



**BIOENERGY, BIOGAS AND BIOFUELS:**

# Research and innovation gaps in the EU



## List of authors

Name	Entity
Myrsini Christou	CRES, EERA Bioenergy JP Coordinator
Wolter Elbersen	WUR, EERA Bioenergy SPI Coordinator
Berend Vreugdenhil	TNO, EERA Bioenergy SP2 and SP4 Coordinator
Marcelo E. Domine	ITQ-CSIC, EERA Bioenergy SP3 Coordinator
Raquel S. Jorge	NTNU, EERA Bioenergy SP5 Coordinator
Margarita de Gregorio	BIOPLAT, EERA Bioenergy Technical Secretariat
Paloma Pérez	BIOPLAT, EERA Bioenergy Technical Secretariat

## List of contributors

Name	Entity
Chungen Yin	Aalborg University
Günnur Koçar	BESTMER
Raquel Iglesias	CIEMAT
Joana Bernardo	CoLAB BIOREF
Nuno Pereira	CoLAB BIOREF
Benjamin Herklotz	DBFZ
Elena Angelova	DBFZ
Franziska Müller-Langer	DBFZ
Karl-Friedrich Cyffka	DBFZ
Kathleen Meisel	DBFZ
Nora Szarka	DBFZ
Stefan Majer	DBFZ
Daniela Thrän	DBFZ
Francesco Zimbardi	ENEA
Carla Silva	FCiências.ID
Florian Kraxner	IIASA
Michael Kuhn	IIASA
Omkar Patange	IIASA
Stefan Wrzaczek	IIASA

Name	Entity
Hans-Joachim Gehrman	KIT
Francisco Gírio	LNEG
Tiago Lopes	LNEG
Francesco Cherubini	NTNU
Marcos Watanabe	NTNU
Paolo Pisciella	NTNU
Pedro Crespo del Granado	NTNU
Rita V. D'Oliveira Bouman	NTNU
Serge Biollaz	PSI
Tilman Schildhauer	PSI
Michael Becidan	SINTEF
Øyvind Skreiberg	SINTEF
Andre van Zomeren	TNO
Arjan Smit	TNO
Walter Zegada-Lizarazu	UNIBO
Dominik Rutz	WIP Renewable Energies
Rainer Janssen	WIP Renewable Energies
René van Ree	WUR

# Executive summary

**EERA Bioenergy is the European Alliance for excellent research in sustainable bioenergy. The main European universities, research alliances, technology centres, scientific agencies, institutes and associations involved in R&D&I in bioenergy and bioeconomy are part of EERA Bioenergy, which currently comprises 46 members. Its main focus is addressing the challenges of the European energy and environmental policies from a research and innovation perspective and promoting international cooperation to accelerate the SET-Plan priorities.**

This document 'Bioenergy, biogas and biofuels: Research and innovation gaps in the EU' was drafted in the first semester of 2024 and published on 25th June 2024 in the framework of the EUBCE. It's an update of the EERA Bioenergy Strategic Research and Innovation Agenda published in spring 2019 to respond to the current momentum the energy landscape is going through.

The COVID-19 pandemic -initiated in Europe at the beginning of 2020- and the Ukraine invasion -started in February 2022 and is still ongoing- changed substantially the European energy policy landscape. Fit for 55 was launched with the ambition to decrease emissions by 55% in 2030 (on a 1990 basis) and RePowerEU (which put forward a Biomethane Action Plan), ReFuelEU Aviation and FuelEU Maritime initiatives seek to increase significantly the local production and use of renewable energy, gases, and fuels to strengthen Europe's energy autonomy. Some of the current policies have concrete targets for bioenergy, biogas, and biofuels and their implementation in Europe. While bioenergy, biogas, and biofuels contribute to the phase-out of fossil fuels and the defossilisation of the EU economy, the EU Commission also points out that they must be used sustainably<sup>1</sup>.

Given the described policy scenario the energy and climate goals in the region and the current status of bioenergy in Europe, EERA Bioenergy has identified several key issues that require a stronger research focus for the achievement of these goals. This paper summarises some of the main bioenergy-related topics in Europe in need of further research and provides recommendations regarding the way forward for European bioenergy, biogas, and biofuels R&D&I. This also includes suggestions for topics not currently included in European R&D&I funding schemes targeting bioenergy, biogas, and biofuels research and innovation, e.g. Horizon Europe, Innovation Fund, etc. which can be relevant to include in future calls.

The main takeaways for the reader are the following:

- Bioenergy (power, heat, fuels) will always be an integral and inescapable part of optimised biomass valorisation strategies, either being the main product in so called bioenergy/biofuel-based biorefineries or being secondary product(s) in so called bioproducts/biochemicals/biomaterials-based biorefineries.
- Defossilisation means that more biobased carbon is needed. Too often the focus is on maximizing carbon yield and the option of CO<sub>2</sub> sequestration or biochar utilization as a means towards negative emissions is forgotten. This important aspect of bioenergy needs to be stronger emphasized.
- When developing bioenergy/biofuel systems it shouldn't be forgotten that materials and energy go hand in hand. In the ongoing effort to develop the bioenergy/biofuels sector, the synergies with biobased product creation from biomass should be addressed much more, from low TRL to deployment.
- To meet future biomass demands required in the various sectors of the European Circular Bio(based) Economy (Biocircularity), both European non-food crops and aquatic feedstocks, and agro, process and post-consumer residues should be used circularly

and sustainably. Also, huge amounts of sustainably sourced non-European biomass feedstocks should be made available to further fill up future European market demands and ensure security of supply. Further development of so-called biocommodities and a global biocommodities market will be the key success factor for making available the right amounts of right quality biomass feedstocks at the right place and acceptable costs.

- The emergence of a biofuels industry often involves significant technological changes and **economic effects** stretching beyond the sector itself, which can be estimated using CGE<sup>2</sup> models; such models are also well suited for studying the effects of policy interventions/support and can simulate the market dynamics of biofuels.

- Regarding bioenergy **environmental impacts**, access to company data will increase the credibility of LCA<sup>3</sup> studies; proper upscaling of the product system is required to ensure that environmental assessments reflect commercial-scale conditions; moreover, LCAs should also consider the effects of future technological changes in the value chains associated with or supporting the advanced fuels production.
- Public knowledge and **awareness of bioenergy in Europe** is low, as compared to other renewables. Some of the main concerns within the populations are related to water resource scarcity and competition with existing food supply and price. Enhancing social acceptance and engagement will lay the foundations for increasing the market share of bioenergy/biofuel production systems.



**For EERA Bioenergy, as an Alliance for Excellent Research, it's of utmost importance to define strategic areas of research and the key research questions that need further research efforts, in each of its Sub-Programmes.**

Advances in the development of technologies and processes of bioenergy, biofuels, and biogas will bring direct benefits to the European policy context. Sustainable deployment of this sector will contribute to the spread and consolidation of the bioeconomy in all the European regions, which has implications above the energy and environmental concerns.

It can induce significant benefits in both, the primary and secondary sectors and the demographic challenge. The main R&D&I gaps in the fields of bioenergy, biogas, and biofuels (as well bio-based products) that should be addressed to significantly contribute to reaching the ambitious climate EU goals and gain strategic sovereignty (industrial capacity / local energy resources) are listed below and have been described along the document:

<sup>1</sup> [https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal\\_en#:~:text=Bioenergy%20contributes%20to%20the%20phase,increase%20climate%20and%20biodiversity%20ambition.](https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en#:~:text=Bioenergy%20contributes%20to%20the%20phase,increase%20climate%20and%20biodiversity%20ambition.)

<sup>2</sup> Computable general equilibrium models

<sup>3</sup> Life Cycle Assessment studies

#### Sub-Programme 1: Sustainable production of biomass.

- Biomass commodities.
- Mobilisation of feedstock.
  - Feedstock availability.
  - Feedstock Logistics and Supply Chain Management.
  - Building Integrated Biomass Supply Chains.
  - Community and Stakeholder Engagement.
  - Market Development and Incentive Mechanisms.
  - Techno-Economic Analysis.
  - Continues Improvement and Innovation.
- Innovative cropping systems.
- Safety issues for biomass storage.

#### Sub-Programme 2: Thermochemical platform.

- Ramp up the deployment of advanced biofuels.
- Thermochemical bio-refineries.
- Flexibility to increase the resilience of the overall energy system.
- Next-generation biomass pellets via mild thermochemical conversion of biomass.

#### Sub-Programme 3: Biochemical platform.

- Next-generation biorefineries for the treatment and transformation of lignocellulosic biomass in integrated schemes via cascade-type processes.
- Quality and price of the obtained bio-based products.
- Development of new fermentation routes.
- Optimise the pretreatments and operating conditions of the anaerobic digestion.

#### Sub-Programme 4: Stationary bioenergy.

- Optimisation of energy performance and emissions.
- Utilising existing combustion infrastructure.
- Innovation oxy-combustion in stationary bioenergy for CO<sub>2</sub> capture.

#### Sub-Programme 5: Sustainability/techno-economic analysis and public acceptance of bioenergy.

- Socio-economic impacts at community/household level and societal engagement.
  - The use of CGE models to understand macro-economic implications of bioenergy.
  - Further economic modelling approaches.
  - Bioenergy in Europe: societal engagement and governance.
- Environmental sustainability.
  - LCA for bioenergy.
  - Sustainability criteria in the revised RED.
  - Phasing out of first-generation biofuels worldwide and switching to advanced biofuels based on lignocellulose.
  - Environmental impacts: hydrogen and/or CO<sub>2</sub>.





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