



EERA-Bioenergy SP2 Workshop on
Evaluating Current and Novel Pretreatment Biomass Technologies, Madrid,
March 10th, 2016

Attendees (industry representatives in bold): Francisco Gírio (LNEG, Portugal), Mercedes Ballesteros (CIEMAT, Spain), Juan Carrasco (CIEMAT, Spain), Jose Miguel Oliva (CIEMAT, Spain), Maria José Negro (CIEMAT, Spain), Paloma Manzanares (CIEMAT, Spain), Ignacio Ballesteros (CIEMAT, Spain), Cristina Alvarez (CIEMAT, Spain), Elia Tomás (IMDEA, Spain), Ines del Campo (CENER, Spain), Marcelo E. Domine (UPV-CSIC, Spain), **Antonia Rojas (BIOPOLIS, Spain), Ana Isabel Garcia (Abengoa, Spain), José Adrio (Neol Bio, Spain)**, Rafal Lukasik (LNEG, Portugal), Florbela Carvalheiro (LNEG, Portugal), Federico Rossi (CIRIAF, Italy), Franco Cotana (CIRIAF, Italy), Gianluca Cavalaglio (CRB, Italy), Francesco Zimbardi (ENEA, Italy), **Piero Cavigliasso (Biochemtex, Italy)**, Mats Galbe (ULund, Sweden), Bernd Wittgens (SINTEF, Norway), Reinhold Spörl (IFK, Germany), Klaus Raffelt (KIT, Germany), Henning Jørgensen (TUD, Denmark), **Soren Kraemer (BioVantage, Denmark), Borge Holm Christensen (IBUS, Denmark)**, Hinrich Uellendahl (UAalborg, Denmark).

1 Update of activities of EERA Bioenergy Joint Programme in 2016

Mercedes Ballesteros, Francisco Gírio and Juan Carrasco addressed an introductory welcome and later Juan Carrasco, leader of EERA Bioenergy Joint Programme gave an overview of the current goals and activities of the SP2 of EERA-Bioenergy for 2016. He also mentioned the importance of EERA be an open R&D alliance and open for new members. One of the key points addressed was to provide a recent update regarding the actual participation of EERA-Bioenergy in H2020 calls namely in LCE-33-2016.

2 Vision from Industry

As announced this workshop aimed to allow different EERA partners to share information, opinions and experience as well as confront their ideas with guests, notably those representing the industries. The overall aim of the workshop was to identify the current bottlenecks and provide some ideas for future more energetically and economically feasible technologies of biomass (lignocellulosic) pretreatment.

For this purpose the vision from industry, as KEY NOTE presentations, was given. The first was Borge Holm Christense from IBUS Innovation who proposed **Integrated, Continuous, Organosolv Pretreatment and Separation System**

(ICOPASS). The main novelties of ICOPASS are: continuous operation, lower solvent-to-solid ratio, enzyme recycling and higher value lignin product with a large demand – e.g. bunker oil.

Next KEY NOTE was given by Abengoa which provided the most recent update from their activities in the field of biomass pretreatment. Shortly (due to the confidentiality issue) Abengoa uses the process based on dry biomass in batch process with catalyst.

The Biochemtex vision about the biomass deconstruction and biorefinery is based on their technology called PROESA to provide Biofuels, Biochemicals, Biopolymers and Lignin-derived chemicals. In other words, the only way to achieve the economic feasibility of (advanced) biofuel production is the biorefinery concept implementation. Biochemtex addressed also very crucial aspect often tackled in the very limited was such as biomass feedstock availability (continuous) at desired quantity and quality as well as feedstock price alterations depending on the local constrains (e.g. alternative end-uses, political reasons).

The last two KEY NOTE presentations were given by two fine-tech companies such as NEOLBIO and BIOPOLIS. Their interest in the biomass pretreatment field is by the feedstock –sugar solutions - they require for their processes. From NEOLBIO and BIOPOLIS point of view, the key aspects for biomass pretreatment is low CAPEX and OPEX, pretreatment intensification, scalability of the process, effective breaking down of lignin and removal/absence of toxic agents (organic acids, furans, phenols) as well as high polysaccharide hydrolysis yield (>95%).

3 SP2 EERA-Bioenergy update

After the vision from industry, Francisco Girio provided visions and targets to be achieved in SP2 of EERA-Bioenergy. Among them are: i) Constructing new robust cell factories using advance consolidated bioprocessing (Cell Factories – Meeting in Brussels, 26th June 2015), Novel pre-treatment biomass technologies (Lignocellulosic Biomass Deconstruction - Meeting in Madrid, 10th March 2016), Hemicellulose and Lignin platform through biological and/or chemical conversions (Biomass (biofuel based) Biorefineries – Meeting in Lund, 3rd November 2015). One of the important issues was also to give information about current activities of SP2 in terms of H2020 applications. SP2 of EERA-Bioenergy actively co-promotes the preparation and submission of proposals to:

H2020 – Call - INFRAIA-01-2016-2017 – Integrating activities for Advanced Communities presenting BRISK2 project proposal with 9 out of 16 members are from EERA-Bioenergy – deadline 30th March 2016

LCE-33-2016: ECRIA (RIA) with AMBITION project integrating SP1 and SP2 of EERA-Bioenergy – deadline 5th April 2016

LCE-22-2016: UE-Brazil (RIA) on Advanced Biofuels - - deadline 8th September 2016

4 Discussion and input from EERA-Bioenergy members about the novel biomass pretreatments

The discussion was centred on previously identified questions:

- 1) Do you share the vision that current biomass pretreatments at DEMO 2G Plants (eg steam explosion, hydrothermal) shall be obsolete in 10-years time?
- 2) What is your vision about the ideal pre-treatment for the future?
- 3) What is, in your opinion, the goal to be achieved in 5-10-year time in the field of pre-treatment?
- 4) What, in your opinion, are the technical (not economic) bottlenecks of potential disruptive pre-treatments for now?
- 5) What is your opinion about new innovative processes based on the use of ionic liquids (or others)?
- 6) Do you think that enzymes can still play a key role in next-generation disruptive pretreatments?

One of the clear opinion presented during this meeting was that despite the hydrothermal processes are little selective (remove only hemicellulose) and energy-consuming, there is still a lack of sufficient pilot scale proves allowing to get a reliable data obtained at industrial environment scale confirming that novel pretreatments can be implement in the industrial practice. Thus, there is a need for continuous support for research (TRL 2-4) and implementation (TRL 5-7) of novel alternative methods (compared with the current ones) of biomass pretreatments which should be characterised by the following properties:

- Lower energy demands (low temperature of the process – e.g. 120 °C),
- Pretreatment intensification (high solid/liquid loading maintaining as high as possible conversion/fractionation yield),
- Low OPEX (avoidance of expensive reagents and extensive downstream separation processes),
- Effective fractionation (production of main fractions ready to be used in the processes running simultaneously to diverse preferentially value-added products – biorefinery concept),
- Enzyme charge (reduction, or if possible avoidance of enzymes for saccharification)

5 Discussion concerning collaborative opportunities

Francisco Girio briefly presented the upcoming H202 calls. Several topics were identified as being promising opportunities. In particular, attendees noted that LCE-6-2017 (New knowledge and technologies – RIA – TRL 4) could be a good opportunity. The LCE-6-2017 call should tackle the following topics:

- Development of novel microorganisms, enzymes and catalysts or a combination of these systems with improved performance for obtaining paraffinic biofuels or higher alcohols from lignocellulosic biomass;
- Development of renewable alternative fuels from CO₂ in industrial waste flue gases through chemical catalytic conversion;
- Development of renewable alternative fuels from H₂O, CO₂ and energy from renewable, autonomous sources through micro-organisms, synthetic molecular systems or chemical synthesis, or a combination of these processes;
- Development of middle distillate range biofuels (i.e. diesel and jet fuel) from liquid organic or lignocellulosic waste streams through advanced thermochemical conversion processes.) the most interesting from the SP2 seem to be:
 - Development of novel microorganisms, enzymes and catalysts or a combination of these systems with improved performance for obtaining paraffinic biofuels or higher alcohols from lignocellulosic biomass;
 - Development of renewable alternative fuels from CO₂ in industrial waste flue gases through chemical catalytic conversion; Development of renewable alternative fuels from H₂O, CO₂ and energy from renewable, autonomous sources through micro-organisms, synthetic molecular systems or chemical synthesis, or a combination of these processes;

Because of these topics LCE-6-2017 is one of the core calls for 2017.

Another relevant call is LCE-8-2017: Development of next generation biofuel technologies –RIA TRL 3-4 to 4-5 which in 2017 is focused on feedstock (Biofuels from CO₂ in industrial waste flue gases through biochemical conversion by autotrophic (chemo and photo –autotrophic) micro-organisms; Biofuels from organic fraction of municipal and industrial wastes through thermochemical, biochemical or chemical pathways with improved performance and sustainability; Biofuels from phototrophic algae & bacteria with improved performance and sustainability) contrary to 2016 call which was more focused on technology.

Other H2020 topics worthy of the attention of the group are:

LCE 22 UE-Brazil – Francisco pointed out that he already previously coordinated a UE-Brazil action.

LCE 19 Demonstration of promising technologies (in 2016, technologies for conversion of lignocellulosic biomass) and in 2017, fuels from waste and residues (including crop residues)

LCE 20 pre-commercial production of fuels for aviation

H2020 Biobased Industries consortium

BBI VC valorization of agri-residues and side streams from the food industry

BBI 2016.R2 - Develop consolidated bioprocesses for direct fermentation into bio-compounds for chemicals and materials

(goal: Consolidated bioprocesses, converting at lower scales, pre-treated biomass in one step into valuable bio-products without using technical and specific enzymes)

BBI 2016.R4 - Flexible biorefining technologies able to handle different feedstock, leading to new value chains or enlarging existing ones by utilising the same processing plant

(goal: Dependence on a single source of feedstock is one of the main bottlenecks for biorefinery operations. The challenge is to develop flexible biorefining processes capable of handling feedstock of variable origin, composition and quantity without major investment in (new) equipment)

BBI 2016.R9 - Exploiting algae and other aquatic biomass for production of molecules for pharma, nutraceutical, food additives and cosmetic applications

(goal: Algae and other aquatic biomass thus could be excellent feedstock from aquatic/marine sources to produce chemical building blocks and materials for specific niche market applications)

6 Actions decided (Workshop output)

The workshop did not provide sufficient time to establish an action plan, but attendees did agree that a strong and continuous support for novel pretreatments is needed at all levels (that is also reflected in H2020 for 2017 calls).

There was a general agreement on organisation of specific meetings for participants interested in preparations of projects for H2020 calls however no specific decisions were taken yet.

The organising committee compromise to prepare in medium term the white paper about the novel pretreatments.

Madrid, 10th March 2016

The Organizing Committee:

Mercedes Ballesteros (CIEMAT, Spain, Chairman)

Ines del Campo (CENER, Spain),

Francesco Zimbardi (ENEA, Italy),

Rafal Lukasik (LNEG, Portugal)

Francisco Gírio (LNEG, Portugal; SP2 EERA-Bioenergy Coordinator)