SET4BIO

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

Horizon 2020, Grant Agreement no. 884524

Title of the Deliverable	Due date	Actual submission date
Report on the state of play of the SET Plan IP8	**31.08.2023 Final update**	**22.08.2023 Final update**

Work Package (WP): 1 - Funding and financing roadmap and investments

Task: Task 1.1 - IP8: State of play

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EXECUTIVE SUMMARY

Deliverable 1.1 addresses SET4Bio's Task 1.1 governing the state of play of the research and innovation activities relevant for SET Plan IP8. The aim is mapping of the relevant ongoing and recently finished projects at EU and national level, especially for the SET Plan countries engaged in IWG8 as well as at European level. The projects covered in this deliverable contribute to the execution of IP8 covering the entire TRL spectrum, from research and development activities up to demonstration and scale-up initiatives.

The deliverable is organized as follows. The actual project list is presented in an excel file in Appendix 1, showing the ongoing and recently finished projects for the EU and the individual countries, each in their own sheet. The list has been updated continuously throughout the project period and serves as the basis of the interactive map available on the SET4Bio homepage showing the projects in their respective countries.

The first section of this document gives a background by describing the Set Plan Implementation Plan action 8 as well as the list of participating countries. Chapter 2 covers the value chains considered and Chapter 3 describes the data and information collection methodology. Chapter 4 summarizes the results, while Chapter 5 gives a short conclusion and outlook.

The initial deliverable showed the challenges in data collection of relevance to follow up the progress of IP8, primarily due to the enormous differences in funding national projects and available data related to them. To improve the quality of the deliverable, the data presented in this updated document has been further elaborated and systematized with the involvement of key national stakeholders/expert sources in the field of bioenergy/renewable transportation fuels in collecting and quality assuring the data. Among the upgrades included in the current work, it is worth mentioning the inclusion of the correlation between listed project and R&I activities of the SET Plan IP8, providing a clearer picture about the progress of the realization of IP8. Despite the quality gain of the data presented in this updated version, it is necessary to be aware of that there are structural barriers that must be considered when aiming to collect, align and compare data effectively across Europe. There is a need to define a common taxonomy to characterize national and Europe projects facilitating comparisons to discuss best-practices/lessons-learnt on funding mechanisms. Further, it is crucial that countries having several funding agencies establish coordination instruments to align national data within the country.

The financing goal achievement of IP8 is rather low, even if the green hydrogen value chain has been receiving massive support and funds lately. The bioenergy related projects receive less focus and funds, especially from MSs and the private and their overall goal achievement is around 1%. It has been found that in all investigated countries the R&I projects are funded by funding agencies through competitive calls and that means that they have the capability of proposing future calls adjusting the focus to the needs of the IP8 according to its progress. The maturity of the technologies addressed in the projects financed through national funding agencies or ministries is on average between low and low-to-medium, with TRLs ranging from 3 and reaching 6-7. However, projects financed through the new schemes (RRF and IPCEI) are closer to commercialization with TRLs of 7-8. The information available in this report reveals that industry's engagement and investment in R&I projects should be deeper and larger in the bioenergy projects.

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Statement of Originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

Content

1. Introduction

The European Strategic Energy Technology Plan (SET Plan)[1] is a major tool to enable the transition towards a climate neutral energy system in Europe through the development of cost efficient low-carbon technologies. The Integrated SET Plan defines the European R&I targets in 10 key areas, of which one covering renewable fuels and bioenergy defined by *"Action 8: Bioenergy and Renewable Fuels for Sustainable Transport"*. In December 2017, the representatives of the European Commission services, SET Plan countries and stakeholders agreed upon a SET Plan Declaration of Intent (DoI8[2]), and later in June 2018 upon an Implementation Plan for Action 8 (IP8)[3].

The overall objective of Work Package 1 in Set4Bio is to identify the most promising funding and financing mechanisms to realize the IP8 and to create awareness of funding needs and challenges among key stakeholders. Task 1.1 in the SET4Bio project has set a goal on mapping the most important ongoing and recently finished projects contributing to the realization of theIP8, *Bioenergy and Renewable Fuels for Sustainable Transport*, including, when data is available, an analysis of the funding schemes behind the projects, within both public and private funding, players involved, and committed resources. The work in Task1.1 during the past years has been focusing on upgrading of the existing and adding missing data as well as on systematizing and improving the presentation of the data for the countries involved in IWG8.

The member countries of IWG8 are as follows:

- Austria
- Belgium
- Cyprus
- Finlandd
- France
- Germany
- Italy
- Netherlands
- Poland
- Portugal
- Spain
- Sweden
- Türkiye

[1] https://ec.europa.eu/energy/topics/technology-and-innovation/strategic-energy-technology-plan_en
[2] https://setis.ec.europa.eu/implementing-integrated-set-plan/renewable-fuels-and-bioenergy-ongoing-work
[3] https://setis.ec.europa.eu/system/files/setplan_bioenergy_implementationplan.pdf

2. Value chains covered in the report

The IP8 along with DoI8 address three major goals in the field of bioenergy and biofuels: improve efficiency and reduce GHG emissions and costs of production. Due to the complexity of the field as well as versatility of the specific value chains, the IP8 identifies 13 research and innovation (R&I) activities to be implemented to meet the targets defined in DoI8/IP8. The 13 research and innovation activities are:

Advanced Biofuels

1. Develop advanced liquid and gaseous biofuels through biochemical / thermochemical / chemical conversion from sustainable biomass and/or from autotrophic microorganisms and primary renewable energy
2. Demonstrate advanced liquid and gaseous biofuels through biochemical / thermochemical/ chemical conversion from sustainable biomass and/or from autotrophic microorganisms and primary renewable energy
3. Scale-up advanced liquid and gaseous biofuels through biochemical / thermochemical/ chemical conversion from sustainable biomass and/or from autotrophic microorganisms and primary renewable energy

Other renewable liquid and gaseous fuels

4. Develop other renewable liquid and gaseous fuels (excluding hydrogen) through thermochemical/ chemical/ biochemical /electrochemical transformation of energy neutral carriers with renewable energy
5. Demonstrate other renewable liquid and gaseous fuels (excluding hydrogen) through thermochemical/ chemical/ biochemical/electrochemical transformation of energy neutral carriers with renewable energy
6. Scale-up other renewable liquid and gaseous fuels (excluding hydrogen) through thermochemical/ chemical/ biochemical/electrochemical transformation of energy neutral carriers with renewable energy

Renewable hydrogen

7. Develop and demonstrate the production of renewable hydrogen from water electrolysis and renewable electricity

Bioenergy

8. Develop high efficiency large scale biomass cogeneration of heat and power
9. Demonstrate high efficiency large scale biomass cogeneration of heat and power
10. Scale-up high efficiency large scale biomass cogeneration of heat and power

Intermediate bioenergy carriers

11. Develop solid, liquid, and gaseous intermediate bioenergy carriers through biochemical / thermochemical/ chemical conversion from sustainable biomass
12. Demonstrate solid, liquid, and gaseous intermediate bioenergy carriers through biochemical / thermochemical/ chemical conversion from sustainable biomass
13. Scale-up solid, liquid, and gaseous intermediate bioenergy carriers through biochemical / thermochemical/ chemical conversion from sustainable biomass

Upon discussions with the IWG8 group at the start of the project, it was decided that the SET4Bio project adapted a portfolio management approach to assess the R&I projects in the member countries. The portfolios were identified as the ETIP Bioenergy value chains, however, this has not been implemented. Instead, this final update assesses selected national/European projects covering one or several of the 13 R&I activities in the SET-Plan IP8 to determine the degree of contribution of each IWG8-country to the realization of the SET-Plan IP8. This update also includes an analysis based on the projects compared to the IP8 funding and financing goals (both public and private). It must be noted that those conclusions are based on the available data, i.e., indicate the minimum spent on reaching IP8 goals.

3. Methodology – data collection

The gathering of new inputs to either upgrade existing data or include additional projects has been primarily relied on intelligence from key personnel from national agencies and national scientific experts from the EERA JP Bioenergy community and to some extent on primary data from publicly available databases. Initially it was also foreseen to complement these data with inputs from SETIS, however, they did not have any additional information to include.

To improve the data quality, dedicated telco-meetings with each country's representatives were conducted to gain understanding about the initial contributions delivered to SET4Bio previously as well as to obtain updates from the respective countries. Several interactions through email and phone have been conducted regularly after the initial telco-meetings to check the progress of the collection process and to clarify doubts/questions. This approach has proved to improve the data quality of this deliverable and facilitate analysis of the data received. Before the final update in 2023, the country representatives were contacted again and additional inputs on new projects were received. Many of these projects were under new calls or schemes, such as IPCEI and RRF.

The information that has been aimed to gather for each national/European project is the following:

- ✓ **Name** of the project
- ✓ **R&I activity** of IP8 associated to each project
- ✓ **Funding source**, distinguishing between governmental (ministerial) funding, typically allocated to a given research organization, and funding from national/regional funding agencies, associated to competitive funding
- ✓ **Country/region** where the project is established
- ✓ **Leading partner** in the project
- ✓ **Project lifetime**, with start and end date, and covering ongoing and recently finished (from 2018 onwards)
- ✓ **Technology Readiness Level** (TRL) associated to each project
- ✓ **Budgets**, discerning between total budgets and public ones
- ✓ **Type of funding,** featuring three categories, i.e., i) **public vs. private**, ii) **national vs. European**, and iii) **competitive**, typically through calls, **vs. institutional**, typically allocated

directly from a Ministry/funding agency to a research organization in absence of a competitive process.

The association of a R&I activity to each project has been determined by the project topic (advanced Biofuels, other renewable liquid and gaseous fuels, renewable hydrogen, bioenergy, intermediate bioenergy carriers) and the TRL (divided into development, demonstration and scale-up). This information is crucial to monitor the progress of the realization of IP8, being able to on one hand identify which of the 13 R&I activities are further ahead in their implementation and which ones are given a lower priority and, on the other hand comprehend the degree of commitment of each IWG8 country in the realization of IP8.

The second essential data collected in this work is the allocated resources, providing total budgets as well as public budgets. It is assumed that the difference between them corresponds to funding from the private sector. The IP8 shows an estimation of the volume of investment for the successful implementation of all 13 R&I activities (~106 bill. EUR) as well as for each of them. Further, the IP8 estimates (see Appendix 2 for more information and numbers) the share of this investment among sectors, i.e., industry, Member States/Associated countries (MS/AC) and the EU and the largest portion of the financing is clearly attributed to the private sector (~73 %), followed by national public funding (~21 %) and the EU (~6%). By collecting project budgets and comparing them with the aforementioned estimation one can easily picture the advance of the realization of IP8 in its totality as well as at R&I level.

The third crucial piece of information to gather is the type of funding, closely related to the funding source and budgets, and divided into three subcategories (except for the EU projects). The first one is the geographical origin of funding, distinguishing between regional, national, and European projects as well as co-funded projects which are particularly necessary to national alignment across Europe. The second subcategory indicates whether the funding is public, private or a combination of those. This piece of information is highly relevant to monitor the progress of IP8, knowing that the private sector is expected to contribute to the realization of the 13 R&I activities at a great measure (73 %). The third and final subcategory defining the type of funding reveals whether the projects are funded by funding agencies through a competitive process (proposal selection) or directly from national/regional governments (ministries). If a significant proportion of the projects are funded through competitive calls, it means that the funding agencies have the capability of proposing future calls adjusting the focus to the needs of the IP8 according to its progress. On the other hand, if a country funds the majority of their projects directly from governments, it is then up to the governments or the top management of the research organizations to allocate the resources to their priority projects. For the EU projects the type of funding distinguishes between Research and Innovation actions (RIA), Innovation actions (IA) and Coordinated and Support actions (CSA), following the definition given by the EC.

4. Mapping of Ongoing and Recently Finished Projects – Results

The available information on the ongoing and recently finished projects is presented in an excel sheet in Appendix 1. This section presents a short analysis of the project portfolios, funding landscape and summary of the results.

Progress and trends on the national contributions to IP8

Analysis was performed to reveal the contribution from the monitored projects in SET4Bio WP1 to the 2030 targets of SET Plan IP8. The contribution by value chains is shown in Figure 1. The financing numbers combine public and private funds within the projects and shown in million Euros. Note, the projects can be planned, ongoing and recently finished, thus the actual investments might differ from the announced or budgeted ones. It must also be noted that the monitored projects do not represent the entire reality, there are probably more projects contributing to the targets that have not reached the attention of the authors. The list of projects is not exhaustive and does not include all IWG8 member states.

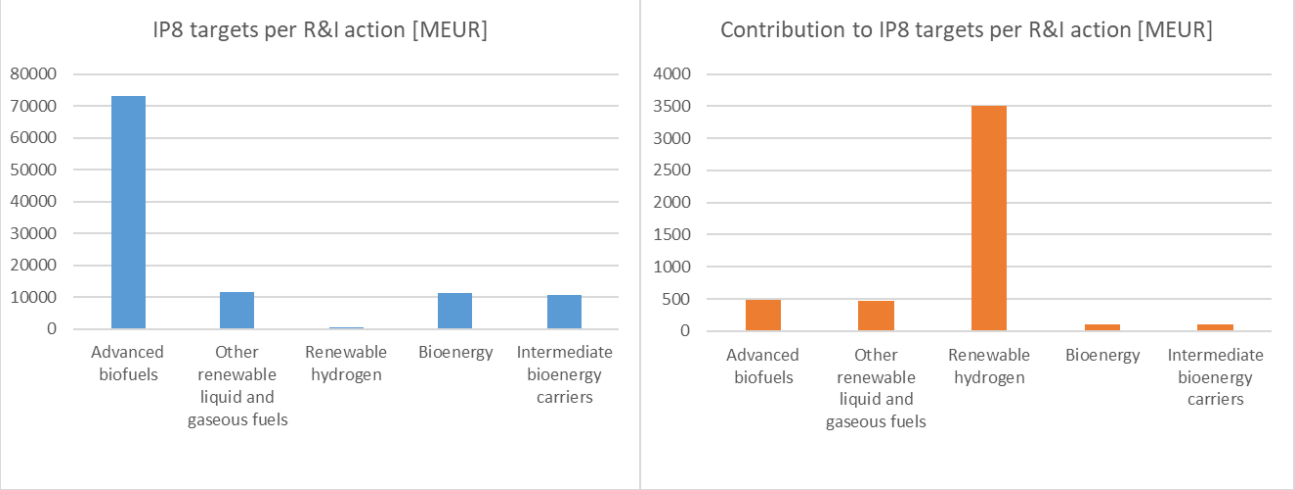

Figure 1 Investments and investment targets in million Euros in the various value chains of IP8 from 2018 and onwards. NOTE: the investment targets are on the left and have a 20x scale compared to the contribution (right). Data collected from: EU projects, Austria, Belgium, Finland, Germany, Italy, the Netherlands, Portugal, Spain

As Figure 1 shows, the investments are very low in bioenergy and biofuel projects (1% IP8 goal achievement), somewhat higher but still very low in the "other renewable liquid and gaseous fuels" value chains (4% compared to IP8 investment goal). The investment levels are very high in hydrogen value chains compared to the targets (more than 850%). The latter is a direct result of the investments under IPCEI and somewhat under RRF schemes and represent a significant change in the investments since those instruments came online as a result of the Fit-for-55 package, RePowerEU and the war in Ukraine. Figure 1 also shows that the SET Plan targets were not updated accordingly and hence, did not keep up with the changing realities in Europe. It must also be mentioned that investments in the bioenergy projects need to increase to achieve targets of the

SET Plan and a carbon neutral Europe, but the uncertainties of bioenergy regulations probably impede the investor interest in those projects.

Figure 2 shows the total contribution of monitored projects to the 2030 targets of SET Plan IP8, and Figure 3 shows the contribution of development projects to their individual financing targets. Information on high TRL projects is very difficult to retrieve, due to confidentiality. For some countries, the TRL ranges of the projects were not known, therefore a total contribution of the monitored projects is given. Those projects are excluded from the overview in Figure 3.

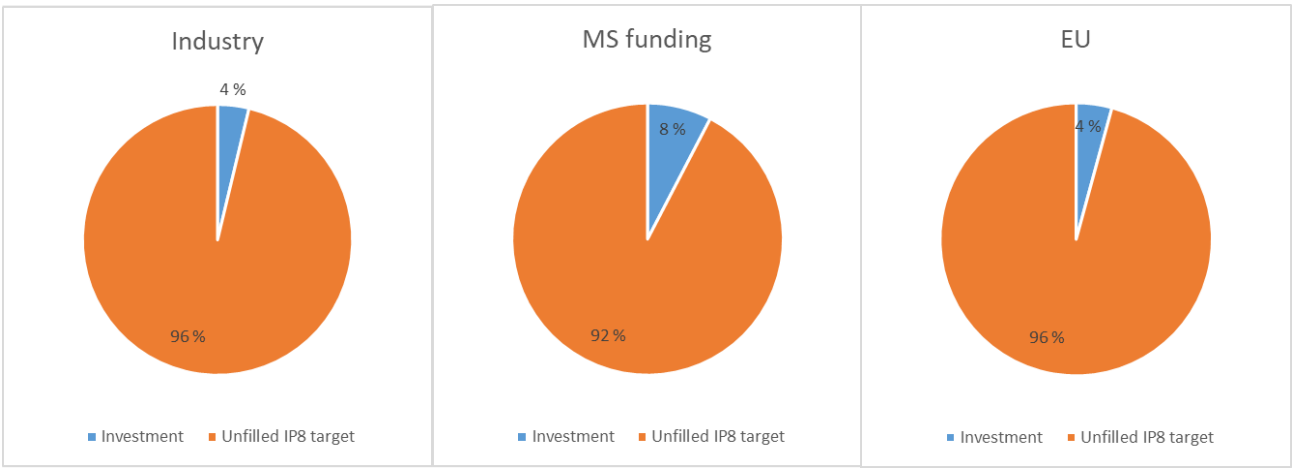

Figure 2 Total contribution of monitored projects to the 2030 financing contribution targets within development and demonstration of SET Plan IP8. National and EU projects collected from 10 countries from 2018 until today, Data collected from: Austria, Belgium, Finland, France, Germany, Italy, the Netherlands, Spain, Portugal, Turkey

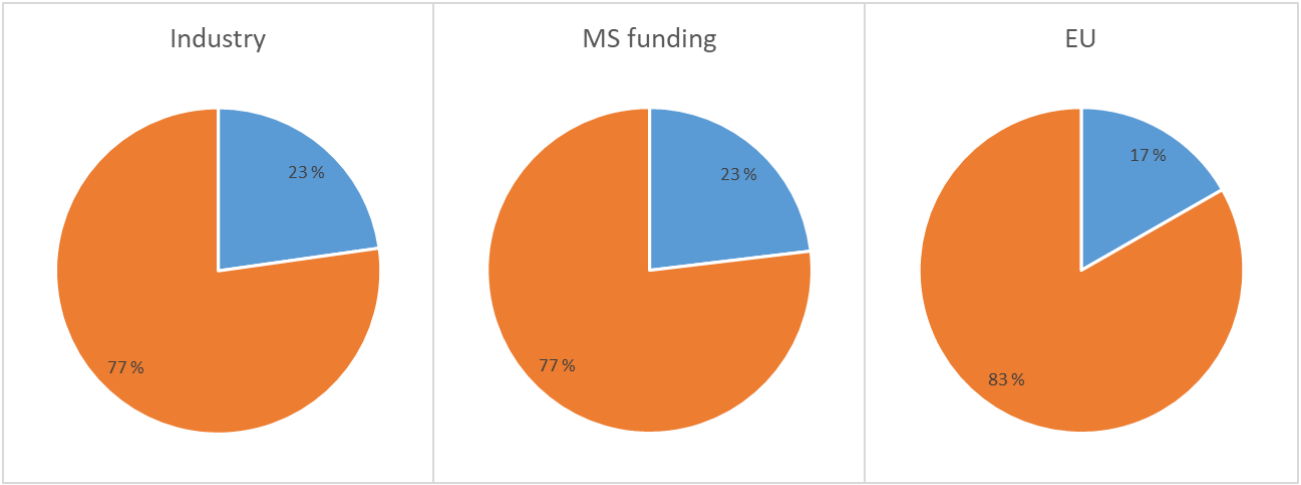

Figure 3 Contribution of monitored projects to 2030 targets of SET Plan IP8 for Development. Industry and MS contribution collected from: Austria, Belgium, Finland, Germany, the Netherlands, Spain, Turkey

Based on the figures above, it might appear that IP8 contributions are very low. This is due to the very high targets of scale-up. For development projects, the situation is better, although financing is still needed to reach the goals. The majority of financing is originating from the demonstration projects in the hydrogen value chains financed through IPCEI. The figures show that EU funding and funding of low-level TRL projects still need to increase to achieve the targets of IP8. Contribution is especially needed in biomass and bioenergy value chains.

Projects at EU Level

The information on EU projects gathered in 2020 has been upgraded substantially, particularly in terms of R&I activities and budgets. About 75% of the listed projects focus on production of advanced biofuels and among those a hand-full of projects integrate the production of bioenergy carriers. The remaining 25% is a good mixture of projects addressing production of bioenergy carriers, heat and power, other renewable fuels and hydrogen. Approximately 60% of the listed initiatives are at development scale (TRL 3-5), about 30% at demonstration scale (TRL 6-7) and only a couple of projects are expected to close at commercial scale (TRL 8-9). Major efforts shall thus concentrate on upscaling the technologies from lab- and demo-scale, with a greater involvement of industry to successfully advance in the realization of IP8.

The coordination of the projects is spread across Europe, however, it must be noted that not a single project is led by one of the EU-13 countries added after 2004, reflecting the rather low or even non-existent participation of those countries in the realization of IP8. It is therefore of foremost importance to widen the activity of those countries towards the SET-Plan, hence contributing to a more cohesive Europe.

Projects at National Level

1. **Austria**

   The project information has been primarily provided by BEST. More detailed information is also available in The Austrian Research Promotion Agency FFG (https://projekte.ffg.at/projekt) and The Austrian Climate and Energy Fund (https://www.klimafonds.gv.at/projekte/, https://energieforschung.at/projekte/) databases. A substantial share (~37%) of the funding is allocated to projects focusing on other renewable fuels. The rest of the funding is distributed among projects addressing hydrogen (~29%), heating and power (26%) and to a slightly lesser extent advanced biofuels (~21%). About 75% of the initiatives are at low TRL (3-5) and approximately 20% are at medium TRL (6-8). Only 1 project claims commercial scale (TRL 9). Practically all projects, expect two private investment projects, are funded through the Austrian Research Promotion Agency and all of those have a public-private approach and are funded through competitive processes.

2. **Belgium**

The country is divided into three regions, i.e., the Flemish and Walloon Regions and the Brussels-Capital Region. Unfortunately, due to lack of contacts to the other regions, only Wallonia covered in this deliverable. The data was provided by the Public service of Wallonia (SPW). Although contact with the Region of Flanders has been established in 2021, no information was received from this region. Based on the received information, it appears that Wallonia has most of its R&I focus on biogas and renewable hydrogen production and to a lesser extent on heat and power purposes. The majority of the projects address low TRLs (≤5) so efforts are needed in advancing towards up-scaling the technologies. So, the Region of Wallonia contributes first and foremost to the realization of R&I activities 4, 7. These projects are primarily funded with public resources. In some occasions there are public-private collaborations, however the funding from industry is rather limited, reaching up to 40% share in best-case scenarios. Therefore, there is a apparent demand for encouraging the private sector to take a more active role the coming years. Since 2021, there has been a massive increase in hydrogen projects and much less funding available for the bioenergy projects.

3. **Cyprus**

No information has been collected in SET4Bio. In 2020 only a few small biogas R&I projects were running within IP8. Information on them, however, was not available. In 2020 there were no national funding instruments available for biomass and biofuels installations.

4. **Finland**

The inputs from Finland are provided by VTT and shared by two of the most important funding agencies, i.e., Business Finland and Academy of Finland, funding high and low TRL, respectively. Unfortunately, the inputs lack information about TRLs and R&I activities, not allowing an interpretation on the contribution of Finland to the realization of the individual IP8 value chains. All projects funded by Academy of Finland are completely funded by public resources through competitive calls and those funded by Business Finland, also through competitive processes, require the participation of industry. In general terms one could say that the private sector contributes with about 50% of the funding share which is possibly one of the largest shares from the industry across Europe.

5. **France**

The data was acquired from the French National Research Agency (ANR) database. Unfortunately, no information is available for the value chains, TRLs and private share of the financing and therefore no more analysis can be done on the French data.

6. **Germany**

The list of relevant projects in Germany has been substantially updated, based on the publicly available databases enArgus, owned by the Federal Ministry for Economic Affairs and Energy and Projektdatenbank der FNR, owned by the Federal Ministry of Food and Agriculture (BMEL). It is worth noting that projects funded by BMEL are typically rather small budget wise, so not all listed projects can be found in the database as individual projects, as they have been partly clustered in Appendix 1 for the sake of simplicity.

In the previous years, most of the projects were focusing on lab-pilot scale anaerobic digestion and to a lesser extent large-scale heat and power. Further, the updates indicate a gradual increased focus on hydrogen and advanced biofuels, both at development and demonstration scale. Approximately 70% of the projects are 100% publicly funded, usually by a federal ministry, and the other 30% sets public-private cooperation. The funding is allocated through competitive processes. Nearly all listed projects are nationally funded, except one state-regional project and one transnational projects, and thus they are conducted in Germany. However, there is one interesting demonstration project (TRL 6-9), Haru Oni, that even though it is funded by Germany it is conducted in Chile under the so-called German-Chile Energy Partnership. Due to better natural conditions – abundant and cheap wind energy - Chile was chosen to build the demonstration facility. Relevant industrial partners are part of this initiative. This particular showcase indicates two options for Europe: moving (parts) of the business outside Europe, e.g., to places with favorable natural conditions and lower costs, with a potential risk of technology drains and new dependencies or keeping control over the full value chain in Europe with potentially higher costs and lower efficiency. From 2021-22 and onwards, other renewable liquid and gaseous fuels (e-fuels and methanol) seem to have the priority.

7. Italy

Although contact and dialogue were established to Italian national contacts through the EERA network, no information has been provided through those contacts. The list of projects is provided by ETA Florence. The majority of the projects found cover the intermediate bioenergy carrier, advanced biofuels and hydrogen value chains.

8. The Netherlands

The projects originally were acquired from the following database: https://projecten.topsectorenergie.nl/projecten. This website is only in Dutch, making it a barrier for non-Dutch speaking citizens. Fortunately, The Netherlands Enterprise Agency (RVO) was available to translate, validate and structure the information through several telco-meetings and interactions. A substantial proportion of the projects are already at pilot/demonstration scale and focus on the production of bioenergy intermediates such as pyrolysis oil and syngas and other renewable fuels such as biogas as well as large-scale biomass cogeneration of heat and power. Another significant volume of the research in the Netherlands addresses the production of advanced biofuels, however most of these projects are still at lab/pilot scale. Beyond that, it seems like hydrogen projects are gradually receiving more financing support. Nearly all projects, regardless their research focus, are funded through the Netherlands Enterprise Agency (RVO), hence through competitive calls, and all of them require the participation of industry (public-private funding). Depending on the funding program the public subsidies are between 40-60% and the remaining sum is funded by the private sector. Finally, the last update of the project list contains the newly established IPCEI projects. These projects are in the hydrogen value chain with relatively high TRLs and large budgets. The budgets of the individual IPCEI projects are not public but the overall numbers

can be disclosed. These projects, if included, contribute most to the IP8 implementation goals.

9. Poland

No additional updates have been collected in 2021 and thereafter. In 2020, Poland did not have any strategic large R&D program dedicated to bioenergy. There were smaller bioenergy R&D projects financed by several cross and multi-thematic energy R&D programmes. The Polish research programs and projects are administered by the Ministry of Science and Higher Education as well as two national funding agencies (National Centre for Research and Development – for applied research and National Centre of Science – for basic research). There is no information available about the individual projects.

10. Portugal

The list of projects is based on first-hand key information provided by Portuguese senior research experts in the field of bioenergy and biofuels. The detailed information related to these projects was extracted from the project's websites, however it was very limited and hence, it therefore insufficient to be able to extract any conclusions. In 2023, a list of projects in the hydrogen value chain funded through the Resilience and Recovery Plan was received and included in the deliverable. Here as well, a significant funding is given to the hydrogen projects, while the other value chains are not prioritized.

11. Spain

Spain is one of the countries with the best database provided to SET4Bio. Based on the presented projects, the main research focus (~50%) is on the production of advanced biofuels through valorization of various waste resources About 1/3 of these initiatives are at pilot-demonstration scale and the rest at lower TRL. Besides advanced biofuels, the other two key research areas are on hydrogen and on other renewable fuels, at lab-to-pilot-scale. In the last updates the increased focus on hydrogen is obvious, but Spain has still a balanced project portfolio. The national projects are funded by two public bodies, i.e., Centre for the Development of Industrial Technology (CDTI), and the State Research Agency (AEI). About half of the projects are public-private, with the involvement of industry, and the other half are public-public. The results indicate that industry funds approximately 29% of the projects currently listed, thus contributing to the realization of IP8 moderately. Some of the public-private projects are funded through competitive proposals whereas others receive institutional funding, i.e., public funding in the absence of competitive processes. However, in these cases the funding agencies apply a threshold requirement to ensure high-quality projects. As for the public-public initiatives, all projects are granted after a competitive selection and if so, part of the funding originates from the government (through the agency) and the remaining funding comes from the public research organization that has received the funding.

12. Sweden

In 2020, a selection of projects has been received from the Swedish Energy Agency that were within advanced biofuels topic, most of them in development stage (TRL 2-5). RISE updated the project list in 2023 and included further projects with financing from the Swedish Energy Agency. Projects from the other funding organizations are not listed, neither are the value chains and TRLs. Based on the data it is difficult to conclude which value chains are contributing to the IP8 goals. Most of the projects were, however, listed with their budgets, and it seems that the Swedish projects are running public-private with approximately 50% private funding.

13. Türkiye

The data collection for Türkiye has been provided by the national funding agency Tubitak. The data show that Turkey has a research focus with funding on hydrogen, advanced biofuels and other renewable fuels (biogas). The advanced biofuel projects are at demo scale, while the other renewable fuels and hydrogen projects are at low TRL (up to 5). The low TRL projects are funded through The Scientific and Technological Research Council of Turkey While the demo-scale projects are funded through contribution from the EU. As for the type of funding and in contrast to most of the other countries described above, the totality of the projects is publicly funded, without the need for private funding. This funding approach makes the contribution of private funding to the realization of IP8 a real challenge so hopefully this approach can be modified inspired by other national funding schemes described in this report to incentivise the involvement of the industry with own resource commitment.

Table 1: Overview of data collected from projects in the IWG8 member states. No information was retrieved from Cyprus and Poland

	R&I activity	Funding source	TRL	Type of funding	Budgets
Austria	• Other renewable fuels (++), Hydrogen, Heat & power, advanced biofuels (+)	• Funding agency	• Low (≤5, +++) • Medium (6-8, +)	• Public-private (+++); private (+) • Competitive (+++)	• Most of the budgets available
Belgium	• Hydrogen and other renewable fuels (++), Heat & power (+)	• Ministries	• Low (≤5)	• Public (++); public-private (+) • Competitive (+)/institutional (+)	• Most public budgets available
Finland	• Advanced biofuels (++), Other renewable fuels and hydrogen (+)	• Funding agencies • Ministry		• Public-private (Business Finland); public (Academy of Finland) • Competitive (+++)	• Most budgets available
France	• n/a	• Funding agency	• n/a	• n/a	• All public budgets available
Germany	• Other renewable fuels (++) • Hydrogen, advanced biofuels, and heat & power (+)	• Ministries	• Medium (6-8, ++) • Low (≤5)	• Public (++); public-private (+) • Competitive (+++)	• Most of the budgets available
Italy	• Advanced biofuels (++), Hydrogen and large-scale biomass heat and power (+)	• Ministries	• n/a	• Public (++); public-private (+)	• Most of the budgets available
The Netherlands	• Hydrogen (+++), Bioenergy carriers and advanced biofuels (++), Heat & power (+)	• Funding agency	• Low to medium (5-7) • IPCEI: 8	• Public-private (+++) • Competitive (++)	• Most budgets available • IPCEI budgets are not publicly available
Portugal	• Hydrogen (+++)	• RRP (+++) • Funding agency	• 7 (+++) • 5-6 (++)	• Public-private (+++) • Competitive (++)	• Most budgets available
Spain	• Advanced biofuels (++), Other renewable fuels and hydrogen (+)	• Funding agencies	• Low (≤5, ++) • Medium (6-7, +)	• Public-private (++); public-public (++) • Competitive (++) / institutional (++); competitive-institutional (+)	• All budgets available
Sweden	• Advanced biofuels (++), Other renewable fuels, Large -scale biomass CHP	• Funding agencies	• n/a	• n/a	• most budgets available
Türkiye	• Hydrogen, advanced biofuels, and other renewable fuels (+)	• Funding agency (+++) • Ministries (+)	• Low (≤5, +++)	• Public (+++) • Competitive (+++)	• All budgets available

(+++) present to a large extent; (++) present to a moderate extent; (+) present to a little extent

5. Conclusions and Outlook

Since the first update of this D1.1 deliverable, data with a higher degree of elaboration, systematization, and validation is included, presenting a clearer picture of the current situation on research and innovation projects within green hydrogen, renewable fuels, and bioenergy at country level as well as within Europe. Despite this improvement in terms of both quantity and quality there are still a number of shortcomings that can be found in the base data, such as lack of TRLs, budgets or the individual projects are not associated with a value chain. It must also be noted that the project lists are probably subjective to the contact people delivering them to the SET4Bio project.

The RePowerEU and EU's hydrogen strategy have put forward comprehensive support for green hydrogen production and uptake from 2021-2022. This resulted in a massive shift in the value chains contributing to IP8 implementation goals. The bioenergy related projects receive less focus and funds, but the projects within the green hydrogen increased. In addition, financing through the Resilience and Recovery Plans and IPCEIs allows fast commercialization of hydrogen projects and resulting in a high investment interest. In those projects both the public and private financing seem excellent. Bioenergy, on the other hand, seems to remain controversial and unappreciated from the investor's point of view, in spite of the large number of low-TRL projects. The table summarizing the national projects in chapter 4 illustrates that all IWG8 countries diversify their research and innovation investments in several technologies. Projects addressing R&I activities on "hydrogen" and "other renewable fuels" are currently being prioritized in nearly all IWG8 countries, which is in-line with the European strategies, with Austria, Belgium, Germany, and Portugal as key contributors. A focus on advanced biofuels is still important in many of the nations with Spain, Finland and The Netherlands as well as in European projects. Several countries are investing in production of heat and power from biomass, however, it seems like the number of initiatives is slightly less than the other R&I strategic fields. Finally, and with regards to bioenergy carriers, with the information available at this stage, it is a research area with poor national investment at the moment in general terms, despite having many EU projects in this area. All in all, it appears that there seems to be national alignment with the EU priorities for hydrogen as well as, although somewhat declining, there are still multiple key strategic priorities for renewable fuels and bioenergy.

The table presented above also shows that practically all countries the R&I projects are funded by funding agencies through competitive calls and that means that they have the capability of proposing future calls adjusting the focus to the needs of the IP8 according to its progress.

The maturity of the technologies addressed in the projects financed through national funding agencies or ministries is on average between low and low-to-medium, with TRLs ranging from 3 and reaching 6-7. Projects financed through the new schemes (RRF and IPCEI) are closer to commercialization with TRLs of 7-8. The information available in this report reveals that industry's engagement and investment in R&I projects should be deeper and larger in the bioenergy projects. The absence of commercial projects mainly funded by industry can be due to two reasons. One of

them is that they are not public and reported, hence not found, and presented here, or they are non-existent. Several countries have a public-private funding scheme, requiring the involvement of the private sector in R&I initiatives, however, the private sector's participation found to be generically speaking and in economic terms has been poor when compared to the estimates reported to be achieved in IP8 up to 2021-22.

Appendix 1 – mapping results

Please see the separate excel file: SET4Bio D1.1 Project_list.xlsx

Appendix 2 – IP8 value chains and investment budgets

ETIP Bioenergy Value chains

Priority Value Chains (PVC)
PVC1: Transport fuels via gasification
PVC2: Power and heat via gasification
PVC3: Transport fuels via pyrolytic and thermolytic conversion
PVC4: Intermediate bioenergy carriers for power and heat
PVC5: Alcohol fuels from cellulosic sugars
PVC6: Hydrocarbon fuels from sugars and alcohols

Established Value Chains (EVC)
EVC1: Transesterification to biodiesel
EVC2: Hydrotreatment to HVO
EVC3: Sugar and starch fermentation to ethanol
EVC4: Anaerobic digestion to biogas
EVC5: Small-scale combustion for residential heat
EVC6: Large-scale combustion for heat and power
EVC7: Biomass co-firing for heat and power

Development Pathways (DP)
DP1: Conversion of aquatic biomass
Hydrogen Pathways (HP)
HP1: Hydrogen from green power
HP2: Power-to-X

The 13 R&I activities

From SET Plan Implementation Plan, Action 8.

Renewable Fuels for Sustainable Transport

Advanced biofuels
#1 Develop advanced liquid and gaseous biofuels through biochemical / thermochemical/ chemical conversion from sustainable biomass and/or from autotrophic microorganisms and primary renewable energy
#2 Demonstrate advanced liquid and gaseous biofuels through biochemical / thermochemical/ chemical conversion from sustainable biomass and/or from autotrophic microorganisms and primary renewable energy
#3: Scale-up advanced liquid and gaseous biofuels through biochemical / thermochemical/ chemical conversion from sustainable biomass and/or from autotrophic microorganisms and primary renewable energy
Other renewable liquid and gaseous fuels
#4 Develop other renewable liquid and gaseous fuels (excluding hydrogen) through thermochemical/ chemical/ biochemical /electrochemical transformation of energy neutral carriers with renewable energy
#5 Demonstrate other renewable liquid and gaseous fuels (excluding hydrogen) through thermochemical/ chemical/ biochemical/electrochemical transformation of energy neutral carriers with renewable energy

#6 Scale-up other renewable liquid and gaseous fuels (excluding hydrogen) through thermochemical/ chemical/ biochemical/electrochemical transformation of energy neutral carriers with renewable energy

Renewable Hydrogen

#7 Develop and Demonstrate the production of renewable hydrogen from water electrolysis and renewable electricity

Bioenergy

#8. Develop high efficiency large scale biomass cogeneration of heat and power

#9 Demonstrate high efficiency large scale biomass cogeneration of heat and power

#10 Scale-up high efficiency large scale biomass cogeneration of heat and power

Intermediate Bioenergy Carriers

#11 Develop solid, liquid and gaseous intermediate bioenergy carriers through biochemical / thermochemical/ chemical conversion from sustainable biomass

#12 Demonstrate solid, liquid and gaseous intermediate bioenergy carriers through biochemical / thermochemical/ chemical conversion from sustainable biomass

#13 Scale-up solid, liquid and gaseous intermediate bioenergy carriers through biochemical / thermochemical/ chemical conversion from sustainable biomass

The detailed programme of the R&I activities is provided in Annex I.

Financing R&I activities: total investment

Billions €		Industry		MS Funding		EU	
Total Bioenergy and Renewable Fuels for Sustainable Transport	**106,61**	**77,74**	***73%***	**22,23**	***21%***	**6,64**	**6%**
Renewable Fuels for Sustainable Transport	**84,81**	**62,34**	***74%***	**17,48**	***21%***	**4,99**	**6%**
Advanced Biofuels	**73,00**	**53,75**	***74%***	**15,00**	***21%***	**4,25**	**6%**
#1 Development	1,00	0,25	*25%*	0,50	*50%*	0,25	25%
#2 Demonstration	2,00	1,00	*50%*	0,50	*25%*	0,50	25%
#3 Scale-Up	70,00	52,50	*75%*	14,00	*20%*	3,50	5%
Other renewable liquid and gaseous fuels	**11,40**	**8,35**	***73%***	**2,36**	***21%***	**0,69**	**6%**
#4 Development	0,20	0,05	*25%*	0,10	*50%*	0,05	25%
#5 Demonstration	0,40	0,20	*50%*	0,10	*25%*	0,10	25%
#6 Scale-Up	10,80	8,10	*75%*	2,16	*20%*	0,54	5%
#7 Renewable Hydrogen	**0,41**	**0,24**	***59%***	**0,12**	***28%***	**0,05**	**13%**
TRL 2-6 (Development)	0,10	0,03	*25%*	0,05	*50%*	0,03	25%
TRL 7-8 (Demonstration)	0,06	0,03	*50%*	0,02	*25%*	0,02	25%
TRL 9 (Scale-Up)	0,25	0,19	*75%*	0,05	*20%*	0,01	5%
Bioenergy	**11,30**	**8,03**	***71%***	**2,45**	***22%***	**0,83**	**7%**
#8 Development	0,50	0,13	*25%*	0,25	*50%*	0,13	25%
#9 Demonstration	0,80	0,40	*50%*	0,20	*25%*	0,20	25%
#10 Scale-Up	10,00	7,50	*75%*	2,00	*20%*	0,50	5%
Intermediate Bioenergy Carriers	**10,50**	**7,38**	***70%***	**2,30**	***22%***	**0,83**	**8%**
#11 Development	0,50	0,13	*25%*	0,25	*50%*	0,13	25%
#12 Demonstration	1,00	0,50	*50%*	0,25	*25%*	0,25	25%
#13 Scale-Up	9,00	6,75	*75%*	1,80	*20%*	0,45	5%

Members

IWG #8 (at this moment):

- Countries: FI, IT, FR, CY, DE, ES, NL, PL, PT, SE, TR … and EC: JRC, RTD, ENER
- ETIPs Bioenergy & RHC, FCH-JU, EERA-Hydrogen, VTT, Fraunhofer Ins., ENI