SET4BIO

RENEWABLE FUELS AND BIOENERGY FOR A LOW-CARBON EUROPE – ACCELERATING THE IMPLEMENTATION OF THE SET-PLAN ACTION 8

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EXECUTIVE SUMMARY

There is an urgent need to mitigate climate change and, especially in the European context sparked by Russian Invasion of Ukraine, reduce the dependency on fossil fuels imports from Russia to Europe. Unprecedented efforts to decarbonize the European energy system are taking place with the goal of being carbon neutral by 2050. The significance of security and resilience gets more attention in the energy system that is increasingly based on variable renewable energy sources (VRES), in particular wind and solar, and at times of geopolitical uncertainties. **Bioenergy represents a storable, flexible, and dispatchable form of renewable energy, which can be converted to multiple end-products**, including heat, electricity, transport, and chemicals.

Utilization of biomass for products, fuels, and energy is not a new technology, and various bioenergy solutions are available and widely applied for different sectors. In the future, bioenergy is increasingly seen coupled to carbon capture and storage/utilization (BECCS/U) and renewable hydrogen. **Ambition for climate change mitigation and foreseen technology pathways raise the need for research, development, and innovation (RDI)** for sustainable and more resource efficient use of the limited resource. These actions are already taking place both in the research and industry, while EU is setting the scene through legislation and targets. **Given the urgency to meet the climate targets and the plans to end the EU's dependency on Russian fossil fuels, collaboration and coordination in RDI actions cannot be underlined enough.**

In the European context, **a stepping-stone framework to boost the transition towards a climate-neutral energy system through R&I is the European Strategic Energy Technology Plan (SET Plan)**. The target of the SET Plan is to facilitate the achievement of the EU climate and energy goals through **coordinated actions between EU countries, companies, and research institutes**. Key pillars of the SET Plan are the European Technology and Innovation Platforms (ETIPs), the European Energy Research Alliance (EERA), and the Implementation Working Groups (IWGs). One of the IWGs is SET Plan Action 8 - *Bioenergy and Renewable Fuels for Sustainable Transport* (IWG8), which has set research and innovation priorities and targets in its Implementation Plan (IP). As SET Plan was last revised in 2015 and IP developed in 2018, revamping is necessary and an on-going process in 2023. A collaborative Horizon 2020 project SET4BIO (2020-2023) was set to support the implementation and revamping of the SET Plan Action 8 with its strategy constituting of three pillars: activating the stakeholders, mobilizing resources, and stimulating innovation.

The purpose of the Global Outlook report is to 1) identify different initiatives and platforms in the field of Implementation Plan of SET Plan Action 8 *Bioenergy and Renewable Fuel for Sustainable Transport* and review their actions and targets, and 2) benchmark them against SET Plan Action 8 actions and targets. This will help identifying collaboration opportunities for SET Plan Action 8 stakeholders. The report also helps positioning SET Plan Action 8 and IWG8 among other platforms and initiatives and thus, serves as background material for updating the IP8 as a part of SET Plan revamping in 2023.

Altogether 22 European and global platforms and initiatives were identified and analyzed in the field of bioenergy and renewable fuels, and additionally 12 specifically in the field of renewable hydrogen. They were described in terms of their key purpose, members and stakeholders, objectives, and implementation structure, with additional, more detailed data presented in Annexes. Furthermore, 11 platforms and initiatives in the field of bioenergy and renewable fuels seen as the most comparable and relevant for collaboration for SET Plan Action 8, were analyzed in more detail. Focus on research, collaboration, innovation, and deployment was used as a criterion for selection. As a result, collaboration opportunities for SET Plan Action 8 stakeholders were highlighted as well as strengths of SET Plan Action 8 and proposed actions for IWG8.

A typical asset of many European platforms and initiatives in the field of bioenergy and renewable fuels is the wide representation of different members and stakeholders, namely authority, industry, and research. This ensures coverage of different perspectives and exchange of information. Though many platforms and initiatives have similar stakeholder profile, even same representatives, the scope varies, e.g., according to value chains, end-use sectors, and technology readiness. As bioenergy and renewable fuel value chains are typically long and complex, the importance of connecting stakeholders across the value chain increases. **As a key conclusion, well-defined scope and activities of different platforms and initiatives helps to build complementary actions and efficient collaboration.**

Many platforms and initiatives perform similar type of actions. Knowledge sharing is an overarching target and includes many concrete activities from best practices to analysis of national RDI strategies and policies. The analysis shows that there is room for more concrete policy and deployment -related actions in Europe. The work programmes of different platforms and initiatives indicate that commonly interesting topics are, among others, stocktaking of value chains and key techno-economic data, defining project pipelines, and providing knowledge on funding and financing opportunities.

Based on the analyses and benchmarking against several factors, including geographical coverage, scope (e.g., value chains, technology readiness, and end-use sectors), and current connections to IWG8, it is proposed to further discover possibilities for collaboration especially with Biofuture Platform, ETIP Bioenergy, and Renewable and Low-carbon Fuels Value Chain Industrial Alliance (RLCF). Bioenergy and renewable fuel value chains have several interfaces with hydrogen value chains, for instance, through hydrogen production from biomass and hydrogen use in bio-based processes. This opens opportunities for collaboration between these two fields.

<u>Key conclusions and recommendations:</u>

1. The number and content of platforms and initiatives related to bioenergy and renewable fuels sector shows that **the sector is active** in producing and disseminating information, collaborating internationally, and defining agendas for research, innovation, and deployment.
2. **It is recommended to clearly define the scope and activities of different platforms and initiatives to enhance the complementarity of actions and to guarantee efficient collaboration.** In the European context, defining the relations of key SET Plan pillars is of special importance.
3. Cooperation between platforms and initiatives within Europe has been established and takes place. **Complementary collaboration on international level should be sought** to gain global perspectives, promote European expertise, and learn from best practices**.**
4. Member States engagement is sought by many platforms and initiatives. This is important especially for SET Plan pillars to ensure coordinated actions with Member States. IWG8 has **a strong Member States presence, which should be effectively utilized**.
5. Renewable hydrogen is a cross-cutting topic with increasing interest. The scope of IWG8 is in bioenergy and renewable fuels for transportation, which has clear links to hydrogen value chains. It is important to **define synergies between hydrogen value chains and SET Plan Action 8's scope, as well as establish respective targets and KPIs**.

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Content

Introduction

There is an urgent need to mitigate climate change and, especially in the European context sparked by Russian Invasion of Ukraine, reduce the dependency on fossil fuel imports from Russia to Europe. Unprecedented efforts to decarbonize the European energy system are taking place with the goal of being carbon neutral by 2050. In the future energy system based on variable renewable energy sources (VRES), in particular wind and solar, and at times of geopolitical uncertainties, the significance of security and resiliency of the system is highlighted. In contrast to VRES, **bioenergy represents a storable, flexible, and dispatchable form of renewable energy**, thus being able to complement VRE supply both on short-term and on seasonal level and guarantee security of supply.

Utilization of biomass for products, fuels, and energy is not a new technology, and various bioenergy solutions are available and widely applied for heating, electricity, transport, and industry at different scales and in different forms. International Energy Agency (IEA) foresees in its Net Zero Energy (NZE) Roadmap[1] that modern bioenergy will increase by a factor of 2.5, becoming the second largest energy source by 2050. At the same time, the traditional use of bioenergy disappears from the mix. In the future**, bioenergy is increasingly seen coupled to carbon capture and storage/utilization (BECCS/U)**. IEA's NZE scenario anticipates 2.4 Gt per year of CO_2 captured through BECCS and DACCS by 2050 out of the total of 7.6 Gt of CO_2. At the same time, hydrogen production, mainly from water electrolysis, is foreseen to rise nearly fivefold. **Hydrogen and bioenergy have interfaces** in terms of renewable hydrogen production from biomass and hydrogen use in bio-based processes, e.g., Power-to-X with renewable hydrogen and biogenic CO_2 as resources.

Ambition for climate change mitigation and foreseen technology pathways raise the need for research, development, and innovation (RDI) for sustainable and more resource efficient use of the limited resource. These actions are already taking place both in the research and industry, while EU is setting the scene through legislation and targets, e.g., Fit for 55, REPowerEU, Green Deal Industrial Plan, and Hydrogen Strategy. **Given the urgency to meet the climate targets and the plans to end the EU's dependency on Russian fossil fuels, collaboration and coordination in RDI actions cannot be underlined enough.**

Collaboration and coordination are already taking place at different geographical dimensions (regional, national, Europe, global), and at different levels with different stakeholder groups (authority, industry, research) in the field of bioenergy and renewable fuels. Key features of bioenergy are the length and versatility in supply chains with multiple feedstocks, conversion technologies, intermediate bioenergy carriers, and products, as well as multiple uses in different end-use sectors and sustainability issues. **Collaboration takes place from technology, market, and policy perspectives in various platforms and initiatives with the final goal of enhancing RDI and market deployment.**

In the European context, a stepping-stone framework to boost the transition towards a climate-neutral energy system through R&I is the European Strategic Energy Technology Plan (SET Plan). **The target of the SET Plan is to facilitate the achievement of the EU climate and energy goals through coordinated actions between EU countries, companies, research institutes, and academia.** Key Pillars of the SET Plan are the European Technology and Innovation Platforms (ETIPs), the European Energy Research Alliance (EERA), and the Implementation Working Groups (IWGs). One of the IWGs is SET Plan Action 8 - *Bioenergy and Renewable Fuels for Sustainable*

[1] IEA International Energy Agency. (May 2021). Net Zero by 2050 – A Roadmap for the Global Energy Sector. Available at: https://www.iea.org/reports/net-zero-by-2050

Transport (IWG8), which has set research and innovation priorities and targets in its Implementation Plan (IP)[2]. As SET Plan was last revised in 2015 and IP developed in 2018, revamping is necessary and an on-going process in 2023. The collaborative Horizon 2020 project SET4BIO[3] (2020-2023) aims to support the implementation and revamping of the SET Plan Action 8 through a strategy consisting of three pillars: activating stakeholders, mobilizing resources, and stimulating innovation.

While valuable collaboration and coordination takes place in many platforms and initiatives, including ETIP Bioenergy, EERA Bioenergy, and IWG8 at European level, finding the right arena to participate can be a challenge, and there is a risk of inefficiency due to potentially overlapping actions. On the other hand, **through collaboration and coordination between the platforms and initiatives, effective complementary actions can take effect**. Furthermore, expanding the collaboration to platforms and initiatives with global focus can bring further benefits in terms of widening the perspectives, promoting European expertise, and learning from best practices outside Europe.

Global Outlook report aims **to draw a picture of existing platforms and initiatives in the field of bioenergy and renewable fuels** by identifying them and reviewing their actions and targets. Furthermore, they are benchmarked against SET Plan Action 8 actions and targets to identify collaboration opportunities for SET Plan Action 8 stakeholders, and to support positioning of IWG8 and updating Implementation Plan 8 as a part of SET Plan revamping process. Additionally, several platforms and initiatives specifically related to renewable hydrogen are reviewed as there are several interfaces and synergies between hydrogen and bio-based value chains.

The report focuses on European and global platforms and initiatives, while national ones are not covered. Each identified platform and initiative in the field of bioenergy and renewable fuels are described in terms of their key purpose, members and stakeholders, objectives, and implementation structure and collaboration (Section 2). The same information in a shorter format is provided for identified renewable hydrogen-related platforms and initiatives (Section 0). In addition, further detailed information of all platforms and initiatives are provided in Annexes I and II. The platforms and initiatives in the field of bioenergy and renewable fuels seen as the most comparable and relevant for collaboration for SET Plan Action 8 were analyzed and benchmarked in more detail (Section 4). Focus on research, collaboration, innovation, and deployment was used as a criterion for selection for further analysis, whereas associations and fully industrial platforms were excluded. As the result, collaboration opportunities for SET Plan Action 8 stakeholders are highlighted as well as strengths of SET Plan Action 8 and proposed actions for IWG8.

[2] European Commission. (5.6.2018). *SET Plan Implementation Plan Action 8: Bioenergy and Renewable Fuels for Sustainable Transport.* Available at: https://setis.ec.europa.eu/system/files/2021-07/setplan_bioenergy_implementationplan.pdf

[3] ETIP Bioenergy. (2022). *SET4BIO*. Available at: https://www.etipbioenergy.eu/set4bio

1. SET Plan and SET Plan Implementation Plan 8

The European Strategic Energy Technology Plan (SET Plan), established in 2007 by the European Commission[4], is a stepping-stone to boost the transition towards a climate-neutral energy system by developing low-carbon technologies in a fast and cost-competitive way. It serves as a reference framework for addressing clean energy research and innovation in Europe. The SET Plan aims to facilitate the achievement of the EU climate and energy goals through coordinated actions between EU countries, companies, and research institutes. The SET Plan consists of the SET Plan Steering Group, the Bureau of the SET Plan Steering Group, 14 Implementation Working Groups (IWGs), the European Technology and Innovation Platforms (ETIPs), the European Energy Research Alliance (EERA), and the SET Plan Information System (SETIS).[5]

The purpose of the IWGs is to monitor and report the progress of the SET Plan targets and R&I activities carried out at national and European levels across the ten key actions identified in the Integrated SET Plan. The progress is reported in the annual Progress Report. IWGs identify in their Implementation Plans (IPs) specific technological R&I activities, demonstration projects, and other general actions needed to meet the SET Plan targets. The activities and targets are identified in cooperation between national governments, industry, and research bodies. IWGs include representatives from industry, research institutes, academia, and non-governmental organizations as well as national and regional authorities responsible for research, innovation, education, climate action, and energy.

In response to the rapidly changing policy framework, e.g., in terms of the introduction of the European Green Deal in 2019 and its associated Climate Law, adopted in 2021, the Russian Invasion of Ukraine, energy crises, and REPowerEU, the SET Plan is under 'revamp'. The progress report 2022[6] was designed to support the process.

SET Plan Implementation Plan 8: Bioenergy and Renewable Fuels for Sustainable Transport (IP8)[7] was developed by *SET Plan Temporary Working Group on Renewable Fuels and Bioenergy (TWG8)* under one of the key targets of the Integrated SET Plan - Key Action 8 – Bioenergy and Renewable Fuels for Sustainable Transport. The IP8 was endorsed in 2018. In 2019, the former TWG8 became *Implementation Working Group 8 (IWG8)* with the scope to implement the IP 8. *SET Plan Declaration of Intent (DoI8)*[8] worked as the basis for IP8, including challenges, objectives and strategic targets for bioenergy and renewable fuels.

[4] EUR-Lex. (10.1.2007). *Towards a European Strategic Energy Technology Plan.* COM(2006) 847 final. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52006DC0847&from=EN

[5] European Commission. *Strategic Energy Technology Plan.* Available at: https://energy.ec.europa.eu/topics/research-and-technology/strategic-energy-technology-plan_en

[6] European Commission. (4.11.2022). *SET Plan progress report 2022.* Available at: https://setis.ec.europa.eu/set-plan-progress-report-2022_en

[7] European Commission. (5.6.2018). *SET Plan Implementation Plan Action 8: Bioenergy and Renewable Fuels for Sustainable Transport.* Available at: https://setis.ec.europa.eu/system/files/2021-07/setplan_bioenergy_implementationplan.pdf

[8] European Commission. (16.11.2016). *SET-Plan - Declaration of Intent on "Strategic Targets for bioenergy and renewable fuels needed for sustainable transport solutions in the context of an Initiative for Global Leadership in Bioenergy".* Available at: https://setis.ec.europa.eu/system/files/2021-07/declaration_action8_renewablefuels_bioenergy.pdf

1.1 Actions and targets of Implementation Plan 8

IP 8 covers renewable fuels for transport, other renewable fuels of non-biological origin, bioenergy intermediate carriers, renewable hydrogen, and large-scale biomass CHP. It addresses the strategic targets for 2020 and 2030 included in the DoI8. Targets for 2030 are described in the following sub-sections.

Strategic targets for renewable fuels for sustainable transport for 2030

1. Improve production performance

1.1 Advanced biofuels

- Improve net process efficiency of conversion to end biofuels products of up to 30% compared to present levels, with simultaneously reducing the conversion process costs

1.2 Other renewable liquid and gaseous fuels

- Improve net process efficiency of various production pathways of advanced renewable liquid and gaseous fuels of at least 30% compared to present levels
- For renewable hydrogen production by electrolysis improve net process efficiency to reach 70%

2. Improve GHG savings

Total GHG savings through the use of advanced biofuels and renewable fuels will be at least that required in Directive (EU) 2015/1513 where Article 7b (amended) states that greenhouse gas emissions saving from the use of advanced renewable fuels shall be at least 60%. The greenhouse gas emission saving from the use of biofuels shall be calculated in accordance with Article 7d(1) of the same Directive and should be at least 60% of the 40% target in 2030.

3. Reduce costs (excluding taxes and feedstock cost)

In conclusion, the target price in 2020 and 2030 for advanced biofuels and renewable fuels should be within a reasonable margin from parity with fossil-based fuels. Nevertheless, when policy incentives for CO_2 reduction are taken into account, they should aim to be in parity with fossil fuel prices in 2030. Besides the need to address other boundary conditions outside this Implementation Plan, this will require in particular improvements in process efficiency and energy balance through the application of innovative practices.

3.1 Reduce cost for end biofuel products

- Liquid or gaseous advanced biofuels by thermochemical or biochemical processing: <35 €/MWh, e.g., at least by 30% from 2020 levels (<50 €/MWh)
- Algae-based advanced biofuels <35 €/MWh, e.g., at least by 50% from 2020 levels (<70 €/MWh)

3.2 Reduce cost for renewable liquid and gaseous fuels

- Other renewable liquid and gaseous fuels excluding renewable hydrogen: at least by 50% from 2020 levels (<50 €/MWh)
- Renewable hydrogen: <4 €/kg

Strategic targets for bioenergy

1. Reduce conversion system costs for high efficiency (>70% based on net caloric value of which >30% electrical) large-scale biomass cogeneration of heat and power by 50%.

2. Improve performance and reduce GHG emissions by increasing efficiency: Obtain net efficiency of biomass conversion to intermediate bioenergy carriers of at least 75% with GHG emissions reduction of 60% from the use of all types of intermediate bioenergy carrier products resulting in a contribution to at least 4% reduction of the EU GHG emissions from the 1990 levels.

Strategic Targets for intermediate bioenergy carriers

Improve performance and reduce cost (excluding taxes and feedstock cost)

A. Liquid and gaseous intermediate bioenergy carriers by thermochemical or biochemical processing: <10 €/MWh for e.g., pyrolysis oil; <30 €/MWh for higher quality, e.g., microbial oils.

B. Solid intermediate bioenergy carriers by thermochemical or biochemical processing, e.g., bio-char, torrefied biomass, lignin pellets: <5/MWh compared to present levels.

1.2 SET Plan Implementation Working Group 8 on Bioenergy and Renewable Fuels for Sustainable Transport

Implementation Working Group 8 consists of representatives from the European Commission, national and regional authorities responsible for the fields addressed in the IP8, industry, research institutes, academia, and non-governmental organizations. IWG 8 is chaired by Timo Ritonummi (Deputy Director General, Ministry of Economic Affairs and Employment, Finland) and co-chaired by Franco Cotana (University of Perugia, Italy) and René Venendaal (CEO, BTG Biomass Technology Group b.v.). European Commission's Joint Research Centre works as the secretariat of IWG8. Figure 1 presents the IWG8 members and shows that representation of authorities, research, and industry is well-balanced.

Member States represented include Austria, Belgium, Cyprus, Finland, France, Germany, Italy, Poland, Portugal, Spain, Sweden, the Netherlands, and Turkey. From stakeholders, the following have a seat in IWG8: ETIP Bioenergy, ETIP RHC, EERA Bioenergy, EERA Fuel Cells & Hydrogen, Clean Hydrogen Joint Undertaking, European Biomass Industry Association (EUBIA), European Biogas Association (EBA), Neste, Ørsted, VTT Technical Research Centre of Finland Ltd, IFP Energies Nouvelles, Ente Nazionale Idrocarburi, Fraunhofer Institute for Environmental, Safety and Energy Technology, and European University Association (EUA).

SET4BIO *Renewable Fuels and Bioenergy for a Low-Carbon Europe - accelerating the implementation of the SET Plan*[9] is a project funded by the Horizon 2020 programme of the European Union to support the full execution of the Implementation Plan of SET Plan Action 8. This covers both the research and innovation lines and large-scale projects. SET4BIO acts as a

[9] ETIP Bioenergy. (2022). *SET4BIO*. Available at: https://www.etipbioenergy.eu/set4bio

competence center for the IWG8 and proposes solutions and pathways to overcome the essential barriers associated to IP8. The project started in March 2020, and it will run until August 2023. The project is carried out by a consortium of six partners from six countries, coordinated by RISE Research Institutes of Sweden (SE), and participated by SINTEF Energi AS (NO), FNR Fachagentur Nachwachsende Rohstoffe e.V. (DE), Fundación CIRCE-Centro de Investigación de Recursos y Consumos Energetícos (ES), VTT Technical Research Centre of Finland Ltd (FI) and ETA Florence Renewable Energies (IT).

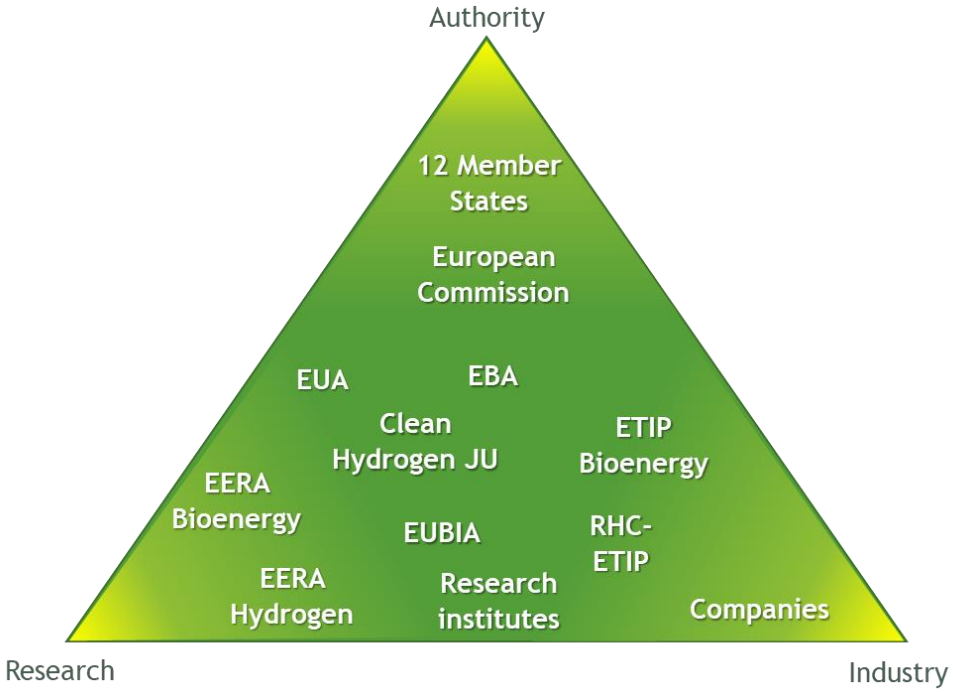

Figure 1. IWG8 members from authority, research, and industry.

1.3 Value chains

ETIP Bioenergy has defined a set of value chains[10] to describe different conversion pathways from a range of feedstocks to a range of products (Figure 2). Value chains group different pathways by technologies to allow the definition of research needs and TRL. ETIP Bioenergy has classified the value chains in: Established Value Chains (EVC, TRL 9, commercially applied), Priority Value Chains (PVC, TRL 5-8), and Development Pathways (DP, < TRL 5). The whole spectrum is relevant for IWG8 and used in different SET4BIO activities, while, though, close to 94% of the investments needed are foreseen for the scale-up (TRL 9) in the IP8. The value chains are presented in Table 1 to allow benchmarking to other platforms and initiatives in the field of IP8, presented in Sections 0 and 0. In addition to bio-based value chains, two value chains for hydrogen were defined in SET4BIO.

[10] ETIP Bioenergy. (2022). *Value chains.* Available at: https://etipbioenergy.eu/value-chains/conversion-technologies/advanced-technologies

Figure 2. General value chain for the production of renewable transport fuels, heat and power from various feedstocks. (Reproduced from ETIP Bioenergy.)

Table 1. Value chains defined by ETIP Bioenergy, and partly adapted by SET4BIO.

Type of value chains	**Value chains**
Established value chains (TRL 9)	EVC1: Transesterification to biodiesel EVC2: Hydrotreatment to HVO EVC3: Sugars and starch fermentation to ethanol EVC4: Anaerobic digestion to biogas and biomethane EVC5: Small-scale combustion for residential heat EVC6: Large-scale combustion for heat and power EVC7: Biomass co-firing for heat and power EVC8: Intermediate bioenergy carriers for power and heat
Priority value chains (TRL 5-8), *adapted from ETIP Bioenergy's priority value chains*	VC1: Production of transport fuels through gasification of biomass feedstocks VC2: Production of power and heat through gasification of biomass feedstocks VC3: Production of transport fuels through thermochemical processes VC4: Production of power and heat through other thermochemical processes VC5: Production of transport fuels through alcohols from sugars via fermentation VC6: Production of transport fuels through conversion to hydrocarbons
Development pathways (< TRL 5)	DP1: Conversion of aquatic biomass
Hydrogen value chains, *defined in SET4BIO*	Hydrogen VC1: Production of hydrogen via electrolysis used in transport and power Hydrogen VC2: Production of hydrogen via electrolysis integrated to biofuels production

2. Initiatives and platforms in the field of bioenergy and renewable fuels

2.1 Global initiatives and platforms

Clean Energy Ministerial (CEM)

Clean Energy Ministerial (CEM)[11] is a high-level global forum that aims to promote clean energy technologies by contributing to policy-making and programs in the field of energy. The CEM serves as a platform to share lessons learned and best practices and to **accelerate the deployment of clean energy solutions**. It is an implementation vehicle that helps its Members to achieve specific domestic clean energy objectives. CEM's mission statement, governance structure, membership, and budget are described in the Framework for the Clean Energy Ministerial document.[12]

The CEM consists of a group of governments that include the major economies and forward-leaning countries. The current CEM Members are Australia, Brazil, Canada, Chile, China, Denmark, European Commission, Finland, France, Germany, India, Indonesia, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, Saudi Arabia, South Africa, South Korea, Spain, Sweden, United Arab Emirates, United Kingdom, and the United States. The CEM Steering Committee is a rotating sub-set of CEM Member countries, India and the USA being the current co-chairs. CEM also has 19 participant countries, and observers and partners as key partners, e.g., IEA, IRENA, the World Bank (observers), NREL, IEA GHG, and VTT (partners).[13]

The CEM operates through three pillars: CEM Ministerial, CEM Work Programme, and CEM Secretariat.

CEM Ministerial is expected to serve as the ultimate priority-setting entity for the CEM. The CEM Ministers are strongly encouraged to participate in the Annual Ministerial Meetings which are events for high-level dialogue between CEM Ministers, invited Partners, and other invitees.

CEM Work Programme consists of international initiatives and campaigns. The initiatives and campaigns are the instruments through which the CEM's mission and objectives are carried out. **CEM Initiatives** are collaborative efforts by CEM Member countries to establish coalitions for clean energy collaboration and acceleration. The Initiatives consist of Member leads, Coordinator, and CEM Secretariat. The Initiatives last a minimum of three years, after which they can be renewed each year. The success of the Initiatives is measured with the following metrics: Engagement/Activity, Delivery, and Output and Outcome. These include, but are not limited to, active coalition participation, expert meetings, and project collaborations.

Campaigns are designed to further promote prioritized Initiatives. The aim of Campaigns is to elevate selected Initiatives from the technical level to the political level, in order to increase public visibility and get more high-level Ministerial guidance regarding the topic. The Campaigns

[11] Clean Energy Ministerial. (2022). Available at: https://www.cleanenergyministerial.org/
[12] Clean Energy Ministerial. (1.6.2016). *Framework for the Clean Energy Ministerial (CEM).* Available at: https://www.cleanenergyministerial.org/content/uploads/2022/03/cem-framework-final-20160601.pdf
[13] Clean Energy Ministerial. (September 2022). *CEM brochure - 2023 Update*. Available at: https://www.cleanenergyministerial.org/resource/cem-brochure-2023-update/

engage with a broader audience in comparison with the Initiatives to build a community that can generate impactful commitments. The Campaigns are shorter in duration, one or two years, and they consist of Member leads, a Campaign Manager, and CEM Secretariat. The success of Campaigns is measured by awareness (events, viewers, participants), engagement (subscribers, followers, amplification), and impact (signatories and commitments) metrics.

Current CEM Workstreams, which consist of different Initiatives, Campaigns, Partnerships, and themes are presented in Table 2. Especially Biofuture Platform and Biofuture Campaign are relevant for SET Plan Action 8 stakeholders.

The CEM Secretariat consists of a small team that serves the CEM Ministerial, Workstreams, and the CEM Members. The Secretariat is hosted by the IEA.

Table 2. The CEM's current and graduated Workstreams and their content.[13]

CEM Workstream	Workstream content
Power	• 21st Century Power Partnership • Nuclear Innovation • International Smart Grid Action Network • Regional & Global Interconnections • Transforming Solar • RISE[3]
Transport	• Electric Vehicles Initiative • EV30@30 Campaign • Commercial Vehicles Drive to Zero Campaign
Industry	• Carbon Capture, Utilization, & Storage • Industrial Deep Decarbonisation • Green Public Procurement Campaign
Buildings	• Super-Efficient Appliance & Equipment Deployment
Cross-sectoral	• **Hydrogen Initiative** • **Biofuture Platform** • **Biofuture Campaign**
Enabling environment	• Empowering People • Equality In Energy Transitions • Equal by 30 Campaign • Long-Term Energy Scenarios • Investment & Finance • Clean Energy Solutions Center
Graduated Workstreams	
• Advanced Cooling Challenge (ACC) Campaign • Advanced Power Plant Flexibility • Corporate Procurement of Renewable Energy Sources • Distributed Generation on Strategic Regions Campaign • Energy Management Campaign • Energy Management Working Group • Global Lighting and Energy Access Partnership (LEAP) • Global Lightning Campaign • Multilateral Solar and Wind Working Group • Nearly Zero Energy Buildings • Sustainable Cities and Eco-Energy Towns • Power System Flexibility • Flexible Nuclear	

Through Ministerial leadership, the CEM aims to accelerate the clean energy transition through the **engagement of the private sector, and international and non-governmental Partners**. From specified targets of CEM Campaigns to minister-level dialogue, CEM aims to increase awareness, promote international collaboration, and **new policy implementation** to accelerate the

deployment of clean energy in a coordinated manner.

The CEM is **financed through voluntary contributions** of the Members on an annual or multi-year basis. The contributions of the Members are channelled to support the Secretariat, specific Initiatives and Campaigns, as well as a central CEM Trust Fund to support CEM activities. Furthermore, the Members are encouraged to provide **in-kind support** to the Secretariat, such as secondments to the Secretariat, in-country resources for remote support, and hosting meetings, workshops, and other efforts. The annual budget and the funding mechanisms are managed and proposed by the Secretariat, reviewed by the Steering Committee, shared with all CEM Members, and ultimately approved at the Annual Ministerial Meeting.

CEM Members agreed to establish a CEM Action Fund[14] at the Global Clean Energy Action Forum (GCEAF) hosted by the USA in Pittsburgh in September 2022. The aim of the fund is to attract new resources to fill the gap in the CEM's existing resourcing structure and to provide larger-scale, multi-workstream, and multi-year support. The Action Fund will be open to governments and the public sector, NGOs, business and industry, and philanthropic organizations to support the CEM as whole or specific sectors, specific countries or regions, targeted activities, and projects.

Biofuture Platform Initiative (part of the CEM)

Biofuture Platform Initiative[15] is a platform with the aim to promote international coordination on bio-based fuels, chemicals, materials (FCMs), and the sustainable low-carbon bioeconomy. It provides a forum for **policy dialogue and collaboration among the leading countries, organizations, academia, and the private sector**. The Initiative was initially launched by Brazil at COP22 in 2016 to acknowledge bio-based alternatives in the field of clean and renewable energy. It was merged with the CEM and relaunched in 2020 as one of the Initiatives carried out by the CEM.

Biofuture Platform is a global, government-led initiative with 22 Members, and it is currently chaired by the U.S. Department of Energy. IEA has coordinated the Biofuture Platform since 2019.

In accordance with its strategic goals, the Biofuture Platform informs policymakers, promotes international collaboration, identifies barriers to bioenergy deployment, develops best practices to evaluate, share and promote sustainable practices throughout the whole biomass value chain, and facilitates CEM Member countries in transition to bioeconomy, for example by developing supportive financing mechanisms.

The main activities include a workstream on Biomass Quantification and Sustainability Governance, Policy Blueprint, and Biofuture Campaign (covered in the next Section). **The Biomass Quantification and Sustainability Governance workstream**[16] was established in 2022 to address the concerns of biomass sustainability and to clarify the contribution of bioenergy in climate change mitigation. The desired outcomes for the work are to ensure the appropriate roles for

[14] Clean Energy Ministerial. (2022). *CEM Action Fund.* Available at: https://www.cleanenergyministerial.org/cem-action-fund/

[15] Biofuture Platform. (2022). *Accelerate the transition to a global bioeconomy.* Available at: https://biofutureplatform.org/

[16] Biofuture Platform. (2022). *Workstream on Biomass Quantification & Sustainability Governance*. Available at: https://biofutureplatform.org/sustainability-workstream/

sustainable biomass in the path towards net-zero, climate-smart energy and sustainable development, reduce the sustainability risks for biomass production and use, and increase the public awareness and acceptance of bioenergy as a part of circular economies. The Platform established a Technical Advisory Group (TAG) to guide and provide feedback on the workstream activities. The TAG consists of experts in the bioenergy industry, research, finance, and policy with documented previous engagement. The responsibilities of TAG include ensuring stakeholder outreach and representation, draft product reviewing, strategic guidance, and feedstock sustainability issue identification and formulating strategies to address them.

Policy Blueprint was launched to assess the development of bioeconomy in a number of countries and to develop a set of guidelines on the key elements for a successful policy portfolio that stimulates a sustainable bioeconomy. The approach is to develop an appropriate policy evaluation methodology, perform the country policy evaluations, and ultimately, provide guidance on policy principles, good practices, and lessons learned. The approach has been tested with Brazil, the Netherlands, and the US, with the aim of extending the approach to other countries.

Biofuture Platform is collaborating with, for example, IEA Bioenergy TCP, IEA, IRENA, FAO, GBEP, and UNIDO. The collaboration with IEA Bioenergy TCP was reinforced with a MoU[17] where the parties agreed to exchange information and data, share expertise, organize joint events, and carry out joint studies on mutually agreed topics.

Biofuture Campaign (part of the Biofuture Platform Initiative)

Biofuture Campaign[18] falls under the Biofuture Platform Initiative and was launched to elevate the Biofuture Platform Initiative goals to advance sustainable commercial-scale bioenergy production, trade, and use globally. The focus of the Biofuture Campaign is to strengthen the cooperation and partnership with the private sector; it is designed **to be the mechanism for the Biofuture Platform Initiative to engage with the private sector.**

Biofuture Campaign is led by Brazil, Canada, India, the Netherlands, and the USA, with Finland and UK as participants. The partners, 44 in total, comprise associations, companies operating within bioenergy, and other bioenergy coalitions and collaboration platforms. The campaign is coordinated by the IEA.

Biofuture Campaign seeks stronger commitment and a faster pace to replace fossil carbon with bio- and waste-based alternatives via joint work between governments and industry. The emphasis of the work is on feedstock availability and sustainability governance between governments and industry, as well as reaching a consensus on carbon accounting and sustainability governance between various governmental jurisdictions and international agencies.

To catalyze action among industry and civil society, Biofuture Campaign launched the **Bio-based Substitution Challenge**, whose signatories commit to substitute bio- and waste-based fuels, chemicals, and materials (FCM) for 10% of their fossil carbon equivalents by 2030. Industry and civil society are encouraged to contribute with their own capacity, and governments endorsing the Campaign activities are expected to direct their ministers to engage through Biofuture Platform Initiative to report progress. Biofuture Campaign leverages its connections to the CEM

[17] IEA Bioenergy Technology Collaboration Programme & Biofuture Platform. (19.10.2022). *Memorandum of Understanding on Programme Cooperation in the Field of Bioenergy*. Available at: https://biofutureplatform.org/wp-content/uploads/2022/11/MoU-BfP-Bioenergy-TCP-Signed-19102022.pdf

[18] Biofuture Platform. (2022). *Biofuture Campaign.* Available at: https://biofutureplatform.org/biofuture-campaign/

community, enabling dialogue with a wide set of actors.

Mission Innovation

Mission Innovation (MI)[19] is an inter-governmental initiative addressing and **accelerating clean energy innovation through action-oriented cooperation**. Joint Member Statement on the Launch of Mission Innovation 2.0[20] took place at the Sixth Mission Innovation Ministerial in May 2021 and MI 2.0 was launched in June 2021 as a descendant for the first 5-year period Mission. MI aims to catalyze action and investment in **research, development, and demonstration** to make clean energy affordable, attractive, and accessible to all this decade.

Mission Innovation has 23 members, namely Austria, Australia, Brazil, Canada, Chile, China, Denmark, Finland, France, Germany, India, Italy, Japan, the Republic of Korea, Morocco, the Netherlands, Norway, Saudi Arabia, Sweden, the United Arab Emirates, the UK, the USA, and the European Commission. MI engages energy Ministers and Ministers of other sectors that play an important role in clean energy innovation. MI Ministerial gathers the Ministers together annually to assess progress and discuss with the key private sector and international players how to further accelerate innovation and bring technologies to market.

MI Steering Committee provides high-level strategic guidance to MI. It is comprised of a subset of MI member representatives. **MI Secretariat** is a central governance and member engagement body of MI, which also develops and implements the overarching strategy, delivers to MI programs, and takes care of communication and collaboration. As a part of the sixth MI Ministerial, a Technical Advisory Group was set up with the purpose of helping MI governments maximize their impact and providing recommendations to the MI Steering Committee.

Mission Innovation provides **an action-oriented forum** for government leaders to pioneer clean energy solutions through domestic innovation actions and international cooperation. MI will **catalyze global action through public-private Missions** that can lead to more rapid technology adaption through improved cost, efficiency, or scale of clean energy solutions. Furthermore, collaboration is supported through **an Innovation Platform**. MI will actively work in **partnership with the private and financial sectors** and other initiatives to boost the demand for new solutions and explore opportunities for public-private investments.

The **Missions**[21] are public-private innovation alliances that bring together countries, corporations, investors, and research institutes. Today, there are altogether seven Missions: **Zero-Emission Shipping**, **Clean Hydrogen**, Green Powered Future, Carbon Dioxide Removal, Urban Transitions, Net-zero Industries, and **Integrated Biorefineries**. The Missions develop, e.g., roadmaps and action plans to achieve Missions' goals, bridge innovation gaps in the sector, and accelerate the adaptation of new technologies by shaping research, development, and demonstrations.

Innovation Platform[22] consists of three modules: Insights, Collaborate and Accelerate. These

[19] Mission Innovation. (2022). *Catalysing clean energy solutions for all*. http://mission-innovation.net/

[20] Mission Innovation. (31.5.2021). *Joint Member Statement on the Launch of Mission Innovation 2.0. Approved 31 May 2021 at the Sixth Mission Innovation Ministerial*. Available at: http://mission-innovation.net/wp-content/uploads/2021/05/MI-2.0-Launch-Statement-FINAL.pdf

[21] Mission Innovation. (2022). *Missions*. Available at: http://mission-innovation.net/missions/

[22] Mission Innovation. (2022). *Innovation Platform.* Available at: http://mission-innovation.net/platform/

initiatives are led and supported by MI Secretariat and members. **Insights** module includes collaboration with e.g., IEA and IRENA to monitor public and private sector investments and clean energy technology progress and to accelerate learning from national programs. Initiatives under **Collaborate** module aim at bringing together policymakers, funders, innovators, and international organizations into an international innovation network to share knowledge, agree on R&D&D priorities, and to identify collaboration opportunities. There are currently four Collaboration initiatives: Innovation for International Sustainable Aviation Fuel (ISAF), Materials for Energy, The Innovation Community on Affordable Heating and Cooling of Buildings, and MI Call series. The first **Accelerate** initiative will be the Mission Innovation CleanTech Exchange led by India and the Clean Energy International Incubator Centre.

MI promoted collaboration and international partnerships in 2019-2021 through joint calls. The calls were sponsored by MI members and open to other MI members. The call topics covered digital transformation for green energy transition, energy storage solutions, hydrogen valleys, industrial CCUS, advanced biofuels, and bioenergy, among other topics.[23] In the first 5-year period of MI, its members increased investments in clean energy innovation by USD 5.8 bn annually, leading to a cumulative increase of USD 18 bn. Some of the countries doubled their MI-related investments.[24] The strategies, activities, and public-sector investments are reported in the annual Country Highlights[25].

Each member seeks to sustain or increase investment in clean energy R&D&D over the second phase of MI. The members will describe the **National Innovation Pathway** of the country, including innovation needs until 2030, plans to address the needs, measures for monitoring the outcomes, and innovation ecosystem developments, **strengthen the international collaboration** through active participation in Missions, and actively contribute to the governance functions of MI.

Mission Innovation collaborates with World Bank Group, Global Covenant of Mayors for Climate and Energy, Breakthrough Energy Coalition, World Economic Forum, IRENA, and IEA.

The next three sections present the most relevant Missions, part of Mission Innovation, focusing on bioenergy and renewable fuels, and therefore, relevant for SET Plan action 8 stakeholders.

Mission Innovation Integrated Biorefineries Mission

The Mission Innovation Integrated Biorefineries Mission[26] was launched in November 2021 as a part of Mission Innovation 2.0. The Mission offers an opportunity to **leverage expertise and international collaboration** to support the development of bio-based Sustainable Fuels, Chemicals, and Materials (SFCM). These are seen as essential elements to reduce greenhouse gas emissions, improve supply chain resiliency and diversification, and support the global transition to a net-zero economy.[27]

The Mission is co-led by India and the Netherlands. Brazil and Canada are core members of the Mission, and the European Commission and the United Kingdom are supporting members. The

[23] Mission Innovation. (2022). *Funding Opportunities.* Available at: http://mission-innovation.net/our-work/funding-opportunities/
[24] Mission Innovation. (2022). *MI's first phase.* Available at: http://mission-innovation.net/about-mi/first-phase/
[25] Mission Innovation. (2022). *MI Country Highlights.* Available at: http://mission-innovation.net/our-members/
[26] Mission Innovation. (2022). *Integrated Biorefineries Mission.* Available at: http://mission-innovation.net/missions/integrated-biorefineries-mission/
[27] Mission Innovation. (2022). *Innovation Roadmap: Mission Integrated Biorefineries.* Available at: http://mission-innovation.net/wp-content/uploads/2022/09/Integrated-Biorefineries-Mission-Innovation-Roadmap.pdf

Mission sees that active participation from industry, governments, and academia through public-private collaboration and partnerships to support cross-sectoral collaboration and coordination is needed.

The goal of the Mission is to **develop and demonstrate innovative solutions to accelerate the commercialization of integrated biorefineries**, with a target of replacing 10% of fossil-based feedstock for fuels, chemicals, and materials with sustainable bio-based alternatives by 2030.

The Mission's key actions are organized across three pillars: **i) Research, Development, and Demonstration (RD&D)** that focuses on technologies and processes that improve both the cost competitiveness of bio-based SFCMs and the sustainability of their production, **ii) pilot scale demonstrations** that support new and novel technologies and facilitate cost-competitive manufacturing of bio-based SFCMs, and **iii) regulatory and policy support** through coordination and collaboration with stakeholders to identify challenges in biorefining and develop supportive policy and regulatory environments for bio-based SFCM production.

As its first step, the Mission defined an **Innovation Roadmap**[27] that serves as a guide to identify gaps and challenges in current biorefining value chains and prioritize key actions to support the Mission. For the roadmap, the participating members identified gaps in their current programs and policy support for integrated biorefining by analysing existing national policies, programs, projects, and roadmaps. Based on the analysis and inputs from national stakeholder consultation workshops, eight key actions were defined to achieve the Mission's goals. The actions aim to enhance support for RD&D, efficiency improvements, and transition from demonstration to commercialization, and to develop standards and a harmonized life-cycle analysis (LCA) methodology for biorefineries. All the actions are scheduled to start in the first half of 2023 and end by 2029.

The Innovation Roadmap identifies two Key Performance Indicators related to the financing of the key actions: i) a minimum of USD 2 million provided by each participating member country to support RD&D projects, and ii) a financial commitment of at least USD 2 million by each participating member country to support at least 10 RD&D projects.

Collaboration is foreseen with other Missions and Mission Innovation's Innovation Platform, and other international initiatives, including IEA, IEA Bioenergy TCP Task 42 Biorefining in a Circular Economy, CEM Biofuture Platform Initiative and Campaign, IRENA, as well as standards-setting-organizations.

Mission Innovation Zero-Emission Shipping Mission

Mission Innovation Zero-Emission Shipping Mission[28] is an alliance between governments, industry, research institutes, and civil society to **develop, demonstrate, and deploy zero-emission fuels, ships, and fuel infrastructure together by 2030**. It focuses on the value chains of zero-emission ships in order to promote their commercialization.

Co-leads of the Mission are Denmark, Norway, the USA, Global Maritime Forum, and Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. Core Mission Members are the United Kingdom,

[28] Mission Innovation. (2022). *Zero-Emission Shipping Mission*. Available at: https://explore.mission-innovation.net/mission/zero-emissions-shipping/

Morocco, India, and Singapore. Mission Support Group consists of France, Ghana, and South Korea.

Mission stakeholders include governments/regulators (international, national, regional, local, maritime authorities), maritime industry R&D (research institutes, OEMs, shipyards, manufacturers), ship owners/operators (manufacturers, system integrators, designers), fuel producers and providers (upstream industry, supply chain), ports, terminals and infrastructure, and knowledge community (academia, think tanks, digital services, start-ups, financial institutions).

The Mission's goal is to "**demonstrate commercially-viable, zero-emission ships by 2030**, making vessels that operate on zero-emission fuels the natural choice for ship owners when they renew their fleet". They have further divided their goals into three: ships, fuels, and fuelling infrastructure. The specific objectives of these three pillars are that by 2030:

- Introduce fit-for-purpose and viable vessels that operate on zero-emission fuels to the global fleet; at least 200 ships primarily use zero-emission fuels across main deep-sea shipping routes.
- Scale up efficient production of zero-emission fuels; ships capable of running on hydrogen-based zero-emission fuels and advanced biofuels constitute at least 5% of the global deep-sea fleet measured by fuel consumption.
- Establish global port infrastructure to support vessels operating on zero-emission fuels; 10 large trade ports covering at least three continents supply zero-emission fuels.

Based on the identified innovation needs for decarbonization of shipping[29], the Mission defined five innovation groups and 120 individual innovation gaps, which are described in Industry Roadmap for Zero-Emission Shipping[30]. The innovation groups are **Safety & operational risk management**, **Policy & regulation**, **Market development**, **business models & financial innovation**, **Technology development & adaption**, and **Market analysis**. Furthermore, the Mission developed an Action Plan for the Zero-Emission Shipping Mission[31], which outlines the actions needed, with their respective timescales (spans until 2030) and required stakeholders. In addition to biofuels, the Action Plan includes also hydrogen related actions.

Blueprint for Future Ports program aims at creating **a 'Blueprint' that can be used to demonstrate commercially viable zero-emission refuelling ports that provide zero-emission fuels at key ports along the major deep-sea shipping routes and green corridors.** The program is foreseen to serve decision-makers and investors as a toolbox. The program is a collection of projects, first of which, **the Green Shipping Corridor Hub**[32], was launched in November 2022 at COP27. The hub is an interactive platform and toolkit to support the development of green shipping corridors and the first action to be delivered from the Mission's Action Plan.

[29] Frelle-Petersen, C., Howard, A. & Poulsen, M.H. (11/2021). *Innovation needs for decarbonization of shipping.* Available at: http://mission-innovation.net/wp-content/uploads/2021/11/TECHNICAL-REPORT_Innovation-needs-for-decarbonization-of-shipping.pdf

[30] MI Zero-Emission Shipping Mission. (04/2022). *Industry Roadmap for Zero-Emission Shipping.* Available at: http://mission-innovation.net/wp-content/uploads/2022/04/Zero-Emission-Shipping-Mission-Roadmap-1-1.pdf

[31] MI Zero-Emission Shipping Mission. (09/2022). *Action Plan for the Zero-Emission Shipping Mission.* Available at: https://explore.mission-innovation.net/wp-content/uploads/2022/09/Zero-Emission-Shipping-Mission-Action-Plan.pdf

[32] Mission Innovation. (2022). *Zero-Emission Shipping Mission Green Shipping Corridors Hub to accelerate transition to zero-emission shipping.* Available at: http://mission-innovation.net/2022/11/16/zero-emission-shipping-mission-green-shipping-corridors-hub-to-accelerate-transition-to-zero-emission-shipping/

Innovation Platform 'Innovation for Sustainable Aviation Fuels' (ISAF)

Innovation for Sustainable Aviation Fuels (ISAF)[33] is an Innovation Platform under the MI, which aims to establish global partnerships to promote sustainable and cost-effective strategies for sustainable aviation fuels.

ISAF has six participants: India, the USA, China, the European Commission, the Netherlands, and Denmark, of which India and the USA are the Co-Leads of the Mission. IEA and IRENA are participating as Knowledge Partners. ISAF aims to build a global community of public and private stakeholders that shares the ambition for research and innovation collaboration, and, as a result, establish a shared and prioritized innovation agenda and working groups.

The activities of ISAF include developing and demonstrating bio-based aviation fuel value chains, mobilizing national and international resources for testing and certification processes, and supporting end-use market creation. Additionally, ISAF aims to organize workshops to identify priority areas and exchange knowledge, as well as develop demonstration projects for newer technology pathways and develop international technical specifications.

International Renewable Energy Agency (IRENA)

The International Renewable Energy Agency (IRENA)[34], founded in 2008, is an inter-governmental organization that supports its members in their transition to a sustainable energy future. It acts as a platform to promote the knowledge sharing, adoption, and sustainable use of all forms of renewable energy, bioenergy included. IRENA's objectives are to foster effective policy and decision-making and to shape the global discourse on energy transformation by **providing timely, relevant, high-quality information and access to renewable energy data**.

IRENA has 168 members in total (2022) and 16 in accession. The ultimate decision-making authority of IRENA is the Assembly, where each Member state has a representative. The Assembly convenes annually to discuss and decide upon the work program, budget, adoption of reports, memberships, and potential amendments to IRENA's activities. Accountable to the Assembly, the Council of 21 elected Member representatives facilitates consultation and cooperation among Members, as well as reviews the draft work program, draft budget, and annual report. The Secretariat comprises the Director-General and his staff, and it is responsible for implementing the work program, preparing and submitting the drafts for the work program, budget, and annual report.

IRENA is active in several multi- and bilateral partnerships between countries, policymakers, organizations, and the private sector. Policymakers are provided with **timely, evidence-based data** and interpretation by IRENA, as well as brought together to **support dialogues** between parliamentarians, parliamentary organizations, and associations in events such as Legislators Forum[35]. Collaborative frameworks[36] were established to facilitate peer-to-peer collaboration on

[33] Mission Innovation. (2022). *Innovation for Sustainable Aviation Fuels.* Available at: http://mission-innovation.net/platform/innovation-for-sustainable-aviation-fuels/

[34] International Renewable Energy Agency. (2022). Available at: https://www.irena.org/

[35] IRENA. (2022). *Legislators Forum.* Available at: https://www.irena.org/Events/2021/Jan/Legislators-Forum-Parliamentary-actions-to-scale-up-renewable-investments

[36] IRENA. (2022). *Collaborative Frameworks.* Available at: https://www.irena.org/How-we-work/Collaborative-frameworks

the key areas of the energy transition. The collaborative frameworks are Critical Materials, Geopolitics, Green Hydrogen, High Shares of Renewables, Hydropower, Just & Inclusive Energy Transition, and Offshore Renewables. Coalition for Action[37] is a multi-stakeholder network facilitated by IRENA (acts as the Secretariat of the Coalition) that aims to bring together the leading players in renewable energy from the private sector, industry associations, civil society organizations, research institutes, and intergovernmental organizations and to facilitate global public-private dialogues.

IRENA produces **several publications** throughout the year. One of the main publications, World Energy Transitions Outlook[38], has a section dedicated to bioenergy, which states the importance of bioenergy in meeting climate goals, includes the main opportunities and challenges for scale-up and resource estimates, and suggests policy instruments for removing the barriers to bioenergy deployment. Bioenergy for the Transition[39] report provides a more comprehensive overview of the role of bioenergy in the energy transition.

IRENA's budget consists of three streams of funding: mandatory contributions of its Members, voluntary contributions, and other possible sources. The core budget for 2022-2023 amounts to USD 64.8 million. A comprehensive list of outputs concerning IRENA's objectives, as well as budgetary information can be found, e.g., in the Proposed Work Programme and Budget[40].

International Energy Agency (IEA)

International Energy Agency (IEA)[41] was founded in 1974 to ensure the security of the oil supply. Over the years, IEA has evolved into a significant voice of the global dialogue on energy with an all-technology approach. IEA provides statistics and analyses on a wide spectrum within the energy, as well as advocates policies to improve the sustainability, affordability, and reliability of energy.

IEA is a global organization with 31 countries as members, 11 as associate countries, and 4 countries in accession (12/2022 status). IEA acts as a global center of expertise, publishing analysis, roadmaps, policy reviews, and other detailed data. In recent years, IEA has focused more strongly on climate change mitigation and achieving net-zero emissions, e.g., publishing a Net Zero by 2050 roadmap[42]. The report identified bioenergy as one of the critical areas in achieving net zero goals. In addition to including bioenergy in the IEA reports and data, a major part of IEA's bioenergy work is carried out in the **IEA Bioenergy Technology Collaboration Programme** (TCP), which is a legally independent body that promotes research, development, and commercialization of bioenergy technologies.

The next two sections focus on Technology Collaboration Programmes concerning bioenergy and renewable fuels.

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[37] IRENA Coalition for Action. (2022). Available at: https://coalition.irena.org/

[38] IRENA. (2022). *World Energy Transitions Outlook 2022: 1.5 ºC Pathway.* ISBN: 978-92-9260-429-5. Available at: https://www.irena.org/Publications/2022/Mar/World-Energy-Transitions-Outlook-2022

[39] IRENA. (08/2022). *Bioenergy for the energy transition: Ensuring sustainability and overcoming barriers.* ISBN: 978-92-9260-451-6. Available at: https://www.irena.org/Publications/2022/Aug/Bioenergy-for-the-Transition

[40] IRENA. (14.12.2021). *Report of the Director-General – Proposed Work Programme and Budget for 2022-2023.* Available at: https://www.irena.org/-/media/Files/IRENA/Remember/Assembly/Twelfth-session-of-the-Assembly/A_12_4_Proposed-Work-Programme-and-Budget-for-2022-2023.pdf?rev=cbf4efca040343149d09a0d9b3c804cf

[41] International Energy Agency. (2022). Available at: https://www.iea.org/

[42] IEA. (2022). *Net Zero by 2050*. Available at: https://www.iea.org/reports/net-zero-by-2050

IEA Bioenergy Technology Collaboration Programme

IEA Bioenergy[43] is one of the 42 Technology Collaboration Programmes (TCPs) set up by the IEA. TCPs are independent bodies operating in a framework provided by the IEA.

IEA Bioenergy provides an umbrella organization where experts from research, government, and industry from different member countries work collectively towards the joint mission. The structure offers opportunities to coordinate and find synergies between national programs across the wide range of bioenergy technologies. The decision-making body of the TCP is the Executive Committee (ExCo), which consists of one representative designated by and representing each Contracting Party and Sponsor. In addition, each ExCo member has an alternative representative called Alternate. Currently, IEA Bioenergy TCP has 25 Contracting Parties (i.e., member countries) from all over the globe. Each Contracting Party pays an annual fee for the ExCo. ExCo adopts for each triennium the Work Programme and budget for each Task, carries out the functions assigned in the Implementing Agreement, and oversees the implementation of Tasks.

IEA Bioenergy's mission is "to **increase knowledge** and understanding of bioenergy systems to **facilitate the commercialization and market deployment** of environmentally sound, socially acceptable, and cost-competitive, low-carbon bioenergy systems and technologies, and to **advise policy and industrial decision makers** accordingly". A key message of IEA Bioenergy is that modern bioenergy connects to the developments towards a wider circular bio-based economy and is, and will be, one important solution for reaching an energy-secure and net-zero energy mix. The TCP highlights the importance of science-based information in decision-making.

The work is conducted in 11 Tasks (Table 3). Task members, i.e., National Team Leaders, are nominated by the Contracting Party. Tasks conduct the work in three-year periods (trienniums, the ongoing is 2022-2024).

National Team Leaders typically represent academia, or national associations or organizations in the field of bioenergy, while ExCo members expand also to governmental positions. Both levels in IEA Bioenergy bring together the global top-level scientific know-how on bioenergy. The TCP offers opportunities to incorporate national energy RD&D and deployment programs and projects into a larger international context.

In the triennium 2022-2024, two strategic projects were established, gathering together experts from several Tasks. These projects focus on synergies and trade-offs between sustainable bioenergy, green hydrogen, and bioenergy carbon capture and utilization/storage (BECCUS).

[43] IEA Bioenergy Technology Collaboration Programme. Available at: https://www.ieabioenergy.com/

Table 3. IEA Bioenergy TCP's Tasks, and their members and key focus areas in 2022-2024.

Task number	Task name	**Members (2022-2024)** (Task Leader and Operating Agent **bolded**)	**Focus areas (2022-2024)**
32	Biomass Combustion	Austria, Canada, **Denmark**, Germany, Japan, the Netherlands, Norway, Switzerland, the USA	Substitution of fossil fuels, large-scale biomass CHP with negative emissions, integration of biomass combustion into renewable energy system, innovative low-emission biomass heating plants, low-emission residential appliances
33	Gasification of Biomass and Waste	Austria, Belgium, Canada, China, France, Germany, India, Italy, **the Netherlands**, Sweden, UK, the USA	CHP, SNG, biofuels, chemicals, hydrogen, CO_2 balances
34	Direct Thermochemical Liquefaction (DTL)	**Germany**, the Netherlands, Finland, Canada, the USA, Denmark, New Zealand, India	Deployment of high-value products, system services for a future circular economy, commercialization through knowledge transfer, showcases of commercial DTL facilities
36	Material and Energy Valorisation of Waste in a Circular Economy	Germany, Italy, Norway, South Africa, **Sweden**, the USA, Ireland	Energy from Waste in a Circular Economy, sustainability, new technology pathways, new waste stream, smart technologies for waste sorting
37	Energy from Biogas	Austria, Brazil, Canada, China, Denmark, Estonia, France, Finland, **Germany**, India, Ireland, Italy, Norway, Sweden, Switzerland, the Netherlands, UK	Co-benefits of biogas in a circular economy system, decarbonization of industry, energy and transport fuels, emissions, process development and monitoring
39	Biofuels to Decarbonize Transport	Austria, Belgium, **Brazil**, Canada, Denmark, Estonia, EC, Germany, Ireland, Japan, New Zealand, South Korea, **Sweden**, the Netherlands, the USA, US Grains Council	Long distance transport sectors, policies, sustainability
40	Deployment of biobased value chains	**Germany**, Austria, Denmark, the Netherlands, the USA	Regional bioenergy markets and transitions, sustainable bio-based value chains in the circular bioeconomy, sustainable financing
42	Biorefining in a Circular Economy	Austria, Denmark, Germany, Ireland, **Italy, the Netherlands**, Sweden	Techno-economic Environmental assessment of biorefineries, global deployment status, best practices, integration of biorefineries with renewable electricity systems
43	Biomass Supply in Sustainable and Circular Economies	**Australia**, **Canada**, Croatia, Finland, Germany, New Zealand, Sweden, the USA	Sustainable integrated biomass supply chains, biomass recovery and value optimization, bio-hubs
44	Flexible Bioenergy and System Integration	Austria, **Finland**, EC, **Germany**, the Netherlands, Sweden, Switzerland, the USA	Flexibility from bioenergy, system integration, system services from bioenergy, green hydrogen and BECCUS value chains, flexibility and system integration in energy system modelling, the value of flexibility
45	Climate and Sustainability Effects of Bioenergy within the broader Bioeconomy	Austria, Brazil, China, Denmark, Finland, France, **Germany**, Ireland, the Netherlands, Norway, **Sweden**, UK, the US, EC	Metrics, methods and tools for assessing climate and sustainability effects of bioenergy, regulatory systems governing land use and bioenergy supply chains

IEA Advanced Motor Fuels (AMF) Technology Collaboration Programme

IEA AMF[44] is one of the 42 Technology Collaboration Programmes (TCPs) set up by the International Energy Agency (IEA), and it was established in 1984. It provides an information and knowledge share community in which international members from governments, research, and industry work collectively towards the joint mission. The structure offers opportunities to coordinate and find synergies and share lessons learned between national programs and activities across the use of advanced motor fuels in transportation.

The decision-making body of the TCP is the Executive Committee (ExCo), which consists of one representative, a Delegate, designated by and representing each Contracting Party and Sponsor. In addition, each ExCo member has an alternative representative called Alternate. Currently, IEA AMF TCP has 15 Contracting Parties from 13 countries. Each Contracting Party pays an annual fee for the ExCo. Typically, IEA AMF ExCO members are representatives of national organizations or research institutes and universities.

The mission of AMF is to **advance the understanding and appreciation of the potential of advanced motor fuels towards transport sustainability**. It provides sound scientific information and technology assessments facilitating informed and science-based decisions regarding advanced motor fuels on all levels of decision-making. AMF has the following objectives:

1. Expand the network and continue fruitful contributions to R&D,
2. Strengthen the collaboration with other topically closely related TCPs,
3. Continue to involve industry in their work, and
4. Encourage activities on all modes of transport and assess the optimum allocation of different fuels.

AMF TCP works through jointly performed Tasks (similar to projects). Each Task includes participation from a minimum of three ExCo members. All ExCo members can freely suggest a new Task in ExCo meetings, which take place twice a year. In case of a minimum of three ExCo members committing to the proposal, a new Task will be proposed and voted to start. All ongoing and completed Tasks are presented on the web page.[45] On-going Tasks include 'Sustainable Aviation Fuels' and 'E-fuels and End-use Perspectives'.

Task work is typically conducted through a task-share method in which each participating member performs research in individual country projects with their own funding aligning with the commonly planned work structure. Results and outcomes are gathered in a joint report and key messages. Participation via a cost-share method is also possible.

In addition to Task reports, IEA AMF publishes annual reports including country reports, special reports, and newsletters. Knowledge is shared also through workshops and webinars. IEA AMF

[44] IEA AMF Technology Collaboration Programme. Available at: https://www.iea-amf.org/

[45] IEA AMF Technology Collaboration Programme. *AMF Projects.* Available at: https://www.iea-amf.org/content/projects/map_projects

maintains a fuel information database[46]. The current IEA AMF Strategic Work Plan[47] covers the years 2020–2024.

Global Bioenergy Partnership (GBEP)

Global Bioenergy Partnership[48] (GBEP) was established in 2006 to promote biomass and biofuels deployment, particularly in developing countries. The purpose of GBEP is to **provide a platform for its Partners to organize, coordinate and implement international research, development, demonstration, and commercial activities related to bioenergy**.

GBEP has approximately 80 members globally. The Partners comprise 23 national governments with Ministry representatives, and 15 international organizations, including energy agencies and programs, financial institutions, and development organizations. Organizations include e.g., the IEA, IRENA, UNIDO, and European Biomass Industry Association (EUBIA). In addition to Partners, GBEP has 33 countries and 14 international organizations and institutions participating as Observers. Steering Committee is the governing body of the GBEP, providing strategic guidance, reviewing the programs, and deciding on the acceptance of new partners. Brazil and the USA were the Co-Chairs for the biennium 2021-2022. The GBEP Secretariat is hosted by the Food and Agriculture Organization of the UN (FAO), and it is responsible for coordinating the Partnership communications and activities. The implementation of GBEP's objectives is carried out in three streams: a Working Group on Capacity Building and Task Forces on Sustainability and GHG Methodologies, presented in Table 4.

Table 4. GBEP's activities within three streams.

Group	Activity Group
Working Group on Capacity Building	AG1 Regional Forums AG2 GBEP Indicators AG3 Bioenergy Weeks/ Study Tour AG4 Wood Energy AG5 Bioenergy Atlas AG6 Bioenergy and Water AG7 Biogas AG8 Advanced Liquid Biofuels
Task Force on Sustainability	Environmental Social Economic and Energy Security
Task Force on GHG Methodologies	LUC and feedstock production Biomass processing Biofuel transportation and use Biofuel usage compared with fossil fuel

The partnership focuses on three strategic areas: sustainable development, climate change, and food and energy security.

GBEP has published reports, technical papers, guides, and tools regarding bioenergy sustainability and its assessment, as examples a report for Financing options for bioenergy projects and programs

[46] IEA AMF Technology Collaboration Programme. *Fuel Information - Introduction.* Available at: https://www.iea-amf.org/content/fuel_information/fuel_info_home

[47] IEA AMF Technology Collaboration Programme. (4.6.2019). *Implementing Agreement for Advanced Motor Fuels - Strategic Plan 2020-2024*. Available at: https://www.iea-amf.org/app/webroot/files/file/AMF%20Documents/public/AMF%20Strategic%20Work%20Plan%202020-2024.pdf

[48] Global Bioenergy Partnership. (2019). *Working together for sustainable development since 2006.* Available at: http://www.globalbioenergy.org/

(2021)[49] and Sustainability Indicators for Bioenergy[50]. In addition to literature output, GBEP organizes and participates bioenergy related events, such as GBEP Bioenergy Week, webinars, field trips, and workshops, both independently and in collaboration with, e.g., IEA Bioenergy TCP, Biofuture Platform Initiative, IRENA, and FAO. The documentation of GBEP activities can be found on the GBEP website[51].

The GBEP Partners and Observers are contributing financially and in-kind to support the Secretariat and GBEP activities.

United Nations Industrial Development Organization (UNIDO)

United Nations Industrial Development Organization (UNIDO)[52] is a specialized agency of the UN with a mandate to **assist countries in sustainable industrial and economic development**. UNIDO was established in 1966 to accelerate industrialization in developing countries, aimed at fulfilling the Sustainable Development Goals.

UNIDO has 170 Member States globally. It has two policy-making organs: the General Conference (GC) and Industrial Development Board (IDB). The General Conference is the supreme policy-making organ of UNIDO that consists of the Member States and meets every two years. The GC determines the guiding principles and policies, as well as approves the budget and work program of UNIDO. Every four years, the GC assigns the Director General and elects the members of the IDB and the Programme and Budget Committee, which has 27 members. The Committee meets once a year to assist the Board in the preparation and examination of the budget, work program, and other financial matters. The IDB comprises 53 members, elected for a four-year term on a rotational basis from all Member States. It is responsible for reviewing the implementation of the work program and the regular and operational budgets and making recommendations to the General Conference on policy matters, including the appointment of the Director-General. The IDB meets once a year.

UNIDO focuses on promoting renewable energy for productive uses and industrial applications in developing countries and countries with economies in transition. **UNIDO's Bioenergy Strategy** supports the development of bioenergy industries in developing countries, least-developed countries, and small island developing countries in their transition to sustainable bioenergy-based electricity, transportation, and cooking solutions, relying on their agriculture and industrial strength. The objectives include, but are not limited to, replacing a percentage of fossil-based fuels with ethanol, switching to clean cooking fuels, curbing deforestation, promoting circular economy, and cutting GHG emissions. UNIDO's bioenergy program is targeted at governments and national institutions dealing with policy and regulatory issues, industry associations, universities, and research institutes as well as banks and investment funds.

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[49] Global Bioenergy Partnership. (3/2021). *Financing options for bioenergy projects and programmes.* Available at: http://www.globalbioenergy.org/fileadmin/user_upload/gbep/docs/Financing_tool/Funding_Instruments_for_Bioenergy_Projects_and_Programmes_2021_UPDATE.pdf

[50] Global Bioenergy Partnership. (2019). *Report "The GBEP Sustainability Indicators for Bioenergy".* Available at: http://www.globalbioenergy.org/programmeofwork/task-force-on-sustainability/gbep-report-on-sustainability-indicators-for-bioenergy/en/

[51] Global Bioenergy Partnership. (2022). *GBEP events 2022.* Available at: http://www.globalbioenergy.org/events1/gbep-events-2022/en/

[52] UNIDO. (2022). Available at: https://www.unido.org/

The tools for UNIDO's Bioenergy Strategy implementation include the Global Impact Program for Clean Cooking (GIP CC), Waste to Energy in Industries (WtE), and Advisory Services and Capacity Building (AS & CB). GIP CC aims to help large urban populations shift to ethanol-based clean cooking by addressing the financing gaps to enable markets and achieve critical mass, using targeted results-based financing mechanisms. GIP CC aims to mobilize USD 6 million and is expected to generate at least 20 projects in High Impact Countries. WtE program focuses on selected agro-industries, such as the sugar and cassava industry, and aims to carry out specific projects, e.g., in Nigeria and Kenya. AS & CB offer facilitation in the areas where policy and planning for biofuel blending in the transport sector are needed.

The regular and operational budget (expenditure) of UNIDO in 2021 was EUR 85.3 million, and it received USD 197.3 million in net voluntary contributions for project implementation, with a total portfolio of projects in hand of USD 575.2 million.[53] Safeguarding the environment as a thematic focus area attracted USD 98.7 million. Additionally, UNIDO receives funding from global funds such as the Global Environment Facility, the Multilateral Fund for the Implementation of the Montreal Protocol, and the Green Climate Fund, as well as from UN, multi-partner trust funds, and trust funds managed by UNIDO.

World Bioenergy Association (WBA)

World Bioenergy Association (WBA)[54], founded in 2008, is a **non-governmental association** that is dedicated to supporting and representing the actors in bioenergy.

WBA is a membership-based global association with members from more than 65 countries. The members represent national bioenergy associations worldwide, as well as companies operating in the bioenergy sector. The board is composed of experts that are affiliated to universities, research institutes, companies, and associations. The board elected for year 2022 includes 20 members. Regional, national, and international associations are welcome to join as full members, while companies can join as associate members and individuals as individual members.

The mission of WBA is to **promote sustainable bioenergy development and support the business environment of bioenergy globally**. To carry on the mission, WBA publishes statistics, factsheets, reports, and position papers to share knowledge and communicate the opinion of WBA on topical technologies, policies, and issues regarding bioenergy. WBA aims to **offer unbiased information and rational arguments to the public discussion** about bioenergy, as well as **provide guiding tools** for policymakers, researchers, and companies.

In addition to different publications, WBA has had several country missions throughout its history, where it shares knowledge and experience on bioenergy in a specific country. Previous country missions took place in Kenya, Brazil, and Zambia at the invitation of local country representatives.

WBA cooperates with IRENA, where it participates in the General Assembly and Coalition of Action and provides input to the Work Program and actions. Additionally, WBA is an observer in the United Nations Framework Convention on Climate Change (UNFCCC)[55], GBEP, and Green Climate Fund. WBA is financed by membership fees and voluntary contributions of supporter members.

[53] UNIDO. (2022). *Annual Report 2021.* Available at: https://www.unido.org/api/opentext/documents/download/27408572/unido-file-27408572
[54] World Bioenergy Association. (2022). Available at: https://www.worldbioenergy.org/
[55] UNFCCC. (2022). *What is the United Nations Framework Convention on Climate Change?* Available at: https://unfccc.int/process-and-meetings/what-is-the-united-nations-framework-convention-on-climate-change

2.2 European initiatives and platforms

European Technology and Innovation Platform on Bioenergy (ETIP Bioenergy)

European Technology and Innovation Platform (ETIP) Bioenergy[56] was launched in 2016 and combines the efforts of the European Biofuels Technology Platform (EBTP), which started in 2006, and the European Industrial Initiative Bioenergy (EIBI), which started in 2010. ETIPs are **industry-led stakeholder platforms** with the target of driving innovation, knowledge transfer, and European competitiveness in the energy sector. ETIP Bioenergy is recognized by the EC as a key actor for DG-RTD for the bioenergy sector, in particular, to implement the SET Plan in the field of biofuels and bioenergy. The platform is based on a **public-private partnership**, which brings together actors from academia, industry, and civil society, engaged in the development of sustainable bioenergy and biofuel technologies.

ETIP Bioenergy's organizational structure is composed of a Steering Committee, Working Groups, an Advisory Board, a Coordination Group, a Stakeholder Plenary Meeting, and a Secretariat. ETIP Bioenergy is actively supported and facilitated by ETIP-B-SABS 2022-2025 - *European Technology and Innovation Platform Bioenergy - Support of Renewable Fuels and Advanced Bioenergy Stakeholders 2022-2025* project[57] (ETIP Bioenergy secretariat) that is funded under Horizon Europe, the EU Framework Programme for Research and Innovation. The Advisory Board acts as the interface between the ETIP Bioenergy and the Member States as it consists of the technical experts appointed by Member States involved in relevant bioenergy issues as identified in the SET Plan priorities. ETIP Bioenergy's work created a significant base for SET-Plan IP8 and IWG8 and ETIP Bioenergy's expertise and experts are instrumental for IWG8.

ETIP Bioenergy's mission is to "contribute to the development of cost-competitive, innovative world-class bioenergy and biofuels value chains, to the creation and strengthening of a healthy European bioenergy industry and to accelerate the sustainable deployment of bioenergy in the EU through a process of guidance, prioritization, and promotion of research, technology development, and demonstration". One major activity is to **address the technical and economic barriers** to the further development and deployment of technologies.

The key activities of ETIP Bioenergy are carried out in four **Working Groups**, namely WG1 Biomass availability, WG2 Conversion processes, WG3 End-use, and WG4 Sustainability & policy. The main activities target to contribute to the SET Plan activities and strategy, elaborate and update the Strategic Research and Innovation Agenda (SRIA), assist the EC and Member States in defining their research programs, report on the implementation of R&I activities in European, national/regional and industrial level to support SETIS, support bringing R&I results to deployment through knowledge-sharing, and identify technical and non-technical barriers in delivering innovations to the energy market. The latest update on SRIA was published in 2018[58], and an update process was ongoing during the writing of this report.

ETIP Bioenergy is an important European forum for the **dissemination of technology-neutral fact-based information** on advanced bioenergy and innovative industrial models. Stakeholders of the

[56] ETIP Bioenergy. (2022). Available at: https://www.etipbioenergy.eu/
[57] ETIP Bioenergy. (2022). *ETIP-B2022-2025*. Available at: https://www.etipbioenergy.eu/about-ebtp/etip-b2022-2025
[58] ETIP Bioenergy. (2018). *Strategic Research and Innovation Agenda 2018 - Cost-competitive innovative world-class bioenergy and biofuel value chains.* Available at: https://www.etipbioenergy.eu/images/ETIP_SRIA_2018.pdf

platform can participate in various activities, such as Working Groups, workshops, and annual Stakeholder Plenary meetings, to debate and exchange information.

European Technology and Innovation Platform on Renewable Heating and Cooling (RHC-ETIP)

European Technology and Innovation Platform on Renewable Heating and Cooling (RHC-ETIP)[59] is a networking platform, which focuses on the promotion and deployment of renewable technologies in the heating and cooling sector in the EU and the implementation of the SET Plan. It was endorsed by the European Commission in 2008 and launched as ETIP in 2016. The platform is based on the interaction between public and private stakeholders, convening stakeholders from industry, research and academia, civil society, NGOs, Member States, and the European Commission. It brings together almost 900 operators.

The Board of the RHC-ETIP comprises the President and 15 Members. The Board is responsible for defining the overall strategy and monitoring the execution of the mission of the RHC-ETIP, establishing and implementing a Roadmap for the large-scale development and deployment of renewable heating and cooling systems, defining the overall Common Vision, and setting up the shared Strategic Research and Innovation Agenda (SRIA).

RHC-ETIP is actively supported and facilitated by SecRHC-ETIP2022-2025 project[60] (RHC-ETIP secretariat) that is funded under Horizon Europe, the EU Framework Programme for Research and Innovation. The project aims to assist the RHC-ETIP stakeholders in coordinating activities and fostering the growth and market uptake of heating and cooling technologies. The project activities include organization of events and preparation of technical and political documents. The project is coordinated by the Association of European Renewable Energy Research Centres (EUREC), with the support of the European Geothermal Energy Council (EGEC), Euroheat & Power (EHP), Solar Heat Europe/European Solar Thermal Industry Federation, the European Heat Pump Association (EHPA), and WIP.

As stated in its mission, RHC-ETIP "aims at playing a decisive role in **maximizing synergies and strengthening efforts towards research, development and technological innovation which will consolidate Europe's leading position in the sector"**. It is a channel to influence the EC's funding instruments for the heating and cooling sector and to deliver messages about the research, development, and deployment funding needed.

The implementation of the mission is carried out by the Technology Panels and Horizontal Working Groups. The Technology Panels (Table 5) focus on specific technologies and consist of experts from their respective areas. The Technology Panels provide input to the strategic documents produced by the Horizontal Working Groups and to the activities of RHC-ETIP. The Biomass Technology Panel aims at defining a common strategy to increase the use of biomass-based heating and cooling in Europe.[61]

[59] European Technology and Innovation Platform on Renewable Heating and Cooling. (2022). Available at: https://www.rhc-platform.org/

[60] European Commission. (2022). *Secretariat of the European Technology and Innovation Platform on Renewable Heating and Cooling*. Available at: https://cordis.europa.eu/project/id/101075746

[61] European Technology and Innovation Platform on Renewable Heating and Cooling. (2022). *Biomass.* Available at: https://www.rhc-platform.org/about-us/structure/technology-panels/biomass/

Table 5. Technology Panels and their coordinators.

Technology Panel	**Managed by**
The European Solar Thermal Technology Platform (ESTTP)	Solar Heat Europe
Biomass Technology Panel	WIP Renewable Energies
Geothermal Technology Panel	EGEC
Heat Pump Technology Panel	EHPA
District Heating and Cooling and Thermal Energy Storage Technology Panel	DHC+ Technology Platform c/o Euroheat & Power

The Horizontal Working Groups (HWGs) offer a cross-cutting approach to common topics on renewable heating and cooling technologies and bring together interested experts from different Technology Panels. Complementary to technical experts, HWGs leverage external expertise, e.g., socio-economic experts, or experts from the building or traditional heating and cooling sectors. Each HWG has defined objectives, actions, work packages, timelines, and deliverables. The HWGs are Deployment and implementation study for the RHC sector, 100% RE Cities, 100% RE Districts, 100% RE Buildings, and 100% RE Industries.

RHC-ETIP supports the SET Plan goals by establishing and updating SRIAs per technology area, including identification of priorities in the short, medium, and long term, identifying priorities of cross-cutting nature and innovation barriers especially related to regulation and financing, monitoring the implementation of R&I activities at European, national, and industrial levels, and developing knowledge-sharing mechanisms. To further these actions, RHC-ETIP publishes, e.g., policy statements, strategic documents, and reports. The latest strategic documents include SRIA for Climate-Neutral Heating and Cooling in Europe[62], Strategic Report on Implementation of R&I Priorities and Deployment Trends of the Renewable Heating and Cooling Technologies[63], and 2050 vision for 100% renewable heating and cooling in Europe[64]. Biomass Technology Panel contributed to the SRIA to present state-of-the-art and R&I priorities of biomass technologies for renewable heating and cooling across all sectors addressed.

European Energy Research Alliance EERA: Bioenergy Joint Programme

European Energy Research Alliance (EERA)[65] is a research alliance founded in 2011. EERA serves as a public research pillar of the SET Plan, and the operations are aligned with the research priorities defined in the SET Plan. EERA is organized into 18 Joint Programmes (JPs), of which EERA Bioenergy[66] focuses on bioenergy and bioeconomy. The positioning of EERA Bioenergy is to address the energy and environment policies in Europe from a **research and innovation perspective**.

[62] European Technology and Innovation Platform on Renewable Heating and Cooling. (2022). *Strategic Research and Innovation Agenda for Climate-Neutral Heating and Cooling in Europe.* Available at: https://www.rhc-platform.org/content/uploads/2020/10/EUREC-Brochure-RHC-SRI-06-2022-WEB.pdf

[63] European Technology and Innovation Platform on Renewable Heating and Cooling. (2021). *Strategic Report on Implementation of Research and Innovation Priorities and Deployment Trends of the Renewable Heating and Cooling Technologies.* Available at: https://www.rhc-platform.org/content/uploads/2021/10/RHC-Report-MRes-1.pdf

[64] European Technology and Innovation Platform on Renewable Heating and Cooling. (2019). *2050 vision for 100% renewable heating and cooling in Europe.* Available at: https://www.rhc-platform.org/content/uploads/2019/10/RHC-VISION-2050-WEB.pdf

[65] European Energy Research Alliance. Available at: https://www.eera-set.eu/

[66] EERA Bioenergy. Available at: https://www.eera-bioenergy.eu/

The structure of the JPs consists typically of the Steering Committee, the Management Board, and the Joint Programme Coordinator. Different JPs are linked to the umbrella organization by the Secretariat.

Organizations within the EU (including candidate countries and countries associated with the EU Framework Programme) that are actively involved in research on bio-based fuels, power, and heat are welcome to join EERA Bioenergy. EERA Bioenergy has two membership categories: Full Members and Associate Members. Full Members, currently 26, can provide inputs in the Strategic Research and Innovation Agenda (SRIA)[67], have access to responsibility positions, and have voting rights. Associate Members, currently 20, do not have voting rights but can provide inputs in SRIA and participate in the activities. EERA Bioenergy organizes scientific committee meetings biannually, where members explain their current situation and plans for research and receive information about the research topics of the EC. Members are encouraged to deliver research proposals and form their own consortia based on the information they receive. Currently, EERA Bioenergy has **five sub-programs**: Sustainable production of biomass, Thermochemical platform, Biochemical platform, Stationary bioenergy, and Sustainability/techno-economic analysis/public acceptance. The sub-programs are led by different partners based on their research interests.

The key target of EERA Bioenergy is to **bring together the research field** and act as the voice of research. It covers all TRLs, from basic research to markets. EERA Bioenergy regularly organizes internal workshops and webinars, objectives being, e.g., identification of funding opportunities and building of collaborative projects. Through its alignment with SET Plan, EERA Bioenergy is a direct channel for communication between policymakers and researchers, as well as ETIP Bioenergy. For policy development, the umbrella organization EERA has a dedicated **Policy Working Group**, which regularly prepares policy updates and makes them available to its members. Moreover, EERA Bioenergy collaborates with EU-funded SUPEERA[68] project in the form of biannual workshops.

EERA Bioenergy activities are funded by membership fees and in-kind contributions. EERA Bioenergy offered post-doc researcher exchanges due to a surplus budget resulting from COVID-19, but it is currently postponed.

Biomethane Industrial Partnership (BIP)

Biomethane Industrial Partnership (BIP)[69] was launched in September 2022. The European Commission announced a target to increase the annual production and use of sustainable biomethane to 35 billion cubic meters by 2030 in **REPowerEU plan**. BIP was established to support the target achievement, as well as to **support the further development of sustainable biomethane towards 2050**. BIP is **an industrial partnership that promotes multi-stakeholder participation** between the European Commission, EU countries, industry, feedstock producers, academia, and NGOs. The topics and actions covered by the BIP are linked with the proposed actions communicated in the Biomethane Action Plan[70].

BIP is composed of a Governing Board, several Task Forces, and a secretariat, and it is coordinated

[67] EERA Bioenergy Joint Programme. (2020). *Strategic Research and Innovation Agenda 2020.* Available at: https://www.eera-bioenergy.eu/wp-content/uploads/pdf/EERABioenergySRIA2020.pdf
[68] SUPEERA. (2022). Available at: https://www.supeera.eu/
[69] Biomethane Industrial Partnership. Available at: https://bip-europe.eu/
[70] European Commission. (18.5.2022). *Biomethane Action Plan, SWD/2022/230 final.* Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022SC0230&from=EN

by the European Biogas Association (EBA). The Governing Board is designed so that the group of up to eight members includes representatives from the European Commission, Member States, and the biomethane supply and value chain. The Governing Board is the highest decision-making body, responsible for taking all strategic decisions and working to achieve the goals set for the BIP. Meeting once every four months, the Governing Board is in charge of the life cycle of the Task Forces, including their creation, chair and member appointment, progress monitoring, and closing.

The activities are carried out via Task Forces, which consist of two to three co-chairs and 10-25 members, excluding Task Force 1 which can have up to 35 members with co-chairs. The co-chairs are appointed by the Governing Board so that each Task Force has one policy maker (European Commission official or Member State representative), one biomethane value chain representative, and possibly a civil society or academia representative as co-chairs. The membership of Task Forces is limited to a two-year term for other members than those from the European Commission, Member States, or EBA. At the launch of the BIP, five Task Forces were created. A summary of Task Forces is presented in Table 6. Detailed descriptions can be found in BIP Work Programme[71].

Table 6. Description of BIP's Task Forces.

Task Force	Task name	Purpose	Suggested deliverables
1	National Biomethane Targets, strategies and policies	Creation of national biomethane targets, which should be incorporated into the draft updated National Energy and Climate Plans (NECPs) Facilitating and sharing best practises on biomethane policy making	Report with starting points for setting national biomethane targets and strategies Report outlining existing national biomethane policies Matching bilateral teaming in which a Member State with more advanced biomethane policies assists another Member State with less developed policies
2	Accelerated biomethane project development	Developing solutions to identified barriers to scale-up investments An overview of available public funding and ways to combine funding sources	A series of seven papers, each addressing a specific barrier or opportunity to speed up investments
3	Sustainable potentials for innovative biomass sources	Identifying EU potentials for innovative biomass sources and the conditions under which the potentials could be unlocked	An overview of existing studies and projects on biomethane A series of expert hearings or workshops
4	Cost efficient production and grid connection	Identifying and facilitating ways to decrease the cost of production and grid connection	Papers and reports on business case optimization, technology and operation cost reduction measures, e-methane business case analysis, grid cost reduction, and standardization Interactive consumer guide for investors Tours to showcase best practises in biomethane production and grid connection
5	Research, Development and Innovation needs	Identifying the current status of R&D&I in biomethane production, grid connection and end-use applications	A report outlining the status of R&D&I

[71] Biomethane Industrial Partnership. (10/2022). *BIP Work Programme.* Available at: https://bip-europe.eu/wp-content/uploads/2022/11/BIP-Work-Programme_24-October-2022.pdf

The platform is to observe and look for synergies with other ongoing initiatives, in particular, with ETIP Bioenergy and the SET Plan Action 8 Implementation Working Group on Bioenergy and Renewable Fuels (IWG8). For example, ETIP Bioenergy is to provide information on R&I and technologies that have not reached the commercial stage yet.

Renewable and Low-Carbon Fuels Value Chain Industrial Alliance (RLCF)

Renewable and Low-Carbon Fuels Value Chain Industrial Alliance (RLCF Alliance)[72] is a new initiative that was established in 2022 to accelerate and aid in the development of the production and supply of low-carbon and renewable aviation and maritime fuels. The focus is on **gaseous and liquid biofuels and e-fuels that are drop-in and co-combusted.** The Alliance is a key adjoining measure to the FuelEU Maritime and RefuelEU Aviation initiatives.

RLCF Alliance has 195 members. The members are mostly businesses and industry initiatives or associations, but there are also many authorities, research institutes, and other types of organizations involved. The Alliance is based on a voluntary collaboration of stakeholders. Stakeholders across the entire value chains are needed, from sourcing to end-users, as well as technology and finance providers. The stakeholders represent both the supply and demand sides from the addressed sectors. Any company or organization, EU body, and agency, Member State, local and regional authority or their agency, recognized social partner organizations, other stakeholder groups, civil society organizations or members of Horizon Europe Partnerships can become a member of the Alliance by transmitting a signed Alliance Declaration[73] to the EC.

The work is led by the Steering Group, which plans and suggests goals and milestones for the operations. The Steering Group consists of the Chairs of the two chambers of the General Assembly, nominated representatives of each of the members entrusted with the Secretariat and the EC, and is presided over by the EC. European Commission, Fuels Europe, SAFRAN, Hydrogen Europe, and Fincantieri form the current Steering Group. All Alliance members can take part in the General Assembly. It has been divided into two chambers: aviation (current chair SAFRAN) and waterborne (current chair Fincantieri). The chairs are appointed for one-year periods. The Alliance Secretariat assists in the tasks. In 2022, the Secretariat is composed by Fuels Europe and Hydrogen Europe.

The key objective of the Alliance is **"to ensure that aviation and maritime sectors have sufficient access to renewable and low-carbon fuels** while taking into account the future use of these fuels in road transport, and thus **contribute to the reduction in the transport sector's GHG emissions by 90% by 2050"**. More specific objectives include finding the most suitable fuels from the economic, environmental, and scalability points of view, assessing the market conditions, finding investment opportunities on both public and private sides, building up a pipeline of new investment projects (including high TRL level R&D activities), and identifying synergies between modes of transport to better secure sufficient resources for different renewable fuels. The last one considers especially the collaboration with the European Clean Hydrogen Alliance and ensuring consistency between hydrogen production and consumption (e.g., for e-fuels). The goals are in

[72] European Commission. *Renewable and Low-Carbon Fuels Value Chain Industrial Alliance*. Available at: https://transport.ec.europa.eu/transport-themes/clean-transport-urban-transport/alternative-fuels-sustainable-mobility-europe/renewable-and-low-carbon-fuels-value-chain-industrial-alliance_en

[73] European Commission. (2022). *RLCF-Alliance Declaration.* Available at: https://circabc.europa.eu/ui/group/0b82951d-8321-4ad5-8a5b-bbb0610e3ed6/library/c95eb290-bf44-4809-b576-b0e958a138c2/details?download=true

line with FuelEU Maritime[74] and ReFuelEU Aviation[75] initiatives.

The Steering Group has developed a Framework Work Plan[76], upon a proposal from the EC DG MOVE, and it has been endorsed by the General Assembly. The Work Plan will be reviewed and updated once a year. It will include specific short- and medium-term deliverables. The members of the Alliance carry out the work in **roundtables** around four themes:

- Roundtable 1: The availability of feedstocks, synergies among sectors and the Just Transition,
- Roundtable 2: Production pathways and value chain – Aviation
- Roundtable 3: Production pathways and value chain – Waterborne transport
- Roundtable 4: Access to public and private finance.

The Alliance cooperates with many associations and initiatives, such as European Sustainable Shipping Forum, ETIP Bioenergy, and European Clean Hydrogen Alliance. There is no direct funding for the Alliance.

Advanced Biofuels Coalition (LSB)

Advanced Biofuels Coalition (Leaders of Sustainable Biofuels, LSB)[77] is a coalition established by the leading biofuel producers and technology developers operating in the European market. The coalition is focused on the **development and upscaling of advanced biofuels made from waste- and residue-based feedstock**.

LSB has 11 members. The members of the LSB must be technology developers or investors that already have invested in large-scale or demonstration-scale facilities. The members in 2022 were BTG, Clariant, Enerkem, Enviral, Global Bioenergies, GoodFuels, Praj, SEKAB, St1, Technip Energies, and UPM Biofuels. One Chair, UPM for the year 2022, and two Vice Chairs, St1, and Clariant, form the administrative body of the coalition.

The goal of LSB is to **accelerate the market penetration and technology deployment and use of advanced biofuels** to meet the EU targets of transport emissions reduction and promote the use of advanced biofuels in the EU.

Being a company-based coalition, LSB members have several pilot and demonstration projects

[74] European Parliament. (2023). Sustainable maritime fuels – 'Fit for 55' package: The FuelEU Maritime proposal. Briefing. Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698808/EPRS_BRI(2021)698808_EN.pdf

[75] European Parliament. (2023). *ReFuelEU Aviation initiative – Summary of Parliament's and Council's positions.* Briefing. Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/739347/EPRS_BRI(2023)739347_EN.pdf

[76] RLCF Alliance. (12.7.2022). *Annual Programme for 2022-2023.* Available at: https://transport.ec.europa.eu/system/files/2022-07/RLCF%20Alliance%20-%20Work%20Programme%202022-2023%20-%20endorsed.pdf

[77] Advanced Biofuels Coalition. Available at: https://www.advancedbiofuelscoalition.eu/

globally, such as a First-of-a-Kind 2G ethanol bio-refinery[78] and Ecoplanta project[79] carried out under the Innovation Fund. Besides the demonstrations with the infrastructure owned by the members, LSB is actively addressing the EU policy institutions, national governments, and financial institutions on issues of common interest in the form of, e.g., position papers and joint letters.

Bioenergy Europe

Bioenergy Europe[80] is a Brussels-based, non-profit organization that aims to **develop a sustainable bioenergy market and ensure that bioenergy contributes to a carbon-neutral Europe**. It was established in 1990. Bioenergy Europe is an umbrella organization of the European Pellet Council (EPC) and the International Biomass Torrefaction Council (IBTC).

Bioenergy Europe has approximately 200 members, which consist of companies, associations, and research institutes. The members pay a membership fee, the amount of which depends on the type and size of the organization. The administrative activities are managed through the Board of Directors, the General Assembly, and the Core Group. The Board of Directors is a group of a maximum of 18 representatives, and it is responsible for electing the Vice President and the Core Group, preparing the decisions of the General Assembly, and approving new members. The Core Group is a group of five people, which prepares the decisions of the Board of Directors and takes an active role in strategy discussions. The General Assembly approves the budget and annual report, decides on the membership fees, and elects the President and the Board of Directors members, among other things.

Bioenergy Europe's main mission is **advocating for the interests of the bioenergy sector in Europe**. The main topical focus areas are, e.g., the implementation of sustainability criteria for bioenergy, taxonomy criteria adoption, RRF, and the revision of RED II.

The mission is carried out in six Working Groups, which are Agro-biomass, Competitiveness, Domestic Heating, Pellet, Sustainability, and Wood Supply. Moreover, Task Forces for National Advocacy and Carbon Dioxide Removal were established in 2021 and 2022, respectively, to provide updates on relevant EU policies and, in case of CO_2 removal, explore policy options in advance of forthcoming EU legislation.

Bioenergy Europe publishes seven statistical reports annually, addressing the key aspects of each sector, as well as providing policy recommendations. The statistical reports concern pellets, bioelectricity, bioheat, biogas, biofuels for transport, biomass supply, and bioenergy landscape. Additionally, Bioenergy Europe owns two certification schemes for wood fuels: EN*plus*®[81], which is a certification scheme for wood pellets, and SURE[82], which is a sustainability certification for solid and gaseous biomass fuels and was developed in compliance with the legal requirements of RED II. In the context of advocacy, Bioenergy Europe reported having 123 meetings with European policy makers in 2021, as well as publishing in total of 64 documents including public consultation replies, policy briefs, press releases, position papers, etc. Regarding market intelligence, Bioenergy Europe published 400+ pages of statistics. The full statistical reports are available for

[78] Advanced Biofuels Coalition, press release. (17.8.2022). *Praj partners with IOCL to launch First-of-It's-Kind and Asia's First 2G Ethanol Biorefinery*. Available at: https://www.advancedbiofuelscoalition.eu/2022/08/17/auto-draft/

[79] European Commission. (4/2022). *Innovation Fund. Ecoplanta: Reduction of CO_2 emissions from municipal non-recyclable waste to produce methanol.* Available at: https://climate.ec.europa.eu/system/files/2022-07/if_pf_2022_ecoplanta_en_0.pdf

[80] Bioenergy Europe. (2022). *The Voice of European Bioenergy*. Available at: https://bioenergyeurope.org/

[81] EN*plus*®. (2022). Available at: https://enplus-pellets.eu/en-in/

[82] SURE. (2022). Available at: https://sure-system.org/en/

members only.

Bioenergy Europe participates in EU-funded projects[83], either as a partner or coordinator. There are three ongoing projects where it is involved: MUSIC - Market Uptake Support for Intermediate Bioenergy Carriers, AgroBioHeat, and RE4Industry.

European Biogas Association (EBA)

European Biogas Association (EBA)[84] is a non-profit organization founded in 2009 and based in Brussels. It aims to **promote the deployment of sustainable biogas and biomethane production and use in Europe**. It addresses the whole value chains for biogas and biomethane from feedstock to end-products.

EBA has over 200 members from 36 different countries, representing both national biogas associations and other members, which include companies, research institutes, universities, public authorities, and individuals active in the field. Its executive board members represent both countries and industry. EBA represents nearly 8,000 stakeholders from the whole biogas and biomethane value chain.

Two different councils work under EBA: Scientific Advisory Council and Company Advisory Council. The first one is a network of researchers, scientists, and university teachers, and it promotes the biogas and biomethane sector through scientific evidence, e.g., in EBA position papers and public communications. The latter is an industry platform dedicated to the European industry dealing with biogas and biomethane production, anaerobic digestion, and gasification. Company Advisory Council facilitates knowledge exchange and industrial inputs to policies. Furthermore, the Company Advisory Board, which consists of voluntary members representing the company members of EBA, aims at providing strategic political advice to the secretariat and the executive board to steer the political advocacy and policy priorities. As an initiative of the Company Advisory Council, EBA has six working groups, namely circular economy, competitiveness, energy and industry, sustainability, technology and innovation, and transport.

According to EBA, renewable gases, including biogas and biomethane, will be in a central role to achieve carbon neutrality by 2050 and help the EU become less dependent on external energy supplies. Thus, EBA **advocates for the recognition of biomethane and other renewable gases** as sustainable, on-demand, and flexible energy sources that provide multiple knock-on socio-economic and environmental benefits. The benefits include supporting the development of a circular bioeconomy, making optimal use of resources (i.e., improving resource efficiency) by valorising waste resources and promoting the agroecological transition, and improving the security of supply and the storage of renewable energy.

EBA works with its members and stakeholders, including institutions, industry, agricultural partners, NGOs, and academia. EBA highlights the importance of collaboration with **sustainability certification** bodies. EBA has set six policy priorities for the legislative period of 2019-2024.[85] EBA is also strongly involved in the recently launched Biomethane Industrial Partnership, e.g., as the

[83] Bioenergy Europe. (2022). *Projects.* Available at: https://bioenergyeurope.org/about-us/our-projects.html
[84] European Biogas Association. (2022). Available at: https://www.europeanbiogas.eu/
[85] European Biogas Association. (2022). *What we care about.* Available at: https://www.europeanbiogas.eu/about-us/vision-mission/

coordinator and a permanent member of the Governing Board. EBA also participates actively in EU projects[86].

European Biomass Industrial Association (EUBIA)

European Biomass Industrial Association (EUBIA)[87], is a non-profit association established in 1996. EUBIA **supports biomass industries at all levels within the EU, as well as seeks opportunities for bioeconomy deployment outside the EU**.

All companies and organizations operating within biomass and bioenergy are welcome to join EUBIA. EUBIA has 21 members, which represent research and industry. Especially universities and research organizations are well-represented in EUBIA. The membership categories are Associate Member, Member, and Corporate Member, of which two latter ones are eligible to vote in the General Assembly.

EUBIA aims to serve the role of the key representative institution of the industrial sector at the highest levels by strengthening European policy and advocating for the interests of the industry.

EUBIA is frequently participating in EU-funded international projects[88], usually as a project partner. The expertise of EUBIA in the context of EU projects is focused on identifying EU funding opportunities, partnership development, project proposals, and project management. Additionally, EUBIA is looking at and promoting international possibilities for cooperation and commercial activities outside the EU that could enhance learning within the EU. Strong emphasis is given to opportunity identification and the creation of partnerships. EUBIA is also a founding member of GBEP. Outside the ongoing projects listed on the projects page, little activities carried out recently by EUBIA were found.

2.3 Summary of initiatives and platforms in the field of bioenergy and renewable fuels

Different platforms and initiatives reviewed in Sections 2.1 and 2.2 are challenging to compare due to their different composition, stakeholders, targets, and organizational and governance structures, among other things. However, to highlight their differences and help SET Plan Action 8 stakeholders to identify opportunities for collaboration, the initiatives and platforms are summarized in Annex 1 with nine categories that were identified as key features for them. Furthermore, some of the key features are highlighted in Figure 3Figure 4. The categories used in figures are explained below.

Dialogue level answers the questions: who is involved in the discussion, and at which level the discussion takes place. The used categories include: policymakers/ministers, policy officers, industry, and research. **Policymakers/Ministers level** differentiates from **policy officers level** in that regard that policymakers/ministers conduct higher level policy discussion (e.g., CEM), whose initiatives or decisions at a national level can impact the investment willingness or change the frame conditions. **Industry level** refers to initiatives and platforms which have a strong presence of private companies (e.g., ETIPs, BIP) or are fully industrial platforms (e.g., LSB). **Research level** refers to platforms that include universities or research organizations as key members (e.g., MI Missions, WBA) or are fully scientific platforms (EERA).

[86] European Biogas Association. (2022). *Projects*. Available at: https://www.europeanbiogas.eu/project/
[87] EUBIA. (2022). Available at: https://www.eubia.org/
[88] EUBIA. (2022). Ongoing projects. Available at: https://www.eubia.org/cms/projects-2/ongoing-projects/

Projects/Tasks/Working Groups (WGs) indicates the initiatives and platforms that have set up projects/Tasks/WGs for the implementation of their mission and objectives. Typically, these are defined in e.g., a Work Programme.

Infra/Demos is marked for those initiatives and platforms that clearly focus on demonstrations or other concrete infrastructure-related actions. Typically, an initiative or a platform does not jointly invest in demonstrations or other infrastructure but brings the demonstrations or other infrastructure of its members in a central role of its actions and leverages them among the members for the joint goals, e.g., by sharing data and key learnings.

Funding level answers the questions: who is funding/financing the initiative or platform and is the funding/financing directed to the initiative or platform in general or directly to projects/Tasks/WGs. **Governmental funding** refers to obligated (e.g., membership fee) and voluntary contributions that member countries pay to support the initiative or platform. **Project funding** indicates if funding is allocated to certain projects/Tasks/WGs. This can include different sources, e.g., from the initiative or platform itself, membership fee to a certain project/Task/WG, in-kind contributions from the members, or support from EC's Framework Programme (explicitly marked in Figure 3).

Geographical coverage identifies if the initiative or platform has **European** or **global** members and focus. The focus on developing countries is explicitly marked. Though an initiative or a platform has members from Europe and a European focus, it can still have stakeholders from outside Europe.

Actions category indicates what kind of actions the initiative or platform performs. However, it must be noted that the four categories presented are not a comprehensive set of possible actions. **Knowledge share** is further divided into 12 actions, which include e.g., different types of reports, workshops, Best Practices, and databases. Furthermore, participation to work related to standardization, certification, specifications, and safety issues is included in the knowledge share category. **Policy recommendations** includes general policy recommendations and research policy recommendations. The first one refers to producing policy recommendations e.g., to policymakers, while the latter means producing strategic research-related recommendations in the form of, for instance, a Strategic Research and Innovation Agenda (SRIA), an Innovation Agenda, or a roadmap. **R&D&D schemes** refer to having projects/Tasks/WGs to implement the defined R&D&D scheme or bringing together and further elaborating research results from the members in a structured way. **Technology deployment** refers to an industrial initiative or platform, whose members are deploying technologies (e.g., LSB), which is in the interface of research and/or policy and industry and has industrial members (e.g., ETIPs), or which has or whose members have the authority to make decisions with direct impact on deployment (e.g., CEM).

	Dialog level				Projects/ Tasks/WGs	Infra/ demos	Funding/ financing level		Geographical coverage	
	Policymakers/ Ministers	Policy officers	Industry	Research			Governmental	Project	Global	Europe
IWG8								Pu*		
CEM										
Biofuture Platform								n.a.		
Biofuture Campaign								n.a.		
Mission Innovation Framework										
MI Integrated Biorefineries										
MI Zero-Emission Shipping										
MI Platform ISAF	n.a.	n.a.					n.a.	n.a.		
IRENA										
IEA Bioenergy TCP								Pr		
IEA AMF TCP								Pr		
Global Bioenergy Partnership									*	
UNIDO									*	
World Bioenergy Association								Pr		
ETIP Bioenergy								Pu*		
ETIP Renewable Heating and Cooling								Pu*		
EERA Bioenergy JP								Pr		
Biomethane Industrial Partnership								Pr		
RLCF Alliance										
Advanced Biofuels Coalition										
Bioenergy Europe								Pu,Pr		
European Biogas Association								Pu,Pr		
EUBIA								Pu,Pr		
	WG – Working Group Pu – Public funding Pu* - Support project financed by EU Pr – Private funding * - Special focus in developing countries									

Figure 3. Dialog level, implementation structure, infrastructure, funding and financing, and geographical coverage of different platforms and initiatives in the field of bioenergy and renewable fuels. Green color indicates relevance to the given platform or initiative, while uncolored aspects are irrelevant.

	Knowledge share	Policy recommendations		R&D&D schemes	Technology deployment
		General policy recommendations	Research (policy) recommendations		
IWG8	3, 4, 5, 6, 9				
CEM	9				
Biofuture Platform	2, 4, 10				
Biofuture Campaign	9				
Mission Innovation Framework	2				
MI Integrated Biorefineries Mission	3, 5, 6, 7				
MI Zero-Emission Shipping Mission	3, 4, 6, 8, 11, 12				
MI ISAF	5, 7, 11		n.a.		
IRENA	1, 4, 5				
IEA Bioenergy TCP	2, 3, 4, 5, 11, 12				
IEA AMF TCP	2, 3, 4, 5, 12				
Global Bioenergy Partnership	4, 5, 6				
UNIDO	11				
World Bioenergy Association	1, 4, 5				
ETIP Bioenergy	4, 5, 12				
ETIP Renewable Heating and Cooling	4, 5, 12				
EERA Bioenergy JP	4, 5				
Biomethane Industrial Partnership	3, 4, 5, 7, 11				
RLCF Alliance	3, 6, 7, 8				
Advanced Biofuels Coalition	4				
Bioenergy Europe	1, 4, 5, 7				
European Biogas Association	1, 4, 5				
EUBIA	6, 9				
	Research (policy) recommendations refer to e.g., SRIA, Innovation Agenda, Roadmap, etc. 1) Statistical reports 2) Country reports 3) Status quo/framework analysis 4) Reports/communications on specific topic 5) Workshops, webinars, conferences, other events 6) Funding and financing opportunities 7) Standardization, certification, technical specifications 8) Safety issues 9) Awards, Innovation Challenges, Challenges 10) Roundtables 11) Best practices 12) Database				

Figure 4. Different actions of platforms and initiatives in the field of bioenergy and renewable fuels. Green color indicates relevance to the given platform or initiative, while uncolored aspects are irrelevant.

3. Initiatives and platforms in the field of renewable hydrogen

3.1 Global initiatives and platforms

Clean Energy Ministerial (CEM): Hydrogen Initiative (CEM H2I)

Hydrogen Initiative (CEM H2I)[89] by Clean Energy Ministerial (CEM) is a voluntary multi-government initiative aiming to international collaboration on policies, programs, and projects to promote the commercial deployment of hydrogen and fuel cell technologies. The initiative focuses on the implementation of hydrogen in industrial applications and transport, and the position of hydrogen related to societal energy needs.

[89] Clean Energy Ministerial. (2022). *Hydrogen.* Available at: https://www.cleanenergyministerial.org/initiatives-campaigns/hydrogen-initiative/

International Energy Agency coordinates the initiative. Co-leads are European Commission, the USA, Japan, Canada, and the Netherlands, but there are also 17 other countries participating. The Initiative Participants include companies, organizations, and other initiatives.

The Hydrogen Initiative has defined five working groups (WGs), one activity and one strategic project in its Work Programme for 2020-2021[90]:

1. WG - Global aspirational goals for hydrogen
2. WG - Global Ports Coalition
3. WG - Roundtable on the North-West European region
4. WG - Large-scale hydrogen supply chain
5. WG - H_2 Twin Cities Initiative
6. Activity - Hydrogen Certification
7. Strategic project - Hydrogen in Marine

The CEM H2I shares the vision of other international initiatives to advance clean hydrogen production and use. It focuses on advancing commercial scale deployment of hydrogen and fuel cell technologies. CEM H2I complements other international initiatives and seeks for collaboration in Initiative's activities. These partners include for example Hydrogen Council, IEA (Advanced Fuel Cells and Hydrogen TCPs), Mission Innovation, and the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE).

CEM members are encouraged to support the initiative annually either financially or in-kind.

Mission Innovation Clean Hydrogen Mission

Mission Innovation is a global initiative aiming to promote investments in clean energy research and demonstration to reach net zero emissions. Clean Hydrogen[91] is one of its Missions, aiming to enhance the cost-competitiveness of clean hydrogen in all parts of the hydrogen value chain.

Co-leads of the Clean Hydrogen Initiative are Australia, Chile, European Commission, the United Kingdom, and the USA. 14 other countries are part of the core members, and there are also initiatives and organizations involved. The 14 countries participating through their related ministries are Austria, Canada, China, Finland, Germany, India, Italy, Japan, the Republic of Korea, Morocco, Norway, the Netherlands, Saudi Arabia, and the United Arab Emirates. The initiatives or organizations participating are CEM Hydrogen Initiative, IPHE Secretariat - International Partnership for Hydrogen and Fuel Cells in the Economy, UNFCCC - Green Hydrogen Catapult, World Bank Group - Energy Sector Management Assistance Program, and World Economic Forum - Accelerating Clean Hydrogen Initiative.

One of the initiative's specific targets is to make way for a future large-scale hydrogen economy. The initiative has set a specific goal: it aims at reducing the cost of hydrogen to 2 USD/kg by 2030. Another mission of Mission Innovation is called Hydrogen Valley Platform. Its target is to be a platform for large-scale hydrogen projects globally. Additionally, all members have committed to developing at least three hydrogen valleys and to developing a national hydrogen strategy. This would lead to 100 new clean hydrogen valleys by 2030 around the world.

[90] Clean Energy Ministerial, Hydrogen Initiative. (2020). *Work Plan 2020-21*. Available at: https://iea.blob.core.windows.net/assets/10a6b8b2-1c6a-4f70-9b44-3b955822b147/H2IWorkplan2021-2022.pdf

[91] Mission Innovation. (2022). *Clean Hydrogen Mission.* Available at: http://mission-innovation.net/missions/hydrogen/

Mission Innovation has 22 countries and the European Commission as members. It ensures funding from its members, which have funding programs.[92]

IEA Hydrogen Technology Collaboration Programme (TCP)

IEA Hydrogen[93] is one of the 42 Technology Collaboration Programmes (TCPs) set up by the IEA. TCPs are independent bodies operating in a framework provided by the IEA. The goal of Hydrogen TCP is to accelerate the use of hydrogen by coordination of research, development and demonstration activities, and international cooperation.

The TCP is participated by the European Commission, UNIDO, and 24 countries, who are contracting parties. There are also seven sponsoring parties. If a country is a member, it allows all national companies or other parties to take part in Tasks.

Hydrogen TCP has many hydrogen-related Tasks, which are cooperative projects focusing on certain themes. The Tasks can be further divided into subtasks. So far, there have been more than 40 Tasks. Currently active Tasks are namely Task 44 Hydrogen from Nuclear Energy, Task 43 Safety and RCS of Large-Scale Hydrogen Energy Applications, Task 42 Underground Hydrogen Storage, Task 41 Analysis and Modelling of Hydrogen Technologies, and Task 40 Energy Storage and Conversion Based on Hydrogen.

Funding for the Tasks is provided by the participating countries. Typically, the countries involved choose and compensate the experts from their countries.

Accelerating Clean Hydrogen Initiative

Accelerating Clean Hydrogen Initiative[94] by World Economic Forum provides roadmaps of measures needed to accelerate the green hydrogen economy in global regions. The initiative also promotes and tries to speed up final investment decisions (FID) by bringing together industries, finance, and policy sides to overcome possible bottlenecks.

The goal of the initiative for the years 2022-2023 is to develop roadmaps for important regions in the world, for example, Latin America and China. The initiative works together with IRENA and Accenture, especially regarding the roadmaps. Another goal was fulfilled at the Annual Meeting of the World Economic Forum (2022) when the Initiative launched the Clean Hydrogen Project Accelerator for Japan and Europe.

The initiative has more than 200 members from 60 partner organizations. The partners include IEA, IRENA, and the Hydrogen Council. The Initiative takes advantage of its wide and global network of organizations in its actions.

[92] Mission Innovation. (2022). *Our members.* Available at: http://mission-innovation.net/our-members/
[93] IEA Hydrogen TCP. (2020). Available at: https://www.ieahydrogen.org/
[94] World Economic Forum. (2023). *Accelerating Clean Hydrogen Initiative.* Available at: https://initiatives.weforum.org/accelerating-clean-hydrogen-initiative/home

International Partnership for Hydrogen and Fuel Cells in the Economy

International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)[95] was established in 2003. The partnership aims to aid in the transition to hydrogen-based, clean energy and mobility systems.

The partnership includes 21 countries and the European Commission as members. The member countries are Australia, Austria, Brazil, Canada, Chile, China, Costa Rica, France, Germany, Iceland, India, Italy, Japan, the Republic of Korea, the Netherlands, Norway, the Republic of South Africa, Switzerland, United Arab Emirates, United Kingdom, and the USA. The partners share information and participate in initiatives. Every two years, the partners choose a chair to lead the activities.

The partnership has two active working groups: Regulations, Codes, Standards & Safety, and Education & Outreach. There is currently one active Task Force, called Hydrogen Production Analysis (H2PA). Its goal is to develop a common methodology for considering emissions related to hydrogen production, so that clean hydrogen's market valuation would become easier. Hydrogen Trade Rules (H2TR) Task Force was completed in February 2022. It aimed at finding possible issues and opportunities for hydrogen trade in large-scale.

Hydrogen Council

Hydrogen Council[96] was established in 2017 at the World Economic Forum. It is an initiative that covers companies from the entire hydrogen value chain. The council provides advice regarding the implementation of hydrogen-related solutions and safety standards, but it also serves as a marketplace for businesses and investors.

The council has almost 150 members, and it is led by the CEOs of the participating companies. It collaborates with other organizations, such as the CEM, IEA, IRENA, Mission Innovation, and World Economic Forum.

The Hydrogen Council aims at enhancing the recognition of hydrogen as an important part of decarbonization. The Council tries to promote collaboration between key stakeholders and make recommendations for them.

The Hydrogen Council has membership fees. The cost depends on the category of the membership.

Global Programme for Green Hydrogen in Industry by UNIDO

UNIDO (United Nations Industrial Development Organization) has a program called Global Programme for Green Hydrogen in Industry[97]. Launched in 2021, it promotes global partnerships in industry and technical cooperation. Together with the Chinese government, they have established International Hydrogen Energy Centre in China. The program operates under United Nations and its member countries.

UNIDO's Programme has two goals: one is to promote the strategic dialogue related to hydrogen in the industry, and the second is to enhance technical collaboration. The first goal is related to

[95] International Partnership for Hydrogen and Fuel Cells in the Economy. (2023). Available at: https://www.iphe.net
[96] Hydrogen Council. (2023). *About the Council.* Available at: https://hydrogencouncil.com/en/about-the-council/
[97] United Nations Industrial Development Organization. (2022). *UNIDO's Global Programme for Green Hydrogen in Industry*. Available at: https://www.unido.org/green-hydrogen

information and knowledge exchange, and the second is to create national roadmaps and hydrogen clusters.

The program has several policymaking organs, and the operation aims at supporting the member countries in industrial decarbonization.

3.2 European initiatives and platforms

European Energy Research Alliance (EERA): Joint Programme Fuel Cells and Hydrogen

JP Fuel Cells and Hydrogen[98] is one of the Joint Programmes operating under EERA, European Energy Research Alliance, which is the largest European energy research community. The goal of EERA JP FCH is to speed up and harmonize European research on electrolysers, fuel cells, and hydrogen handling.

The program has 32 full participants and 10 associated participants. The members are research organizations, institutions, and universities. The complete list of members can be found at the EERA website[99]. VTT Technical Research Centre of Finland coordinates the JP FCH.

The program includes seven sub-programs: SP1 Electrolytes, SP2 Catalysts & Electrodes, SP3 Stack Materials and Design, SP4 Systems, SP5 Modelling, Validation and Diagnosis, SP6 Hydrogen Production and Handling, and SP7 Hydrogen Storage.

EERA is based on memberships, so it collects an annual membership fee from its members.[100]

European Clean Hydrogen Alliance

European Clean Hydrogen Alliance[101] was established in 2020 to assist in near future clean hydrogen technologies deployment in large-scale. The goal of the Alliance is to advance and facilitate investments and ease the implementation of clean hydrogen.

The members of the Alliance are European companies, civil society organizations, research & technology organizations, public bodies, financial institutions, and trade unions. The alliance is open to new participants who fulfil the criteria and requirements. It is possible to join whether working in the private or public sector, with activities in low-carbon or renewable hydrogen. The joining party must commit to contributing to the Alliance's operations.

They Alliance has six roundtables that meet throughout the year, namely:

- Hydrogen production
- Clean hydrogen transmission and distribution

[98] EERA JP Fuel Cells and Hydrogen. (2022). Available at: https://www.eera-set.eu/component/projects/projects.html?id=37

[99] EERA. (2022). *Members.* Available at: https://www.eera-fch.eu/about/members.html

[100] EERA. (2022). *Become a member.* Available at: https://www.eera-set.eu/about-us/become-a-member.html

[101] European Commission. *European Clean Hydrogen Alliance*. Available at: https://single-market-economy.ec.europa.eu/industry/strategy/industrial-alliances/european-clean-hydrogen-alliance_en

- Clean hydrogen in industrial applications
- Clean hydrogen for mobility
- Clean hydrogen in the energy sector
- Clean hydrogen for residential applications

The Roundtable on clean hydrogen in industrial applications covers e.g., e-fuels and refineries. It is facilitated by Cefic.
In early 2022, two more working groups were set up: Standards and Permitting procedures.

Smart Specialisation Platform – European Hydrogen Valleys Partnership

European Hydrogen Valleys Partnership[102] operates on Smart Specialisation Platform. The platform is a strategic platform working under the European Commission. The European Hydrogen Valleys Partnership is set to contribute to the target of the EU being climate neutral by 2050. The platform works on four thematic working areas: Sectoral integration, Zero emission mobility, Hydrogen for heating and cooling applications, and Hydrogen as industry feedstock.

Leading regions of the platform are Aragon (Spain), Auvergne Rhone-Alpes (France), Normandie (France), and North Netherlands (the Netherlands). There are several participating regions located in European countries.

The partnership aims to increase the TRL of fuel cells and hydrogen technologies, spread knowledge and expertise related to hydrogen, lead investment collaborations in European regions, make hydrogen production green, consolidate the value chains related to hydrogen and fuel cells through collaboration, and actively participate in the EU policy framework regarding hydrogen. The partnership organizes events related to the main themes around hydrogen.

The European Hydrogen Backbone (EHB) initiative

The European Hydrogen Backbone (EHB) initiative[103] is developed to aid in the decarbonization of Europe. It provides European Hydrogen Backbone Maps, which propose future hydrogen infrastructures, based on countries' visions.

The initiative has 32 energy infrastructure operators, such as Gasgrid Finland, Nordion Energi, and Enagás, as members.

The goal of the EHB initiative is to speed up decarbonization by highlighting the need for hydrogen infrastructure. It emphasizes supply and demand security, market competition, and collaboration between European countries and countries close by.

The initiative highlights the need for collaboration in the EU and between its members, as well as the need for a well-built and flexible regulatory framework. The members of the initiative provide their country-specific information.

[102] European Commission. *Hydrogen valleys*. Available at: https://s3platform.jrc.ec.europa.eu/hydrogen-valleys
[103] European Hydrogen Backbone. (2023). *The European Hydrogen Backbone (EHB) initiative*. Available at: https://ehb.eu/

Clean Hydrogen Partnership/Clean Hydrogen Joint Undertaking

Clean Hydrogen Partnership, or Clean Hydrogen Joint Undertaking[104] is a partnership between the public and private sectors. It is a successor of the Fuel Cells and Hydrogen 2 Joint Undertaking and was established in 2021 to contribute to European research and innovation of hydrogen applications. The Partnership's main objective is to contribute to EU Green Deal and Hydrogen Strategy through optimized funding of R&I activities.

The partnership has three members: European Commission, Hydrogen Europe (representing the industry side), and Hydrogen Europe Research (representing the research side).

The partnership aims to speed up the progress of clean hydrogen-related technologies. To succeed in this, the partnership aims to consolidate and integrate the scientific competencies of the EU.

The European Union supports the undertaking with EUR 1 bn (2021-2027), and the members from the private sector support it with another EUR 1 bn. The Hydrogen Strategy of the EU is the main driver for the partnership's activities.

3.3 Summary of initiatives and platforms in the field of renewable hydrogen

Different initiatives and platforms reviewed in Sections 3.1 and 3.2 are summarized in Annex II with nine categories that were identified as key features.

[104] Clean Hydrogen Partnership. *Who we are*. Available at: https://www.clean-hydrogen.europa.eu/about-us/who-we-are_en

4. Positioning of SET Plan Action 8 and opportunities for SET Plan Action 8 stakeholders

As the review in Section 2 shows, there are many platforms and initiatives in the field of bioenergy and renewable fuels, both with European and global focus. In addition, several renewable hydrogen related platforms and initiatives have been established, as shown in Section 0, and they have interfaces to the renewable fuels sector.

From the point of view of SET Plan Action 8 and its stakeholders, it is important to identify its current and future desired position among the other platforms and initiatives in the field, and how to collaborate. This section explores potential synergies and opportunities for collaboration with other platforms and initiatives from IWG8's point of view. Platforms and initiatives in the field of bioenergy and renewable fuels that focus on research, collaboration, innovation, and deployment are considered in the analysis, whereas association and industry platforms are not included. Renewable hydrogen related platforms and initiatives are excluded – their relevance for collaboration is acknowledged, but IWG8's interfaces with them are left for later consideration.

Figure 5 describes the dialogue level of different platforms and initiatives, i.e., who are discussing within the platforms and initiatives, and at which level the discussion takes place. The dialogue level is presented in a triangle, in which the corners represent different levels, i.e., authority (e.g., policy officers, ministers), research, and industry. All the levels are well represented in IWG8 due to its wide stakeholder base, which is its key strength to support the implementation of SET Plan Action 8. Among the European platforms and initiatives, ETIPs, RLCF, and BIP have rather similar dialogue levels and stakeholder profiles, but only ETIP Bioenergy has similar scope. RHC-ETIP focuses on the heating and cooling sector, while the scopes of RLCF and BIP are narrower compared to IWG8 and ETIP Bioenergy.

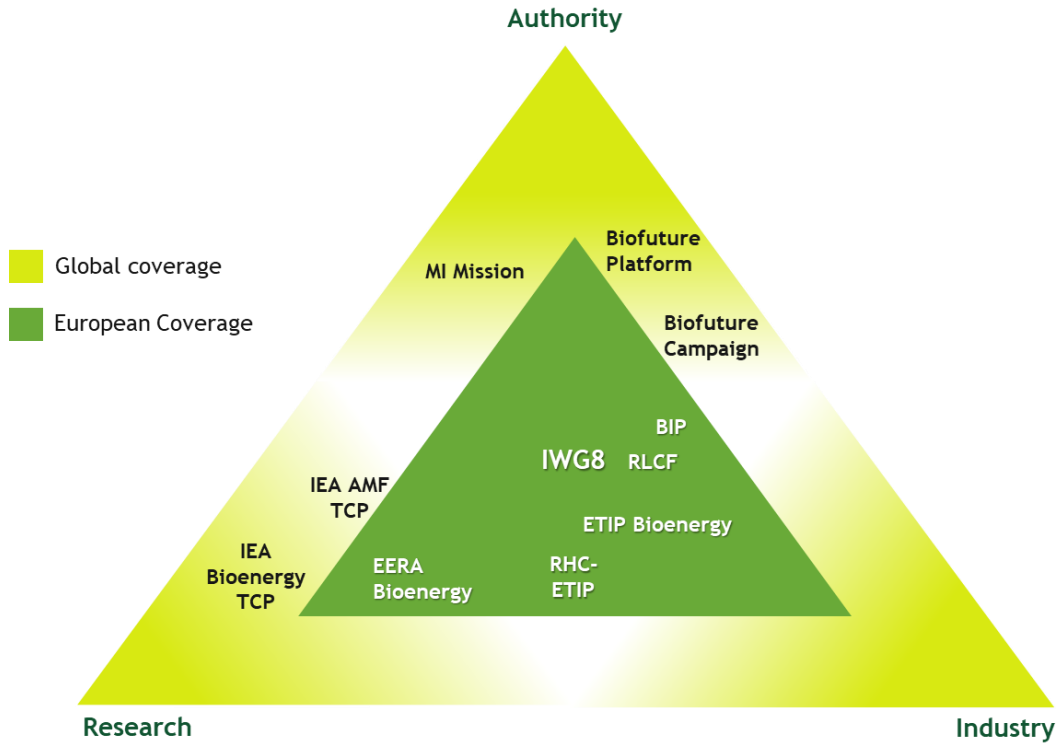

Figure 5. Positioning of IWG8 and other platforms and initiatives identified as most relevant collaborators for it according to the dialogue level in the platforms and initiatives (authorities - research - industry).

Different types of collaboration take place between platforms and initiatives. Experts from authorities, research, and industry are present in the platforms and initiatives, either as nominated representatives or as volunteering stakeholders. Platforms and initiatives have interfaces both on individual, institutional, and formal level. Informal collaborations are challenging to track, whereas formal collaborations established are easier to identify, e.g., platform's representative having a position in other platform's steering committee, or a MoU between two platforms or initiatives (as between IEA Bioenergy TCP and Biofuture Platform). For many of the European platforms and initiatives, SET Plan is a common backbone, such as for IWG8, EERA Bioenergy JP, RHC-ETIP, and ETIP Bioenergy. Furthermore, European Commission provides a strong link between SET Plan pillars and other initiatives, e.g., BIP and RLCF. Identified established connections, either formal or informal, are indicated in Figure 6. In addition, recommended collaborators for IWG8 are presented.

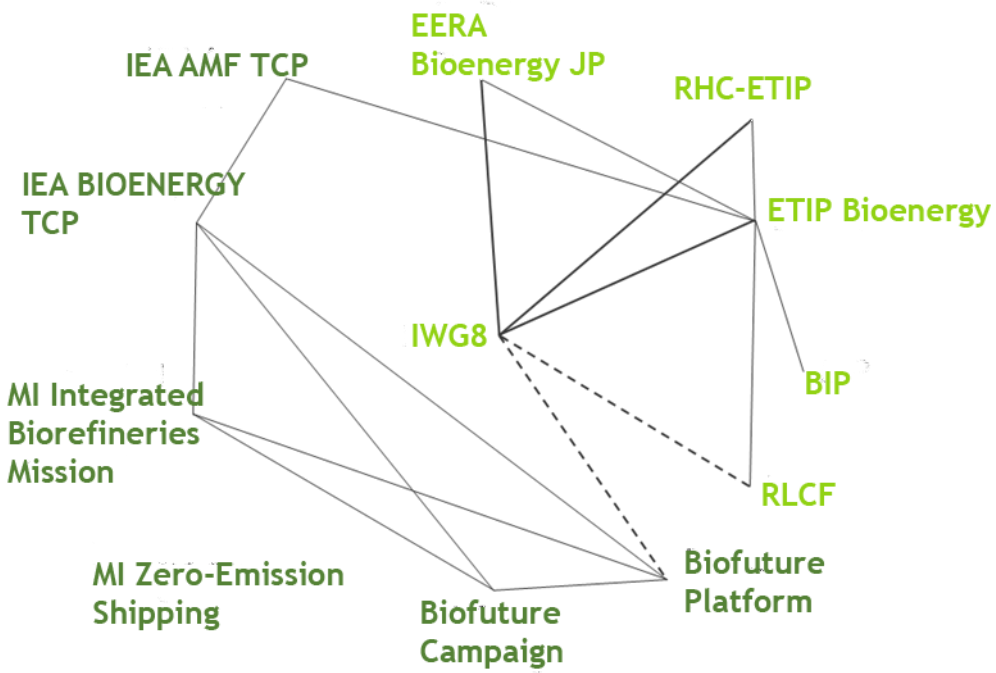

Figure 6. Established formal and informal collaborations (solid line) between selected platforms and initiatives in the field of bioenergy and renewable fuels. In addition, suggestions for most relevant collaborators for IWG8 are presented (dashed line; see Table 7). European platforms and initiatives are indicated with light green color and global with dark green color.

Overall objectives, specific targets, and focus areas of the selected platforms and initiatives are summarized in Table 7, followed by considerations on their relevance and opportunities for collaboration with IWG8. The relevance is outlined based on many factors, such as geographical coverage, scope (e.g., value chains, technology readiness, and end-use sectors/applications), and current connections to IWG8.

In Table 8, opportunities for IWG8 and recommendations for actions are further elaborated with respect to key features, defined in Section 2.3.

Table 7. Summary of objectives, specific targets, and focus areas of different platforms and initiatives in the field of bioenergy and renewable fuels, that were identified as the most relevant ones from IWG8's point of view, and evaluation of their relevance to IWG8. Green color coding suggests to actively seek for collaboration with the platform or initiative, and yellow color code to exchange and stay informed on both directions.

Platform/ Initiative	Objectives	Specific targets	Focus areas	Relevance and opportunities for collaboration to IWG8
Biofuture Platform Initiative	To accelerate the transition to a global, advanced low-carbon bioeconomy that is sustainable, innovative and scalable.	To lead global actions to accelerate development, scale-up, and deployment of sustainable bio-based alternatives to fossil-based fuels, chemicals, and materials (FCMs). No specific targets.	Bio- and waste-based FCMs. Biomass availability, sustainability and governance, policy, regulations, technologies, financing mechanisms, sustainable bioeconomy.	Relevant in terms of value chains for biofuels. Collaboration could provide a possibility to exchange e.g., about Best Practices on policies and financing mechanisms on global and European levels, thus supporting the knowledge base of MS representatives in IWG8. Finland, France, Italy, the Netherlands, Portugal, and Sweden are members of both IWG8 and Biofuture Platform, ensuring a strong connection on MS level.
Biofuture Campaign	To enable the reduction of GHG emissions and foster a circular economy by showcasing pathways by which countries, companies, and consumers can substitute sustainable bio- and waste-based FCMs for their fossil equivalents.	To substitute bio- and waste-based FCMs for 10% of their fossil carbon equivalent in relevant sectors and products by 2030, relative to a 2019 baseline.	Bio- and waste-based FCMs. Focus on commercialization and mobilizing private sector engagement.	Relevant in terms of value chains for biofuels at high TRL, and industrial engagement and presence. Collaboration possibilities e.g., on mobilizing investments and flagship projects. From IWG8 members, Finland and the Netherlands are members of Biofuture Campaign.
Mission Innovation Integrated Biorefineries Mission	To advance sustainable biorefining pathways and technologies to support the development and commercialization of bio-based FCMs.	To replace 10% of fossil-based feedstock for FCMs with sustainable bio-based alternatives by 2030.	Low-carbon and sustainably sourced FCMs. Advanced pilot-scale demonstrations, feedstock and product diversification, legislation and regulations, standards, sustainability criteria, LCA methodology.	Very relevant in terms of product diversification, de-risking of investments, and supporting development of policies and regulations in the case on biorefineries related value chains. Relevant especially in demonstration scale, i.e., TRL 6-9. From IWG8 members, the Netherlands is a co-lead of the Mission, while European Commission supports the Mission.
Mission Innovation Zero-Emission Shipping Mission	To demonstrate commercially viable zero-emission ships by 2030, making zero-emission fuels-driven vessels the natural choice for ship owners when they renew their fleet.	By 2030, at least 200 ships primarily use zero-emission fuels across main deep sea shipping routes, ships capable of running on hydrogen-based zero emission fuels and advanced biofuels make up at least 5% of the global deep-sea fleet, and 10 large trade ports covering at least three continents supply zero-emission fuels.	Ships, fuels, fuelling infrastructure, hydrogen, advanced biofuels, demonstrations.	Relevant in terms of many value chains leading to products for maritime sector, especially at demonstration scale. France is the only IWG8 member engaged to the Mission (Mission Support Group).
IEA Bioenergy	To improve cooperation and	No specified target.	Several value chains and cross-	Relevant in the case of certain topics, focused e.g., on

Platform/ Initiative	Objectives	Specific targets	Focus areas	Relevance and opportunities for collaboration to IWG8
TCP	information exchange between countries that have national programs in bioenergy research, development and deployment.		cutting themes, perspectives from supply chains to technologies and products, and to wider circular bio-economy.	certain value chains (based on e.g., combustion, gasification, biogas, and hydrothermal liquefaction) and certain themes (e.g., sustainability or energy system integration). Possibility to draw expert knowledge on a certain topic and views on sector development from a vast knowledge pool. Almost all IWG8 Member States belong to IEA Bioenergy TCP. Though the TCP is global, it has good national connections through ExCo representatives and Task members.
IEA AMF TCP	To advance the understanding of the potential of advanced motor fuels towards transport sustainability by providing sound scientific information and technology assessments that facilitate informed and science-based decisions regarding advanced motor fuels.	No specified target.	Several value chains for transport sector, aviation fuels, and marine fuels.	Relevant in the case of certain value chains and topics, monitoring of sector development and markets, and drawing expert knowledge on certain topics. From IWG8 Member States, Austria, Finland, Germany, Spain, and Sweden participate in IEA AMF TCP.
ETIP Bioenergy	To contribute to the development of cost-competitive, innovative world-class bioenergy and biofuels value chains, to the creation and strengthening of a healthy European bioenergy industry and to accelerate the sustainable deployment of bioenergy in the EU.	No specified target.	Identified primary and established value chains for production of biofuels, energy, and intermediate bioenergy carriers. Contribution to the SET Plan activities and strategy, research programs at EU and Member States levels, monitoring of R&I activities, knowledge-sharing, technical and non-technical barriers for deployment.	Very relevant as a platform with similar profile, scope, and many same stakeholders, with IWG8 having roots in ETIP Bioenergy's expertise, and with joint goal to support SET Plan implementation. Both platforms have formally engaged representatives from each other. Significant potential for complementary actions foreseen; constant coordination proposed.
RHC-ETIP	To accelerate the deployment of low-carbon technologies in the heating and cooling sector.	No specified target.	Heating and cooling, solar thermal energy, bioenergy, geothermal energy, heat pumps, district energy, thermal energy storage.	Relevant in terms of bioenergy related value chains and joint goal to support SET Plan implementation. However, RHC-ETIP's technological scope is wider, whereas end-use applications are more limited. ETIP-RHC is formally represented at IWG8.

Platform/ Initiative	Objectives	Specific targets	Focus areas	Relevance and opportunities for collaboration to IWG8
EERA: Bioenergy JP	To address the challenges of the European energy and environment policies from a research and innovation perspective.	No specified target.	Biomass, thermochemical conversion, biochemical conversion, stationary bioenergy, sustainability, techno-economics, acceptance.	Relevant in terms of many value chains at low TRL and joint goal to support SET Plan implementation. EERA Bioenergy JP is formally represented at IWG8.
Biomethane Industrial Partnership	To support the achievement of the EU target on biomethane production for 2030 and to create the preconditions for a further ramp up of its potential towards 2050 through closer involvement of stakeholders.	To increase the annual production and use of biomethane to 35 billion cubic meters by 2030 in EU.	Biomethane value chains, REPowerEU.	Relevant in terms of biomethane value chains, aim for strong Member State engagement, and national biomethane strategies that are planned to be incorporated in National Energy and Climate Plans (NECPs; scheduled for 2023). ETIP Bioenergy is engaged to BIP regarding low TRL value chains, and research and innovation activities - this is a channel to stay informed and support by IWG8.
Renewable and Low-Carbon Fuels Value Chain Industrial Alliance (RLCF)	To boost production and supply of renewable and low-carbon fuels in the aviation and maritime sectors.	To contribute to the reduction in the transport sector's GHG emissions by 90% by 2050.	Renewable and low-carbon fuels, FuelEU Maritime initiative, RefuelEU Aviation initiative.	Very relevant in terms of value chains for drop-in and co-combusted liquid and gaseous biofuels and e-fuels. Stocktaking of value chains, proposing project pipelines, and identifying funding and financing opportunities provide a good base for potential collaboration.

Table 8. Benchmark of IWG8 in relation to other similar type of platforms and initiatives in the field of bioenergy and renewable fuels, and key strengths of SET Plan Action 8 and proposed actions for IWG8.

Features of initiatives and platforms	Benchmark of actions and targets in relation to IWG8	Strengths of SET Plan Action 8 and proposed actions for IWG8
Dialog level, stakeholders, and collaboration	Different stakeholders, namely authorities, industry, and research, are well represented within IWG8, ensuring that different perspectives are covered. This seems to be a typical asset for many European initiatives and platforms in the field of bioenergy and renewable fuels, i.e., in ETIP Bioenergy and RHC-ETIP, Biomethane Industrial Partnership (BIP), and Renewable and low-Carbon Fuels Value Chain Industrial Alliance (RLCF).	The broad range of stakeholders representing European Commission, Member State authorities, industry, and research is a key strength of IWG8, and it is suggested to **support maintaining and further strengthening the broad coverage of stakeholders**. This is an enabler for efficient knowledge exchange and coordinated implementation of defined actions. It also makes it possible to have the whole TRL range from research to development and scale-up covered on one table.
	Many European platforms have similar stakeholder profile, but the scope varies. While IWG8 and ETIP Bioenergy cover the whole spectrum of value chains and end-use sectors, BIP, as an example, focuses on biomethane value chains, RLCF on aviation and maritime sectors, and RHC-ETIP on heating and cooling sector. Additionally, many global platforms, e.g., IEA AMF TCP and MI Missions, have more narrow scope compared to IWG8. Some global platforms, e.g., IEA Bioenergy TCP, have a wide scope, but the work is divided in individual streams according to different themes, sectors, and value chains.	Opportunities for collaboration with many other initiatives and platforms are foreseen, taken the wide R&I action and TRL scope of IWG8. It would be beneficial to **clearly define the specific areas and actions of IWG8 where collaboration is sought** in different timeframes, considering the scope and strengths of collaborating parties.
	IWG8 and ETIP Bioenergy have similar profiles regarding dialogue level and scope. Member States have strong presence at IWG8, which supports knowledge exchange with MSs and allows influencing national policy making, whereas industry is well represented at ETIP Bioenergy.	Implementation Plan 8 will be updated, also regarding the targets and KPIs. This process will support positioning of IWG8 in relation to other platforms and initiatives. The presence of Member States provides IWG8 opportunities, e.g., for **sharing knowledge on national level, monitoring sector development, and coordinating actions. It is suggested to strengthen the Member State presence and role in a coordinated manner in Implementation Working Groups.** There is potential for **structured complementary actions between IWG8 and ETIP Bioenergy**. Partly common stakeholder base creates a good basis for stronger collaboration. It is suggested to **clearly define the roles.**
	Many experts are present in different platforms and initiatives. On one hand this strengthens the information exchange, on the other hand it can create unclarity of which initiative/platform/organization is represented.	Knowledge of both formal and informal connections and collaborations between initiatives and platforms support efficient collaboration. Attracting more experts from different stakeholder groups to platforms and initiatives would widen the stakeholder base.
	Bioenergy value chains are long and complex by nature. Thus, it is important to connect stakeholders across the whole value chains.	It is important to frequently define possible gaps in stakeholder base.

Features of initiatives and platforms	Benchmark of actions and targets in relation to IWG8	Strengths of SET Plan Action 8 and proposed actions for IWG8
	Many renewable hydrogen related platforms and initiatives have been established both on European and global level, and at different dialogue levels. Hydrogen is a cross-cutting topic spreading out to multiple sectors and technologies. Hydrogen value chains have many connection points to bio-based value chains, e.g., different pathways to produce hydrogen from biomass and to use hydrogen in bio-based processes. Many of the platforms and initiatives in the field of bioenergy and renewable fuels state explicitly that they cover renewable hydrogen in part of their activities, e.g., Mission Innovation, IEA Bioenergy TCP, IEA AMF TCP, and IWG8.	Topics covered in SET Plan Action 8 have many interfaces to hydrogen economy and hydrogen value chains. Implementation Plan 8 includes separate targets for renewable hydrogen, and Clean Hydrogen Joint Undertaking is a member of IWG8. IWG8 can be seen as a good foundation to emphasize the interfaces of hydrogen and bio-based value chains, though, the focus of IWG8 is not in hydrogen value chains. Hydrogen should be covered in an aligned way in actions and monitoring within the SET Plan bodies, especially between different Implementation Plans, to ensure efficient implementation.
Infra/demos	Demonstrations and other infrastructure do not seem to be in focus of any European platforms except Advanced Biofuels Coalition (LSB), which is an industry platform. On the global level, MI Missions have clear focus on demonstrations.	If closer connection to demonstrations is of interest, that could be sought through industrial representatives of IWG8 or through collaboration with MI Missions on certain areas.
Funding	Several European platforms in the field of bioenergy and renewable fuels, namely ETIP Bioenergy, RHC-ETIP, EERA and IWG8, currently receive support from EC's framework programs to facilitate and accelerate the activities, either directly or via supporting projects. This funding enables facilitated and coordinated implementation of work programs or implementation plans.	Influence for further funding opportunities for support projects in the field of bioenergy and renewable fuels.
	It is challenging to track the funding practices and volumes of different initiatives and platforms, and there are versatile practices to fund actions.	Clear funding structure is needed for dedicated and coordinated actions.
	Strong Member States presence in IWG8 ensures good knowledge of funding opportunities.	Seek for national funding opportunities and connect IWG8 stakeholders to apply R&D&D funding.
Geographical coverage	Europe has many platforms and initiatives in the field of bioenergy and renewable fuels, and collaboration with each other already exists. Collaboration with corresponding global initiatives and platforms is more limited.	Clarify existing and needed collaboration in Europe and identify opportunities for global collaboration.
Actions	Many platforms and initiatives have similar type of activities. Knowledge sharing is an overarching target and includes many concrete activities from best practices to analysis of national R&D&I strategies and policies.	Already clearly arising topics for possible collaboration are stocktaking of value chains and key techno-economic data, defining project pipelines, and providing knowledge on funding and financing opportunities, which all are recent actions also in IWG8. There is room for more concrete actions and outputs in the policy and deployment areas in Europe, especially for industry driven-actions.

5. Conclusions

The purpose of the Global Outlook report was to 1) identify different initiatives and platforms in the field of Implementation Plan of SET Plan Action 8 *Bioenergy and Renewable Fuels for Sustainable Transport* and review their actions and targets, and 2) benchmark them against SET Plan Action 8 actions and targets. This will help identifying collaboration opportunities for SET Plan Action 8 stakeholders. The report also helps positioning SET Plan Action 8 and Implementation Working Group 8 (IWG8) among other platforms and initiatives and thus, serves as background material for updating the Implementation Plan 8 (IP8) as a part of SET Plan revamping in 2023.

Altogether 22 initiatives and platforms were identified and analyzed in the field of bioenergy and renewable fuels, and 12 in the field of renewable hydrogen. In the first group, 13 initiatives and platforms were global and nine were European. In the second group, seven of the initiatives and platforms were global and five were European. All initiatives and platforms were described in terms of their key purpose, members and stakeholders, objectives, and implementation structure. In addition, they were summarized according to nine information categories, namely members/participants, aim, implementation/governance, projects/programs, ways of influence/key outputs, geographical dimension, dialogue level, stakeholders, and financing.

Among the bioenergy and renewable fuels platforms and initiatives, the most relevant ones for IP8, 11 in total, were selected for further analysis and benchmarking. The selected ones represent those focusing on research, collaboration, innovation, and deployment, whereas associations, fully industrial platforms and framework platforms were left out from the analysis. As a results of the analyses, collaboration opportunities for SET Plan Action 8 stakeholders were highlighted as well as strengths of SET Plan Action 8 and proposed actions for IWG8.

Key conclusions and recommendations:

1. The number and content of platforms and initiatives related to bioenergy and renewable fuels sector shows that **the sector is active** in producing and disseminating information, collaborating internationally, and defining agendas for research, innovation, and deployment.
2. **It is recommended to clearly define the scope and activities of different platforms and initiatives to enhance the complementarity of actions and to guarantee efficient collaboration.** In the European context, defining the relations of key SET Plan pillars is of special importance.
3. Cooperation between platforms and initiatives within Europe has been established and take place. **Complementary collaboration on international level should be sought** to gain global perspectives, promote European expertise, and learn from best practices**.**
4. Member States engagement is sought by many platforms and initiatives. This is important especially for SET Plan pillars to ensure coordinated actions with Member States. IWG8 has **strong Member States presence, which should be effectively utilized**, e.g., for sharing knowledge, monitoring sector development, and coordinating actions.
5. Renewable hydrogen is a cross-cutting topic with increasing interest. The scope of IWG8 is in bioenergy and renewable fuels for transportation, which has clear links to hydrogen value chains. It is important to **define synergies between hydrogen value chains and SET Plan Action 8's scope, as well as establish respective targets and KPIs**.

Annex I: Summary of platforms and initiatives in the field of bioenergy and renewable fuels

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
Global initiatives and platforms									
Clean Energy Ministerial (CEM)	**India, USA,** Australia, Brazil, Canada, Chile, China, Denmark, European Commission, Finland, France, Germany, Indonesia, Italy, Japan, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Russia, Saudi Arabia, South Africa, South Korea, Spain, Sweden, United Arab Emirates, United Kingdom	To accelerate the global clean energy transition through a voluntary, efficient global partnership of the world's largest and most forward-leaning economies.	CEM Ministerial, CEM Work Programme, CEM Secretariat, Steering Committee	Six active Workstreams: Power, Transport, Industry, Buildings, Cross-sectoral, and Enabling environment. Corss-sectoral Workstream includes Biofuture Platform and Biofuture Campaign.	Annual Ministerial Meeting CEM Initiatives and Campaigns CEM Awards Social media: LinkedIn, Twitter, YouTube	Global	Policy (policy makers/ ministers)	Industry, international, and non-governmental Partners	Voluntary financial and in-kind support from Member States Establishment of CEM Action Fund agreed at GCEAF 2022
Biofuture Platform Initiative (part of CEM)	22 Members: Argentina, Brazil, Canada, China, Denmark, Egypt, Finland, France, India, Indonesia, Italy, Morocco, Mozambique, the Netherlands, Paraguay, the Philippines, Portugal, South Africa, Sweden, United Kingdom, **United States**, Uruguay	To lead global actions to accelerate development, scale-up, and deployment of sustainable bio-based alternatives to fossil-based fuels, chemicals, and materials (FCMs). To help member countries reach their Nationally Determined Contribution targets by nurturing solutions in low carbon transport and bioeconomy.	Chaired by U.S. Department of Energy, coordinated by the IEA (Facilitator), Supporting organizations, Core Group Governance Framework Document, Nov 2018	Workstream on Biomass Quantification and Sustainability Governance, Policy Blueprint, CEM Biofuture Campaign, Biofuture Summit	Resources: Roundtables (e.g. Sustainable Bioenergy and Biorefineries Roundtable at GCEAF), Reports and papers, Country profiles, Statements, Dissemination materials, and Principles Social media: Facebook, LinkedIn, Twitter, YouTube	Global	Policy - Industry	Private-sector, international and non-governmental Partners, industry, policymakers, academia Partner organizations include e.g., IEA Bioenergy TCP, IEA, FAO, IRENA, GBEP, and UNIDO. Working closely with other CEM/MI initiatives including those focusing on Innovation,	Voluntary financial and in-kind contributions from Member countries and Partner organizations to the Facilitator

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
								Biorefineries, Hydrogen, and Carbon Capture.	
Biofuture Campaign (part of the Biofuture Platform Initiative)	**Brazil, Canada, India, the Netherlands, US (co-leads),** Finland, UK (participants) 44 partners, including NGOs (such as IEA Bioenergy TCP, IRENA, GBEP, WBA) and companies (such as Eni, Stora Enso, Maersk, Clariant, Topsoe) Country Leads – Campaign members (companies) – Association partners – Interested parties	To enable the reduction of GHG emissions and foster a circular economy by showcasing pathways by which countries, companies, and consumers can substitute sustainable bio- and waste-based FCMs for their fossil equivalents. To substitute bio- and waste-based FCMs for 10% of their fossil carbon equivalent in relevant sectors and products by 2030, relative to a 2019 baseline. To elevate Biofuture Platform: garner high level ministerial guidance, public visibility and support.	Country leads, Participating countries, Partners (platforms, organizations, companies), Coordinated by the IEA	Bio-based Substitution Challenge, whose signatories aspire to substitute bio- and waste-based FCMs for 10% of their fossil carbon equivalent in relevant sectors and products by 2030, relative to a 2019 baseline. Thematic working groups: Carbon Footprint of Bio-based Chemicals & Plastics, Carbon Intensity as a policy enabler and driver & the need to get the accounting 'right'	Bio-based Substitution Challenge Social media: Facebook, LinkedIn Twitter, YouTube	Global	Policy - Industry	Industry, NGOs	CEM Members participating in the Campaign with in-kind contribution or funding
Mission Innovation	23 members: Austria, Australia, Brazil, Canada, Chile, China, Denmark, Finland, France,	Aims at catalyzing a decade of action and investment in research,	Steering Committee, Secretariat, Technical Advisory Group	Seven Missions: Zero-Emission Shipping, Clean Hydrogen, Green Powered Future,	Mission Innovation 2.0 Vision	Global	Policy (policy makers/ ministers)	Collaborators: World Bank Group (WBG),	Members contribute voluntarily based on their priorities.

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
	Germany, India, Italy, Japan, the Republic of Korea, Morocco, the Netherlands, Norway, Saudi Arabia, Sweden, the United Arab Emirates, the UK, the US, European Commission	development and demonstration to make clean energy affordable, attractive and accessible for all. This will accelerate progress towards the Paris Agreement goals and pathways to net zero.		Carbon Dioxide Removal, Urban Transitions, Net-zero Industries, Integrated Biorefineries Innovation Platform consisting of three modules: Insights, Collaborate, Accelerate Missions' Roadmaps and Action Plans, such as Zero-Emission Shipping Mission's Action Plan	Mission Innovation Country Highlights - 6th MI Ministerial 2021 MI Newsletter Social media: LinkedIn, Twitter, YouTube			Global Covenant of Mayors for Climate and Energy (GCoM), Breakthrough Energy Coalition, World Economic Forum (WEF), IRENA, IEA	MI has funded projects in 2019-2021 through joint calls that are sponsored by MI members and open to MI members.
Mission Innovation Integrated Biorefineries Mission	The Mission has six members: Co-leads are **India** and **the Netherlands.** Core Mission Members are Brazil and Canada. Mission Support Group consists of European Commission and the United Kingdom.	To develop and demonstrate innovative solutions to accelerate the commercialization of integrated biorefineries, with a target to replace 10% of fossil-based feedstock for FCMs with sustainable bio-based alternatives by 2030. To promote international RD&D collaboration.	Three pillars: i) RD&D to improve the cost-competitiveness of bio-based SFCMs and the sustainability of their production, ii) Pilot scale demonstrations to facilitate cost-competitive manufacturing of bio-based SFCMs, and iii) Regulatory and policy support through collaboration to develop supportive policy and regulatory environments	Innovation Roadmap published at GCEAF 9/2022 A database of national biorefining related policies, funding programs and projects (Database summary and analysis are in the Annex 1 and 2 of the Innovation Roadmap) Techno-economic workshops 2022-2023 Research Initiative on New Uses for Biomass in Bio-based SFCM 2023-2026 Energy and Conversion Process Efficiency Program 2023-2027 Review and Comparison of Domestic Biorefining	RD&D initiative, Funding program for RD&D and pilot & demonstration projects, Innovation Roadmap and its eight Key Actions, Workshops, International knowledge exchange and collaboration	Global	Research - Industry - Policy	Industry, governments, academia, standard-setting organizations, other Missions, MI's Innovation Platform, IEA, IEA Bioenergy TCP Task 42, CEM Biofuture Initiative and Campaign, IRENA Highlights the need for cross-sectoral collaboration and coordination, and active participation from stakeholders through public-	Membership requirement for core members is a national investment between 2–5 million USD/year in one or more sustainable bio-based FCM approaches OR demonstrated prior commitments in sustainable bio-based FCM-Integrated Biorefineries facilities/companies that can be committed and leveraged as part of the Mission.

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
				Legislation and Regulations 2023-2024 Development of Biorefinery Business Plan/Framework 2023-2025 Standards Development to Support Biorefining Processes & End-products 2024-2029 Development of Sustainability Criteria for Biorefineries 2023-2025 Development of LCA Methodology for - Biorefineries 2022-2025				private partnerships.	
Mission Innovation Zero-Emission Shipping Mission	The Mission has 12 members: Co-leads are **Denmark, Norway, the USA, Global Maritime Forum, and Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping**. Core Mission Members are the United Kingdom, Morocco, India, and Singapore. Mission Support Group consists of France, Ghana, and South Korea.	The Mission aims to demonstrate commercially-viable zero-emission ships by 2030, making zero-emission fuels-driven vessels the natural choice for ship owners when they renew their fleet. The goal is divided into three pillars: ships, fuels, and fueling infrastructure, each	n.a.	Program: Blueprint for Future Ports Projects: Green Corridors, Ports Network, Port Connections Green Shipping Corridor Hub launched in November 2022	Roadmap, Action Plan, Reports, Newsletter Social media: LinkedIn	Global	Research - Industry - Policy	Governments, research institutes, private sector, and industry	Mission projects are sponsored by the members.

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
		having a specific target.							
Innovation Platform 'Innovation for Sustainable Aviation Fuels' (ISAF)	**India**, **the USA**, China, European Commission, the Netherlands, and Denmark The IEA and IRENA are participating as Knowledge Partners	To convene the global R&I community on SAF with a shared and prioritized innovation agenda and dedicated working groups.	n.a.	Working groups - no detailed information available	Workshops to identify priority areas, exchange of best practices, and secure resource commitment Development of international technical specifications	Global	Research - Industry	IEA, IRENA	n.a.
International Renewable Energy Agency (IRENA)	168 member countries, 16 in accession	To support countries in their transition to sustainable energy: - Analyze, monitor and systematize current renewable energy practices - Training and education of Members - Advice on the financing for renewable energy - Initiate discussion and ensure interaction with other governmental and non-governmental organizations and networks - Provide relevant policy advice and assistance to its Members upon their request	Assembly, Council, Secretariat	Initiatives: Clean Energy Corridors, Coalition for Action, Global geothermal alliance (GGA), Parliamentary Network, Renewable energy roadmaps (REmap) program, Renewables Readiness Assessment (RRA), SIDS Lighthouses initiative, Climate Investment Platform (CIP), Energy Transition Accelerator Financing Platform (ETAF) Collaborative Frameworks: Critical Materials, Geopolitics, Green Hydrogen, High Shares of Renewables, Hydropower, Just & Inclusive Energy Transition, and Offshore Renewables	Reports (e.g. Bioenergy for the energy transition: Ensuring sustainability and overcoming barriers, Aug 2022) Renewable energy roadmaps Provision of data, e.g. Statistical Yearbooks Legislators Forum Social media: Facebook, LinkedIn, Twitter, YouTube, Instagram	Global	Policy - Research	International, intergovernmental and non-governmental organizations, private sector, industry association, civil society organizations, research institutes. Civil-society groups can contribute to the IRENA vision by advocating and observing the actions of governments and the private sector.	Mandatory contributions of its Members (based on the scale of assessments of the United Nations), voluntary contributions, and other possible sources

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
IEA Bioenergy Technology Collaboration Programme	Australia (participation partially withdrawn in 2022), Austria, Belgium, Brazil, Canada, China, Croatia, Denmark, Estonia, European Commission, Finland, France, Germany, India, Ireland, Italy, Japan, Korea, the Netherlands, New Zealand, Norway, South Africa, Sweden, Switzerland, United Kingdom, the USA	To improve cooperation and information exchange between countries that have national programs in bioenergy research, development and deployment.	Executive Committee (ExCo) consists of representatives designated by and representing each contracting party and sponsor. ExCo adopts for each triennium the Work Program and budget for each Task, carries out the functions assigned in the Implementing Agreement, and oversees the implementation of Tasks. Secretariat Most of the activities are carried out in 11 Tasks, which cover different aspects from resources, conversion technologies, end-products and applications to system perspective. Tasks are managed by the Operating Agents and Task leaders. TCP participants can join the Tasks with an annual fee and designate a National Team Leader to represent the participant. Topics with common interest can be covered in strategic Inter-Task projects and collaborative projects by several Tasks.	Tasks' Work Programs are scheduled for three year periods (current period 2022-2024). They constitute of different projects and outputs, such as reports, workshops and webinars. Work Programs or their summaries are available at Task web pages.	Workshops, Webinars, End-of-Triennium conference, Press releases, Publications (reports, case studies, success stories, best practices, factsheet), Databases, Newsletter Bioenergy Review 2023 Social media: LinkedIn, Twitter, YouTube	Global	Research - Policy	Government ministries and national agencies, industry, scientific community, IEA, other TCPs (e.g. AMF TCP, Hydrogen TCP, GHGT TCP), other platforms and initiatives in the field of bioenergy, biofuels and circular bioeconomy (e.g. FAO, IRENA, GBEP, SEforALL, Biofuture Platform, Mission Innovation)	Annual basic fee for participants, annual fee per Task for participation in Task activities. In-kind contributions from National Team Leaders to support Task work
IEA Advanced Motor Fuels	15 contracting parties from 13 countries:	To advance the understanding and appreciation of the	Executive Committee (ExCo), Secretariat	The work is performed in Tasks.	Project reports, Annual report, Country reports,	Global	Research - Industry - Policy	Government ministries and national agencies,	Annual participation fee

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
(AMF) Technology Collaboration Programme	Austria, Canada, China, Denmark, Finland, Germany, India, Japan (three contracting parties), Republic of Korea, Spain, Sweden, Switzerland, and the USA	potential of advanced motor fuels towards transport sustainability by providing sound scientific information and technology assessments that facilitate informed and science-based decisions regarding advanced motor fuels on all levels of decision-making.			Special reports, Newsletter, Fuel Information database, Workshops, Webinars Social media: LinkedIn, Twitter			industry, scientific community, other TCPs (e.g. Bioenergy TCP, Hydrogen TCP, GHGT TCP)	with one mandatory Task, In-kind/in-cash contribution to Tasks/projects
Global Bioenergy Partnership (GBEP)	GBEP Partners comprise 23 countries and 15 international organizations and institutions. Brazil and the USA were the Co-Chair in 2021-2022. 33 countries and 14 international organizations and institutions participate as Observers	To support biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent, and to advance bioenergy for sustainable development, climate change mitigation, and food and energy security.	Steering Committee, Secretariat hosted at FAO	Working Group on Capacity Building, Task Forces on Sustainability and GHG Methodologies Programme of Work 2023-2024	Sustainability indicators for bioenergy Financing options for bioenergy projects and programmes, March, 2021	Global, focus in developing countries	Policy	Public decision-makers, the private sector and civil society, international agencies	The GBEP Partners and Observers contribute financially, directly and/or in-kind, to support the Secretariat and GBEP activities on a voluntary basis.
United National Industrial Development Organization (UNIDO)	170 Member States (2019)	To promote and accelerate industrial development and co-operation on global, regional and national, as well as on sectoral levels, and in the developing countries with a view to assisting in the establishment of a	The General Conference (GC), The Industrial Development Board (IDB) (53 members), The Director-General, The Programme and Budget Committee (27 members), The Secretariat	Thematic focus area 'Safeguarding the environment': Bioenergy Strategy's key areas: - Bioenergy for industry - Biofuels and the implications for Climate Change - Solid biomass for heat and power: South-South technology transfer and commercialization	Project example from Annual report 2021: Increasing boiler efficiency to cut emissions in Viet Nam Annual report 2020: Demonstrating the value of using waste to produce energy in Uruguay	Global, developing countries	Policy	Governments and national institutions dealing with policy and regulatory issues, industry associations, universities and research institutes, banks and investment funds.	Member countries pay a membership fee. Each Member and observer is responsible for own costs, e.g., travelling costs. Industrial Development Fund is financed

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
		new international economic order.		- Liquid biofuels: Ethanol from residues and wastes - demonstrating the value chain - Liquid biofuels: Biodiesel - building the local-global bridge for SMEs - Biogas from industrial wastes - Biorefineries: providing clearinghouse services	Social media: Facebook, LinkedIn, Twitter, YouTube, Instagram			Direct beneficiaries of the bioenergy programme are SMEs, institutions and enterprises involved in biomass conversion, processing or user technologies.	through voluntary contributions. UNIDO's regular and operational budget in 2021 was EUR 85.3 million. USD 197.3 million net voluntary contributions in 2021 for project implementation, with a total portfolio of projects in hand of USD 575.2 million.
World Bioenergy Association (WBA)	182 members in 2020 Non-governmental: International, national and regional associations (Full membership) Corporations (Associated Membership)	To promote sustainable bioenergy development and support the business environment of bioenergy globally. To assist in the setting up of national or regional bioenergy associations worldwide.	Board (20 members), General Assembly, Nominating Committee, Secretariat	Country Missions WBA has set up the website www.pellets.africa to support African developers of pellet plants. WBA has partnered with ITN Productions Industry News to make program Bioenergy for the Future fully available to the public, that looks at the innovations and developments in the bioenergy sector.	Bioenergy magazine, Global bioenergy statistics, Factsheets, Mission Reports, Reports (e.g. Biomethane Vision Document, Dec 2022), Position papers, Study Tours, Webinars Social media: Facebook, LinkedIn, Twitter	Global	Industry	Industry, research, national/regional bioenergy associations and individuals	Membership fee to be paid, ranging from 1,000 to 10,000 EUR depending on the membership type. Activities are financed by the membership fees.

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
European initiatives and platforms									
European Technology and Innovation Platform on Bioenergy (ETIP Bioenergy)	Steering Group with 20-25 members from main industries, research, civil society and other organizations Advisory Board with representatives from each Member State and EC Officials from DG RTD	To contribute to the development of cost-competitive, innovative world-class bioenergy, biofuels and other renewable liquid and gaseous fuel value chains (including electrofuels), to the creation and strengthening of a healthy European bioenergy industry and to accelerate the sustainable deployment of bioenergy and renewable fuels in the EU through a process of guidance, prioritization and promotion of research, technology development and demonstration.	Organizational structure: Steering Committee, Four Working Groups, Advisory Board, Coordination Group, Stakeholder Plenary Meeting	Working groups on biomass availability (WG 1), conversion processes (WG 2), end-use (WG 3), and sustainability & policy (WG 4)	Strategic Research and Innovation Agenda, 2018, Position papers, Reports, Workshops, Newsletter, Annual Stakeholder Plenary Meetings, European biofuels and bioenergy stakeholder database New SRIA 2023 under process Providing strategic recommendations and input to the SET Plan Steering Group Assisting the EC and Member States in defining and implementing the research programs and financial instruments Social media: LinkedIn, Twitter, YouTube	Europe/EU	Industry - Policy	Organizations that participate in biofuels/bioenergy research, feedstocks, conversion pathways, production, distribution, end-use, sustainability and deployment in Europe Stakeholder database (around 600 entries covering companies, universities, trade associations, research institutes, government organizations and NGOs)	In-kind contribution of members In 2022-2025, ETIP Bioenergy is supported and facilitated by ETIP-B2022-2025 project, funded with EUR 997,988 by the Horizon Europe Framework Programme for Technology and Innovation of the EC under Grant Agreement No. 101075503. In 2018-2021, the platform was supported and facilitated by the ETIP-B-SABS 2 project, which received funding (EUR 997,720) from the EU's Horizon 2020 Research and Innovation programme (CSA project under call H2020-LC-SC3-2018-Joint-Actions-3) under

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
									grant agreement No 825179.
European Technology and Innovation Platform on Renewable Heating and Cooling (RHC-ETIP)	n.a.	To accelerate the deployment of low-carbon technologies in the heating and cooling sector. To bring together stakeholders to define common strategy to increase renewable technologies.	The Board consisting of the President and 15 members, Horizontal Working Groups, Technology panels, including a Technology Panel for biomass, Secretariat	Project database Horizontal working groups: 100% RE Districts 100% RE Buildings 100% RE Industries 100% RE Cities	Policy statements, Strategic documents, Reports, Events, Project database Strategic Research and Innovation Agenda for Climate-Neutral Heating and Cooling in Europe, 2022 Strategic Report on Implementation of Research and Innovation Priorities and Deployment Trends of the Renewable Heating and Cooling Technologies, 2021 2050 vision for 100% renewable heating and cooling in Europe, 2019 Social media: LinkedIn, Twitter	Europe/EU	Industry - Policy	Almost 900 stakeholders from European institutions and national governments, companies and industries seeking ways to decarbonize production, and associations in related sectors.	In 2022-2025, RHC-ETIP is supported and facilitated by SecRHC-ETIP2022-2025 project, funded with ca. EUR 1,049,387 by the Horizon Europe Framework Programme for Technology and Innovation of the EC under Grant Agreement No. 101075746. In 2018-2022, the platform was supported and facilitated by SecRHC-ETIP project, funded by the Horizon 2020 Framework Programme for Technology and Innovation of the EC under Grant Agreement No. 825998. The EU contribution was EUR 984,200.
European Energy	Members consist of European universities, research alliances,	To align research priorities and	Steering Committee, Management Board,	EERA Joint Programmes (JPs) are aligned with the	SRIA 2020 (under revision),	Europe/EU	Research	Communities, SET Plan	Membership fees,

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
Research Alliance EERA: Bioenergy Joint Programme	technology centers, scientific agencies, institutes and associations involved in RD&I in bioenergy and bioeconomy (46 in total)	activities with other external stakeholders, assess R&I priorities in Europe, and be a prominent actor in RD&I in bioenergy to accelerate the SET Plan objectives.	Joint Programme Coordinator, Secretariat	SET Plan research priorities. EERA Bioenergy JP is divided into five sub-programs: Sustainable production of biomass, Thermochemical platform, Biochemical platform, Stationary bioenergy, and Sustainability / techno-economic analysis / public acceptance	Researchers' exchange program, Workshops, Newsletter		EERA Policy WG contribute to ensuring that EERA is involved in European energy R&I policy developme nt.	stakeholders, businesses, individuals (e.g., forest owners), industrial sector, ETIP Bioenergy, external research organizations, national and regional bioenergy agencies and authorities	In-kind contributions
Biomethane Industrial Partnership (BIP)	n.a. Possible Memberships: Associated Membership, Task Force Membership	Target to increase the annual production and use of biomethane to 35 billion cubic meters by 2030. Topics to be covered by the Partnership mostly link to proposed actions included in the Biomethane Action Plan.	Governing Board, Multiple Task Forces, Secretariat The Governing Board consists of up to eight representatives of the European Commission, Member States and the biomethane value chain. Governing Board members who represent a company (2) are appointed by the value chain Support Group on a rotating basis. The secretariat provides day-to-day practical support and is funded by the value chain Support Group to the partnership, a group consisting of the European Biogas Association (EBA) plus up to twenty companies.	Task force 1 National biomethane targets, strategies and policies Task force 2 Accelerated biomethane project development Task force 3 Sustainable potentials for innovative biomass sources Task force 4 Cost efficiency of biomethane production and grid connection Task force 5 Research, Development and Innovation needs	BIP Work Programme (10/2022) Reports, Workshops, Interactive consumer guide for investors, Tours to showcase best practices	Europe/EU	Industry - Policy	All EU countries, companies, industry associations, academia and civil society organizations. Task 1: All Member States, focusing on national biomethane policies and strategies Task 2: In addition to policymakers in particular: Biomethane companies and private and public investors Task 3: In addition to policy makers in particular:	Free and open membership for all relevant parties

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
								Primary biomass producers, biomethane producers, farmers associations, academia and civil society. Task 4: In particular: Biomethane companies, private and public investors and gas infrastructure companies Task 5: In addition to policymakers in particular: Biomethane companies, private and public investors, and academia	
Renewable and Low-Carbon Fuels Value Chain Industrial Alliance (RLCF)	195 members, mostly representing businesses and industry initiatives or associations, but also authorities, research institutes and other types of organizations Membership through application at all stages of Alliance's operation. The Alliance is open to any	To boost production and supply of renewable and low-carbon fuels in the aviation and maritime sectors, thus contributing to the reduction in the transport sector's GHG emissions by 90% by 2050. The focus is on drop-in	The Steering Group, The Alliance General Assembly (all signatories of the Alliance Declaration) consisting of chambers for waterborne and aviation modes, Secretariat (Fuels Europe and Hydrogen Europe in 2022)	Framework Work Plan Roundtables: Roundtable 1: The availability of feedstocks, synergies among sectors and the "Just transition", Roundtable 2: Production pathways and value chain – Aviation, Roundtable 3: Production pathways and value chain	Specific short- and medium-term deliverables will be outlined in the Framework Work Plan.	Europe/EU	Policy - Industry - Research	ReFuelEU Aviation and FuelEU Maritime stakeholders, other initiatives such as European Sustainable Shipping Forum, ART Forum, ETIP Bioenergy, and European Clean Hydrogen Alliance	Membership is free of charge. There is no direct funding for the Alliance.

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
	company or organization, EU body and agency, Member State, local or regional authority or their agency, recognized social partner organization, stakeholder group, civil society organization or member of Horizon Europe Partnerships.	and co-combusted liquid and gaseous biofuels and e-fuels.		– Waterborne transport, and Roundtable 4: Access to public and private finance. Steering Group will arrange a call for projects in the beginning of 2023.					
Advanced Biofuels Coalition (LSB)	St1, Sekab, Praj, UPM, Clariant, Enviral, Technip Energies, Enerkem, BTG, Global Bioenergies, GoodFuels Chair: Marko Janhunen, UPM Members of the LSB must be: - Technology developers of advanced biofuels who have already been investing in large scale demonstration scale facilities - Investors in plants (demo or flagship) of advanced biofuels	Manifesto To liaise and interface with the other EU and international groups that are pro-active in advocating and developing advanced biofuels. To address and close the existing gap in terms of technology representation, appropriate financial instruments, policy development and lack of market incentives both at EU and national level. To stimulate the EU policy towards accelerated industrial research and innovation into emerging biofuel technologies, including new conversion pathways, supported	Chair / Policy implementation, Vice chairs (two company representatives), Coalition members	Pilots and demonstrations carried out by the member companies, can be found from the news section.	Position paper on the EU 'Fit for 55' climate package proposal Statement on the need to accelerate domestic renewables and on the 'REPowerEU' communication Joint Letter to EU Commissioners to adopt a dedicated sub-target for advanced biofuels under the REFuelEU Aviation Regulation Social media: LinkedIn, Twitter	Europe Some global actors, but targets are aligned with EU targets	Industry	EU policy institutions (the European Commission, the Council and the European Parliament), the National Governments and the financial institutions, on issues of common interest	n.a.

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
		by public and private policies promoting deployment.							
Bioenergy Europe	Approximately 200 members, consisting of 40 national associations, 157 companies, and 11 academia and research institutes	To facilitate the development of a sustainable, strong and competitive bioenergy sector through advocating for the interest of the European bioenergy sector in Brussels and at national level, providing market intelligence for members and for supporting decision making, and tools, e.g., certification schemes, to promote sustainability and credibility.	The Board of Directors (maximum of 18 representatives), The General Assembly, The Core Group (five members)	Working groups: Agro-biomass, Competitiveness, Domestic heating, Pellet, Sustainability, and Wood supply Task forces: National Advocacy, and Carbon Dioxide Removal Hosting two international networks: European Pellet Council (EPC), and International Biomass Torrefaction Council (IBTC) Two certification schemes for wood fuels: EN*plus*®, and SURE EU-funded projects	Annual statistical reports on bioelectricity, biogas, biofuels for transport, biomass for heat, pellets, biomass supply, and bioenergy landscape (full versions available for members only) Press releases, Position papers, Policy briefs, Publication database, European Bioenergy Future (EBF) conference Social media: LinkedIn, Twitter, YouTube	Europe	Industry	Bioenergy companies	Membership fees, amount depending on the type and size of the organization
European Biogas Association (EBA)	Over 200 members covering 36 countries and representing both national biogas associations and other members, which include companies, research institutes, public authorities and individuals active in the field of biogas.	To advocate for the recognition of biomethane and other renewable gases as sustainable, on demand and flexible energy sources that provide multiple knock-on socio-economic and	Executive board, Secretariat, Scientific Advisory Council, Company Advisory Council, Company Advisory Board	Nine working groups: Digestate and fertilizers, Biogas market design, Biomethane in transport, Gasification, Agriculture, Bio-LNG and maritime, Wastewater, Biogenic CO_2 valorization, Bio-hydrogen	Publications, including position papers, recommendations and annual activity reports, Statistical reports, Workshops, Conferences	Europe	Industry - Research	Near 8,000 stakeholders from the whole biogas and biomethane value chain, including institutions, industry, agricultural partners, NGOs,	R&D funding through EU projects Membership fee of 500-17,500 EUR depending on the type of member

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
	Association members are from Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, the Netherlands, Ukraine and UK.	environmental benefits. Different ambitions regarding sustainability, circular economy, competitiveness and networks, transport, innovation, and renewable energy, that support the deployment of biogas and biomethane. A specific target of 45 GW of installed capacity available in Europe in 2030 to contribute to the need for renewable gas in transport, industry and heating sector.		Participation in R&D projects as a partner	Social media: LinkedIn, Twitter			academia and sustainability certification bodies	
European Biomass Industrial Association (EUBIA)	21 members, most of which universities and research institutes	To support the biomass actors in Europe at all levels, strengthen the European policies in the sector, protect industrial interest, identify new opportunities, and promote job creation.	n.a.	Participated in >30 EU-funded projects. Ongoing projects: Valuewaste - Unlocking new value from urban biowaste Life Resilient Forests - Coupling water, fire and climate resilience with biomass production from forestry to adapt watersheds to climate change	Newsletter, EUBIA Award Social media: Facebook, LinkedIn, Twitter	Europe	Research - Industry	Universities, research institutes, large industry, SMEs	Membership fee, amount depending on the type of the organization

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
				BLAZE - Biomass Low cost Advanced Zero Emission small-to-medium scale integrated gasifier fuel cell combined heat and power plant					

Annex II: Summary of platforms and initiatives in the field of renewable hydrogen

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/ Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
Global initiatives and platforms									
Clean Energy Ministerial (CEM): Hydrogen Initiative (CEM H2I)	**IEA** (coordinator), Co-leads: EC, the USA, Japan, Canada, and the Netherlands, Initiative Participants: Australia, Austria, Brazil, Chile, China, Costa Rica, Finland, Germany, India, Italy, New Zealand, Norway, Portugal, Saudi Arabia, South Africa, South Korea, United Arab Emirates, and United Kingdom. Partners of the initiative also include companies, organizations, and other initiatives. Participation is open to any CEM Member. States that are not CEM Members may also become Initiative Participants.	To promote the commercialization of hydrogen and fuel cell technologies and to speed up their development and implementation in all sectors. The focus is on industrial applications, transport and the position of hydrogen related to societal energy needs.	Coordinator (IEA), Initiative Participants, Initiative Leads, Initiative's Advisory Group Cooperation Framework	Work Plan 2021-22 Working groups: Global aspirational goals for hydrogen, Global Ports Coalition, Roundtable on the North-West European region, Large-scale hydrogen supply chain, H2 Twin Cities Initiative Activity: Hydrogen Certification Strategic Project: Hydrogen in Marine	Annual work plans, Roadmaps, Campaigns to raise ambition levels, Analysis and studies, Reviews, Reports (e.g., Global Hydrogen Review 2022, Sept 2022, together with IEA), Workshops, Webinars, Strategic partnerships	Global	Policy - Industry	Industry, Hydrogen Council, International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), IEA's Advanced Fuel Cells and Hydrogen Technology Collaboration Programmes, Mission Innovation, World Economic Forum, Air Products, Ballard, Enel, Engie, Nel Hydrogen, Port of Rotterdam, and ThyssenKrupp	Initiative Participants are encouraged to support the initiative annually either financially or in-kind. Each Participant is expected to provide a voluntary annual financial contribution (expected to be at 20,000 EUR) directly to the Coordinator.

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/ Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
Mission Innovation Clean Hydrogen Mission	Co-leads: **Australia, Chile, EC, UK, and the USA**, 14 other countries are part of the core members: Austria, Canada, China, Finland, Germany, India, Italy, Japan, Republic of Korea, Morocco, Norway, the Netherlands, Saudi Arabia, and United Arab Emirates.	To promote investments in clean energy research and demonstration to reach net-zero emissions, and to reduce the cost of hydrogen to 2 USD/kg by 2030. Also, all members have committed to developing at least three hydrogen valleys and to developing a national hydrogen strategy.	Member countries manage their own national efforts, for example the development of national hydrogen strategies. There are five co-leads facilitating the joint actions.	Three Pillars: Pillar 1 - Research and Innovation, Pillar 2- Demonstration and Clean Hydrogen Valleys, Pillar 3 - Enabling Environment Hydrogen Valley Platform	Reports (Hydrogen RD&D Collaboration Opportunities: Global Report), Action plans, (Action Plan 2022-2024, Sept 2022), Discussion paper	Global	Public - Private - Policy	Partners with CEM: Hydrogen Initiative, IPHE Secretariat: International Partnership for Hydrogen and Fuel Cells in the Economy, UNFCCC: Green Hydrogen Catapult, World Bank Group: Energy Sector Management Assistance Program, and World Economic Forum: Accelerating Clean Hydrogen Initiative. Academia, policymakers, private sector.	Funding is ensured from the members who have funding programs.

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/ Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
IEA Hydrogen Technology Collaboration Programme (TCP)	Members: Australia, Austria, Belgium, Canada, China, Denmark, Finland, France, Germany, Greece, Israel, Italy, Japan, Korea, Lithuania, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the Netherlands, and UK. Sponsors: EC, Hydrogen Council, HYCHICO, NOW GmbH, Reliance Industries Limited (RIL), Southern Company, Shell Global Solutions International BV, and UNIDO.	To accelerate the use of hydrogen by coordination of research, development and demonstration activities and international cooperation.	The Executive Committee (ExCo) is formed from the representatives of all contracting parties and sponsor members. The current Technical Secretariat of the TCP is a Spanish company ARIEMA Energía y Medioambiente S.L.	On-going Tasks: Task 44: Hydrogen from Nuclear Energy, Task 43: Safety and RCS of Large Scale Hydrogen Energy Applications, Task 42: Underground Hydrogen Storage, Task 41: Analysis and Modelling of Hydrogen Technologies, Task 40: Energy Storage and Conversion Based on Hydrogen	Reports, Case studies, Tasks, Webinars and workshops, Hydrogen TCP Awards	Global	Research - Policy	Other TCPs (e.g., IEA AMF TCP, IEA Bioenergy TCP)	Funding of the Tasks is provided by the participating countries. Typically, the countries involved choose and compensate the experts from their country.
Accelerating Clean Hydrogen Initiative	The initiative is set up by World Economic Forum. It has more than 200 members from 60 partner organizations.	To speed up final investment decisions (FID) by bringing together industries, finance, and policy sides to overcome possible bottlenecks. The goal of the initiative for the years 2022-2023 is to develop roadmaps for important regions in the world, for example Latin America and China.		Clean Hydrogen Project Accelerator, Enabling Measures Roadmaps	Enabling Measures Roadmaps for Green Hydrogen (Europe and Japan, Jan 2022)	Global	Industry - Finance - Policy	The Initiative works together with IRENA and Accenture especially regarding the roadmaps. Partners include IEA, IRENA, and the Hydrogen Council.	n.a.
International Partnership for Hydrogen and Fuel Cells in the Economy	Australia, Austria, Brazil, Canada, Chile, China, Costa Rica, EC, France, Germany, Iceland, India, Italy, Japan, Republic of Korea, the Netherlands, Norway, Republic of South Africa, Switzerland, United Arab Emirates, UK, and the USA	To aid in the transition to hydrogen-based, clean energy and mobility systems, to develop a common methodology for considering emissions related to hydrogen production, and to find possible issues and opportunities for hydrogen trade in large-scale.	Every two years, the partners choose a chair to lead the activities.	Working groups: Regulations, Codes, Standards & Safety, Education & Outreach Task Forces: Hydrogen Production Analysis (H2PA) (active), Hydrogen Trade Rules (H2TR) (completed 2/2022)	Webinars, Reports, Presentations, Meetings, Forums	Global	Governmental/ Policy	Policymakers, academia, industry, non-governmental organizations the public	n.a.

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/ Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
Hydrogen Council	The council has almost 150 members.	To enhance the recognition of hydrogen as an important part of decarbonization and promote collaboration between key stakeholders and make recommendations for them.	The Council is led by the CEOs of the participating companies. Hydrogen Council Team supporting the work of the Council.	The council provides advice regarding the implementation of hydrogen-related solutions and safety standards, but it also serves as a marketplace for businesses and investors.	Studies, Reports (e.g., Hydrogen Insights), Articles, Videos, Infographics	Global	Industry - Finance	CEM, IEA, IRENA, Mission Innovation, World Economic Forum	Membership fees, the cost depends on the category of the membership.
Global Programme for Green Hydrogen in Industry by UNIDO	The program operates under United Nations and its member countries.	To promote the strategic dialogue related to hydrogen in the industry (information and knowledge exchange), and to enhance technical collaboration (creating national roadmaps and hydrogen clusters).	The program has several policymaking organs.	Global Programme for Green Hydrogen in Industry, International Hydrogen Energy Centre (in China)	International Hydrogen Energy Centre, Publications	Global	Policy/ Governmental - Industry	The public and private sectors, financial organizations, academia	n.a.
European initiatives and platforms									
European Energy Research Alliance (EERA): Joint Programme Fuel Cells and Hydrogen	32 full participants and 10 associated participants, coordinated by VTT Technical Centre of Finland Ltd. List of members	To speed up and harmonize European research on electrolysers, fuel cells and hydrogen handling.	Coordinator, Sub-programmes (SPs), which have their own leads from member organizations	Seven sub-programmes: SP1 Electrolytes, SP2 Catalysts & Electrodes, SP3 Stack Materials and Design, SP4 Systems, SP5 Modelling, Validation and Diagnosis, SP6 Hydrogen Production and Handling, SP7 Hydrogen Storage JP Fuel Cells and Hydrogen researcher mobility platform	JP FCH Implementation Plan for 2018-2030	Europe/EU	Research	Academia, policymakers, industry	EERA has annual membership fee from members. This consists of a central fee (6,000 EUR per year for full members, 2,000 EUR per year for associate members) and a participation fee for some of the Joint Programmes.

Platform/ Initiative	Members/Participants (Chair **bolded**)	Aim	Implementation/ Governance	Projects/Programs	Ways of influence/ Key outputs	Geographical dimension	Dialogue level	Stakeholders	Financing
European Clean Hydrogen Alliance	The members are European companies, civil society organizations, research & technology organizations, public bodies, financial institutions, and trade unions.	To advance and facilitate investments and ease the implementation of clean hydrogen.	The roundtables are co-chaired by CEOs/executive board members of companies with relevant activities in Europe. Each Roundtable has a facilitating organization.	Roundtables: Hydrogen production, Clean hydrogen transmission and distribution, Clean hydrogen in industrial applications, Clean hydrogen for mobility, Clean hydrogen in the energy sector, Clean hydrogen for residential applications Working groups: Standards, Permitting procedures	Reports, Presentations, Project pipeline	Europe/EU	Policy - Industry	Industry, public authorities, academia, civil society	n.a.
Smart Specialisation Platform – European Hydrogen Valleys Partnership	Leading regions of the platform are **Aragon (Spain), Auvergne Rhone-Alpes (France), Normandie (France), and North Netherlands (the Netherlands)**. There are many participating regions located in European countries.	To contribute to the target of EU being climate neutral by 2050, to increase technological readiness level of fuel cells and hydrogen technologies, to spread knowledge and expertise related to hydrogen, to lead investment collaborations in European regions, to make hydrogen production green, to consolidate the value chains related to hydrogen and fuel cells through collaboration, and to actively participate in the EU policy framework regarding hydrogen.	European Hydrogen Valleys Partnership operates on Smart Specialisation Platform. The platform is a strategic platform working under the European Commission. The four leading regions facilitate the work.	Thematic working areas: Sectoral integration, Zero emission mobility, Hydrogen for heating and cooling applications, Hydrogen as industry feedstock	Events, Progress reports (July-December 2020 report)	Europe/EU	Policy, regional level emphasized	Policymakers, industry, the public, investors	n.a.

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The European Hydrogen Backbone (EHB) initiative	The initiative has 31 energy infrastructure operators as members. The companies that participate in the initiative are Amber Grid, Bulgartransgaz, Conexus, CREOS, DESFA, Elering, Enagás, Energinet, Eustream, FGSZ, FlusSwiss, Fluxys Belgium, Gas Connect Austria, Gasgrid Finland, Gassco, Gasunie, GAZ-SYSTEM, Gas Networks Ireland, GRTgaz, National Grid, NET4GAS, Nordion Energi, OGE, ONTRAS, Plinacro, Plinovodi, REN, Snam, TAG, Teréga, and Transgaz. **Daniel Muthmann** is the Chair of EHB.	To aid in decarbonization of Europe, to speed it up by highlighting the need for hydrogen infrastructure. The initiative emphasizes supply and demand security, market competition and collaboration between European countries and countries close by.	All members provide information on the hydrogen infrastructure development of their country.	European Hydrogen Backbone Maps	European Hydrogen Backbone Maps, Country-specific developments, Roadmaps, Future demand analyses Publications site	Europe/EU	Industry - Policy	Policymakers, companies, initiatives along the hydrogen value chain	The members of the initiative provide their country-specific information.
Clean Hydrogen Partnership/ Clean Hydrogen Joint Undertaking	The partnership has three members: European Commission, Hydrogen Europe (representing the industry side), and Hydrogen Europe Research (representing research side).	To contribute to European research and innovation of hydrogen applications, to speed up the progress of clean hydrogen related technologies, and to consolidate and integrate the scientific competences of the EU. The main goal is to contribute to EU's Hydrogen Strategy and the European Green Deal.	The Governing Board, The Executive Director, assisted by the Programme Office, The States Representatives Group, The Stakeholders Group	Projects	Calls for proposals, Webinars, Events, Reports, Clean Hydrogen Partnership Awards Publications site	Europe/EU	Public - Private	Representatives of sectors which generate, distribute, store, need or use clean hydrogen, other relevant European partnerships, as well as representatives of the European Hydrogen Valleys Interregional Partnership and of the scientific community.	The EU supports the JU with EUR 1 billion (2021-2027), and the members from the private sector support it with another EUR 1 billion.