Portugal), Norwegian University of Science and Technology-NTNU and SINTEF (Norway), ECN and Wageningen Food & Biobased Research (The Netherlands), National Technical University of Athens (Greece).

It is expected that some ideas will generate full proposals to be submitted for those H2020 calls.

Almost a dozen of proposal ideas has been generated, most of them targeted for the Calls LC-SC3-RES-21-2018 (Development of next generation biofuels and alternative renewable fuel technologies for road transport) and LC-SC3-RES-1-2019-2020 (Developing the next generation of renewable energy technologies) and a template for each idea proposal has been filled and distributed by all participants. It is expected that some ideas will generate full proposals to be submitted for those H2020 calls.

Bioenergy highlights

INTEGRATION OF WASTEWATER TREATMENT PLANTS WITH MICRO-SCALE GASIFICATION AND MICROALGAL GROWTH

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In this study, 3 different sludge wastes were used as feedstock to cultivate microalgae species: *Neochloris oleoabundans and Chlorella sp.*

The sludges obtained from three different treatment plants were used as algal growth mediums after the necessary optimization of the original waste have been done. 4 microalgal growth mediums were used: Sludge1, Sludge2, Sludge3 and BG11 growth medium as control. According to the sludge contents a certain amount from each sludge sample has been used for microalgal growth medium (Figure 1). The culture medium components and the conditions were optimized according to commercial microalgal growth medium components (also microalgal growth conditions in nature).

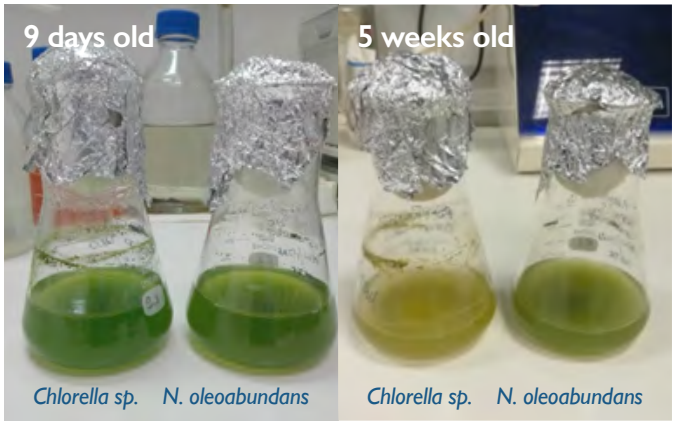
Microalgal growth in sludge waste feedstock Inoculation (1st day)

The cell growth parameters of two microalgal species were monitored within 10 days: Cell concentration, optical density, cell biovolume (cell size), photosynthetic pigment content (chlorophyll *a*, chlorophyll *b* and carotenoid (carotene and xantophylls); total lipid and total pigment contents have been measured within 16 days of growth period.

As a result, each sludge waste is suitable to use as microalgal feedstock. Sludge1 feedstock provided a higher amount of lipid content and in some conditions higher amount of photosynthetic pigment content. Accordingly, these optimized mediums are suitable to use for both heterotrophic and photoautotrophic culture growths together with the needed optimizations.

While especially Sludge 1, plus Sludge 2 can be used as microalgal growth medium for lipid extraction from, Sludge 3 can have a better use also for heterotrophic growth medium.

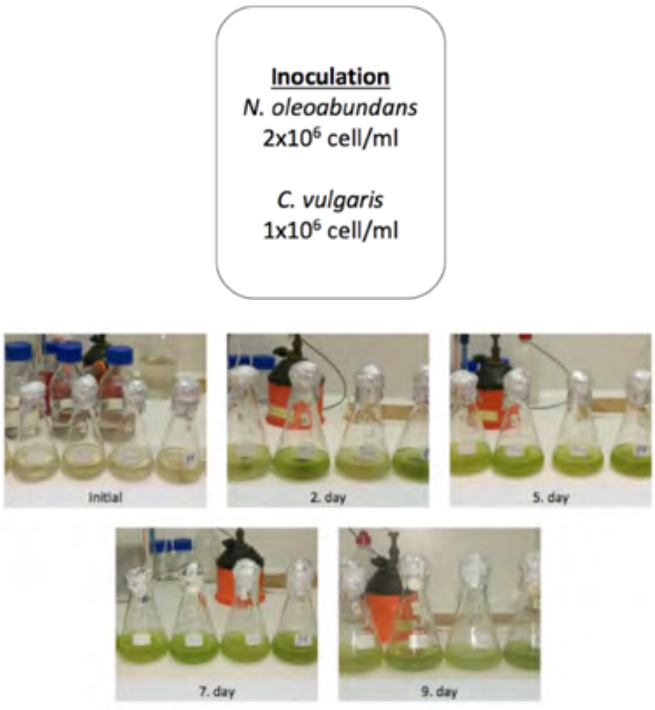
The initial growth period of *Chlorella sp.* is observed to be earlier and faster than *N. oleoabundans.* In the beginning of the growth *Chlorella sp.* grows faster than *N. oleoabundans* but *N. oleoabundans* can be adapted stronger against the stress factor of the sludge mediums. *Chlorella sp.* consumes the nutrients faster than *N. oleoabundans,* than having lack nutrient problem. This problem can be solved by refreshing the growth medium more frequent. *N. oleoabundans* able to continue its growth longer under the same conditions and medium.



N. oleoabundans and *Chlorella sp.* Growth in Sludge3 Medium

As a result, the culture growth conditions and nutrient content of these three-waste sludge can be useful for batch cultures or higher amounts of microalgal cultures. The point is the necessary product that has to be provided from microalgae. Protein, lipid or other secondary metabolites can be provided in higher amounts if the necessary culture conditions are optimized. These conditions can be adjustable according to the product need. An algae cultivation can be fortified to enhance the lipid production or protein production etc. The way of efficient product gain is to provide the right growth conditions for the specific product in need.

Microalgal growth within 9 days



Microalgal growth within specific period in the growth mediums optimized from sludge waste.

A high number of cells were used for the initial cell inoculation which means cell concentrations of the initial cultures were $2x10^6$ and $1x10^6$ for *N. oleoabundans* and *Chlorella sp.*, respectively. The microalgae culture inoculation with a higher cell concentration can provide a successful growth rate according to lesser cell inoculation in the stress conditions.

Additionally, these mediums optimized from sludge wastes have been also used for heterotrophic growth (in the dark, by adding carbon source) of *N. oleoabundans,* after the photoautotrophic growth.

A further option is the gasification of sludge pellets in a downdraft reactor connected to an IC engine-electrical generator of 20 kW peak power. The process is modeled with chemical equilibrium Barman model.

The gasifier modeled for sludges thermo-chemical conversion.

SUSTAINABILITY AND INNOVATION OF THE WINE-PRODUCTION VALUE CHAIN IN THE EMILIA ROMAGNA REGION, ITALY: SOSTINNOVI PROJECT

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From a device that analyzes grapes and sends data via smartphones, allowing them to "estimate" aging, robots and drones to monitor vineyards. Passing through sensors that in the cellar control the main indicators of the winemaking process and processes that retrieve production waste and transform them into bioplastics and building materials.

Vineyards monitoring with drones

These are some of the first scenarios already open to the future Emilian-Romagna wine-growing industry: more sustainable, efficient and technological. These are some of the first experimental and prototype results that have been developed in the research project "SOSTINNOVI, that I coordinate as professor at the interdepartmental research center BIOGEST - SITEIA (UNIMORE).

SOSTINNOVI

The SOSTINNOVI project, which started in April of 2016 and to be completed in March 2018 was financed with around € 800,000 The research also involves companies that cube 80% of the regional wine production such as Caviro, Cantine Riunite & Civ, Cevico Group, Cantina Sociale San Martino in Rio and Emilia Wine. In the vineyard, grapes are monitored with drones and smartphones to determine the degree of maturation of the grapes. In the cellar, it works on environmental control and management, using less energy-consuming techniques and eliminating, as far as possible, allergens such as sulphur dioxide.

Temperature-controlled grape juice stabilization

In addition, the management of by-products of the vineyard waste is used to produce energy (syngas and heat) and biochar used in vineyards as a fertilizer improves the fertility and sequestration of CO_2 from the atmosphere.

The residual grape residues from wine making can be used as 'filling' for the production of plastic materials using conventional resins but with the saving of this material.

Polypropylene and clay bricks samples produced with waste material from the wine production chain

Finally, the fermentation process is handled remotely, so a sign from the wine tank tells you how much it is full and other useful directions for the process. With SOSTINNOVI you want to bring a good amount of innovation in all aspects of the supply chain. The vocation of the laboratories involved is to interfere with production realities. Five of the largest oenologists in the region now collaborate, but in the continuation of this work will also be involved small cellars with excellent productions, because systems that have been developed or are being refined are applicable to large industrial realities but also small, smaller production companies.

IEA BIOENERGY TASK42: BIOREFINING IN A FUTURE BIOECONOMY

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IEA Bioenergy

Task42

Biorefining in a Future BioEconomy

Aim of IEA Bioenergy Task 42

http://task42.ieabioenergy.com

The aim is to facilitate the commercialisation and market deployment of environmentally sound, socially acceptable, and cost-competitive biorefinery systems and technologies, and to advise policy and industrial decision makers accordingly. Task42 provides an international platform for collaboration and information exchange between industry, SMEs, GOs, NGOs, RTOs and universities concerning biorefinery research, development, demonstration and policy analysis. This includes the development of networks, dissemination of information, and provision of science-based technology analysis, as well as support and advice to policy makers, involvement of industry, and encouragement of membership by countries with a strong biorefinery infrastructure and appropriate policies. Gaps and barriers to deployment will be addressed to successfully promote sustainable biorefinery systems market implementation.

Work Programme 2016 – 2018

The priority of the Task42 activities for the 2016 – 2018 triennium all have the objective to further contribute to the market deployment of sustainable biorefineries. The focus will be on international and national networking activities, standardisation and certification of biobased products, policy advice, and the role of industrial and SME stakeholders from the bioenergy and biofuel sectors in the transition to a BioEconomy. The Work Programme 2016 – 2018 is divided into four main Activity Areas, viz.:

- Biorefinery Systems – Analysis and assessment of biorefining in the whole value chain.
- Product Quality – Reporting on related biobased products/ bioenergy standardisation, certification and policy activities at national, European and global levels.
- Evolving BioEconomy – Analysing and advising on perspectives of biorefining in a Circular BioEconomy.
- Communication, Dissemination and Training – Knowledge exchange by stakeholder consultation, reporting and lecturing.

Recent Workshops

The Role of Industrial Biorefineries in a Low-carbon Economy, IEA Bioenergy / IEA IETS, Gothenburg, Sweden, 16 May 2017.

Interactive workshop focus:

- Pulp and paper mills
- Chemical industries
- Food and feed industries
- Petroleum refineries
- Energy utilities

Main deployment barriers:

Social
- Public perception on both BM sustainability and BBPs
- Food habits, throw-away society
- Resistance to change

Technological
- TRL, complexity BRs, lack of qualified staff, etc.

Economic
- Large investments, high risks, profitability?
- BR business models, etc.

Markets
- Conservative industry, need for cooperation
- Opposition and competition, volatile markets

Policy
- Lack of consistency and LT vision
- Legislation (waste, food safety, etc.)

Bioenergy and Biorefining in a Circular (Bio)Economy – IEA Bioenergy, FAO, OECD, EERA Bioenergy, ETIP Bioenergy, IRENA, EC DG JRC, DOE – Brussels, Belgium, 27 September 2017

Attendees (from left to right in the picture): Kees Kwant and Luc Pelkmans (IEA Bioenergy), Jeffrey Skeer (IRENA), Irini Maltsoglou (FAO), Birger Kerckow (ETIP Bioenergy), Michiel Klinkenberg (EC DG JRC), Juan Esteban Carrasco Garcia (EERA Bioenergy), René van Ree (IEA Bioenergy T42); photographer: Bert Annevelink (IEA Bioenergy T42).

iea Energy Technology Network

Foreseen future cooperation:

- Continuation parallel activities and keeping each other actively informed on major achievements (reports, etc.).
- Organising an annual joint dissemination event on Bioenergy and Biorefining in a Circular BioEconomy: success stories, lessons learned, innovation needs etc.
- Joint database bioenergy/biorefinery facilities or coupling existing ones.
- Contact other international organisations (OECD, BIC/BBI, etc.) and assess cooperation opportunities.
- Identifying (2018) and final (2019 onward) execution of some joint projects.

New Work Programme 2019–2021 - Request for input

Early 2018, Task 42 will draft a first work programme for the 2019-2021 triennium. All stakeholders, e.g. SMEs, industry, policy makers, NGOs, research institutes, universities, etc., active in the biorefinery/BioEconomy sector are invited to come-up with specific ideas for this new work programme.

Questions we have are:

- What biorefinery/BioEconomy data are you looking for?
- What kind of assessment tools are still lacking?
- What type of reports or papers provide added-value for your activities?
- Do you need any biorefinery/BioEconomy based training?
- Do you want to be involved more closely to the activities of Task42?

So please send us your ideas, input and requests before the end of 2017 by e-mail to secretariaat.bbp@wur.nl, stating in the subject line: 'IEA Bioenergy Task42 – Input 2019-2021 Work Programme'.

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APPLY TO BOOST YOUR BIOFUELS RESEARCH WITH BRISK2

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BRISK2
BIOFUELS RESEARCH INFRASTRUCTURE

The second Biofuels Research Infrastructure for Sharing Knowledge has launched. Academic and industry biofuels researchers are invited to submit proposals to access state-of-the-art equipment and specialist expertise, funded by BRISK2.

Researchers from around the world working on biofuels, including thermochemical conversion, biorefinery and biochemical conversion can now apply to visit any of the 15 BRISK2 research partners located outside of their home country. BRISK2 will pay for Transnational Access to biofuels research facilities in the BRISK2 network, along with a grant for travel and subsistence.

Project Co-ordinator, Andrew Martin of The Royal Institute of Technology (KTH) in Stockholm said: "It is a pleasure to be a part of BRISK2, and I am really looking forward to working with the consortium and welcoming researchers for Transnational Access. The exciting part of BRISK2 is the ability to offer Transnational Access to researchers both inside and outside Europe, making this project truly international."

The Biofuels Research Infrastructure for Sharing Knowledge (BRISK2) launched in June 2017, following in the footsteps of the first BRISK, which ran from 2011 and 2015 and supported over 200 research visits across Europe. BRISK2 will run until 2022 with funding of nearly €10m from the European Horizon 2020 programme. BRISK2 aims to support more biofuels researchers from across the world on a broader range of projects, and enquiries for research visits in 2018 are now welcome.

To find out more about the BRISK2 programme of Transnational Access, visit the project's brand new website **www.brisk2.eu** or email Project Coordinator KTH at **brisk2@energy.kth.se**.

Project partners include: Aston University (UK), CENER (Spain), KIT (Germany), KTH (Sweden), Bioenergy2020+ and Graz University of Technology (Austria), ENEA and Politecnico di Torino (Italy), Sintef (Norway), LNEG (Portugal), ECN, Delft University of Technology and Wageningen (Netherlands), CERTH (Greece) and VTT (Finland).

Funded by Horizon 2020, BRISK2 will improve the success of biofuels implementation by accelerating the development of expertise and knowledge, leading to new renewable energy developments across Europe. It will provide opportunities for international collaboration foster a culture of co-operation and establish Europe as a global centre of excellence in biofuels.

BRISK2 project partners are also collaborating on Joint Research Activities, investigating feedstock characterisation, developing advanced measurement techniques and system simulation tools, as well as researching innovative biorefining approaches.

CLAMBER R&D BIOREFINERY – A DEMONSTRATIVE FACILITY IN SPAIN DEVELOPED WITH THE SCIENTIFIC ASSISTANCE OF CIEMAT

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In order to place itself in the centre of the new European Strategy for Bioeconomy, Castilla-La Mancha (CLM) region, situated in south east of Spain, developed, through the Forest, Food and Agriculture Research Institute of Castilla-La Mancha (IRIAF), the Castilla-La Mancha Bioeconomy Region Project (CLAMBER Project). As a result, and with the scientific assistance of CIEMAT, two actions were developed: 1) a Pre-Commercial Public Procurement to carry out 19 R&D projects related to biomass valorization and 2) the construction of the **CLAMBER R&D Biorefinery** in Puertollano, near an oil refinery in the centre of Spain. This location was chosen considering the interest of CLM industries, enhancement of technological and market opportunities owing to the proximity to large tractor industries and the petrochemical hub of CLM.

CLAMBER R&D Biorefinery is a public demonstrative facility at the service of companies for process optimization, development of new bioproducts, scale-up of experiments (from kilograms to one ton of dry matter per day) and training in biotechnology, ensuring full confidentiality. The type of biomass that can be fed and studied are lignocellulosic biomass (prunings, branches, straw, etc.), sugar or starch biomass (corn, beet, etc.) and wet biodegradable biomass (whey, grape marcs and lees, OFMSW, etc.).

To fulfil these general aims, its technical characteristics are:

- **Flexibility** to develop several processes from very different raw materials. Also, it can integrate different technologies temporarily, especially in up-stream and down-stream zones.
- **Relevant size** of the basic operations and technologies. A steam explosion reactor of 400 l and a fermenter of 20.000 l, almost industrial, allow companies to obtain more reliable information for process scale-up.
- **Robust equipment** which allows the development of **innovative processes**.
- **Complementary** to existing capacities in Spain and, especially, in CLM.
- **Modular**, bearing in mind two points of view: a) it can work on areas and processing units in isolation without using the whole plant and b) it can be likely to expand to other technologies not covered in the initial project.
- **Sustainable** in terms of energy consumption and effluent management.

The demonstrative plant is organized into several areas:

UPSTREAM:

- Mills for herbaceous and woody biomass (200 kg/h)
- Extractor with vapour (3 m^3)
- Two-step Steam Explosion Reactor (400 l, up to 21 barg)
- Solid/liquid separators (15 m^3/h)

Up-stream unit of the lignocellulosic biomass

MID-STREAM:

- Microbiology laboratory for micro management (starters, inoculants, etc.)
- Reactors for hydrolysis and anaerobic and aerobic fermentation: 2 x 3 l, 2 x 30 l, 1 x 300 l, 1 x 3,000 l and 1 x 20,000 l
- Systems for sterilization, substrate preparation, addition of sterile reactants, cleaning in place, and other utilities

Fermentation train of the Mid-stream unit: 300 l, 3,000 l and 20,000

DOWN-STREAM:

- Harvesting Tanks with capacity to act as a extractor: 2 x 10000 l and 2 x 1500 l
- ATEX area
- Microfiltration system (1 m^3/h)
- Centrifugation system (1.5 m^3/h)

ANAEROBIC DIGESTION PLANT:

- Storage tanks for liquids (20 m^3) and solid (10 m^3) wastes
- Pasteurization System (1 m^3)
- Anaerobic Digester (11 m^3)
- Gasometer (20 m^3)

MODELING INTEGRATED CROPPING SYSTEM FOR FOOD AND ENERGY PURPOSES IN EUROPE

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The **Brazil-EU Cooperation for Development of Advanced Lignocellulosic Biofuels (BECOOL)** is an EU-H2020 project structured into **three main pillars** covering in a balanced way the whole range of activities of advanced biofuel value chains (i.e. biomass production, logistics and conversion).

The **first pillar** (biomass production and feedstock diversification) seeks to enhance the multitasking of traditional agriculture as a key strategy to fulfill the EU - Horizon 2020 targets. Currently in EU-27 about 86% of the cropped areas are cultivated under conventional crop rotation schemes including very few crops, often only two crops, with wheat being by far the most important one. It is not unusual that soil remains uncultivated (fallow) for several months, up to 9-10 months in certain circumstances. Therefore, there is a great potential for introducing annual lignocellulosic species into existing crop rotations. This could dramatically increase the production of lignocellulosic biomass without reducing food crop acreage. For example, a rotational system intercropping the leguminous species sunn hemp (Crotalaria juncea L.) between wheat and maize can provide 10-12 Mg ha-1 of additional dry lignocellulosic biomass. Moreover, this species, being a legume, does not need N fertilizers, while also could lower the input for the following crop, and provide additional ecosystem services such as crop diversification and attraction of pollinating insects during flowering. Sunn hemp is only one example of an alternative suitable and easy-to-grow annual lignocellulosic species that might be introduced in Europe to dramatically increase lignocellulosic biomass production on arable land without reducing food availability.

Modeling approaches are seen as important tools for forecasting the performance of such agricultural systems across time and space. The present modeling activity aims at simulating the potential lignocellulosic biomass yields of integrated cropping (food non-food crops) systems across EU temperate climates. The specific acclimation of the identified crop combinations and sequences to determined areas/regions will be extrapolated to larger areas based on biophysical factors such as climate, soil characteristics, crop phenology and management, biomass yield, as well as current rotational systems. In order do to that the platform BioMA will be used. This open source software is designed and implemented for developing, parameterizing and running modeling solutions in agricultural and environmental fields. This modeling studies will be calibrated and evaluated at three locations (Italy, Spain and Greece) and then extrapolated to temperate climates of EU. This modeling approach will allow to promote integrated, sustainable, and near-to-practice solutions to reduce the gap of lignocellulosic feedstock demand in the short term.

BECOOL project consortium at the kick-off meeting

www.becoolproject.eu

A STUDY FOR THE EC COORDINATED BY CENER GATHERS INFORMATION ON ILUC GHG EMISSIONS ASSOCIATED WITH BIOFUELS PRODUCTION

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The European Commission, by its Directorate-General for Energy commissioned CENER the coordination of this study, which has been elaborated in collaboration with researchers of Wageningen Economic Research, Netherlands Environmental Assessment Agency and Wageningen Environmental Research.

Research experts of CENER (National Renewable Energy Centre of Spain) have coordinated the project commissioned by the European Commission to gather comprehensive information on, and to provide systematic analysis of the latest available scientific research and the latest available scientific evidence on indirect land use change (ILUC) greenhouse gas emissions (GHG) associated with production of biofuels and bioliquids.

The study describes the selection and review of ILUC related literature, especially highlighting the development and progress in understanding and quantifying ILUC in the recent years. The main methods used to quantify ILUC are described, and the most relevant ILUC related studies, which provide detailed qualitative and quantitative results, are outlined. Besides, ILUC factors found in the literature are presented and related to the quantification methodology applied. The report also provides an in-depth analysis of key assumptions in ILUC research and related uncertainties. Finally, it also analyses the main mitigation options for ILUC, including low ILUC-risk biofuels.

Among the main conclusions of the study coordinated by CENER, it is underlined that ILUC factors identified in the literature vary significantly across biofuel pathways, studies, or even within studies depending on the hypothesis used. Besides, studies that have investigated parametric uncertainty conclude that this fact has a significant effect on the outcomes. Because of all the uncertainties in the components of ILUC emissions, it is very difficult to narrow them down.

EC policies requiring the study

According to Article 3 of the European Union's **Directive (EU) 2015/1513** of 9 September 2015, the European Commission has to **provide information on, and analysis of the available and the best available scientific research results,** scientific evidence regarding ILUC emissions associated to the production of biofuels, and in relation to all production pathways.

Besides, according to Article 23 of the **revised European Union's Directive 2009/28/EC** (RES Directive), the Commission also has to provide the latest available information with regard to **key assumptions influencing the results from modelling ILUC GHG emissions,** as well as an assessment of whether the **range of uncertainty** identified in the analysis underlying the estimations of ILUC emissions can be narrowed down, and if the possible **impact of the EU policies,** such as environment, climate and agricultural policies, can be factored in. An assessment of a possibility of setting out criteria for the identification and certification of **low ILUC-risk biofuels** that are produced in accordance with the EU sustainability criteria is also required.

More information and access to the study

The full study is **available in English.** For further information click here, and for a short summary presentation of the study click here.

PROJECT H2020 ERANET-LAC: SMIBIO 'SMALL-SCALE INTEGRATED BIOREFINERIES'

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This H2020 ERANet-LAC funded project, coordinated by Dr. Francisco Gírio (LNEG, EERA Bioenergy member) involves scientific partners and private companies from Latin America (Mexico, Colombia, Chile, Argentina) and Europe (Portugal, Spain and Germany).

From 13th to 16th of November, SMIBIO Consortium (www.smibio.net) met in Cuernavaca, Mexico and did also organize the 3rd SMIBIO Workshop "Small-scale Biorefineries for Rural Development in Latin America and Europe" in cooperation with the Biotechnology Institute of Universidad Nacional Autónoma de México (IBt–UNAM). The aim of the workshop was to present the recent developments towards the optimization of small-scale integrated biorefineries case studies developed within the SMIBIO project and to discuss with stakeholders the opportunities and challenges of deployment small-scale biorefineries for rural development. Compared to large scale biorefineries (feedstock inputs usually between 300,000 – 1,000,000 ton/year), small-scale biorefineries require a significantly lower investment and much less biomass supply. Such concept represents new opportunities for rural development and job creation. However, numerous challenges still hamper the commercial deployment of such small-scale biorefineries. The current biorefineries are under study:

LNEG (SMIBIO coordinator) is using as biomass feedstock corn stover and swine manure. The production scenarios for ethanol, xylitol, oligosaccharides, lignin and biogas (for CHP) is being assessed for a biorefinery plant located in Chamusca region (Portugal). The biorefinery input shall be between 30,000 and 100,000 ton/year dry corn stover.

UNC (Colombia) are considering pseudostem and plantain peel as feedstock, which can be converted into ethanol, butanol, xylitol, furfural, PHB, steam, electricity and biogas. To reach the economic feasibility, a biorefinery feedstock input above 60,000 ton/year has been modelling in Leticia and Arauca regions (Colombia).

PUCV (Chile) also deals with wheat straw and swine manure as dry and wet feedstocks, respectively. The products envisaged are butanol, biogas (CHP) and stabilized sludge (soil fertilizer). The process is energy intensive and requires additional energy sources (wheat straw). Other by-products production is now being considered to reach the economic profitability.
UNAM (Mexico) are dealing with agave bagasse and tequila's industry stillage as feedstocks. Products include ethanol, xylitol, furfural, lactate and succinate. A plant input for 150,000 ton/year feedstock and a dilute acid hydrolysis pretreatment are being considered.

CIEMAT (Spain) is modelling a biorefinery using olive oil prunnings as dry biomass, while fermentation stillage is used as wet feedstock. Envisaged products include ethanol, antioxidants, sugars and electricity. The integrated production of biogas leads to an increase in energy efficiency.

WIP (Germany) is working with a green biorefinery approach, using grass clippings and grass-like waste as feedstock. Production of fertilizers or the use of ion exchange resins to separate different types of fertilizers is being considered.

In the last day of SMIBIO related events, a Course in Advanced Biorefineries was also organized by the consortium and it was geared to students, researchers and stakeholders working on Biofuels, Biorefineries and Bioenergy subjects. In the afternoon, SMIBIO partners visited the IBt-UNAM facilities in Cuernavaca (Mexico).

3rd SMIBIO Workshop "Small-scale Biorefineries for Rural Development in Latin America and Europe"

SMIBIO members also participate in the 4th Annual Meeting of the Thematic Network on Bioenergy (of Mexico) and in the 13rd meeting of Mexican Network of Bioenergy. This photo: Francisco Gírio (LNEG, Portugal, left side) and Alfredo Martinez (UNAM, Mexico, right side)

ENABLING THE BIOCARBON VALUE CHAIN FOR ENERGY

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In the project **BioCarb+** (Enabling the biocarbon value chain for energy; 2014-17) a huge effort has been made towards studying the biocarbon value chain and its different value chain elements with respect to improvement possibilities while satisfying end-user demands.

BioCarb+ is a competence building project led by SINTEF Energy Research and 80% financed by the Research Council of Norway and 20% financed by several industrial partners. The overall objective has been development of new strategies for use of low-grade biomass, pulpwood and energy wood resources for BC production for raw material for industrial applications (reduction agent / metallurgical coke) and conversion for energy purposes, specifically:

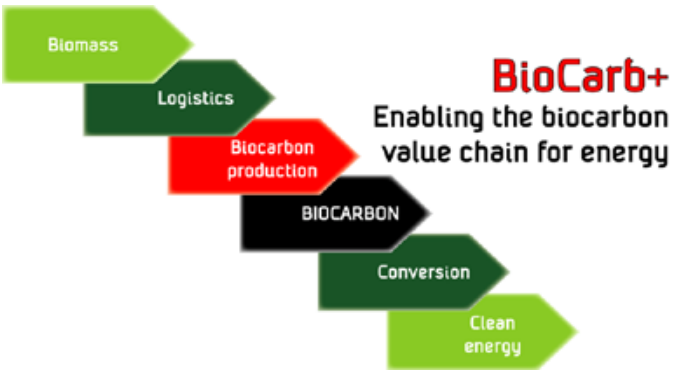
- New or improved biomass harvesting and logistics solutions, with special attention to forest residues, but also pulpwood and energy wood (including hardwood), and their properties.
- New or improved biocarbon production solutions through development or improvement of biomass pretreatment methods, biocarbon production processes and applications and biocarbon logistics solutions.
- New or improved biocarbon conversion solutions through development or improvement of biocarbon conversion applications with focus on high energy efficiency and low emissions, and biocarbon properties for industrial applications.
- Efficient utilisation of by-products from the biocarbon production process to improve overall economy and improve sustainability (CO_2-footprint) of biocarbon production and utilisation.
- Education of highly skilled candidates within this area and training of industry partners.
- Monitoring of activities and state-of-the-art within this area and dissemination of knowledge to the industry partners, and other interested parties where applicable.

In BioCarb+, a large number of deliverables has been finalised, including many journal publications. In sum they point towards a very significant improvement potential throughout the value chain, providing guidelines for sustainable biocarbon value chains for both energy use and for the use as reductant in metallurgical processes, based on Norwegian forest resources.

The project has been highly international, through both international partners and scientific collaborators, and has as well had a significant integrated and international educational activity, through PhD candidates financed by the project, and connected graduate students as well.

However, especially for metallurgical industries, there is a need to optimize the value chain towards the needs of the specific metallurgical processes, i.e. quality criteria with respect to the biocarbon properties. This is a challenge, but also an opportunity, as the available and highly heterogeneous forest resources can be sourced and the biocarbon can be tuned towards a specific end-use, satisfying the end-user quality demands while at the same time maximizing the sustainability of the value chain.

To arrive at this a continued research momentum towards broad use of renewable biomass based reductants in the Norwegian metallurgical industries is needed.



The biocarbon value chain for energy

More information about the BioCarb+ project, project partners, and results, can be found on the project homepage: www.sintef.no/biocarb

CASCATBEL PROJECT REACHS ITS FINAL MILESTONE. A NEW CONTRIBUTION FOR PAVING THE WAY TO ADVANCED BIOFUELS TECHNOLOGY DEVELOPMENT

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The final meeting of the CASCATBEL project was held at the IMDEA Energy facilities, in Móstoles (Spain), last October 24th and 25th with the attendance of the Monitor appointed by the European Commission. CASCATBEL project (www.cascatbel.eu) has received funding from the European Community's Seventh Framework Programme FP7/2007-2013 under Grant Agreement nº 604307. The project has been executed under the coordination of IMDEA Energy (Spain) with a team of 17 partners from 10 different EU countries. The aim of the project was to "design, optimize and scale-up a novel multi-step process to produce second-generation liquid biofuels from lignocellulosic biomass in a cost-efficient way using next-generation high surface area tailored nano-catalysts".

The main achieved innovations include new efficient catalysts for catalytic pyrolysis and further bio-oil upgrading via hydrodeoxygenation as well as new and robust analytical protocol for assessment of critical catalyst properties evolution like acidity/ basicity and coke formation.

The commercial feasibility of the process has been confirmed through a study based on the design and optimization of a large-scale plant co-producing advanced biofuels and renewable electricity with an overall energy efficiency over 50%.

Finally, the project team has developed a strong global vision including scientific, engineering and environmental capabilities that will enable them to act in the future as expert consultant in the advanced biofuels production. From now, the team continues working in the results dissemination and looking for new opportunities to continue the technological development.

cascatbel

New members

New Associate Participant

EERA Bioenergy welcomes the following organisations for having recently joined the Joint Programme as Associate members:

FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

FCiências.ID is a non-profit private association, endowed with legal personality. It was created in january 9, 2017 as a common initiative of:

- Faculdade de Ciências da Universidade de Lisboa
- Maxdata Software, S.A.
- ESRI Portugal - Sistemas e Informação Geográfica, S.A.
- SAER - Sociedade de Avaliação Estratégica e Risco Lda.
- SAPEC PORTUGAL - SGPS, SA
- SGS PORTUGAL – Sociedade Geral de Superintendência, S.A.
- StartFactor, Statistical Consulting and Training

FCiências.ID envisages supporting, potentiating and developing R&D and innovation activities of its seven associates, therefore creating a more challenging environment for research and innovation. FCiências.ID is the legal representative of 20 research centres, in the fields of Mathematics, Statistics and Operational Research, Physics, Space and Astrophysics, Chemistry and Biochemistry, Geology, Geophysics, Biology, Computer Science and Informatics and Philosophy and History of Sciences. It manages R&D projects and performs research work.

One of the research groups is IDL-Instituto Dom Luiz whose main research areas are Climate change, Planet Earth Dynamics and Energy and Earth Resources. The Group for Energy Transition works on net-zero energy buildings, on integration of intermittent renewable energy sources in the energy system in articulation with electric mobility and on Energy and emission analysis of systems in general, including LCA.

The group labs are as follows:
- Outdoor solar energy lab
- Indoor PV testing lab
- Semiconductor characterization lab
- Static air quality monitoring gas analyzers for $PM_{2.5}$, O_3 and CO_2
- Portable outdoor sensors for $PM_{2.5}$, O_3, CO_2, NO_x

Regarding the bioenergy research area, it is mainly focused on energy and emission analysis of biorefinery systems, biofuel plant systems, or extended bioenergy-transportation systems. The idea is also to develop methods for valorization of waste streams: from lab-scale to pilot/industrial scale.

They have an extensive track record in:

i) Bioenergy use in the transportation sector
ii) Biorefinery sustainability analysis
iii) Energy and emission analysis of systems in general

A sample of books and referee articles was selected to show the research within the three mentioned areas.

Books and book chapters (3 out of 7)

1. Rabaçal, M., Ferreira, A.F., Silva, C.A.M., Costa M (ed) (2017) Biorefineries Targeting Energy, High Value Products and Waste Valorisation. Springer-Verlag.
2. Silva CM (editor). Grid Electrified Vehicles: Performance, Design and Environmental Impacts. Nova Publishers, 2013.

ISBN: 978-1-62808-840-3.
3. Silva CAM, Prunescu RM, Gernaey K V, et al (2017) Biorefinery Sustainability Analysis. In: Rabaçal M, Ferreira AF, Silva CAM, Costa M (eds) Biorefineries: Targeting Energy, High Value Products and Waste Valorisation. Springer International Publishing, Cham, pp 161–200.

Refereed articles (14 out of 47)

1. Nara Angélica Policarpo, Carla Silva, Tâmara Freitas Aragão Lopes, Rinaldo dos Santos Araújo, Francisco Sales Ávila Cavalcante, Cira Souza Pitombo, Mona Lisa Moura de Oliveira. Road vehicle emission inventory of a Brazilian metropolitan area and insights for other emerging economies. Transportation Research Part D: Transport and Environment. Volume 58, pp 172–185, 2018, doi: 10.1016/j.trd.2017.12.004.
2. Yesmith Santos-Panqueva, Carlos Alberto Guerrero-Fajardo, Edith Oliva Cuevas-Rodriguez, Lorenzo Antonio Picos-Corrales, Carla M. Silva and Ignacio Contreras-Andrade. Production of Bio-ethylene From Wastes of Microalgae to Biodiesel Biorefinery. Waste Biomass Valorization. 2017, pages pp 1–10. Doi: 10.1007/s12649-017-0064-1.
3. S. Vale, L. Heber, P.J. Coelho, C.M. Silva. Parametric study of a thermoelectric generator system for exhaust gas energy recovery in diesel road freight transportation. Energy conversion and management, 2017 Doi: 10.1016/j.enconman.2016.11.064.
4. Demostenes R. Cassiano, João Ribau, Francisco Sales A. Cavalcante, Mona Lisa M. Oliveira, Carla M. Silva. On-board Monitoring and Simulation of Flex Fuel Vehicles in Brazil. Transportation Research Procedia Volume 14, 2016, Pages 3129–3138. DOI: 10.1016/j.trpro.2016.05.253.
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6. [L. Alves, S. M. Paixão, R. Pacheco, A. F. Ferreira and C. M. Silva. Biodesulphurization of fossil fuels: energy, emissions and cost analysis. RSC Adv., 2015,5, 34047-34057. DOI: 10.1039/C4RA14216K;
7. Gonçalo N. Correia, Teresa P. Batista, Sara S. Marques, Carla M. Silva, How car material life-cycle emissions are considered in environmental rating methodologies? Suggestion of expedite models and discussion. Renewable and Sustainable Energy Reviews, 38, 20-35, 2014 Doi: 10.1016/j.rser.2014.05.055;
8. Ana F. Ferreira, Joana Ortigueira, Luís Alves, Luísa Gouveia, Patrícia Moura, Carla Silva. Biohydrogen production from microalgal biomass: Energy requirement, CO_2 emissions and scale-up scenarios. Bioresource Technology, 144, 156-164, 2013 Doi: 10.1016/j.biortech.2013.06.079.
9. Alexandre Lucas, Rui Costa Neto, Carla Alexandra Silva. Energy supply infrastructure LCA model for electric and hydrogen transportation systems. Energy, Vol. 56, 1 July 2013, Pages 70–80 Doi: 10.1016/j.energy.2013.04.056.
10. [Patricia C. Baptista, Carla M. Silva, Tiago L. Farias, John B. Heywood. Energy and environmental impacts of alternative pathways for the Portuguese road transportation sector. Energy Policy 51, 802–815, 2012 Doi: 10.1016/j.enpol.2012.09.025.
11. [Alexandre Lucas, Rui Neto, Carla Silva. Impact of energy supply infrastructures in life cycle analysis of hydrogen and electric systems applied to the Portuguese transportation sector. International journal of Hydrogen Energy, Vol 37, 10973-10985, 2012 Doi: 10.1016/j.ijhydene.2012.04.127.
12. Mona Lisa Moura de Oliveira, Carla Monteiro Silva, Ramon Moreno-Tostb, Tiago Lopes Farias, Antonio Jiménez-López and Enrique Rodríguez-Castellón. A study of copper-exchanged mordenite natural and ZSM-5 zeolites as SCR–NOx catalysts for diesel road vehicles: Simulation by neural networks approach. Applied Catalysis B: Environmental, Volume 88, Issues 3-4, Pages 420-429, 2009 Doi: 10.1016/j.apcatb.2008.10.015.
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14. C. M. Silva, T. L. Farias, H. Christopher Frey and Nagui M. Rouphail. Evaluation of numerical models for simulation of real-world hot-stabilized fuel consumption and emissions of gasoline light-duty vehicles. Transportation Research Part D: Transport and Environment, Volume 11, Issue 5, Pages 377-385, 2006 Doi: 10.1016/j.trd.2006.07.004.

Conference proceedings (7 out of 65)

1. Carla Silva. Biorefinery for bioenergy and bioplastics use in automotive industry. 4th UNI-SET Energy Clustering Event. Imperial college, 27-28 March 2017.
2. Carla Silva. Simulation, on-road trials and assessment of sustainable mobility solutions, special session on VEHITS 2017, 22 April Porto.
3. Joana Ortigueira, Carla Silva, Patrícia Moura. Assessing the potential of organic waste for fermentative hydrogen production: an application to the Portuguese study-case. 11th Conference on Sustainable Development of Energy,

Water and Environment Systems, 4-9 September 2016.
4. Joana Ortigueira, Carla Silva, Patrícia Moura. Fermentative hydrogen production from Portuguese agricultural and agro-industrial byproducts: Brewery's Spent Grain, Corn Cobs and Carob Pulp. ECO-BIO 2016. 6 - 9 March 2016 | Rotterdam, The Netherlands. Warsaw, Poland - 18-21 April 2016.
5. Carla Silva, Miguel Angulo-Escalante, Alfredo Estrada-Angulo, Jorge Milán Carrillo, Ignacio Contreras-Andrade. Non-toxic Jatropha Curcas Biorefinery evaluation: sinaloa case study. EFS 2015, 14-15 May Coimbra.
6. Carla Silva. Evaluation of the sustainability of industrial biohydrogen production by microalgae, and integration in taxi/bus transport systems. Energy for Sustainability EfS 2013, 8-10 September 2013, Coimbra.
7. Ribau, J.P., Silva, J.M.S., Silva, C.M. Multi-objective optimization of fuel cell hybrid vehicle powertrain design – cost and energy. SAENA, ICE2013 - 11th International Conference on Engines & Vehicles, Capri, Napoli (Italy), September 15-19, 2013.

https://ciencias.ulisboa.pt/en

UNIMORE
UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

University of Modena and Reggio Emilia (UNIMORE)

UNIMORE (1176) is the third oldest University in the world, and has always been ranked among the first Italian universities for quality of teaching and research since 2007. UNIMORE is a networked campus located in the towns of Modena and Reggio Emilia. It counts about 20,000 students, including 3,500 postgraduates, 900 faculty members, 13 PhD schools. UNIMORE has over 300 international exchange agreements and cooperation programs to encourage students and researcher to actively interact in a globalized world. Currently UNIMORE project portfolio includes more than 50 running FP7 projects, plus several other European projects. UNIMORE is taking part in other European association, JTI and PPP such as JTI Fuel Cell and Hydrogen – N.Erghy research group and the PPP on BioBasedIndustries. Among the others, the Dept. of Engineering and the Dept. of Life Science are the most involved.

Bio Energy Efficiency Laboratory (BEELab)
www.beelab.unimore.it

The Bio-Energy Efficiency Laboratory (BEELab) is part of the Engineering Department "Enzo Ferrari" of the University of Modena and Reggio Emilia. BEELab is the result of the experience and knowledge gained throughout the years by the research group of energy efficiency in the field of renewable energies and thermo-fluidodynamics measures. BEELab offers a wide range of services to supporting researches mainly focused on the development of advanced and innovative solutions for bio-energy efficiency: kinetic simulation of the gasification process, biomass chemical and physical characterization for thermal treatment, biomass chemical and physical characterization for anaerobic digestion, biomass power plant design, economical evaluation of power plant ROI, biomass supply and storage.

Facilities:

- Lab scale and pilot scale fixed bed stratified gasifier

- 25 kW fixed bed downdraft gasifier
- All Power Labs v.4 10 kW commercial gasifier
- All Power Labs PP20 15 kW commercial gasifier
- 28 kW hot air pellet stove

Instrumentation and analysis:

- Size and density analysis
- Composition (CHSN-O analyzer)
- Ash content (furnace)
- Ash syntering/melting point (heated microscope)
- Moisture content (stove)
- HHV (mahler bomb calorimeter)
- Lab scale gasification
- Pilot scale gasification
- Gas chromatography
- Tar sampling protocol

BEELab researchers demonstrate small-scale gasification to bachelor students

BIOGEST – SITEIA

www.biogest-siteia.unimore.it

BIOGEST – SITEIA laboratory (Interdepartmental Research Centre for Agri-food Biological Resources Improvement and Valorisation) belongs to the Technopole development programme and it gives continuity to the industrial research and technology transfer activities implemented by the Emilia-Romagna Region over the past few years. Technopoles host and organize activities, services and facilities for industrial research, experimental development and technology transfer. They are a network of infrastructures located in 10 sites throughout the Emilia-Romagna regional territory and are promoted by the Emilia-Romagna Regional Government in co-operation with universities, research centres and local authorities.

Technopoles:

- Host industrial research laboratories of the Emilia-Romagna High Technology Network; are equipped with modern research infrastructures and dedicated staff; carry out activities and provide services of interest for the enterprises of the region;
- Foster the liaison between enterprises and researchers and offer access to state-of-the-art scientific facilities, thus narrowing the gap between demand and supply of research;
- Include facilities and service for dissemination, demo and information activities, as well as premises for innovative spin-offs, private enterprises and research laboratories;
- Act as gate of access to the whole Emilia-Romagna High Technology Network and promote its role at national and international level.

In particular, BIOGEST - SITEIA focuses on the following R&D and technology transfer priorities:

- Assessment and deployment of existing biodiversity of relevant crops
- Evaluation of the agronomic potential of agrifood waste, byproducts, and dedicated crops for bioenergy use in a circular economy context
- Use of solid and liquid digestate and other sludge as fertilizers in agriculture

- Application of analytical methods to assess food quality, production processes and raw materials, including waste management
- Active packaging to improve the shelf-life of foods
- Development of microbic techniques to improve the shelf-life of food
- Improvement of the nutritional characteristics of foods
- Identification of molecules with nutritional and health function
- Development of a platform of enhancing the seed industry productivity
- Improvement and enhancement of the quality of raw fruit and vegetables
- Development and management of germplasm bank of cereal crops
- Development of assays for pesticide resistance of pest

Deployment sectors range from the food industries, suppliers of raw materials and semi-finished products, slaughtering companies, producers of sensors and packaging materials, seed companies, mills, fruit and vegetable consortiums, phytosanitary products manufacturer, waste management companies and farms.

Biogest – Siteia head quarter

Participation in national projects

Regional Project REBAF: this project concerns the modeling, realization and experimental validation of innovative pathways for the exploitation of grass and woodsy biomasses from river maintenance operations. The final goal is to make the river maintenance operations self-sustainability from the economic and environmental point of views. The project starts with the characterization of the biomasses that are produced by these activities. The woodsy part is then tested as fuel in a commercial gasification power plant that produces electrical energy suitable for river maintenance. The by-products of this process is biochar. This can be used as fertilizer/amendment on the river banks with the final goal to reinforce the vegetation and the resistance of the banks. In this project, biochar from gasification is used on field on Arundo donax plantations to assess his behavior on biomass growth. The choice of this plant was made because is well diffuses near the Italian rivers and because it renews its biomass very rapidly. About the grass biomass, the part collected from river maintenance is not suitable for gasification processes as result of his low quality in terms of high moisture and high ash amount. For this reason, this biomass is treated in a lab scale pyrolysis power plant with the final goal to produce biochar with a high silica amount. This biochar is used to produce construction material such as brick, tile and other lightweight materials suitable for protection walls and bike roads near the banks.

Regional Project PSR "ValSoVitis" where biochar produced with our gasifiers is tested in vineyards

Regional Project POR-FESR "Sostinnovi" where gasification is used to increase the sustainability of the wine production sector

Regional Project POR-FESR "Valoribio" - valorization of organic waste using insects to obtain biomaterials for agricultural purposes

Regional Project "Biovivi" - enhancement and valorization of solid digestate from biogas plants in the vine and wine sector

Biogest – Siteia head quarter

Vine prunings on field

Bio-char applied to Arundo Donax plantation

Small Scale PP20 APL Gasifier

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UNIVERSITÀ DEGLI STUDI
DI TORINO

Università di Torino (UNITO)

The University of Torino is one of the largest Italian Universities, with about 70,000 students, 3,900 employees (academic, administrative and technical staff), 1,800 post-graduate and post-doctoral research fellows. Research and training are performed in 27 Departments, encompassing all scientific disciplines. As for internationalization, UNITO is involved in roughly 450 formal international cooperation agreements with institutions from all around the world (South America, Mediterranean countries, India and China, in addition to Europe), including joint educational programs at undergraduate and doctoral level. UNITO is deeply involved in scientific research and manages roughly 500 projects per year, both at national and international level. The long record of participation of UNITO in the EU strategic research agenda results from **59 H2020 funded projects among which 5 ERC grants as host institution.**

Most of the research activities funded by the European Commission (and its DGs) are collaborative research projects in which the **interdisciplinary approach, the involvement of territorial and private sector actors** is essential. All projects have impact in economic and social terms: the resources are invested in research, development and innovation, prototyping and patents, exchange of good practices as well as business incubation.

UNITO adheres to several national and international platforms and strategic initiatives in different domains. In the Energy sector UNITO is active for example in the JU Fuel cells and Hydrogen and EERA, where it is already active operationally in JPs Geothermal, Fuel Cells and Hydrogen, Solar Photovoltaic, AMPEA, CCS, E3S and, of course, Bioneregy.

At National level, University of Turin is member of The National Technology Cluster of "Green Chemistry" SPRING – Sustainable Processes and Resources for Innovation and National Growth.

UniToGO is the "office" of the University of Turin for environmental sustainability: It is an interdisciplinary network composed by Professors, Researcher, technical and administrative staff and students with the purpose of analysing and promoting sustainable strategic plan for the University of Turin. UniToGO is the main promotor of the "Environmental Sustainability Action Plan" (ESAP), a strategic 5 years plan for the University of Turin and leads, coordinates, promotes every activities and initiatives about environmental sustainability

within the University of Turin at three complementary levels: Engagement, Third Mission and Communication, Research and Action (structural intervention, building renovation, for instance).

The Energy Working Group (http://www.green.unito.it/?q=en/Energy), steadily monitors the energy consumption and has developed the Energetic Plan of the University of Turin with the aim to reduce the primary energy consumption, to improve the building energy efficiency, to reduce the energy leakage, to increase the renewable energy production, to plan the energy balance and to release all available data.

Snapshot at local initiatives and institutional commitment in the energy sector

The Energy Working Group, moreover, in collaboration with several private enterprises and startups of the City of Turin, has worked on the ComfortSense research project, with three first pilot test within the Campus Luigi Einaudi, the physics department and the management school. ComfortSense is an Internet of Thing project with the aim to improve the building energy efficiency and the people indoor Comfort.

Current Research Activities:

The research activities on Bioenergy at the University of Torino are mainly (but not only) based on the joint and interdisciplinary expertise of four departments: "Chemistry", "Life Sciences and Systems Biology", "Agricultural, Forest and Food Sciences" and "Drug Science and Technology".
Research activities are focused on the valorization of residual biomass by its conversion into bioenergy, biofuels and high added-value chemicals and biochemicals. The aim is the development of an integrated biorefinery for waste valorization. Residual biomass includes municipal waste, agricultural residues and food wastes. In addition, alternative methods for the fractionation of the biomass are currently investigated.

Theme 1: Added-Value Chemicals and biochemicals and production of clean energy – research activities related to Biochemical and Chemical Platform

The inherent chemical complexity of the bio-waste makes it very attractive source to be recycled and converted into value-added chemicals and biochemicals representing perhaps the largest challenge facing the 21st century.

Experience and collaborations are available at UNITO in the field of biofuel production from waste, and on enzyme catalysts waste treatment and bioconversion. Whole cell systems and enzyme based exploitation of waste biomass for release of sugars, fermentation and biorefinery processes. Research interest in the field includes energy production from renewable sources (combustion, anaerobic digestion, gasification): Feedstocks pre-treatments, biomass characterization for energy applications, reuse of by-products (ashes, biochar, digested slurry) from biomass-to-energy conversion technologies, the study of enzyme based biomethane and biohydrogen production from biomasses, including Organic Fraction of Municipal Solid Waste, straw and Olive Mill Waste, optimization and pre-treatment strategies and optimization of the biochemical pathway/microbial activity in anaerobic digestion (AD) for microbial production of both hydrogen and ABE solvents.
The extraction of bioactive compounds and the conversion of the recovered carbohydrates, and lignin to more value-added chemicals could represent a big alternative in the effective use of bio-waste: *"We are working on the development of sustainable methods, based on biocatalysts, for the valorization of the lignin by its conversion into valuable aromatic compounds for the chemical industry and the market. Chemical conversion of hemicellulose into platform chemicals is investigated using the same technologies and biobased solvents".*

These activities could lead to energy-and time-saving methods for the sugar platform, with the reduction of waste and by-products. Furthermore, the use of bio-based solvents and additives should avoid the use of compounds from fossil sources, according to the biorefinery concept.

Moreover, the energy consumption of these enabling processes is evaluated for the eventual industrial scaling up. In addition, environmentally friendly technologies, such as microwaves

(MW) and ultrasound (US) alone or combined, hydrodynamic cavitation, ball milling with "green solvents" such as water, y-valerolactone (GVL) or natural deep eutectic solvents (NADES), could be applied for biomass pre-treatment and subsequent fractionation. New processes will be studied to make the fractionation of biomass more feasible. Another possibility we are exploring is the optimization of a "one-pot" process in which in situ released platform molecules can be directly converted into added value chemicals in the presence of new designed green catalysts. More in details, both heterogeneous and homogeneous catalysis with green and recyclable catalysts are used to obtain fine chemicals from waste. New synthetic strategies based on fine chemical obtained from biomass are realized in the presence of water or of Nades as medium. Mycellar catalysis is realized with surfactants derived from biomas.

Theme 2: Bio-oils from algae and micro-algae - research activities related to Algae Platform

The use of cavitational reactors (US and HC) and MW systems strongly promote the extraction of algae or microalgae for the production of bio-oils. These green procedures required a lower amount of solvents, avoiding chlorinated waste and proceeding in a short extraction time. These techniques also enable one-pot sequential extraction/transesterification for biodiesel production. All these advantages, together with the lower energy consumption, may further reduce the environmental impact of the extraction process. Recent industrial advances in biodiesel production and plant extraction in MW, HC and US flow reactors showed that a fully automated continuous flow production is now available for several applications.

Specific research lines include:

Biomass production, transport and exploitation (management of agrozootechnical and forest biomass value chain)

- Optimization of biomass supply chain logistics (harvesting, transport and utilization); design of innovative technologies for harvest of residual biomass, including study, design and development of agro-forestry machines. Optimization of equipment and schedule of fleets for biomass and digestate transportation.
- Monitoring and energetic evaluation of plants for energy production from renewable sources (combustion, anaerobic digestion, gasification): Feedstocks pre-treatments, biomass characterization for energy applications.
- Agricultural reuse of by-products (ashes, biochar, digested slurry) from biomass-to-energy conversion technologies: Study design and development of machines for their application to soil, measurement and control of ammonia and GHG emissions from digested manure.

Chemical and biochemical strategies for sustainable energy production and biobased economy

Biomass Conversion (Catalysis and Biocatalysis)

- Solvent free synthesis of lytic peptides from unactivated amino acids. Elucidation of the factors ruling the interaction between supports (organic/inorganic; insulators/semiconductors) and anchored enzymes/proteins.
- Agro wastes fermentation and biocatalysis using whole cell fungal systems and fungal enzymes, including culture-independent mining of natural diversity of fungal genes encoding enzymes involved in plant biomass degradation.
- Enzyme-based biocatalysts and industrial biotechnology processes.
- Preparation, characterization and testing of heterogeneous catalysts and photocatalysts for the production of chemicals from bio-based building blocks.

New Technologies

- Optimization of lipid extraction from microalgae, as biofuel sources by non-conventional techniques such as ultrasound (US) hydrodynamic cavitation and microwaves (MW). Hybrid technologies have been exploited for extraction processes and oil transesterification by means of new reactors combining high-shear mixers with MW and last generation HC rotor-stator units.

Big Data

- Big data analysis of biomass production and exploitation, discrete event simulation models of logistic of biomass and digestate, for evaluation of scenarios in term of technical, environmental and economic aspects. Application for biomass and biogas operation, logistic costs, emissions.
- Analysis of GIS data, remote sensing data and production data along with simulated data to predict biomass exploitation at both local and regional level. Development of web and mobile applications to assess the feasibility of biomass and by product production considering technical, economic and environmental aspects business plan of biogas installation.

- Numerical dynamic modelling of energy systems (heating energy, cooling energy, steam) in food plants for design and operational optimization.

- Energy saving application to agri-food industry product and energy flows monitoring in multi-source multi-product systems for energy demand assessment, KPI of food product chains.

- Optimal scheduling of shiftable loads and energy demand and supply optimal matching in a context of industrial micro-smart grid by exploiting energy recovery, energy waste, RES.

- Energy performance assessment and indoor environmental control of greenhouses and livestock houses.

The Departments are also jointly involved in managing a **Master course in Industrial Biotechnology,** a **Master Course in Plant Biotechnology** and several PhD programmes on Bioenergy related topics as the new **Innovation for the Circular Economy.**

Equipment:

UNITO laboratories offer facilities in

- **Non-conventional synthetic and extraction techniques and products characterisation:** High-Intensity Ultrasound reactors (batch and flow), Hydrodynamic cavitation units (lab and pilot scale), Turbine reactors (lab and pilot scale), Monomode and multimode Microwaves Reactors (batch and flow), Ball Milling reactors (lab and pilot scale). Gas Chromatography (GC, GC-MS, HSGC), High Performance Liquid chromatography (HPLC, HPLC-MS, HPLC-DAD, HPLC-Light Scattering), CombiFlash, UV-Visible and FT-IR Spectrophotometers, Thermal Gravimetric Analysis (TGA)., Mass Spectrometry, CW and Pulse EPR-ENDOR at X and Q band frequencies, solid state and liquid NMR (400 MHz and 600 MHz).

- **Volumetric and thermal analysis Volumetric (BET), Sievert-type PCI and thermo gravimetric (TGA) techniques for surface area and ad/ab-sorptive properties measurements, differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), adsorption microcalorimetry**

- **Structural and microstructural characterization techniques UHR-TEM and SEM microscopies, X-ray Diffraction, even as a function of pressure and temperature;**

- **Electrochemical and photo-electrochemical techniques** potentiostats for cyclic voltammetry, exhaustive electrolysis, impedance spectroscopy and electrochemical cells for VT gel and solid-state conductivity. Protein electrochemistry.

- **Vibrational spectroscopies** in situ Raman and in situ/operando FTIR spectroscopies (Transmission, diffuse reflectance, ATR). In-situ FT-IR spectroscopy under UV-Vis illumination under controlled atmosphere is also available. As regards Raman spectroscopy, at UniTO, five exciting laser lines (ranging from the red to the far UV laser) are available, which will allow operating in resonant mode avoiding fluorescence problems. UV Circular Dichroism (both absorption and emission mode).

- **Electronic spectroscopies** UV-Vis-NIR in reflectance mode, (from 873 to 77 K), photoluminescence (steady state, time resolved; from room temperature down to 77 K).

- **Lab and field scale determination of ammonia and greenhouse gases** (carbon dioxide, methane, nitrous oxide) emission from manure. In detail, the research group has a gas Chromatograph, a Multigas monitor, Wind Tunnels and 3 Large Open Dynamic Chambers (24 m^2 each).
  - Multi-field web application www.bioresource4energy.eu for calculation of Energy balance of crops and biomasses including logistic operation to farm and to processing plant/collection center.
  - Simulation model to optimize biomass retrieval and distribution of digestate back to the fields.

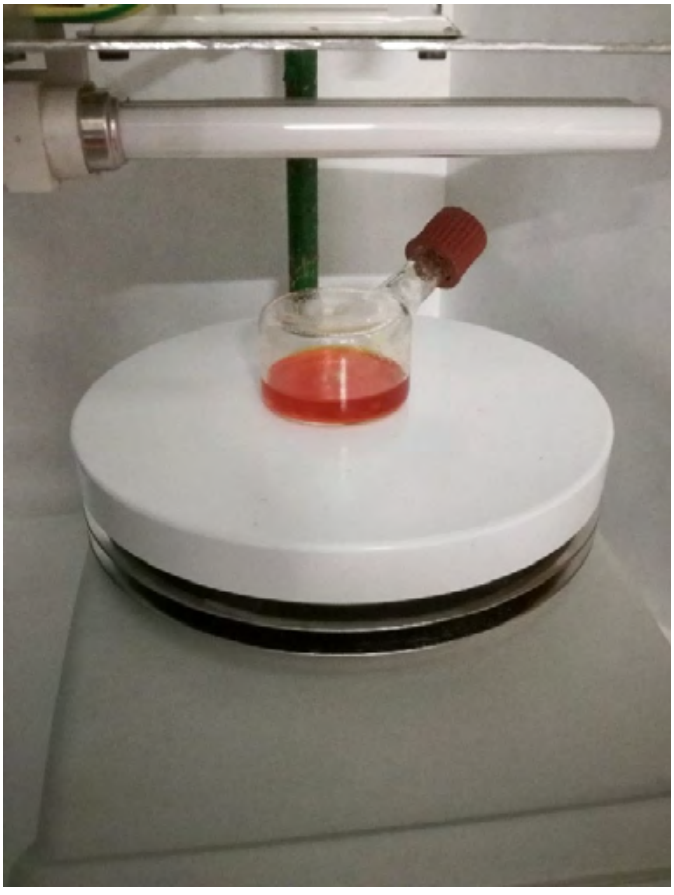
- **Characterization of biomass for energy production** A laboratory equipped with 2 thermostatic chambers, 120 batch reactors and 9 continuous stirring tank reactors (CSTR) is available for the determination of biomasses biochemical methane potential (BMP), to evaluate the efficacy of different pre-treatments (mechanical, thermal and chemical) and to increase the biogas and methane yield of the feedstocks; - A bomb calorimeter to measure the calorific value of biomasses

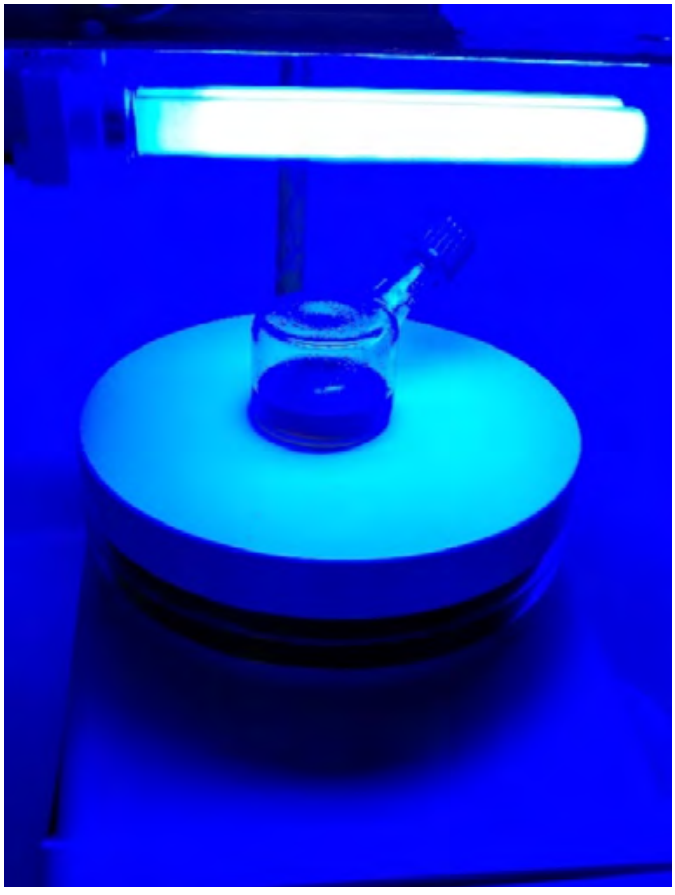
- **Microbiology:** fully equipped microbiological laboratory. Moreover, MUT provides to the scientific and industrial communities its fungal collections of about 6,000 fungal strains (preserved accordingly to the best practises and complying the Nagoya protocol for access and benefit sharing of genetic resources).

- **Protein catalyst production, purification and characterisation** standard molecular biology facilities for recombinant protein production, pilot scale 2, 5, 10 L fermenters, chromatography, SDS-PAGE and 2D electrophoresis, HPLC, gas-chromatography, UV-vis and

fluorescence spectroscopy, circular dichroism, diode array stopped flow, electrochemistry, Grazing angle FT-IR, contact angle, GPC-UV, glove box for anaerobic manipulation.

Besides the instrumentations available in the laboratories of UNITO, a selected team of researchers has frequent access to several synchrotron radiation sources, (among which ESRF (Grenoble, France), ELETTRA (Trieste, Italy) and MAX-Lab (Lund, Sweden)) and developed a large experience in the application of XAS, XES and XANES spectroscopies to the characterization of solids. UNITO also provides a network of local SMEs and other companies interested in exploitation of waste biomasses for bioenergy and added value products, including an innovation centre with facilities pilot scale plants 35 to 250 Lt.





Phocatalys

Useful information

1 Horizon 2020: Work Programme from 2018 to 2020 presented

The European Commission launched on 27 October 2017 the final Work Programme for Horizon 2020, covering the budgetary years 2018, 2019 and 2020 and representing an investment of around €30 billion.

Horizon 2020, the EU's €77 billion research and innovation funding programme, supports scientific excellence in Europe and has contributed to high-profile scientific breakthroughs.

The 2018-2020 Work Programme will focus efforts on fewer topics with bigger budgets, directly supporting the Commission's political priorities:

- A low-carbon, climate resilient future: €3.3 billion
- Circular Economy: €1 billion
- Digitising and transforming European industry and services: €1.7 billion
- Security Union: €1 billion
- Migration: €200 million

In the Participant Portal the Work programmes and the open calls are available.

Link

2 Energy Union: Commission takes action to reinforce EU's global leadership in clean vehicles

On 8th November 2017, the European Commission proposed new targets for the EU fleet wide average CO_2 emissions of new passenger cars and vans to help accelerate the transition to low- and zero emission vehicles.

This **second mobility package** represents a decisive step forward in implementing the EU's commitments under the Paris Agreement for a binding domestic CO_2 reduction of at least 40% till 2030.

The **Clean Mobility Package** includes new **CO_2 standards** to help manufacturers to embrace innovation and supply low-emission vehicles to the market. The proposal also includes targets both for 2025 and 2030 and the **Clean Vehicles Directive** to promote clean mobility solutions in public procurement tenders and thereby provide a solid boost to the demand and to the further deployment of clean mobility solutions.

Link

3 Clean Energy Package: vote on the Renewable Energy Directive and Energy Efficiency Directive

On 28th of November, the European Parliament - ITRE Committee (European Parliament's Industry and Energy Committee) voted on two reports on the Promotion of the use of energy from renewable sources (Recast) and Energy Efficiency, which are key files of the Clean Energy for All Europeans Package, tabled a year ago.

MEPs (Members of the European Parliament) voted with a large majority provisions for introducing binding minimum Union targets of at least 35% share of energy from renewable energy sources on 2030; measures for renewable heat included a 2 percentage point increase per year up to 2030. For the transport sector, at least 12% of the energy consumed in each member state would have to be produced from renewables.

The Energy Efficiency vote validated a strong ambition level of 40% national binding target in 2030 with a tight difference: 33 in favour, 30 against and 2 abstentions.

These measures are highly welcomed by the European Biomass Association - AEBIOM, and show the European Parliament's commitment to reaching its long-term climate and energy objectives.

Link

4 Mapping European Biorefineries

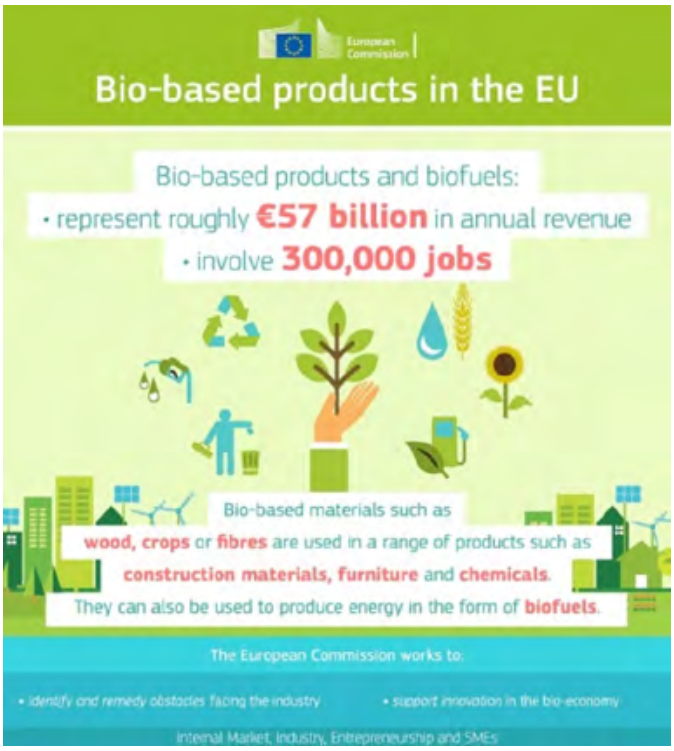
The Bio-based Industries Consortium (BIC) and nova-Institute have developed a poster that maps the commercial biorefineries in Europe anno 2017. For the map, a biorefinery has been defined as "an integrated production plant using biomass or biomass-derived feedstocks to produce a range of value added products and energy".

In total 224 biorefineries have been mapped. The mapping exercise shows the diversity of biomass used as well as different types of biorefineries: the oil-/fat-based biorefineries mainly produce biodiesel (64) or oleochemicals (54); 63 sugar-/starch-based bio-refineries mainly produce bioethanol but also products for use in food or feed or biochemicals; 25 wood-based biorefineries (excluding pulp for paper only) produce pulp, tall oil, specialty cellulose or bioethanol; 5 biorefineries produce cellulosic fibre or bioethanol from other lignocellulosic feedstock such as wheat straw, Miscanthus or switch grass; 13 biorefineries produce bioethanol or biodiesel from biowaste (incl. food waste). The mapping will be updated annually.

Link

5 Commission expert group on bio-based products calls for alignment of bioeconomy strategy with the EU policy framework

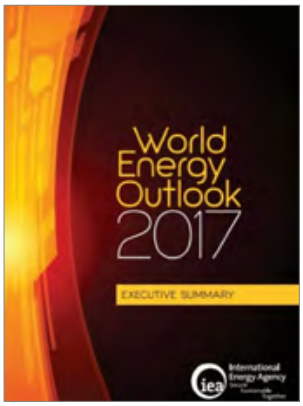
The commission expert group on bio-based products calls for alignment of bioeconomy strategy with the EU policy framework. The new report contains 9 guiding principles and 8 policy recommendations for jobs and growth through bio-based products.



The bioeconomy is already worth over €2.2 trillion while providing over 18 million jobs in Europe. It is a key contributor to Europe's jobs and growth agenda. In addition, it has the potential to add value, increase competitiveness in many of its sectors, and contribute to both rural and urban economies.

Link

Publications



World Energy Outlook 2017 Executive Summary (IEA)

International Energy Agency

The World Energy Outlook-2017 includes a full update of energy demand and supply projections to 2040 based on different scenarios. The projections are accompanied by detailed analyses of their impact on energy industries and investment, as well as implications for energy security and the environment.

The report this year includes a focus on China, which examines how China's choices could reshape the global outlook for all fuels and technologies. In addition, it presents various projections to 2040 based on different policy assumptions, in order to give policy makers the tools to decide what path to follow. The main case is called the **New Policies Scenario,** and it models current and announced energy policies, including those in the Paris Agreement. This year, the report introduces the Sustainable Development Scenario, which offers an integrated way to achieve a range of goals: climate stabilization, cleaner air and universal access to modern energy.

PDF

Access-to-finance conditions for Investments in Bio-Based Industries and the Blue Economy

European Investment Bank (EIB)

This EIB study, published in June 2017, reviews the access-to-finance conditions for Bio-based Industries (BBI) and the Blue Economy (BE) and proposes potential solutions that could catalyse investments into the sector.

The study puts forth a number of recommendations to address the funding gaps, among which is the development of a new dedicated risk-sharing instrument addressing the specific needs of project promoters in this sector.

PDF

Technology Roadmap: Delivering Sustainable Bioenergy

International Energy Agency

This Technology Roadmap re-examines the role of bioenergy in light of changes to the energy landscape over the past five years as well as recent experience in bioenergy policy, market development and regulation. It identifies the technical, policy and financial barriers to deployment, and suggests a range of solutions to overcome them.

The Roadmap also indicates that modern bioenergy is an essential component of the future low carbon global energy system if global climate change commitments are to be met, playing a particularly important role in helping to decarbonise sectors such as aviation, shipping and long haul road transport.

PDF

Accelerating the Energy Transition through Innovation

International Renewable Energy Agency (IRENA)

This working paper from the International Renewable Energy Agency (IRENA) examines the basic conditions required to nurture innovation and produce new technologies for a low-carbon future.

PDF

Save the date! International bioenergy events

JANUARY 2018

22 – 23 January 2018
Fuels of the Future: International Conference on Renewable Mobility
Berlin, Germany
link

30 – 31 January 2018
Pellets 2018
Helsingborg, Sweden
link

FEBRUARY 2018

7 – 8 February 2018
Lignofuels 2018 - Advanced Biofuels & Materials
Amsterdam, The Netherlands
link

21 February 2018
2018 IrBEA National Conference – Bioenergy Future Ireland
Croke Park, Ireland
link

28 February – 1 March 2018
The European Pellet Conference
Wels, Austria
link

MARCH 2018

4 – 7 March 2018
ECO BIO 2018
Dublin, Ireland
link

6 – 8 March 2018
BIOKET Conference- BIOKET, the BIOeconomy's Key Enabling Technologies conference
Strasbourg, France
link

20 – 22 March 2018
World Bio Markets
Amsterdam, Netherlands
link

APRIL 2018

16 – 18 April 2018
International Biomass Conference & Expo
Atlanta, U.S.A.
link

19 – 20 April 2018
Global Bioeconomy Summit
Berlin, Germany
link

MAY 2018

14 – 18 May 2018
26th European Biomass Conference and Exhibition, EUBCE 2018
Copenhagen, Denmark
link

15 – 16 May 2018
11th International Conference on Bio-based Materials
Cologne, Germany
link

JUNE 2018

6 – 8 June 2018
Canadian Bioeconomy Conference and Exhibition
British Columbia, Canada
link

6 – 7 June 2018
EXPOBIOGAZ
Strasbourg ,France
link

11 – 13 June 2018
Advanced Biofuels Conference
Nebraska, U.S.A
link

SEPTEMBER 2018

17 – 19 September 2018
Biogas Science 2018
Torino, Italy
link

EERA Bioenergy in Europe

Participants and Associate Participants of EERA Bioenergy Joint Programme.

Aalborg University
Department of Energy Technology (Denmark)

web

AICIA
Asociación de Investigación y Cooperación Industrial de Andalucía (Spain)

web

BERA
Belgian Energy Research Aliance (Belgium)

web

CAMPUS IBERUS
Campus de Excelencia Internacional del Valle del Ebro
web

Universidad de Zaragoza
web
(Spain)

CEA
French Alternative Energies and Atomic Energy Commission (France)

web

CENER
National Renewable Energy Centre – Biomass Deparment (Spain)

web

CIEMAT
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (Spain)

web

CNR
Istituto Motori del Consiglio Nazionale delle Ricerche (Italy)

web

CNRS
Centre National de la Recherche Scientifique (France)

web

CSIC
Instituto de Tecnología Química - Consejo Superior de Investigaciones Científicas (Spain)

web CSIC
web ITQ

DTU
Technical University of Denmark (Denmark)

web

ECN
Energy Research Centre of the Netherlands
(The Netherlands)

web

ENEA
Italian National Agency for New Technologies, Energy and Sustainable Economic Development (Italy)

web

FCiências.ID
Associação para a Investigação Desenvolvimento de Ciências (Portugal)

web

IEN
The Institute of Power Engineering
(Poland)

web

IFK Stuttgart
Institute of Combustion and Power Plant Technology
(Germany)

web

IMDEA
Instituto Madrileño de Estudios Avanzados (Spain)

web

INRA
French National Institute for Agricultural Research (France)

web

KIT
The Research University in the Helmholtz Association
(Germany)

web

LNEG
Laboratório Nacional de Energia e Geologia
(Portugal)

web

NIC
National Institute of Chemistry
(Slovenia)

web

NTNU
Norwegian University of Science and Technology
(Norway)

web

NTUA
The National Technical University of Athens
(Greece)

web IPSEN
web Suschem Greece

PSI
Paul Scherrer Institut
(Switzerland)

web

RISE
Research Institutes of Sweden
(Sweeden)

web

SINTEF
(Norway)

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TECNALIA
(Spain)

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TÜBITAK
Scientific and Technological Research Council of Turkey
(Turkey)

web

UKERC
UK Energy Research Centre
web

ASTON UNIVERSITY
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SUPERGEN Bioenergy Hub
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(United Kingdom)

UNIBO
Universitá di Bologna (Italy)

web

UNIMORE
University of Modena and Reggio Emilia
(Italy)

web

UNITO
Università di Torino
(Italy)

web

Università degli Studi di Padova
(Italy)

web

Università degli Studi di Perugia CRB - Biomass Research Centre
(Italy)

web

VŠB
Technical University of Ostrava
(Czech Republic)

web

VTT
Technical Research Centre of Finland Ltd (Finland)

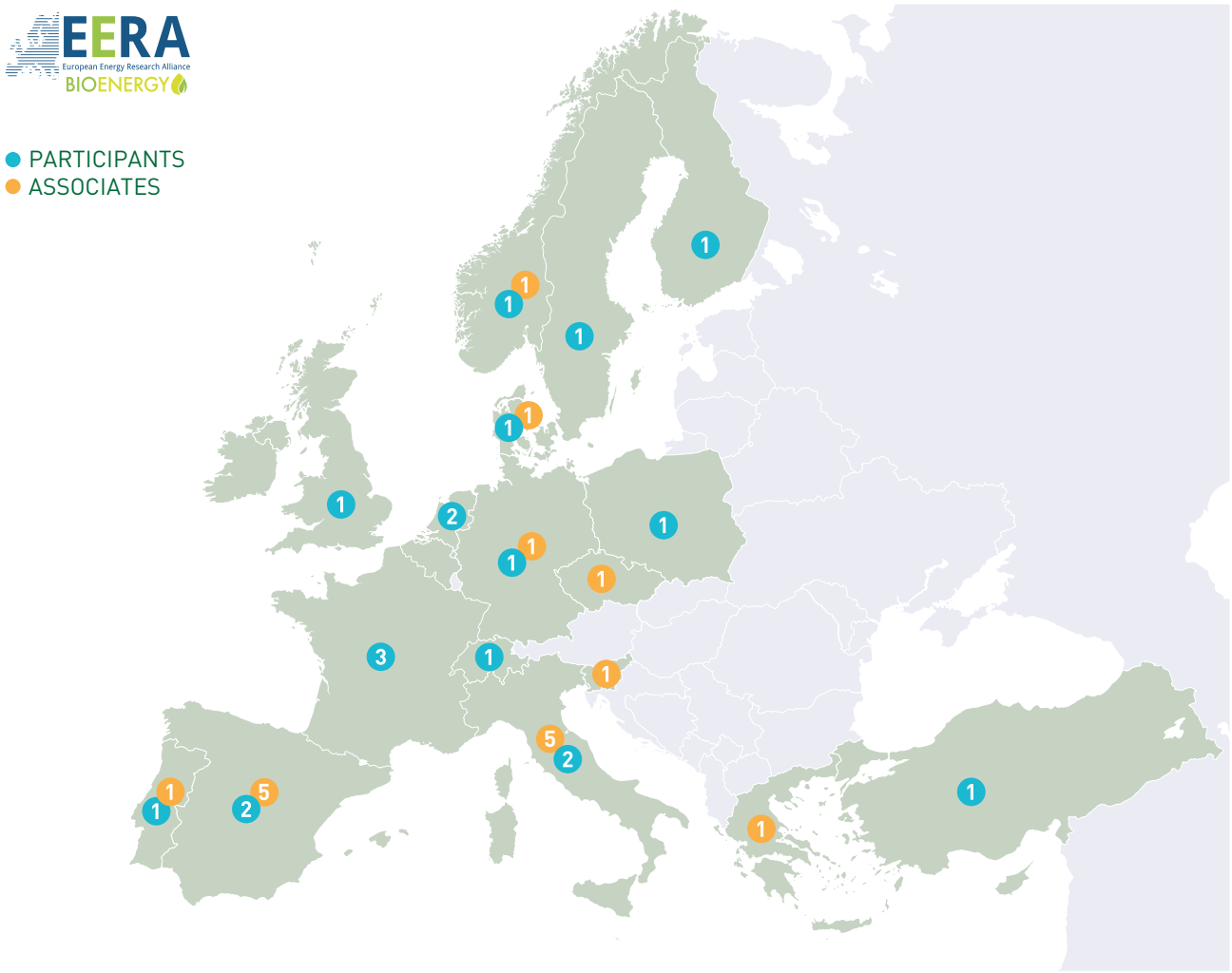
web

WUR
Wageningen University & Research
(The Netherlands)

web

EERA Bioenergy in Europe

EERA Bioenergy is open to new complementary RTD organisations.
Please contact the Joint Programme Secretariat for further details at secretaria@bioplat.org



The EERA Bioenergy Joint Programme consists of 20 participants and 17 associate participants from a total of 17 countries.
www.eera-bioenergy.eu

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