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

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Work Package (WP): 1 – Funding and financing roadmap and investments
Task: Task 1.2 & Task 1.3 – Identification of institutional and competitive funding opportunities

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EXECUTIVE SUMMARY

Deliverable 1.2 presents and summarizes SET4Bio's Tasks 1.2 and 1.3, focusing on the identification of public funding opportunities, both institutional (Task 1.2) and competitive (Task 1.3). The report covers these funding options on a national level for all countries participating in SET Plan Implementation Working Group 8 (IWG8) as well as a short briefing on European level. The present document is the fourth and final update of this report (at the end of the SET4Bio project), covering the national funding situation of the countries participating in IWG8 as well as giving a preliminary overall analysis.

The report is organized as follows. A short introduction gives an overview of the SET Plan, Implementation Plan 8 (IP8) on Bioenergy and Renewable Fuels for Sustainable Transport and its working group members (Section 1). The methodology is explained in Section 2, complemented by Appendices A and B. Section 3 gives an overall analysis of the public funding in the investigated countries. Section 4-17 describes the public funding situation in each of the IWG8 member countries and the European Union. Finally, Section 18 gives a short conclusion and an outlook.

Public institutional funding is usually given to universities and research organizations. They are grants to cover an unspecified part of the expenditures. It gives the opportunity to invest in long-term research activities, competence building and infrastructure. Institutional funding usually covers large thematic areas relevant to the ministries allocating the funds. In competitive funding, expenditures of individual research projects are covered. This usually means short term financing of a certain research project or infrastructure for typically 1-5 years. In most countries, the funds' budgets are allocated by the government or ministries and distributed through various funding agencies according to their programmes. The programmes, strategies and policies which give the basis of competitive funding are regularly (every 1-5 years) revised and updated, thus can change quite often. The situation influences this report as well, the information given here on the calls, and eventually, entire programs will be outdated. The ministries and funding agencies, however, remain more or less stable over time and the reader is advised to seek information directly at the identified national or European stakeholders after the completion of the SET4Bio project.

During the preparation of this report, a number of challenges became apparent. Tasks 1.2 and 1.3 of the SET4Bio project are planned in such a way that the information needed in order to assess the countries' funding situation shall be provided by the countries themselves, i.e., the authors should not be required to gather information. This is necessary as an appropriate assessment of each country's situation requires an understanding of how the local funding landscape is structured as well as the ability to understand the local language, as this information is better known locally and not always available in English. All country contacts of IWG8 were therefore contacted. However, in none of the cases was the first set of information received complete and/or detailed enough to form a basis of an evaluation. Therefore, the information was supplied with data found online and in publicly available reports. A measure for improving the quality of this report was that the individual country reports were sent back to the IWG8 members as well as ministerial contacts for quality assurance as well as for further clarifications. During the course of the SET4Bio project, additional feedback was derived from IWG8 meetings, where the SET4Bio results were presented. Suggestions for improvements were discussed in these meetings throughout the project period. By the time of the final update, feedbacks were received from most of the IWG8 countries, either in form of texts following email and telephone contacts, at bilateral meetings, or through the IWG8 meetings. Certain countries provided very good and informative texts, some provided feedback on the texts from the previous version of this document, and a few did not update, therefore the quality of information provided in Section 4-16 varies.

The follow-up of the SET Plan Implementation Plan 8 as well as this deliverable meets a great challenge with the countries' own recordings of the national R&D expenditures. The individual countries do not report the funding situation with respect to the different Implementation Plans of the SET Plan and such a classification is currently not available. Therefore, the data reported makes conclusions on that point uncertain and an evaluation of the funding situation with respect to its efficiency in reaching the goals of IP8 hardly reliable.

The member states within the EU have autonomy with respect to establishing domestic RD&D strategies and funding schemes. Further, several of the investigated countries have regions or states with a certain grade of autonomy. Hence, the national funding system can be centralized, decentralized or a combination of those. Unfortunately, there are hardly any cases where the national strategies are fully aligned with European ones and no cases at all, where the individual countries align their strategies with each other. It is a great challenge if the research programs are not aligned, or if the funding agencies are not familiar with the programs of the others although there can be measures to avoid those.

While research funding for low TRL activities, doctoral and postdoctoral studies and fundamental research is relatively well described and easy to find, data on R&D implementation at higher TRL levels are more difficult to locate. As they can be distributed by several minor agencies, or combined with private funding, substantial support from the IWG8 members is needed to find the relevant agencies and calls. Although considerable efforts were made and better coverage of the public funding for R&D implementation at higher TRL levels were reached, relevant information still might be missing from this report in certain countries where the authors did not receive the necessary data.

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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.

Table of Contents

1. Introduction

The Strategic Energy Technology (SET) Plan is a first step to establish an energy technology policy for Europe and acts as a decision-making support tool for European energy policy. In 2016, representatives of the European Commission, SET Plan countries and industry agreed on a Declaration of Intent (DoI8) on strategic targets for bioenergy and renewable fuels, which identified several associated challenges. As a follow-up on this declaration, an Implementation Plan on **"Bioenergy and renewable Fuels for Sustainable Transport"** (IP8) was adopted. The goal of the Implementation Plan is to translate SET Plan key actions into specific recommendations for research and development or policy measures. This plan includes 13 research and innovation activities that need to be implemented to meet the targets defined in the DoI8:

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 SET Plan countries

SET plan countries have committed themselves to support the implementation of the research and innovation activities via their national programmes and policies. The countries participating in IWG8 are the focus of this report:

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

Objective

The overall objective of Work Package 1 of Set4Bio is to get a picture about the European public and private financing practice in the member states participating in IWG8, identify the most promising funding and financing mechanisms to realize the SET Plan Implementation Plan 8 and to create awareness of funding needs and challenges among key stakeholders. Task 1.2 focuses on the identification of institutional (public) funding opportunities, typically referring to funding that universities and research organizations receive directly from ministries. Task 1.3 deals with competitive (public) funding, i.e. funding distributed through competitive calls launched by funding agencies, whether national or European.

This report summarizes the results of Tasks 1.2 and 1.3, thereby providing an overview of public institutional and competitive funding mechanisms aimed towards the activities prioritized in IP8 and their efficiency in implementing the respective goals.

Acknowledgement

The authors acknowledge for the received information constructive comments and support of the SET-Plan Implementation Group 8 (IWG8) as well as their appointed contacts at the ministries and funding agencies of the individual countries. The authors are also thankful for the support received from the SET4Bio consortium.

2. Methodology

Tasks 1.2 and 1.3 of the SET4Bio project aim to identify public funding opportunities, both institutional and competitive, in the countries involved in IWG8. The strategy of the project has foreseen that the required information about every country's funding situation will be provided by the respective ministries, with contacts being established via the members of IWG8. To support and harmonize this process, two questionnaires were sent out to the country ministries, specifying the information needed for the evaluation. The questionnaires can be seen in Appendix A (institutional funding, Task 1.2) and Appendix B (competitive funding, Task 1.3).

The collection of information from the IWG8 member countries has shown to be somewhat challenging. Therefore, the received information was supplemented with information found online to complete or refine the picture. In many cases, additional information was only available in the countries' own languages. Another measure for improving the quality of this report is that the individual country reports are sent to the IWG8 members as well as ministerial contacts for quality assurance as well as further clarifications. Additional feedback is derived from meetings with IWG8 core group where the results are presented, and improvement suggestions are discussed. These meetings are held twice a year. The mentioned measures only work with active participation and feedback from the individual group members, which varies significantly from country to country. During the last year of the SET4Bio project, bilateral meetings were conducted with representatives from most of the countries, either ministerial contacts or IWG8 country representatives. The country descriptions from the previous version of this deliverable were provided to the representatives as well. Some country contacts provided improved texts, some provided minor feedbacks or approval, and, in some cases, the authors did not receive feedback at all. The information presented for the different countries in this report depends strongly on the data received from the IWG8 members or their appointed contacts at ministries and funding organizations. Therefore, the described funding situation presented here might be different for the different countries, and there might be funding instruments as well as relevant information missing.

3. Analysis of the public funding in the IWG8 countries and the European Union

Public institutional funding are grants to cover all or an unspecified part of the expenditures of the recipient. Although institutional funding requires regular applications and approvals, it is similar to a long-term commitment on the part of the public funding partner. Institutional funding often supports competence build-up and larger research infrastructures. Unlike project funding, the support is typically not allocated to a distinct activity but targets more far-reaching and long-term measures. Recipients of institutional funding may be extramural research institutions and universities. As the latter, however, also receive a significant amount of public funding to support teaching activities, the separation between teaching and research is not always easy. Institutional funding is often distributed directly by the ministries.

In competitive public funding, the recipients are awarded grants to cover expenditures for individual projects. These can be defined in terms of a specific subject and typically have a limited duration. Unlike institutional funding, there is no long-term commitment from the funding agency and the financial risk after the end of the funding period therewith low. In most countries, the funds' budgets are allocated by the government or ministries and distributed through various funding agencies. The funding agencies establish funding programs that are reviewed every few years, which means they change quite often. The advantage of such a shifting practice is that funding can follow European and international trends, policies and regulations and implement them in a timely manner, while the obvious drawback is that there are no long-term funding possibilities available for the establishment of new industry or research areas. The situation influences this report as well, the competitive funding instruments might change over time, and the information given here on the calls and eventually entire programs will be outdated. Therefore, the calls presented here can be considered as examples. However, the ministries and funding agencies remain more or less stable over time and the reader is advised to seek information directly at the identified national or European stakeholders.

The member states of IEA report their annual energy RD&D budgets found in Figure 3.1 and Figure 3.2. All IWG8 countries apart from Cyprus are members of IEA, hence most of the numbers are available at IEA homepage[1].

[1]IEA: Energy Technology RD&D Budgets, https://www.iea.org/data-and-statistics/data-product/energy-technology-rd-and-d-budget-database-2

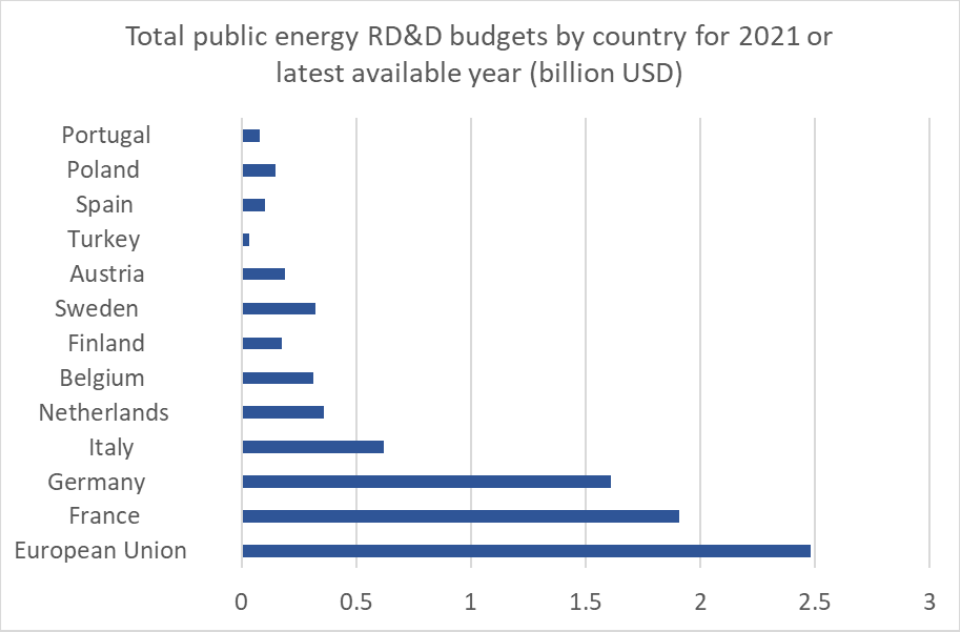

Figure 3.1 Total public energy RD&D budgets by country for 2021 or latest available year (billion USD), Data source: IEA Notes: The amounts shown are based on 2021 energy RD&D budgets for: Belgium, Germany, Poland, Portugal, Sweden and Türkiye. The amounts shown are based on 2020 energy RD&D budgets for: Austria, Finland, France, the Netherlands, Spain and the European Union. The amounts shown are based on 2019 energy RD&D budgets for: Italy. European Union refers to the European Union budget under Horizon 2020 and the Innovation Fund, and not to the sum of national budgets of European Union member countries.

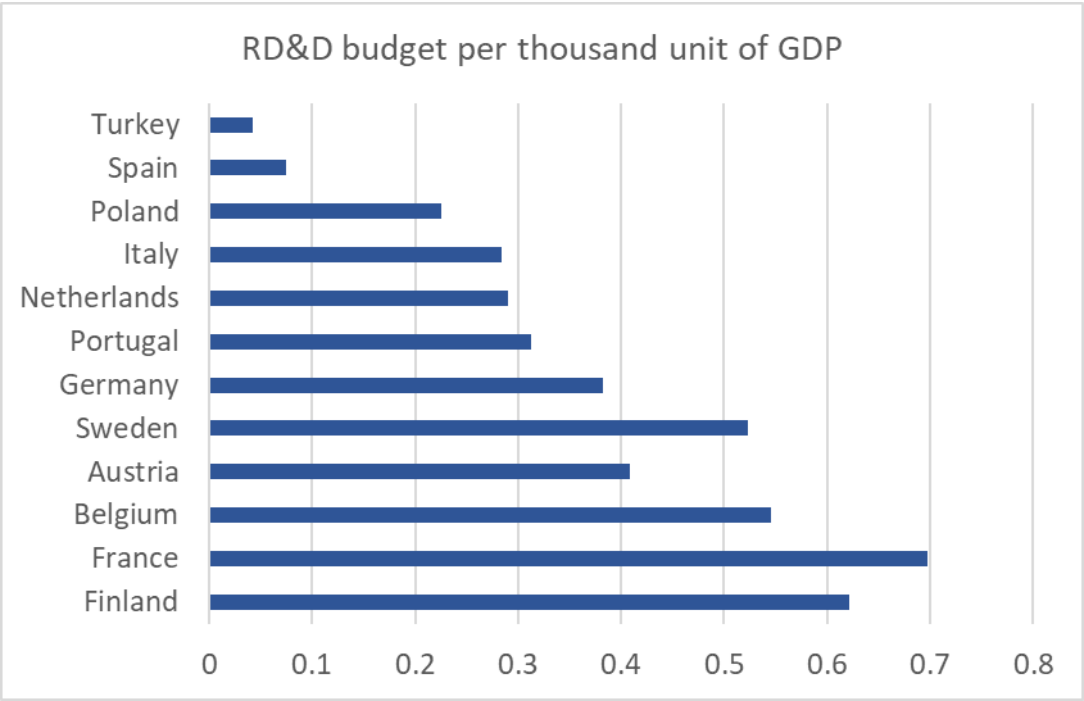

Figure 3.2 RD&D budget per thousand unit of GDP, Data source: IEA, Notes: Total RD&D in nominal national currencies divided by GDP in nominal national currencies at market prices and volumes, expressed in thousand units of GDP. The amounts shown are based on 2021 energy RD&D budgets for: Belgium, Germany, Poland, Portugal, Sweden and Türkiye. The amounts shown are based on 2020 energy RD&D budgets for: Austria, Finland, France, the Netherlands, Spain and the European Union. The amounts shown are based on 2019 energy RD&D budgets for: Italy. European Union refers to the European Union budget under Horizon 2020 and the Innovation Fund, and not to the sum of national budgets of European Union member countries.

It must be noted that the data provided from the individual countries to IEA, thus present on the figures above, do not distinguish between the different energy forms, it includes the interest of IP8, but is not limited to. This particular challenge applies to the individual national expenditures as well: **Even though generally well documented, the funding situation is not reported with regard to the classification made in IP8**. Especially the different classification of research topics in IP8 and in the data reported makes conclusions prone to uncertainties and an evaluation of the funding situation with respect to its efficiency in reaching the goals of IP8 hardly reliable.

Europe is fragmented. The member states within the EU enjoy autonomy, especially regarding establishing domestic R&D strategies and funding schemes. There are hardly any cases where the national strategies are fully aligned with European and no cases at all, where the individual countries align their strategies with each other. In addition, many European countries are divided into regions with different levels of autonomy. In these countries, the research funding can be either centralized (the Netherlands), decentralized (Belgium) or both (Germany). It is a great challenge if the research programs are not aligned, or if the funding agencies are often not familiar with the programs of the others. In other cases, the alignment and cooperation on research funding exists (Spain), or the regional policies are federally monitored (Belgium). It must be noted that most of the countries have regional research financing opportunities, but in the case of centralized system the available regional funding is limited. There are also joint research funding possibilities such as the Nordic Co-operation[2], where researcher cooperation and infrastructure can be funded through NordForsk[3]. Nordic Development Fund (NDF)[4] is an international funding institution that primarily funds climate mitigation measures in low- and medium-low-income countries.

Different regions, languages as well as political and policy systems may jeopardize an efficient SET-Plan implementation. **It is advised that the individual regions and countries seek to harmonize their research policies and programs both with each other and with the EC**. This work has already begun for example in Spain, where "Achieving and effective coordination of R & D & I policies and financing at regional, state and European level" is one of the specific objectives included in the NATIONAL PLAN FOR SCIENTIFIC AND TECHNICAL AND INNOVATION RESEARCH 2017-2020. A balance must be found in each country for efficient European implementation of IP8 while keeping the countries' own interests in mind at the same time. Furthermore, efficient information transfer is needed so the programs are known and taken into account beyond the boundaries of a region or a country. The mentioned fragmentation also appears in data recording, as the IP8 relevant budgets, calls and projects are not listed separately from other areas of renewable energy. Although the latter does not affect the efficient implementation of IP8, **the lack of information makes monitoring of the process** fairly **impossible**.

Institutional funding and research funding at universities and research institutions are often well known and well described in the individual member states, although there is no earmarked budget available for IP8 relevant research. There are either ministries or dedicated research agencies which fund domestic research according to their existing strategies and programs covering a wide range of fields, such as energy. These research activities are generally at low TRLs (<5-6). Competitive research funding is also easily accessible and well described for lower TRLs in the IWG8 member states. These funding instruments cover much narrower

[2] https://www.norden.org/en
[3] https://www.nordforsk.org/
[4] https://www.ndf.fi/

research topics, such as technologies for biofuels production. In addition, there are open calls with no special topics given. These are tools to finance multidisciplinary research projects or cover research topics not funded elsewhere. In order to efficiently implement the SET-Plan, funding is needed to implement the research results from pilot/demo scale to near-commercial or commercial scale. Public funding to support the establishment and operations of new industry at high TRLs are not as straightforward as lower TRL funding. Many countries, if not all, have an agency dedicated to aid domestic or foreign companies that want to establish themselves in the given country. These agencies can provide guidance for the establishment of business plans, reaching international markets and employee trainings. However, the available funding accessed through these agencies appears very limited. Special funding for increased participation in European research arena and calls are also available in most of the countries. Some of the countries (Austria) are very restrictive for providing public funding to support near-commercial operations at high TRL due to a rather strict interpretation of the European State Aid legislation. Implementation of the research results at high TRL in these countries require private funding. Other countries (Finland) interpret the same legislation differently, making them able to support implementation of the research results at large scale with public funds. In addition, public-private partnerships are also a way to support high TRL operations. The description of public-private partnerships is beyond the scope of this report.

In 2020, The European Commission introduced a temporary funding instrument for the recovery from the COVID-19 pandemic[5]. The aim was to address the economic and social impact of the crisis and promote sustainable development and resilience of the EU economy. The budget of this Next Generation EU recovery instrument has been included in the EU Multiannual Framework of the 2021-2027 period and sums up to €750 Billion. €338 Billion of this fund is provided to the member states as grants, another part, €385.8 Billion, is as loans. To access these funds, the member states must prepare comprehensive national plans and receive approval from Next Generation EU through the Recovery and Resilience Facility (RRF). Thus, these EU funds are provided to the member states who report to the EC. The management of these funds is done at the member state level and therefore RRF is discussed in the individual member state descriptions.

Important Projects of Common European Interest (IPCEI)[6] are research and development projects as well as first-of-a-kind industrial deployment projects that are expected to have significant contributions to EU's economic growth, green and digital transitions and job creations. IPCEI projects receive approved state aid together with private investments which intend to de-risk the industrial penetration of innovative technologies. Currently only hydrogen technology projects of IP8 relevance are among IPCEI.

[5] https://commission.europa.eu/strategy-and-policy/eu-budget/eu-borrower-investor-relations/nextgenerationeu_en
[6] https://competition-policy.ec.europa.eu/state-aid/legislation/modernisation/ipcei_en

4. Public funding in Austria

Public spending on research, development and demonstration projects in the energy sector recorded by the Austrian Energy Agency amounted to €224 M in 2021. As other members of the International Energy Agency (IEA), Austria is obliged to record all publicly funded research, development, and demonstration projects in the energy sector. The corresponding data has been used to analyse the Austrian funding situation for the presented report. If not indicated otherwise, the information shown here (including the data shown in the figures) is taken from an energy research survey on public sector expenditures in Austria for the year 2021 (Energieforschungserhebung 2021, Ausgaben der öffentlichen Hand in Österreich[7]).

Austrian stakeholders

Funding in Austria can be awarded by different agencies and on different levels, shown in Figure 4.1. Around three quarters of the expenditures presented in this report were provided by governmental authorities (federal, regional, funding organizations). The remaining share came from (publicly funded) research institutions and universities provided with equity capital. The funding for energy research showed an increase of €68.9 M or 44.4% compared to 2020.

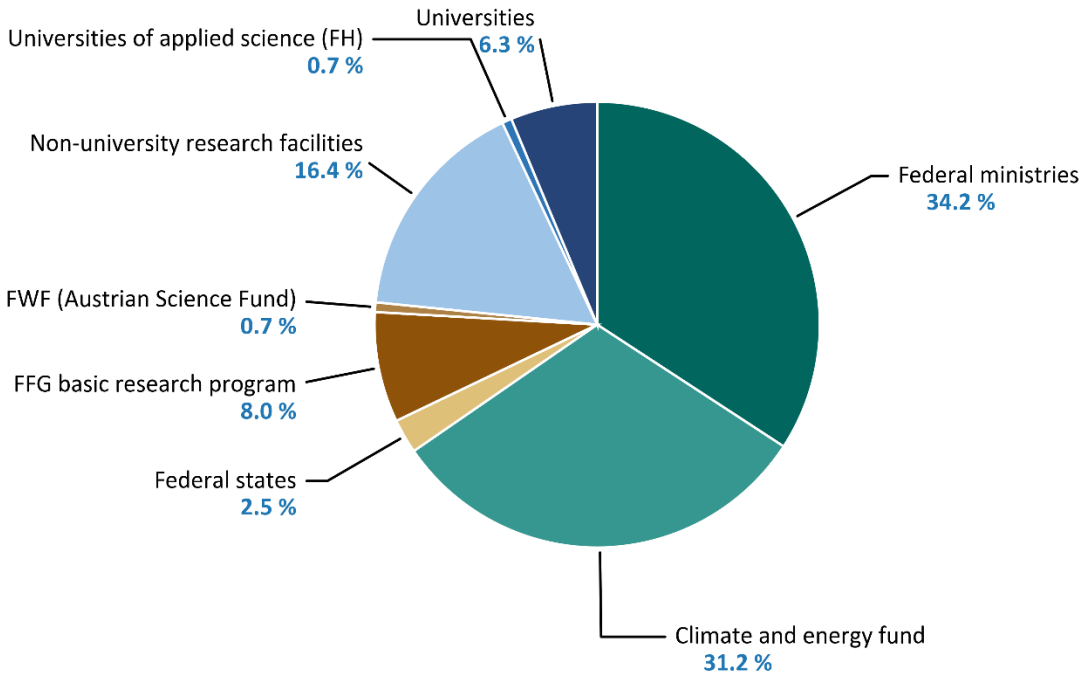

Figure 4.1 Austrian energy research funding in 2021 according to funding source

The following federal ministries are relevant funding sources within Austrian energy research. The expenditures include projects awarded directly by the ministries as well as programs handled by funding

[7] Available at https://nachhaltigwirtschaften.at/resources/iea_pdf/schriftenreihe-2022-22-energieforschungserhebung-2021.pdf

agencies on behalf of these ministries. In 2021, the ministries awarded a total of almost €76.5 M to energy research activities, accounting for 34.2 % of the total R&I expenses in those areas.

- About 87 % (or €66.7 M) of the total share awarded by the ministries has been given out by the Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK). The ministry prioritized topics within energy efficiency (56 % of their awarded funds). Other funded energy topics were other power and storage technologies (26 %), hydrogen and fuel cells (10%) and renewable energies (6 %). The remaining funds were awarded to cross-cutting technologies and research.
- The Federal Ministry of Labour and Economy (BMAW) has awarded 11 % (around €9 M) of the fund given out by Austrian Ministries to energy research 2021. Its funding priorities were renewable energies (37 %), cross-cutting topics (29 %) and energy efficiency (26 %). Other funds were given to transmission and storage technologies (5 %) and hydrogen and fuel cells (3 %).
- Federal Ministry of Agriculture, Forestry, Regions and Water Management (BML) was responsible for 0.8 % (around €0.6 M) of the total expenditures on energy research by the Austrian ministries. The majority (57 %) of this money has funded research within renewable energy. The remaining 43 % were used for energy efficiency research.
- The Federal Ministry of Education, Science and Research (BMBWF) awarded €0.4 M (0.5 % of the total funds awarded by the ministries) for nuclear fission and fusion research.

In addition to the federal ministries in Austria, the Climate and Energy Fund is a major funding source for Austrian energy research, having awarded 31.2 % (€70 M) of the total R&I expenditures on energy in Austria, about the same amount as by all ministries combined. Most expenditures (42 %) have been given to hydrogen and fuel cells research. Other relevant topics funded by the climate and energy fund were energy efficiency (25 %), other power and storage technologies (16 %) and cross cutting topics (10 %). The remainder has been awarded to projects within renewable energy (10 %).

A small fraction of energy research, 2.5 % or €5.5 M, was awarded by the Federal States of Austria. All states reported energy research expenditures for 2021. The states with relevant awarded expenditures funded almost exclusively research activities within energy efficiency and cross-sectional areas.

The majority of funds awarded by the Federal Ministries is channeled through funding agencies, the Austrian Research Promotion Agency (FFG), the Austrian Science Fund (FWF), and Kommunalkredit Public Consulting (KPC). In addition, the funding agencies (with the exception of KPC who only channels demonstration projects for the climate and energy fund) have additional programs to fund energy research. Only these are considered here, the funds channeled for the ministries and the climate and energy fund have been accounted for in the respective sections.

Basic programs of the Research Promotion Agency (FFG) have funded energy research for €18 M in 2021, prioritizing projects within energy efficiency (33 %), transmission and storage technologies (31 %) and renewable energies (21 %). Other topics were hydrogen and fuel cells (13 %) and cross cutting topics (3 %).

The Austrian Science Fund (FWF) was responsible for €1.6 M of energy research in 2021, in energy efficiency (48 %), hydrogen and fuel cells (31 %) and cross-sectional topics (20 %).

Non-university research facilities are an important part of Austrian energy research. In 2021, 16 % of public expenditures on energy research was awarded via these institutions (nearly three quarter of Austrian

Institute of Technology AIT, one quarter of Silicon Austria Labs, but also small contributions of AEE INTEC, Austrian Energy Agency and ÖAW). Public expenditures channeled via non-university research facilities has been awarded to energy efficiency topics in 65 % of the cases. Other funded topics are transmission and storage (22 %), cross-sectional topics (6 %), hydrogen and fuel cells (3 %), renewable energies (3 %), and nuclear energy (0.2 %).

Out of the 22 public universities in Austria, eight have used their own funds to finance energy research: at a total of about €14 M. As for other funding sources, the largest research area funded was energy efficiency (34 %). The other most relevant topics are transmission and storage (18 %), cross-sectional topics (17 %), renewable energies (15 %), and nuclear energy (8 %). Small contributions were given to fossil energy (4 %) and hydrogen and fuel cells (3 %).

Universities of applied science (FH) account for €1.6 M public expenditures on energy research (0.7 %), mainly in the area of energy efficiency (91 %).

The budget for R&I

In 2021, a total of €224 M was spent on Austrian energy research. Figure 4.1 shows the distribution of these expenditure across the different energy topics.

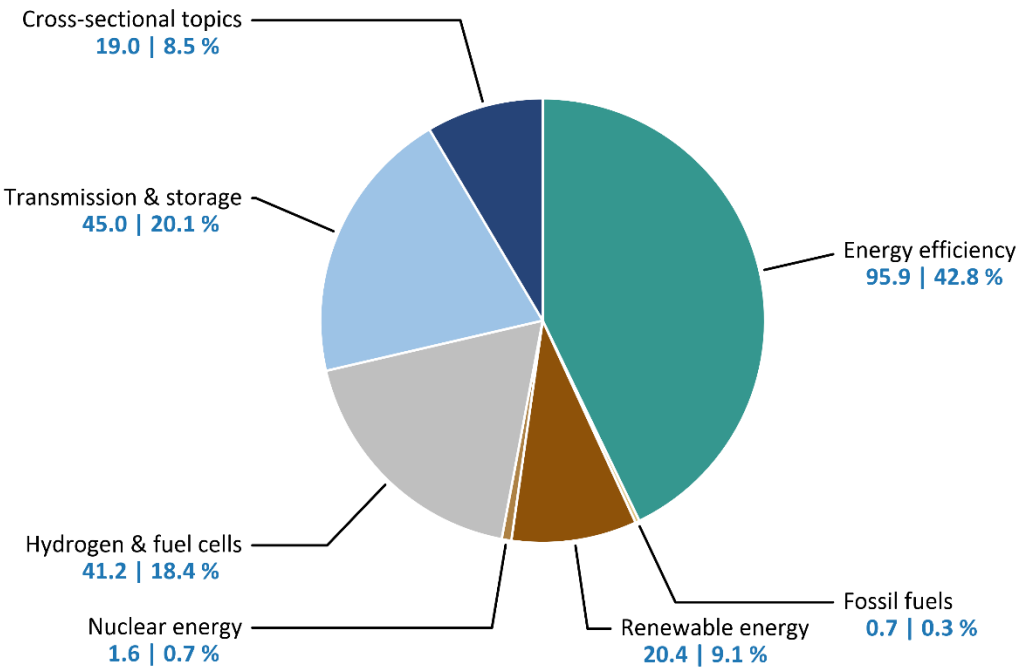

Figure 4.1.2 Total energy research expenditure in Austria 2021

Since 2010, the Austrian energy research landscape has a special focus on energy efficiency, with 43 % of its expenditures funding activities in 2021 in that area. Research within transmission and storage was funded with €45 M and is the second largest topic followed by hydrogen and fuel cells with €41 M funding. Funding for renewable energy declined in recent years to a share of 9 % in 2021 compared to 16 % in 2019. Cross-sectional topics, funded with €19 M, include projects that are located in at least two of the major thematic

areas. Research within nuclear energy (€1.5 M) and fossil energy (€0.8 M) are comparatively far behind in terms of funding and are also not a priority in publicly funded energy research in Austria.

There were about 1 200 projects and activities recorded for 2021. Most of the funds awarded, 62 %, were used for applied research (cf. Figure). Around 19 % of the public investment in energy research was given to experimental development, followed by 15 % for first-of-its-kind demonstration projects. At 3.5 %, investments in energy-related basic research represent the category with the smallest share in this analysis. The importance of energy research - measured in terms of public investment - has stagnated over the past decade, with a rise in the year 2021 from 0.04 % to 0.056 % of the gross domestic product.

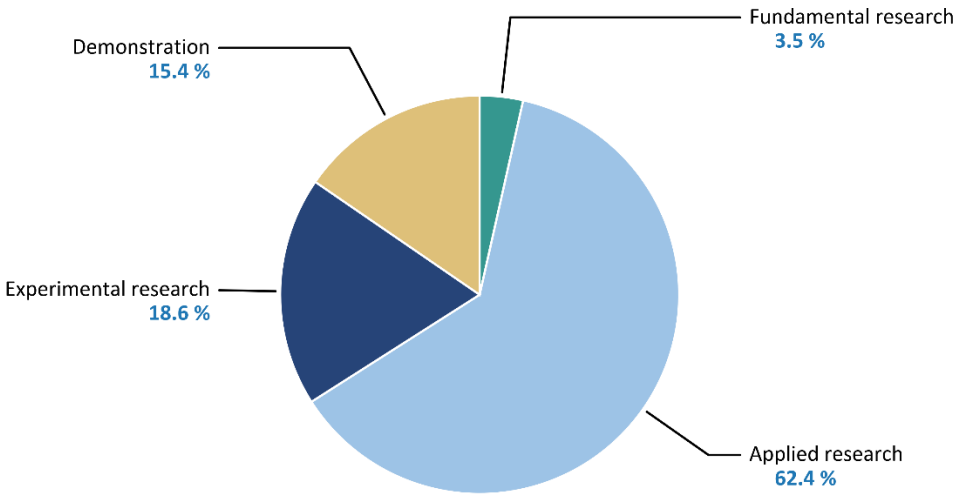

Figure 4.3 Classification of total research expenditures by type by research

More details about the prioritized topic in Austrian energy research, energy efficiency, are shown in Figure 4. Within energy efficiency, most expenditures were made within transportation (40 %), mostly towards batteries and other storage technologies, electrical drives, and charging infrastructure. Research within energy efficient industries was awarded 16 % of the energy efficiency funds. Research for energy efficiency in buildings and equipment (16 %) focused on technologies for building shells and energy management in buildings, among several other smaller topics. The relatively large share of "other" energy efficiency topics (22 %) contains mainly funds for communal service in cities and communities, heat pumps and cooling systems and heat regeneration.

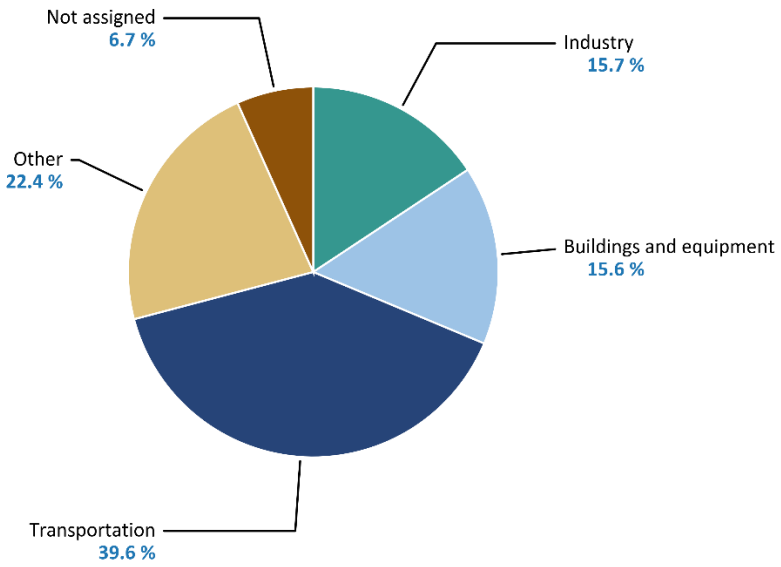

Figure 4.4 Distribution of public expenditures on energy efficiency research in 2021, total of 75 million Euros

Renewable energies are considered with 9 % (€20 M) of the energy research related public expenditures in 2021. More details about this research topic are shown in Figure 5.

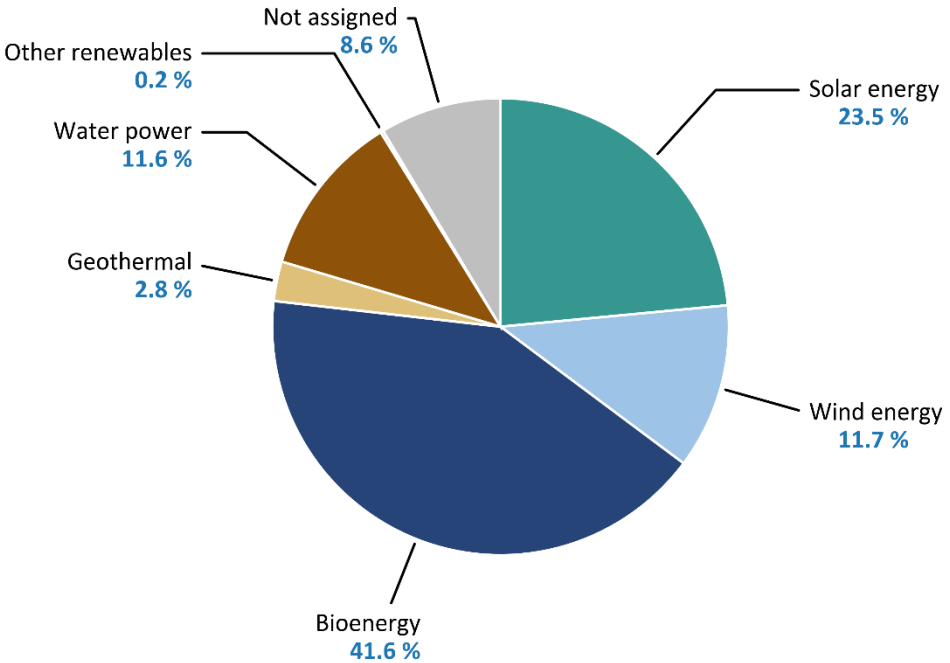

Figure 4.5 Distribution of public expenditures on renewable energy research in 2021, total of 24 million Euros

One of the most relevant subtopics of energy research for the IWG8 activities is that of bioenergy. Research and innovation activities within this subtopic have been awarded €8.5 M in 2021. Bioenergy research in Austria in 2021 consisted of production of solid biofuels (€1.4 M), biochemical conversion (€0.8 M), production of liquid biofuels (€0.8 M), thermochemical conversion (€0.5 M) and a large share of unclassifiable bioenergy topics (€4 M)

The budget for Bioenergy research in Austria between 2016-2021 is shown in Table 4-1 which indicates that the budgets have been relatively constant during those years with a small decrease in 2017-2018 and a renewed decline in 2021.

Table 4-1 Budgets for bioenergy research in Austria 2016-2020

Year	Budget	Source
2016	€ 11 081 331	Energieforschungserhebung 2016
2017	€ 8 579 840	Energieforschungserhebung 2017
2018	€ 7 811 359	Energieforschungserhebung 2018
2019	€ 10 201 991	Energieforschungserhebung 2019
2020	€ 10 249 691	Energieforschungserhebung 2020
2021	€ 8 530 403	Energieforschungserhebung 2021

The research programs and priorities

The Energy Research Program of the Climate and Energy Fund[8] is one the most important instruments in Austria for the funding of energy research. The program relates to the entire energy chain from supply, energy conversion, transport to energy use. It is a mission-oriented, technology-neutral programme that promotes the research and development of forward-looking energy solutions along the entire energy value chain, from primary energy to functionality.

The energy research program targets all groups, from small to large enterprises, universities and non-university research institutions, other science-oriented organizations, but also individual researchers and other actors such as municipalities. In 2021, the fund was responsible for 31 % of all public expenditures on energy research in Austria, with the research priorities of the same year described above.

There are numerous additional programs that fund energy research activities, among them

- The Showcase Energy Region Program (Vorzeigeregion Energie), which focuses on innovative energy technologies from Austria to develop and demonstrate model solutions for energy and transport systems[9]
- The Mobility of the Future program included the topics passenger mobility, freight mobility, alternative vehicle technologies and transport infrastructure[10]
- The Technologies and innovations for the climate-neutral city program, in which new technologies and technological systems for urban environments can be funded[11]
- Smart Cities Demo, the smart cities initiative of the climate and energy fund, award funding to demonstration actions of urban innovations[12]
- Zero Emission Mobility is the research and demonstration program of the climate and energy fund, focussing on sustainable mobility[13]
- With TAKE OFF a program for the Implementation of the RTI strategy for the Austrian aviation sector started[14]

As mentioned above, energy efficiency has been a clear priority in the Austrian research programs on energy.

[8] https://www.ffg.at/energieforschung-das-programm
[9] https://www.vorzeigeregion-energie.at/informationen/forschungsprogramm/
[10] https://www.ffg.at/mobilitaetderzukunft
[11] https://www.ffg.at/tiks/AS2022
[12] https://www.ffg.at/smart-cities
[13] https://www.ffg.at/zero-emission-mobility
[14] https://www.ffg.at/takeoff

Austrian funding schemes and grant types

The Energy Research program of the Climate and Energy fund, one of the most important instruments for funding energy research in Austria, has announced its recent call with a total budget of 17.7 million Euros.[15] The call includes different type of grant types: [16]

- Exploratory projects for the preparation of full R&I activities:
  - Maximum 200 000 EUR
  - Funding rate 50-80 %
  - Maximum duration 12 month
- Collaborative R&D project
  - Industrial research or experimental development
  - Minimum 100 000 EUR, maximum 1 Million EUR
  - Funding rate 35-85 %
  - Maximum duration 36 months
  - Cooperation required
- Lead project - extensive cooperative R&D projects with a signal effect
  - Minimum of 2 Mio EUR
  - Funding rate 35-85 %
  - Maximum duration 48 months.
- Investment funding
  - Maximum 4,5 Mio EUR
  - Up to 40 % funding

The submitted proposals (deadline of the current call is May 10th 2023) for collaborative research and development projects have to address at least one of the following research topics:

- Focus area 1: Sector coupling and renewable hydrogen in the industry
- Focus area 2: Field test heat storage
- Focus area 3: Climate-neutral Heat and cold
- Focus area 4: Climate change- adaptation of the Energy infrastructure

The grant types exploratory projects, collaborative project on industrial research and collaborative project on experimental development are available for most of the abovementioned research topics, with some exceptions.

Relevance to IP8 activities

The Austrian energy research arena has a strong focus on energy efficiency, and therein on e-mobility. Most of the energy research related to public expenses is dedicated toward energy efficiency. Nevertheless, Austria supports a number of R&I activities relevant to the topics of IP8. Within renewable energy research, 42 % (8.5 million Euros) are dedicated towards bioenergy research, which is considered relevant for IP8. Bioenergy research therewith accounts for 4 % of Austrian public expenditures on energy research. Additional relevant activities may be found within hydrogen research and cross-sectional areas.

[15] https://www.ffg.at/2022-Ausschreibung-Energieforschung
[16] If not indicated otherwise, all presented information about the call taken from: https://fdoc.ffg.at/s/vdb/public/node/content/BzdT1mLITDazHDvWHHyQYg/1.0?a=true

5. Public funding in Belgium

Belgium is a federal country and the responsibilities for developing the policies (including R&D policies) for renewables are divided between the federal government and the three regions (Flanders, Wallonia and Brussels). Policies for nuclear energy, offshore wind and biofuels for transport is the responsibility of the federal government, while the other renewables' policies are developed by the regions. The federal government is exclusively responsible for nuclear R&D (fusion and fission) while the regions are primarily responsible for developing and implementing policies for non-nuclear energy R&D. The linguistic communities are responsible for developing and implementing policies for research at universities. In addition, the federal government can also support non-nuclear R&D through dedicated policy support research programs as was the case in the past at BELSPO[17].

Belgian stakeholders

The Walloon Government is responsible for the development and implementation of the national research funding strategies and the budget in the Walloon region. The Ministry of Research and Innovation and The Ministry of Energy are the main ministries responsible for research relevant to IP8. The implementation of the R&D&I is guided by the Policy Declaration that establishes the guidelines for 5 years. Information about research needs is gathered for the Energy Research Officers Team through the Smart Specialization Strategy[18], the SET-Plan documents, BERA bioenergy events[19], the contribution of clusters (GreenWin, TWEED etc.), Walloon research actors (rewallonia.be[20], WARE[21] etc.), NCP, technology watch[22].

The General Operational Directorate for Economy, Employment and Research (EER) manages the major part of the funding for industrial research[23]. The Walloon Public Service manages the funding of academic, public or not-for-profit research centres. In addition, the following agencies are relevant for promoting innovation and networking in the Walloon region:

- Agency for Enterprise and Innovation
- Walloon Export and Foreign Investment Agency, AWEX
- SOWALFIN financing agency set up by the Walloon government to aid SMEs
- SRIW – Wallonian Regional Investment company

In Flanders, innovation is governed under the responsibility of the Minister of Economy, Innovation, Work, Social economy and Agriculture and administered by EWI, (Economie, Wetenschap en Innovatie - Economics, Science and Innovation)[24]. In addition, EWI prepares, monitors, implements and evaluates the research policies. Designing and monitoring research policies is also a task of the politically appointed Ministerial

[17] https://www.ieabioenergy.com/wp-content/uploads/2021/11/CountryReport2021_Belgium_final.pdf
[18] http://economie.wallonie.be/content/smart-specialisation
[19] https://energyresearchbelgium.be/work-programmes
[20] https://en.rewallonia.be/who-we-are/portal-vision/
[21] https://energie.wallonie.be/fr/le-comice-bioenergies-et-combustion.html?IDC=7720&IDD=69467
[22] Information obtained from country representatives.
[23]https://www.crunchbase.com/organization/directorate-general-operational-for-economy-employment-and-research
[24] https://www.ewi-vlaanderen.be/over-ons/beleidsdomein-economie-wetenschap-en-innovatie

Cabinet. VARIO has an advisory role to the Flemish Government on the science, technology and innovation policies of the region. The following agencies are relevant for execution of research policies in the Flanders:

- The Research Foundation - Flanders (FWO): competitive scientific research,
- Flanders Innovation & Entrepreneurship (VLAIO): R&D, innovation and entrepreneurship support to companies
- Participation Company Flanders (PMV): guarantees and loans to companies, coordinating investment funds from the European Fund for Strategic Investments (EFSI) in Flanders
- Flanders Investment & Trade internationalization support

The Research Foundation - Flanders (FWO) aims to facilitate research that is ground-breaking, fundamental, and strategic for the Flemish universities. The FWO aims to increase the cooperation of the Flemish universities with other research institutes as well. The FWO provides fellowships and funding for PhD candidates, postdoctoral fellowships, sabbatical bench fees, international mobility, international collaboration, research infrastructure, support for international contacts, European programs, scientific prizes, research grants and research projects. The latter two are in the scope of this report; however, research grants are no longer distributed, and the details of research project funding is given in the sections below[25].

The Flemish Interuniversity Council (VLIR) - University Development Cooperation (UOS), facilitates partnerships between universities and university colleges that are located in Flanders and the South. VLIR-UOS provides funding for international master programs, international and local collaborations, training programs, and policy supporting research projects. VLIR-UOS does not have a separate funding scheme for IP8 related activities; however, they fund research projects covering IP8 activities which are given in the sections below[26].

Flanders Innovation & Entrepreneurship provides support for entrepreneurs in Flanders by encouraging innovation and entrepreneurship and contributing to a favorable business environment[27]. They support businesses through grants in forms of the growth subsidies, innovation and research and development projects for SMEs, assist SMEs through start, growth and takeover, so that they can continue to grow, transform, and innovate, support organizations that facilitate cooperation within a group of enterprises and knowledge institutions, and help with the development of industrial areas[28].

The Fund for Scientific Research (F.R.S.-FNRS) aims to support fundamental scientific research in line with initiatives of the researchers with scientific excellence principal. F.R.S.-FNRS stimulates the generation and advancement of knowledge through providing support for individual researchers as well as funding research programmes of the universities located mostly in the Wallonia region. The F.R.S.-FNRS provides temporary or permanent payment for individual researchers, funding for research teams, attendance support for international networks and programmes, grants and credits for facilitating scientific exchange and distribution of scientific prizes. In addition, the F.R.S.-FNRS has the duty of informing about and encouraging participation to the European research and innovations programmes which the Wallonia-Brussels Federation is part of[29].

Enabel is the Belgian development agency, which executes Belgian governmental cooperation. Enabel implements projects for other Belgian funding bodies and Belgian and international commissioners (e.g. the

[25] https://www.fwo.be/en/fellowships-funding/
[26] https://www.vliruos.be/en/about_vlir_uos/2
[27] https://www.vlaio.be/nl
[28]https://www.vlaio.be/nl/over-ons/vlaio
[29] https://www.frs-fnrs.be/en/le-fnrs/missions-du-fnrs

European Commission, EU member states and development agencies, global funds, Flanders, the Brussels Region…).. Projects can be implemented independently, also for sectors that are not part of Belgium's thematic areas and for partners that are not defined as Belgium's partner countries. Enabel's new 2030 strategy is built on 4 key strengths gained through previous partnerships: partnerships, co-creation, proximity and expertise[30]. Energy is one of the sectors that Enabel focuses on. They fund urban development projects covering energy aspects such as the increased use of renewable energy including biomass[31].

The budget for R&I

In Walloon Region, most of the research budget is allocated by The Ministry of Research and Innovation. Of a total budget of €250-300 M/year, approximately €4 M/year is dedicated to IP8 activities. The Ministry of Energy funds the research activities aligned with the energy policy with an available budget of €1-10 M/year of which €4.8 M/year is dedicated to IP8 activities. The topic on hydrogen has been taken up a large part of the budget in the last 3 years. The budgets are renewed every 5 years[32].

The research programs and priorities

FWO has currently the following relevant research programs[33]:

- Junior and Senior Research projects (fundamental research, €0.28 M)
- Strategic Basic Research projects (€37.5 M per year)
- EOS Research projects (fundamental research, €0.45-1 M per year)
- Odysseus programme (€ 15.6 M)
- ERC Runner Up projects (€0.177 M)

VLIR-UOS distributed approximately €15 M in 2019 to fund projects in the South Program, and €0.48 M to fund projects in the Policy Supporting Research Program under the country program "Belgium"; these two programs fund projects which were relevant for IP8. Two of the projects funded under the South program were relevant for IP8; bioelectricity production in Morocco and biogas production from organic waste in Kenya[34], both with a budget of approximately €70,000.

Flanders Innovation & Entrepreneurship provides small subsidies, guidance and training to enterprises for research projects. They have several programmes. They fund from 25 to 60% of the project budget, with a minimum €0.025 M and max € 3 M [35].

FRS-FNRS funds individual researchers, research institutions and universities. They had €206.7 M income in 2019 of which €188 M was public subsidies, and €17 M were donations. They have distributed the following subsidies to support research:

- €108.9 M to individual researchers
- €65.3 M to universities and research institutions

[30] https://www.enabel.be/who-we-are/our-strategy/
[31] https://www.enabel.be/what-we-do/offer-expertise/energy/
[32] Information obtained from country representatives in 2021.
[33] https://www.fwo.be/en/fellowships-funding/research-projects/
[34] https://indd.adobe.com/view/5e828796-57df-466a-9946-1f6971aa469a
[35]https://www.vlaio.be/nl/subsidies-financiering/ontwikkelingsproject

- €7.9 M to support international research

Belgian funding schemes and grant types

The national calls are drafted by the funding agencies through joint discussions (Fonds voor Wetenschappelijk Onderzoek – Vlaanderen, Federaal Fonds voor Wetenschappelijk Onderzoek – Fonds National de la Recherche Scientifique, Deutsches Zentrum für Luft- und Raumfahrt e. V., etc.) and approved by the Ministry of Research and Innovation. The "international" calls (calls within SET-Plan dynamic/IWG) are also drafted by the funding agencies and approved by The Ministry of Energy. The public administration drafts a proposal for the regional calls, which is approved by the responsible Minister[36].

Details of the programs that are relevant for IP8 activities are given below for each program.

Junior and Senior Research projects: Research projects are initiated by the researchers in forms of junior and senior research projects to advance fundamental scientific research in all scientific disciplines[37]. Project proposals are evaluated on a scale from 0 to 7, according to the following scoring descriptors[38].

- Scientific capacity, track record and collaboration of the research group
- Scientific quality, relevance of the research project & originality
- Quality of the research approach and feasibility of the project

Strategic Basic Research (SBO) projects**:** the SBO programme has a focus on innovative research with the potential of creating possibilities for economic or societal applications such as a new generation of products, processes and/or services[39]. Research institutions can apply for funding for 4 years for a maximum of €0.5 M per year. The total available budget is €37.5 M. The SBO project proposals are evaluated based on their scientific and utilization potential.

The Odysseus programme: The Odysseus programme offers a start-up funding for researchers who have been working outside Flanders to develop or to establish a research group at a Flemish university and become more active in the Flemish research environment. The programme is unique in the sense of combining a position at a Flemish university and sufficient project funding to establish their own research team, making Flanders attractive for high level, international researchers[40]. Features of the most recent call are listed below. Funding can be granted to established research (Odysseus Type 1) or to postdoctoral researchers (Odysseus Type 2) for a period of 5 years.

There are 8 specialized funds of F.R.S.-FNRS[41]:

- FRIA - The Fund for Research Training in Industry and Agriculture,
- FRESH - Human Sciences Research Fund,
- IISN - The Interuniversity Institute for Nuclear Sciences,
- FRSM - The Fund for Medical Scientific Research,
- FRFC - The Fund for Collective Fundamental Research,
- FRFS - The Strategic Fundamental Research Fund,
- EOS - The Excellence of Science,

[36] Information obtained from country representatives.
[37] https://www.fwo.be/en/fellowships-funding/research-projects/junior-and-senior-research-projects/
[38] https://www.fwo.be/media/891091/PROJ_FO-scoring-grids.pdf
[39] https://www.fwo.be/en/fellowships-funding/research-projects/sbo-projects/
[40] https://www.fwo.be/en/fellowships-funding/research-projects/odysseusprogramme/
[41] https://www.frs-fnrs.be/en/le-fnrs/gouvernance-ca

- FRART: The Art Research Fund.

FNRS has several bottom-up calls annually for proposals where researchers can suggest research themes they want to develop. The three main FNRS calls are announced throughout the year with three major types of instruments[42]:

- "The Grants and Fellowships call, opening in December: instruments that fund researchers with four different levels of expertise
- The Credits and Projects call, opening in spring: instruments that fund individual or collaborative research based on researchers' initiative
- The Large Equipment call focusing on research infrastructures"

An important eligibility criterion is that applicants must be affiliated to a CFB research institution or to a scientific institution of the state. The selection is done considering its scientific excellence, based on a peer review by independent experts. The evaluation is based on:

- Excellence
- Transparency
- Confidentiality
- Ethical aspects

The evaluation grades the proposals as follows: A (A+ outstanding, A excellent, A- very good), B (B+ good, B average, B- weak), C is insufficient. Only projects graded A is funded.

VLIR-UOS has two main programs that are South program funding collaboration projects in Brundi, Democratic Republic of the Congo, Ethiopia, Kenya, Morocco, Mozambique, Rwanda, South Africa, Tanzania, Uganda, Cambodia, Indonesia, Philippines, Vietnam, Bolivia, Cuba, Ecuador, Nicaragua, Peru and Suriname, and Belgium program funding projects held in Belgian institutions[43].

Flanders Innovation & Entrepreneurship offers subsidies to enterprises so that they can develop or strengthen their research and development activities through research projects which can be implemented by one or more companies[44].

Relevance to IP8 activities

Among the FWO research programs, three have broad scopes that can be relevant for IP8 activities: Junior and Senior Research projects, SBO (Strategic Basic Research) projects, and The Odysseus programme.

Even though VLIR-UOS does not have a separate funding scheme for IP8 related activities, they fund research projects covering IP8 activities e.g., the South program under which projects relevant for IP8 were funded. These were bioelectricity production in Morocco and biogas production from organic waste in Kenya that can be classified as the **EVC4: Anaerobic digestion to biogas** value chain.

Similar to the funding offered by FWO and VLIR-UOS, FNRS offers funds with no specific theme, namely "Grants and Fellowships" call, and "Credits and Projects" can fund IP8 related activities.

[42] https://www.frs-fnrs.be/docs/Reglement-et-documents/FRS-FNRS_Guide_Evaluation_EN.pdf
[43] https://www.vliruos.be/en/project_funding/4
[44]https://www.vlaio.be/nl/subsidies-financiering

Evaluation of projects after completion

Evaluation of the projects after completion depends on the call. Some regional projects can be evaluated only by the internal experts, but in majority, the projects are evaluated by a group of experts (1 internal and 2 external/international)[45].

Private sector engagement

Private sector engagement depends on the call. Generally, the consortium must include at least one industrial partner (small, medium or large company) with an operating headquarters in Wallonia. In some infrequent cases, only a patronage of private sector is accepted[46].

[45] Information obtained from country representatives.
[46] Information obtained from country representatives.

6. Public funding in Cyprus

The institutional funds dedicated to research activities are included in the annual institutional funding provided to each public organization via the Annual Government Budget. As a rule, the funding allocation takes into account the Strategic and/or Business Plans of the public and the budgeting of each organization as well as the public funds availability. Institutional funding is usually distributed to the public universities and research organizations via the Annual Government Budget or on ad hoc basis by the Council of Ministries to public and private organizations for specific and significant purposes and after a respective assessment/evaluation.

Competitive funding is assigned through calls. These financial instruments deploy both EU and/or national resources. Competitive funding can provide support by way of loans, guarantees, equity and other risk-bearing mechanisms, possibly combined with technical support, interest rate subsidies and other mechanisms.

The Cypriot stakeholders

The Deputy Ministry of Research, Innovation and Digital Policy (DMRIDP) was established in early 2020 to support scientific research and innovation to ensure the development of a competitive state at both European and International level[47]. Among other duties, the DMRIDP has the responsibility to develop and implement the national strategy for research and innovation, to supervise the National Board for Research and Innovation, and to guide the Research and Innovation Foundation.

The National Board for Research and Innovation (NBRI)[48] is the principal advisory body in the definition of the Research and Innovation Strategy, which NBRI is responsible for promoting and implementing.

The Research and Innovation Foundation (RIF)[49] was established in 1996 as the national authority in charge of supporting and promoting research, innovation and technological development.

The budget for R&I

The budget dedicated to research and innovation is annually set by the Annual Government Budget.

The Cyprus Research and Innovation Strategy Framework published May 2019 set the ambitious target for the R&D expenditure to reach 1.5% of GDP in 2023[50], which implied a growth of circa €280 M with respect to 2019's budget (aiming at a 50%-50% contribution of public and private sector).

The research programs and priorities

The current Cyprus Research and Innovation Strategy Framework is "Innovative Cyprus 2019-2023"[50]. The framework defines nine strategic pillars and enablers, the second of which is the adoption and implementation of a national R&I strategy.

[47] https://www.dmrid.gov.cy/dmrid/research.nsf/mission_en/mission_en?OpenDocument
[48] https://www.nbri.gov.cy/
[49] https://www.research.org.cy/en/
[50] https://www.dmrid.gov.cy/dmrid/research.nsf/All/93BD79089C22336BC225853400356CCB/$file/Innovate-Cyprus-CYRI-Strategy-Framework-2019-2023-NBRI-May-2019.pdf?OpenElement

The Smart Specialization Strategy for Cyprus (S3Cy)[51], endorsed in March 2015, has the aim of enhancing the effectiveness of research, development and innovation. The S3Cy is an ex-ante conditionality set by the EU, for the exploitation of the European Structural and Investment Funds. The Priority Areas identified in S3Cy are (areas relevant for IP8 activities are highlighted in bold and described in further detail):

- Tourism
- **Energy:** Renewable forms of energy, Solar energy, Solar-thermal technology, Solar Photovoltaic, Technologies for solar heating and cooling, Energy storage and transfer
- **Agriculture – Food Industry**: Agricultural and livestock production, Agriculture, Food security and Climate change
- Construction Industry
- **Transportation:** Marine, Shipping, Intelligent transport systems, Road freight
- Health
- **Environment:** Climate change, Pollution, Ecosystems, Eco-Innovation, Water resources
- ICT

The S3Cy defined three pillars to implement the strategy:

- Pillar 1 – Smart Growth**:** To face modern development challenges and prospects in the selected priority sectors
- Pillar 2 – Sustainable R&I System: For the development of a diachronic and dynamic research, technological development, and innovation system
- Pillar 3 – Support R&I System: To enhance the framework, mechanisms, and operational structures of R&U systems

The Operational Programme (OP) "Competitiveness and Sustainable Development"[52] is co-financed by the European Regional Development Fund (ERDF) and the Cohesion Fund. It defines priorities and categories of intervention for the period 2014-2020. It has a total budget of €661 M, of which 85% is financed by the ERDF and Cohesion Fund and 15% from national resources. The programme's interventions are within the Priority Axis:

- Strengthening the Competitiveness of the Economy
- Promoting the Use of Information and Communication Technologies (ICT)
- **Reducing Carbon Dioxide Emissions and Adapting to Climate Chang**e
- **Environmental Protection and Efficient Resource Management**
- **Promoting Sustainable Transport**
- Sustainable Urban Development

The RESTART 2016-2020 Programmes[53] are the current multi-annual frameworks of programmes for research, development, and innovation. The programmes focus on the Priority Areas identified in S3Cy and, at the same time, is part of the OP "Competitiveness and Sustainable Development". The priority areas "Tourism" and "Energy" are defined as dominant priority sectors; "Agriculture – Food industry", "Construction industry", "Transportation" and "Health" as secondary priority sectors; "Environment" and "ICT" as important horizontal sectors. The updated total budget is €215.5 M.

Through 2020 and 2021 it was decided to announce new calls for proposals under the RESTART 2016-2020 Programmes. These will be co-founded by the European Union and the Republic of Cyprus through the

[51] https://stip.oecd.org/stip/interactive-dashboards/policy-initiatives/2021%2Fdata%2FpolicyInitiatives%2F16266
[52] https://www.structuralfunds.org.cy/en/OP-Competitiveness-and-Sustainable-Development
[53] https://www.research.org.cy/en/rifs-ri-programmes/restart-2016-2020/#epidiwksis

Cohesion Programme "THALIA 2021-2027" or through the European Parliaments Recovery and Resilience Facility (RRF) and the Recovery and Resilience Plan "Cyprus_tomorrow". THALIA 2021-2027 is a program constituted in accordance with the Article 22 of the Regulation (EU) 2021/1060 outlining the development strategy for the utilization of the resources allocated to Cyprus through the Cohesion Policy Funds, for the period 2021-2027[54]. The programme aligns the development priorities of Cyprus with the new priorities and the five EU Policy Objectives for the respective period and has a total budget of €1.81 Billion (€968 M from EU Cohesion Policy Funds and €842 M in national contribution). From the indicative actions through the 16 different priorities of the programme, none seem relevant for the IP8.

Cypriot funding schemes and grant types

The RESTART 2016-2020 programs are composed of 22 individual programmes, organized within the three strategic pillars. Each program is described in terms of objectives and specific aims, beneficiaries, schedule, budget, permitted activities, project duration, funding, eligible costs, and other specific participation restrictions. Each pillar is divided into sections, which comprise the specific programs[55]:

Pillar 1 - Smart Growth:

Section – R&I Partnership

- Integrated projects (€10 M): interdisciplinary, large scale, collaborative projects implemented by integrated, mainly local consortia
- Integrated projects (THALIA, €10 M)
- Collaborative Development (RRF, €10.2 M)
- Dual use technologies (RRF, €2.72 M)

Section – Infrastructures

- New strategic infrastructure units – Young Scientists (€11 M): for young scientists, holders of a doctoral degree, with a minimum of five and a maximum of fifteen years from the day receiving the title, to take the lead in the establishment of a new research team.
- Research Infrastructures (THALIA, €17.5 M)

Section – Participation of Enterprises

- Research in enterprises (€9.3 M): for industrial research and experimental development activities.
- Research in enterprises (THALIA, €3.6 M)
- Research in enterprises (RRF, €6 M)
- Research in start-ups (€1 M): to intensify research activities in start-ups.
- Proof of concept for technology/knowhow applications (€1 M): for the preliminary investigation of possible industrial applications of a technology/knowhow.
- Proof of concept for technology/knowhow applications (THALIA, €1.2 M):
- Proof of concept for technology/knowhow applications (HYDRO, €200 k):

Section – Extroversion - open horizons

[54] https://thalia.com.cy/en/strategic-en/short-description-en/
[55] https://www.research.org.cy/en/rifs-ri-programmes/restart-2016-2020/

- Bilateral collaborations (€1.6 M)
- Bilateral collaborations (THALIA, €2.9 M)
- International collaborations – dual targeting (€1.2 M)
- EUREKA Cyprus (€600 k): for at least two organizations from at least two countries.
- European initiatives – National development (€8 M): Joint Programming Initiatives, ERA-NET COFUND, Programmes under the Article 185 of the EU Treaty
- European Partnerships (THALIA, €9.5 M)

Pillar 2 – Sustainable research, development and innovation system

Section – Excellence

- Excellence hubs (€17.1 M): to reward and invest in research excellence, to generate new, internationally significant knowledge, which can form the base for future exploitation.
- Excellence hubs (THALIA €10 M)
- EUROSTARS Cyprus (€2.5 M): for Cypriot organizations to participate in transnational projects.
- DISRUPT (RRF, €10 M)
- Creation and initial development of start-ups with international orientation (PRE-SEED) (1st and 3rd Call by RRF, 2nd Call by THALIA, €4.6 M)
- Development of Internationally Competitive Innovative Products and Services by STARTUPs (SEED) (1st and 3rd Call by RRF, 2nd Call by THALIA, €15 M)
- Development and Promotion of Internationally Competitive Innovative Products and Services by Existing Enterprises (INNOVATE) (1st and 3rd Call by RRF, 2nd Call by THALIA, €17.4 M)

Section – New researchers, new ideas, new opportunities

- DIDAKTOR (Post-doctoral researchers) (€9.4 M)
- HORIZON 2020 – 2nd opportunity (€5.5 M): for project proposals for the Horizon 2020 Programme that, despite of being of high quality, did not manage to secure funding due to budget exhaustion.
- HORIZON 2020 – 2nd opportunities (EIC) (RRF, €1.5 M)
- HORIZON 2020 – 2nd opportunities (MSCA) (THALIA, €2.5 M)
- HORIZON 2020 – 2nd opportunities (ERC) (€600 k)
- Social innovation (€1.5 M): for projects which plan and develop social innovation for addressing a recently identified or insufficiently addressed social need.

Pillar 3 – Transformation of research, development and innovation system

Section – Support mechanisms

- Innovation vouchers (€260 k): to support SMEs to gain knowledge to improve their ability for innovation and development.
- Innovation vouchers (RRF, €350 k)
- Classified Labs – Dual Use Technologies (€195 k)
- Industrial property (€400 k): to protect important research and innovation results.
- Participation in international brokerage events (€ 140 k)
- Encouragement of project coordination in Horizon 2020 (€1 M)

Section – Alternative forms of funding

- Commercial exploitation of research results (€0.27 + 1 M): Stage A – Preparation: Supports the development of a business plan for the commercial exploitation; Stage B - Investment: Support activities for setting a new company and its operational activities.
- Commercial exploitation of research results by enterprises (€0.27 + 1 M)
- Complementary funding (€4 M): for research projects funded under the Horizon 2020 program.

Section – Culture

- Nurturing a research, development and innovation culture (€0.5 M): through competitions, awards, exhibitions, workshops, and other activities

Projects applying to the different programs under Pillar 1 need to carry out activities within one or more focus areas of the priority sectors. Each priority sector is further divided into sub-sectors and focus areas (focus areas are explanatory and not restrictive). The priority sectors of relevance for I8 are further described as follows:

- Priority sector "Energy"
    - A. Development of New or Optimized Technologies for Renewable Energy Sources
        - A1. Solar energy
        - A2. Technologies for solar heating and cooling
        - A3. Wind energy
    - B. Innovative applications of renewable energy sources
        - B1. Solar thermal technologies
        - B2. Solar photovoltaic
        - B3. Innovative Renewable Energy Sources applications in tourism, agriculture, livestock, fish-farming, etc
    - C. Exploitation of Hydrocarbons
    - D. Efficient use -energy saving
        - D1. Developing Innovative and cost-Effective Technologies for Optimized Use of Energy in New and Existing Buildings
        - D2. ICT Systems for Monitoring Energy Consumption and Optimizing Efficiency in Urban Environments and Transportation
        - D3. Networks for Energy Transportation and Distribution (integration of RES)
- Priority sector "Agriculture – Food industry"
    - A. Competitiveness of Agricultural and Livestock Production
    - B. Food quality and safety
    - C. Livestock development
    - D. Climate Change: Agriculture and Food
    - E. Environmental and Socio-Economic Dimension Efficient use - energy saving
        - E1. Effective Use of Biodiversity and Ecosystems
        - E2. Optimal Use of Water Resources
        - E3. Exploitation of Renewable Energy Sources
- Priority sector "Transport"
    - A. Contemporary public transport
        - A1. Development of Urban Transport Systems and Modern Public Transport

A2. Energy Saving (use of alternative fuels)

B. Maritime transport/shipping

C. Sustainable transport development

Depending on the program requirements and according to the provisions of the corresponding Call for Proposals, project proposals are evaluated using one or a combination of the following methods[56]:

- Method I - Remote Evaluation by independent evaluator based on three evaluation criteria (Excellence, Added Value and Benefit, and Implementation)
- Method II - Evaluation by a Scientific Evaluation Committee (SEC)
- Method III - Internal Evaluation.

The RIF conducts at least one monitoring visit for each funded project in order to be closely informed by the project coordinator and the project team on the implementation and progress of the project activities, to ensure that the project is implemented qualitatively and without problems. Furthermore, the monitoring visit enables the project team to get clarifications and advice from the RIF on project management issues[57].

Most of the OP "Competitiveness and Sustainable Development" calls of proposals are part of the RESTORE 2016-2020 programs[58]. Some additional calls are announced for specific topics (no call relevant for the I8 topics could be found).

Evaluations of the OP "Competitiveness and Sustainable Development" are carried out before, during and after the implementation of the programme, to assess the quality of the planning, implementation and effectiveness of the programme[59].

Evaluation of projects after completion

The project results are evaluated by an independent expert group. The evaluation has the scope of highlighting remarkable results that arise from the funded projects, but also aims at identifying and dealing with the cases where the public funding does not bring the desired results. The experts who conduct the project evaluations are different from the experts used for the evaluation of the proposals.

Private sector engagement

Most of the above programs with their different financial instruments are eligible for participation of enterprises and entities in the private sector. Moreover, the programs have the goal of mobilizing additional investments in the private sector. Some programs are particularly designed for enterprises, such as Pre-Seed, Seed, Innovate, Innovation Vouchers.

[56] https://www.research.org.cy/en/rifs-ri-programmes/restart-2016-2020/#toggle-id-8

[57] https://www.research.org.cy/en/rifs-ri-programmes/project-monitoring/#toggle-id-2

[58] https://www.structuralfunds.org.cy/Calls-of-Proposals

[59] https://www.structuralfunds.org.cy/Evaluation

7. Public funding in Finland

Finnish stakeholders

The Academy of Finland (AoF) is the prime funding body for scientific basic research in Finland. It is a government agency administrated under the Finnish Ministry of Education, Science and Culture. AoF's mission is to "fund high-quality scientific research, provide expertise in science and science policy, and strengthen the position of science and research" with the goal of "the renewal, diversification and increasing internationalization of Finnish research" through promotion of excellent, responsible, and high-impact research covering all scientific disciplines. AoF provides i) grants for conducting research, training researchers, and improving research conditions, ii) expertise to both Finnish and international collaboration networks, iii) collection and analysis of scientific research data as well as data on science, and iv) scientific policy expertise. AoF has strong collaboration with other key actors for the improvement of research quality and impact as well as education and innovation.[60]

The Ministry of Economic Affairs and Employment of Finland (MEAE) provides funding through various channels, including direct grants and subsidies, loans, venture capital investments, support for internationalization of enterprises[61], and EU funding. MEAE has established several agencies and organizations that have been given the authority to provide funding and support for companies and projects. These include, for example, Business Finland[62], Finnvera[63], and Climate Fund Finland[64].

Business Finland is a government agency that is funded by the Ministry of Economic Affairs and Employment of Finland to support innovation in Finnish companies. Business Finland's funding comes from the Finnish government's budget, and it is allocated to the agency based on its objectives and performance targets. It offers funds for research and product development as well as business development funds for research organizations, SMEs, and public service providers in form of grants and loans. They offer guidance for Finnish companies to reach global markets and promote investments and travels or they can coach foreign companies with establishment in Finland. Business Finland has 40 offices globally and 16 regional offices in Finland.

The Finnish Innovation Fund (Sitra) is an independent funding organization operating under the Finnish Parliament.[65] In Sitra's latest strategy, "finding solutions to the ecological sustainability crisis, promoting a fair data economy, and strengthening democracy and engagement" are identified as the main themes.[66] Sitra operates as an investor for companies and start-ups to enable the creation of profitable businesses. Sitra's future operation is funded by the returns of its capital. The Bank of Finland and the Finnish Parliament provided Sitra the endowment capital, which laid the foundation for its investment assets.

[60] https://www.aka.fi/en/about-us/what-we-do/what-we-are/
[61] https://tem.fi/en/supporting-internationalisation
[62] https://www.businessfinland.fi/en/for-finnish-customers/services/funding
[63] https://www.finnvera.fi/eng
[64] https://www.ilmastorahasto.fi/en/
[65] https://www.sitra.fi/en/topics/organisation-decision-making/
[66] https://www.sitra.fi/en/news/sitras-new-strategy-out-now/

The Finnish national Agency for Education (EDUFI) provides scholarship and exchange programmes for young people, students, and researchers for the development of education and training, early childhood education and lifelong learning in addition to the promotion of internationalization in Finland.[67]

The Council of Finnish Foundations is an association of grant-makers providing a range of services for grant applicants and grant recipients such as "issuing opinions on proposals to reform laws that govern the interests of foundations and other grant-making organizations"[68], even though it does not offer funds itself.

The budget for R&I

The Ministry of Economic Affairs and Employment (MEAE) in co-operation with Business Finland is setting the state budget relevant for IP8 activities. While the Ministry of Finance sets the overall scheme and overall numbers, MEAE can fine-tune funding inside its budget. There is no ear-marked budget for IP8 scope in Finland. In the budget for 2023, MEAE has allocated €253 M for energy aid[69] and IP 8 related projects have gained funding related to e.g., biomethane and renewable fuels. Energy aid may support renewable energy, energy efficiency, and low-carbon energy systems if it incentivizes investment and research. Aid may also fund waste heat recovery and Important Projects of Common European Interest. The energy aid regulation aligns with the June 2022 Climate and Energy Strategy and the Government Programme, prioritizing projects that apply new technologies. The MEAE decides whether to grant aid to an investment project and performs other related tasks if the eligible costs of the project exceed €5 M or if the project involves new technology and the eligible costs exceed €1 M. The decisions to grant aid with costs smaller than the aforementioned are taken by Business Finland. Before, the budget for energy aid was smaller, e.g., in the range of €35-40 M per year. The substantial increase in aid can be explained by the channeling of RRF funds through energy aid.

Additionally, MEAE allocates €0.47 bn to Support for research, development, and innovation funding. These include, but are not limited to, research, development and innovation activities for companies and entities, carrying out research and development projects and international programs by state budgetary organizations and universities, professional development projects for public sector organizations, membership and participation fees for innovation cooperation and programs in international organizations, national and European Union contributions to European cooperation projects, and financing for important projects of common European interest. €29.6 M of the funding is allocated for Veturi ecosystems and €1.1 M for low-carbon, circular, and digital industrial renewal program. These funding programmes can support IP 8 related activities. Additional possible funding sources may be found in programmes for boosting key sectors and strengthening skills, promoting innovation and research infrastructure, and support for innovative growth companies, for which €8.4 M, €8.6 M, and €5.6 M is allocated, respectively.

The Academy of Finland's budget is provided in Table 7.1.

[67] https://www.oph.fi/en/about-us
[68] https://www.efc.be/member-post/council-of-finnish-foundations-2/
[69] https://tutkibudjettia.fi/talousarvio/menot/32/20

Table 7.1: Academy Projects: Number of funded projects, total funding, and average funding per funded Academy Project by organization in 2020-2022. The table only includes organizations which at least 5 funded projects in 2020, 2021 or 2022. The organizations are listed in alphabetical order. A star (*) indicates that the organization had less than 5 funded projects that year. In the data, consortium subprojects have been counted as separate projects. The Academy Project funding is typically granted for a 4-year funding period.[70]

Organisation	Funded projects in 2020	Funded projects in 2021	Funded projects in 2022	Granted funding total (MEUR) in 2020	Granted funding total (MEUR) in 2021	Granted funding total (MEUR) in 2022
Aalto University	36	30	23	15.5	12.8	10.1
Finnish Environment Institute	6	*	*	2.4	*	*
Finnish Meteorological Institute	*	7	6	*	2.9	2.4
Lappeenranta-Lahti University of Technology LUT	*	*	7	*	*	2.8
Natural Resources Institute Finland	5	*	8	2.2	*	2.7
Tampere University	21	26	37	8.7	12.2	14.8
University of Eastern Finland	25	21	15	10.2	8.5	6.4
University of Helsinki	81	79	59	35.3	34.2	24.7
University of Jyväskylä	14	18	17	6.4	7.5	8.0
University of Oulu	14	17	22	6.7	7.5	9.7
University of Turku	31	29	22	12.8	12.2	9.9
VTT Technical Research Centre of Finland Ltd.	12	5	10	4.8	2.4	4.1
Åbo Akademi University	*	6	5	*	2.4	2.0
Total (incl. organisations not listed above)	**268**	**270**	**251**	**114.4**	**115.4**	**104.5**

The research programs and priorities

The Academy Programmes are the AoF's funding schemes. None of its programmes specifically covers any of the 13 activities of IP8.[71]

- **BioFuture2025 (2017-2025)**
- Digital Humanities (DIGIHUM) 2016-2022
- Molecular Regulatory Networks of Life (R'Life) 2020–2023
- **C1 Value (2020–2023)**
- Climate Change and Health (CLIHE) 2020-2023

[70]https://www.aka.fi/globalassets/1-tutkimusrahoitus/2-arviointi-ja-paatoksenteko/5-rahoituspaatokset/table_7_average_funding_of_academy_projects.pdf
[71] https://www.aka.fi/en/research-funding/programmes-and-other-funding-schemes/academy-programmes/

- Academy Programme for Climate Change and Carbon Neutrality Research (Climate-Synergy) 2022–2023
- Critical Materials in Circular Economy of Cities (Romulus) (2022-2025)
- Development research – DEVELOP2 (2023–2026)
- Pandemics and Other Crises – Response and Preparedness (RESILIENCE) 2021–2023

The Academy of Finland has a Strategic Research Council (SRC), which funds long-term, programme-based research that provides solutions to major challenges facing Finnish society. The programmes aim at finding solutions to these challenges, and at seeking opportunities connected to those through multidisciplinary research projects. Dynamic collaboration between research knowledge producers and users is a significant factor in SRC programmes. Every year, the SRC proposes the main strategic research themes according to the needs defined by the Finnish Government, who makes the final decision on the themes and priorities. According to the decision outcomes, the SRC programmes are announced. Current SRC programs are given below.[72]

- **Adaptation and Resilience for Sustainable Growth, ADAPT (2018-2023)**
- **Keys to Sustainable Growth, GROWTH (2018-2023)**
- Towards a Sustainable, Healthy and Climate-Neutral Food System, FOOD (2019–2025)
- Innovative Materials and Services to Promote Resource Wisdom and Sustainable Development, IMPRES (2019–2025)
- The Changing Role of Public Authority and the Potential for Steering Society, STEER (2019–2025)
- Culture in an Increasingly Technologically Driven Society, CULT (2019–2025)
- Climate change and humans, CLIMATE (2020–2026)
- Information literacy and evidence-informed decision-making, LITERACY (2020–2026)
- Demographic Changes – Causes, Consequences and Solutions, DEMOGRAPHY (2021–2027)
- Environmental and Social Links to Biodiversity Loss, BIOD (2021–2027)
- Pandemics as a Challenge for Society, PANDEMICS (2021–2024)
- Children and young people – healthy, thriving and capable makers of the future, YOUNG (2022–2028)
- Security and trust in the age of algorithms, SHIELD (2022–2028)

Projects related to the IP8 activities can find funding in some of the above programmes (highlighted in bold).

The SRC assesses research projects it funded, evaluating them for societal impact and scientific quality at the programme level. This provides an overview of programme activities and facilitates continuous funding development by sharing information between programmes. Both achieved and potential effects are considered, with attention to programme-specific details.

Centres of Excellence (CoE) funded through the Academy of Finland's Centre of Excellence Programmes are scientifically first-rate research communities, which are at the cutting edge of their fields, creating new scientific avenues, and creative and innovative research environments in addition to the training of new talented researchers with the capacity for renewal and high societal impact. The CoEs are jointly funded by the AoF, universities, research institutes and business companies for a period of eight years. The AoF selects CoEs according to international evaluations and objectives of science policy based on their scientific quality, contribution to science renewal and scientific impact.[73].

[72] https://www.aka.fi/en/strategic-research/strategic-research/strategic-research-in-a-nutshell/programmes-and-projects/

[73]https://www.aka.fi/en/research-funding/programmes-and-other-funding-schemes/finnish-centres-of-excellence/current-centres-of-excellence/

The AoF's Flagship Programmes support high-quality research with an aim to increase the societal impact emerging from the research. The Finnish Flagships have a host institute (six universities, two research institutes and Helsinki University Hospital) which facilitate active collaboration between different actors and promote the development and expansion of systematic operations by providing substantial long-term funding[74].

The AoF funds Research infrastructures which are promoting research through the Finnish Research Infrastructure Committee (FIRI Committee). The scope is for Finnish research to reach higher quality, renewal, competitiveness and interdisciplinarity and increase attractiveness. Applications for infrastructure funding are evaluated similarly to that of other AoF's funding instruments.[75]

Additionally, the AoF supports the implementation of the Recovery and Resilience Plan.[76] In years 2021 and 2022, the AoF's RRF-based funding amounted to €45 M and €40 M, respectively.

The AoF helps to strengthen the research profiles of Finnish universities through the funding instrument called Profi. Profi has achieved strengthening of specific components, reduction of fragmentation within disciplines and increasing multidisciplinary and interdisciplinary cooperation as well as lowering the administrative burden needed during the application and reporting stages[77].

Business Finland launched a mission-based approach in 2023. The first two missions are Diginative Finland and Carbon Neutral Future, as a response to global changes that present promising future markets for Finnish companies. These missions aim to enhance Finnish companies' ability to capitalize on future market opportunities by combining strategic foresight with current business support. Moving forward, Business Finland's focus will be on missions, both current and forthcoming. The missions are promoted through programmes, a list of which is given below.[78] (The ones relevant for the IP8 activities are described in the further details):

- 6G Bridge
- Creative Business Finland
- Decarbonized Cities Finland
- Digital Trust Finland
- Experience Commerce Finland
- Food from Finland
- New Space Economy
- Personalized Health Finland
- Smart Life Finland
- Sustainable Manufacturing Finland

[74] https://www.aka.fi/en/research-funding/programmes-and-other-funding-schemes/flagship-programme/
[75] https://www.aka.fi/en/research-funding/programmes-and-other-funding-schemes/research-infrastructures/
[76] https://www.aka.fi/en/research-funding/programmes-and-other-funding-schemes/funding-from-eu-recovery-and-resilience-facility-rrf/
[77] https://www.aka.fi/en/research-funding/programmes-and-other-funding-schemes/university-profiling/
[78] https://www.businessfinland.fi/en/for-finnish-customers/services/programs

Additionally, Business Finland offers partnership funding for research, development, and innovation projects in leading companies' ecosystem themes (Veturi).[79] Funding is intended in particular for joint projects between companies and joint projects between companies and research organizations. Launched in 2020 and 2021, the Veturi challenges aimed to encourage companies to significantly increase their R&D and innovation activities in Finland and create new jobs and billion-euro ecosystems for new business. The Veturi companies are **ABB**[80], Borealis Polymers, Fortum, Kone, Metsä Group, **Meyer Turku**[81], **Neste**[82], Nokia, Sandvik, TietoEVRY, **Valmet**[83] and **Wärtsilä**[84], being the ones in bold particularly relevant for IP8.

Finnish funding schemes and grant types

BioFuture2025 programme has the scope of promoting the shift away from a fossil-fuelled economy and to a biobased economy. It has several calls that can be of interest for the IP8 activities:

- BioFuture2025, funding €10.3 M, funding period: 1 Jan 2017-31 Dec 2020
- NordForsk, Nordic Centre of Excellence (NCoE) call (2016): Nordic Bioeconomy Programme, funding period 2017-2021
- ForestValue – Innovating Forest-based Bioeconomy ERANET cofund – Call (2017), €1.36 M, funding period 2019-2021
- ForestValue Joint Call 2021, €0.75 M, funding period 2022-2025

C1 Value promotes research on capture and utilization of C1 compounds (CO2, CO, CH4, CH3OH). The goal is to generate knowledge on how to convert these into useful products. It has a budget of €6 M from 1 Jan 2020 to 31 Dec 2023

The Ministry of Economic Affairs and Employment and Business Finland's funding scheme Energy Aid is granted to investigation and investment projects that involve low-carbon energy solutions. It is open for companies of all sizes, communities, and organizations.[85] Energy Aid provides funding for investments in renewable energy, energy savings and efficiency, phasing-out of coal in energy industries and large demonstration projects. The Business Finland innovation funding centre grants aid for projects whose acceptable costs do not exceed €5 M and for projects involving new technology whose acceptable costs do not exceed €1 M. Aid for higher investment costs is granted by the Ministry of Economic Affairs and Employment. Priority is given to new energy technologies. For large corporations, the maximum level of aid is 30% also for new technology projects.

[79] https://www.businessfinland.fi/en/for-finnish-customers/services/funding/funding-for-leading-companies-and-ecosystems
[80]https://www.businessfinland.fi/492bb4/globalassets/finnish-customers/01-funding/06-ecosystems/abb-green-electrification-2035-veturi-roadmap.pdf
[81] https://www.businessfinland.fi/494cb5/globalassets/finnish-customers/01-funding/06-ecosystems/meyer-turku-2022-03-18-necoleap-veturi-roadmap.pdf
[82]https://www.businessfinland.fi/4a9cd1/globalassets/finnish-customers/01-funding/06-ecosystems/neste_veturi_tiekartta.pdf
[83] https://www.businessfinland.fi/495022/globalassets/finnish-customers/01-funding/06-ecosystems/valmet-beyond-circularity-roadmap-16march2022.pdf
[84] https://www.businessfinland.fi/494cf9/globalassets/finnish-customers/01-funding/06-ecosystems/wartsila-zem-leading-company-ecosystem-roadmap.pdf
[85] https://www.businessfinland.fi/en/for-finnish-customers/services/funding/energy-aid

As part of the renewable energy investment, topics (conventional technology) most relevant for the IP8 activities are:

- Heating plant projects (wood fuels) (funding 10%)
- Landfill gas projects (funding 15%)
- Small CHP projects (funding 15%)
- Biogas projects (funding 25%)

Coal phase-out had €90 M available for the period between 2020 and 2022 that could be used to produce renewable energy, which is relevant for IP8 activities as well.

Large demonstration projects for new energy technologies had €60 M available for 2021. This type of funding supports the areas of transport biofuels, among others, that can cover IP8 value chains. Large demonstration projects typically have high TRL levels. For year 2022, €153 M were made available for large demonstrations, of which €50 M was dedicated to hydrogen projects, and for year 2023, approximately €200 M will be available.[86]

Ministry of Economic Affairs and Employment and Business Finland evaluates the project proposals based on the following criteria[87]:

- The applicant's resources and situation
- Competence
- Project content
- Market potential and the competitive advantage that can be achieved
- The company's willingness and ability to grow internationally

Relevance to IP8 activities

Energy Aid scheme of MEAE and Business Finland as well as Support for research, development, and innovation scheme, of which Veturi partnership is also part of, provide different types of funding that cover IP8 relevant activities and value chains as part of their scope.

Evaluation of projects after completion

The financier monitors Energy Aid project effectiveness and can request reports on energy, environmental, employment, and other impacts. The beneficiary must provide info on plan implementation and business development. The financier can check financial statements for 5 years after project completion and may have them analyzed by another public financier. The final report must also be accompanied by an Energy Aid effectiveness evaluation form and an auditor's report.

The Academy of Finland monitors the impact of Academy-funded research. Key data to support the monitoring can be obtained from research reports. The principal investigator (PI) of the research project or the funding recipient is responsible for the reporting. The scientific reports are submitted by the project PI and the financial reports by the site of research (i.e., the recipient of the government grant). Academy of Finland-funded researchers must submit their project reports online by June 1st of the year after funding

[86] https://tem.fi/-/neljalletoista-puhtaan-energian-rrf-hankkeelle-investointitukea-yhteensa-liki-109-miljoonaa-euroa
[87] https://www.businessfinland.fi/en/for-finnish-customers/services/funding/guidelines-terms-and-forms/how-to-apply

ends. For consortium projects, the lead PI submits the report after all subprojects are complete. The final report covers all funding decisions, with reporting deadlines coinciding with the funding period.[88]

[88] https://www.aka.fi/en/research-funding/apply-for-funding/report--your-project/

8. Public funding in France

The French stakeholders

The Ministry of Higher Education, Research and Innovation (Ministere de l'Enseignement Supérieur, de la Recherche et de l'Innovation, MESRI) is responsible for assigning institutional funding. Its total budget for 2021 is set to €24,000 M.

The French National Research Agency (Agence nationale de la recherche, ANR) was founded in 2005 to promote project-based research and to stimulate innovation by promoting collaboration between the public and private sector[89]. The ANR is responsible for the coordination of calls for proposals for competitive funding and for the implementation of the Work Programme (Plan d'action, PA)[90].

The Ecologic Transition Agency (Agence de la transition écologique, ADEME) is a public institution under the supervision of the Ministry of Ecological Transition and the MESRI that mobilizes citizens, economic players and regions, giving them the means to progress towards a resource-efficient, lower-carbon society. In all areas such energy, air, circular economy, food, waste, soil, it advises, facilitate and helps finance many projects, from research to the sharing of solutions.

The budget for R&I

The government budget for research was €15,000 M for 2020. The research programming law for 2021-2030 (Loi de programmation de la recherche 2021-2030) was initiated in early 2019 by the President of the Republic and the Prime Minister and supported by the MESRI. The law provides for an increase of the research budget compared to 2020 of €400 M in 2021, €800 M in 2022 and €1,200 M in 2023. The objective is to reach an annual budget of €20,000 M in 2030.

Figure 8.1 shows the public investments in the energy field over the years, where the green bars represent investments on new energy technologies that include the topics of interest for IP8[91]. Such funding comes from different programmes that are further described in the next sections.

[89] https://anr.fr/en/
[90] https://anr.fr/fileadmin/documents/2020/ANR-WP-2021.pdf
[91] https://www.ecologie.gouv.fr/sites/default/files/SNRE%9120vf%20d%C3%A9c%202016.pdf

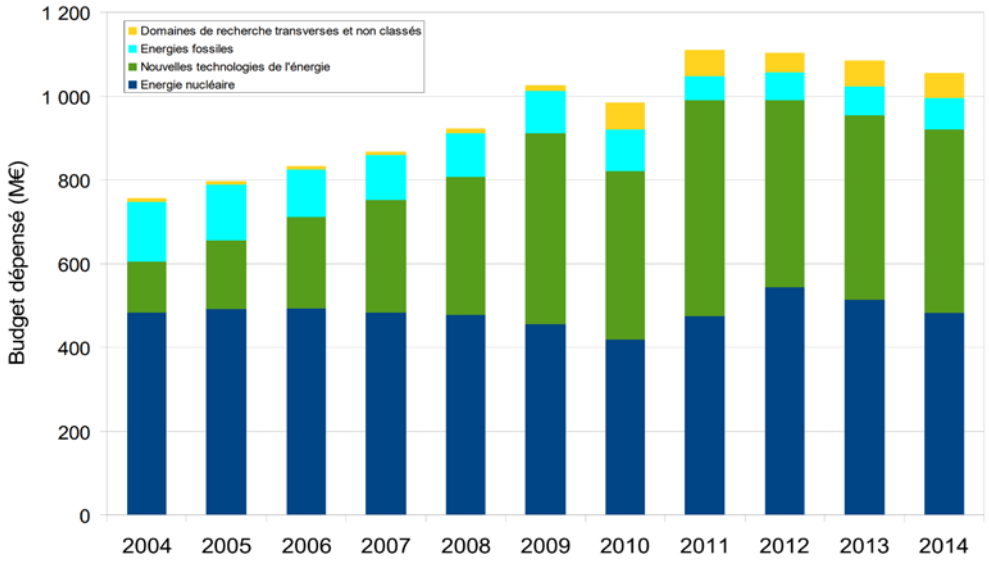

Figure 8.1: Public funding to R&I in the energy fields: nuclear energy (blue), new energy technologies (green), fossil energy (light blue) and transversal and unclassified research areas (yellow). Figure taken from the SNRE[91].

The research programs and priorities

The Ministry of Higher Education, Research and Innovation published in 2013 the National research strategy (Stratégie nationale de recherche, SNR) for the period 2015-2020, under the name "France Europe 2020"[92]. In line with the Horizon 2020 programme, the SNR defines 10 societal challenges, each divided in a number of orientations (only the relevant orientations are described in more detail):

- Sober management of resources and adaptation to climate change
- **Clean, safe and efficient energy**
  - ORIENTATION 10: FOSSIL CARBON SUBSTITUTES FOR ENERGY AND CHEMICALS: The production of biofuels and applications of bio-based chemistry are only in their infancy. For these substitution channels to be sustainable, it will be necessary to break with specialist reasoning and think of the chemical process or biofuel in the light of competing applications, on the scale (local or not) at which the resource and the product are mobilized and used, the conditions for obtaining it, the possibilities for recycling the product, the existence of other substitute materials
- Stimulate industrial renewal
- Health and wellbeing
- Food security and demographic challenge
- Mobility and sustainable urban systems
- Information and communication society
- Innovative, integrative and adaptive societies
- A spatial ambition for Europe
- Freedom and security of Europe, its citizens and its residents.

France has also additional national strategies that are relevant:

[92] https://cache.media.enseignementsup-recherche.gouv.fr/file/Strategie_Recherche/26/9/strategie_nationale_recherche_397269.pdf

- The National Strategy for Energy Research (Stratégie nationale de recherche Energétique, SNRE, 2016)[91]: which outlines 4 orientations, among which "Key transformative themes for the energy transition", where one of the focus is to develop new renewable resources and promote the development of the circular economy.
- The French Bioeconomy Strategy (Une Stratégie Bioéconomie pour la France - Plan d'action 2018-2020)[93]: it defines 5 axes, each subdivided in actions. In particular, Action 13 of Axis 5 supports innovations and investments in advanced biofuels through grants via the Investments for the Future program (Programme d'Investissements d'Avenir, PIA).
- The Strategy for Development of Clean Mobility (Stratégie de développement de la mobilité propre, 2016)[94]: which encourage the development of carbon-free solutions for mobility such as biofuels, increased battery autonomy, hydrogen mobility, hydrogen methanation under peaks of renewable energy production.
- The National Biomass Mobilization Strategy (Stratégie Nationale de Mobilisation de la Biomasse, 2016)[95]: through different plans and instruments, the strategy favours the further use of biomass for different purposes such as biofuels and energy production (cogeneration), through taxation incentives and direct funding e.g., through the Heat Fund (Fonds Chaleur).
- The National Low Carbon Strategy (Stratégie Nationale Bas-Carbone)[96]: serves as France's policymaking road map in terms of climate change mitigation.

French funding schemes and grant types

The Generic Call for Proposals 2021 (Appel à projets générique, AAPG 2021) is the ANR main call[97]. It is open to research groups in both the public and the private sector. The call includes 4 types of funding instruments: individual research projects coordinated by young researchers (JCJC), collaborative research projects between public entities in a national (PRC) or bilateral international context (PRCI) or between public and private entities with a potential opening to the world of business (PRCE). The call includes 50 research themes, among which:

- Theme 2.2. Sustainable, clean, safe and efficient energy: energy from waste (energy related to biomass use goes under the "Bioeconomy" theme), hydrogen.
- Theme 8.9. Bioeconomy: chemistry, biotechnology, processes and system approaches, from biomass to usages.

The Investments for the Future programme (Programme d'Investissements d'Avenir, PIA) was created in 2010 to stimulate investment and innovation in priority sectors to drive growth[98]. The PIA was allocated

[93] https://agriculture.gouv.fr/une-strategie-bioeconomie-pour-la-france-plan-daction-2018-2020
[94]https://www.ecologie.gouv.fr/sites/default/files/Strat%C3%A9gie%20d%C3%A9veloppement%20mobilit%C3%A9%20propre.pdf
[95]https://www.ecologie.gouv.fr/sites/default/files/Strat%C3%A9gie%20Nationale%20de%20Mobilisation%20de%20la%20Biomasse.pdf
[96] https://www.ecologie.gouv.fr/sites/default/files/en_SNBC-2_complete.pdf
[97]https://anr.fr/en/call-for-proposals-details/call/appel-a-projets-generique-2021/?tx_anrprojects_request%5Baction%5D=show&cHash=3cc9801c15d07216467190b2e7615113
[98] https://www.gouvernement.fr/les-appels-a-projets-en-cours

€35,000 M in 2010, €12,000 M in 2013 and €10,000 M in 2017. The PIA has the following relevant calls for proposals

- "Hydrogen technological bricks and demonstrators" (Briques technologiques et démonstrateurs hydrogène) aims to support innovation work, allowing the development or improvement of components and systems linked to the production, transport, and use of hydrogen. Projects must involve one or more companies, to develop equipment, a product or a service, or to create a demonstrator on the national territory using hydrogen, with a view to ecological and energy transition and the structuring of the sector. The call for projects is open as of October 14, 2020, until December 31, 2022 (specifications may be revised annually). Financing varies from 25% to 100% of the project costs, depending on the type of activity and the size of the enterprise.
- "Territorial ecosystem for hydrogen" (Ecosystèmes territoriaux hydrogène): The call is part of the National Hydrogen Strategy, published on September 8, 2020. Applicants are a company, a community or a consortium that want to get involved in the implementation of hydrogen in its territory. This call aims to help investments in ecosystems, which combine hydrogen production/ distribution infrastructures, and the uses of hydrogen. The uses more particularly targeted are: industrial uses (the challenge is to decarbonize the current uses of hydrogen in industry), mobility uses (first deployments of hydrogen vehicles in professional fleets, for transporting people or goods), certain stationary applications relying on generating power with hydrogen fuel cells, for supplying quayside ships, for events and construction, or in support of networks and micro-networks in non-interconnected areas. The projects may involve consortia of actors, either private or public. The participation of local authorities is highly expected. The call is open until September 14, 2021. Two intermediate readings of the complete applications are carried out on December 17, 2020, and March 16, 2021.
- "Demonstrators of solutions for the development of the competitiveness of the anaerobic digestion sector" (Démonstrateurs de solutions pour le développement de la compétitivité de la filière méthanisation). The objective is to propose innovative industrial solutions that deeply structure the sector. These innovations can be technological, organizational, conceptual, service or even financial.
    - The ambition is to contribute on the one hand to speeding up their marketing and to develop a French sector and, on the other hand, to help achieve a 30% reduction in production costs by 2030. This call has two deadlines: an intermediate on January 11, 2021, and a final on May 28, 2021.
- "Bioeconomy and protection of the environment" (Bioéconomie et protection de l'environnement): The main objectives are to generate growth for the French economy and develop sustainable jobs in the field of ecological and energy transition by reducing the environmental impact; to develop a low-carbon and competitive energy mix; to change production methods and consumption practices while facilitating societal acceptability. One of two thematic axes is around the topic of Bioeconomy and aims to adopt new modes of production, development and consumption of resources, including biomass. The bioeconomy encompasses all activities related to production systems, mobilization and sustainable transformation of biomass, whether forestry, agricultural, aquaculture, agrifood or fisheries for valuation in the food chains, biobased products and energy. The call deadline is on January 20, 2021.

The LabCom programme supports the creation of joint laboratories between public research institutions, small and medium enterprises, to develop the potential for industrial partnership and transfer capacity with academic research players. €0.35 M are dedicated to the programme that is subject to specific calls[99].

The Industrial Chairs programme aims to mobilize resources to consolidate and strengthen the competitiveness of French companies[100].

The Enhancement of Carnot Institutes programme (Valorisation-Instituts Carnot) benefits from an endowment within the framework of the "Investments for the Future" programme. Three calls for proposals have been launched in this context; the first on specific actions towards small and medium-sized enterprises, the second on specific actions at international level and the third to allow a structuring of supply in response to the demand of economic[101].

The Building European or International Scientific Network programme (Montage de Reseaux Scientifiques Europeens ou Internationaux, MRSEI) aims to facilitate French researchers' access to European (Horizon 2020 and soon Horizon Europe 2021-2027) and international funding programmes. The proposals submitted will therefore have to prefigure an application to a European or international call for proposals. The programme is subject to continuous submission with several evaluation and selection sessions per year[102].

Figure 8.2: Positioning of the main current national systems of incentives in the energy secor throughout the innovation chain. Figure modified from the SNRE[91].

[99] https://anr.fr/fr/actualites-delanr/details/news/laboratoires-communs-un-instrument-de-financement-ouvert-au-fil-de-leau/
[100] https://anr.fr/fr/detail/call/chaires-industrielles-7/
[101] https://www.instituts-carnot.eu/en
[102] https://anr.fr/fileadmin/aap/2020/aap-mrsei-2020-v1.1.pdf

9. Public funding in Germany

As a federal state, Germany is divided into 16 states (so-called *Länder*), which have a certain degree of authority. Support for research and innovation can therefore be obtained on different levels. In addition to funding from the EU, public funding in Germany – both competitive and institutional – is provided by federal ministries as well as the governments of any one of the 16 states. ("Länder") Whereas the programs of the federal ministries are typically open to applicants from the entire Germany, funding from one of the states is normally only granted to applicants located in that particular state.

As for institutional funding, competitive funding in Germany can be awarded both on the federal level as well as on state-level. This section gives an overview over the German competitive funding situation for energy research, with the goal to quantify funds for research activities of IP8. Due to the way the data is reported however, such a specific allocation is not always possible. The evaluation presented here therefore includes some assumptions and simplifications.

The German stakeholders

The responsibility for funding various research projects is assigned to different ministries, based on the TRL of the system.

The Federal Ministry of Education and Research (BMBF) together with the project management organization PTJ (Project Management Jülich) are responsible for funding fundamental research projects (TRL 1 – 3) for the entire thematic portfolio of the 7th Energy Research Program.

The Federal Ministry of Food and Agriculture (BMEL) and its project management organization FNR (Agency for Renewable Resources) have the responsibility for funding application–oriented projects within energetic biomass utilization (TRL 3 – 7).

The Federal Ministry for Economic Affairs and Climate Action (BMWK) together with the project management organization PTJ (Project Management Jülich) are responsible for applied research and application-oriented biomass research up to real-scale demonstrations (TRL 3-9). BMWK is also the responsible ministry for the entire 7th Energy Research Program.

The Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) is responsible for fleet targets, fuels, renewable energy products including sustainable renewable fuels and funds some related research activities.

The Federal Ministry for Digital and Transport (BMDV) is in charge of mobility and transport research. BMDV is assisted by the NOW GmbH and project management organisations such as VDI/GET and FNR. BMDV owns several relevant funding programmes for alternative fuels.

The Helmholtz Association is a union of 18 German research centres and therewith the largest scientific organization in Germany. The association is structured into six research groups with different focuses, one of them working in energy research, i.e. renewable energies, energy efficiency, nuclear fusion and safety. This group consists of the German Aerospace Center (DLR), Karlsruhe Institute of Technology (KIT), Jülich Research Center (FZJ), German Research Centre for Geosciences (GFZ), Helmholtz Center for Materials and Energy (HZB), Helmholtz-Center Dresden Rossendorf (HZDR), and Max Planck Institute for Plasma Physics (IPP). Financing of the Helmholtz association is 90 % provided by the federal government and 10 % provided by the home state of the respective institute.

The German biomass research centre (Deutsches Biomasseforschungszentrum – DBFZ) was founded in 2008. DBFZ is a limited liability company (*GmbH*) and an important actor in German bioenergy research with about

250 employees. Research activities are within bioenergy systems, biochemical conversion, thermochemical conversion and biorefineries. DBFZ partakes in competitive funding activities. The Federal Republic of Germany is owner of DBFZ and as such, provides the difference between expenses and income (via for example competitive funding) as institutional funding. In 2022, DBFZ received €10.2 M in competitive funding and €11 M in institutional funding, provided by the Federal Ministry of Food and Agriculture (BMEL)[103].

The budget for R&I

Due to the political structure of Germany, research funding – competitive and institutional – can also be provided by each of the 16 states. The energy policy and the resulting funding possibilities of the states are generally in line with the Energy Research Program of the federal government. However, the focus of research funding may differ between the states due to varying local interests. On behalf of the Federal Ministry for Economic Affairs and Climate Action, the Project Management Jülich has been conducting an annual survey on the financial expenditures of the states on non-nuclear energy research. The combined competitive and institutional funding awarded by each of the 16 German states is shown in 9.1.

Due to the funding structure of the Helmholtz association, the institutional funding received can be clearly dedicated to energy research (which is not always the case with recipients of institutional funding in Germany). Federal funds for energy research of the Helmholtz association are attributed to the Energy Research Program.

[103] Deutsches Biomasseforschungszentrum. Jahresbericht 2021. DBFZ_Jahresbericht_2022

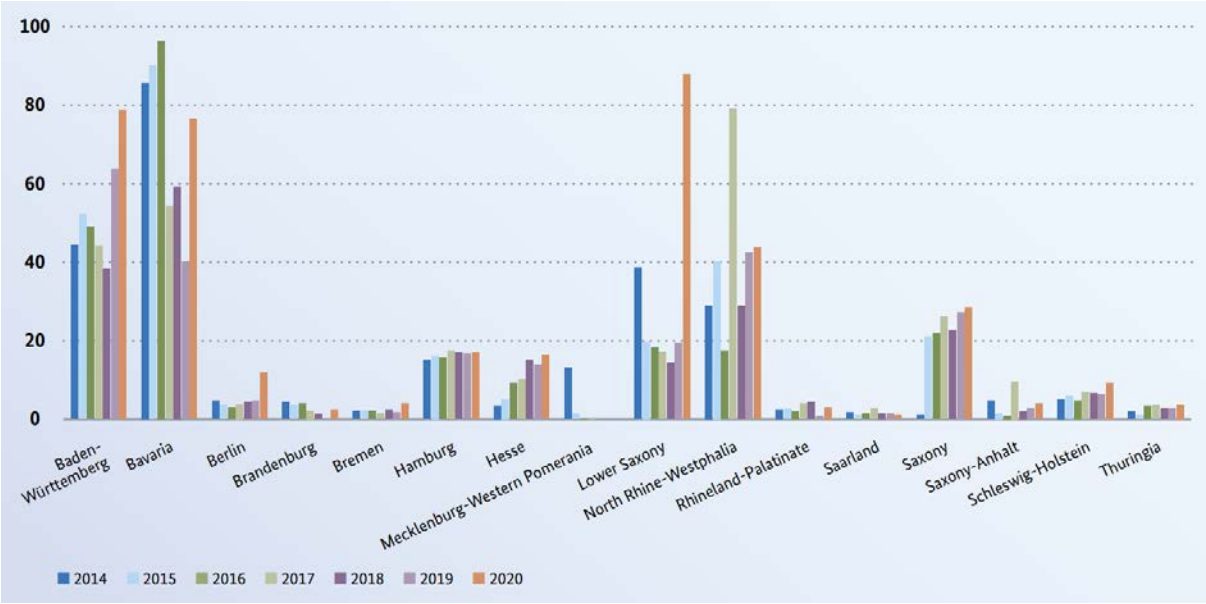

Figure 9.1 Non-nuclear energy research awarded by each of the German states, competitive and institutional funding combined. In million Euros[104]

While the data collection on competitive funding is relatively detailed, accurate information on the institutional funding is generally more difficult to obtain. Due to the broad thematic integration of research topics and the mixed financing of research and teaching, it is not always possible to provide reliable information on institutional energy research funding at reasonable effort. How the states distribute their support between institutional and competitive options varies greatly from state to state and from year to year. In 2020 for example, 90 % of funds for energy research in Rhineland-Palatinate were used as competitive funding, whereas Hamburg only spent 12 % of their energy research investments on projects[105]. The combined institutional and competitive funding in the years 2010 to 2018 (Figure 9.2) has varied between 157 and 311 million Euros and amounted in the last reported year (2020) to €387 M. Over half of it (54.2 % or €210 M in 2020) were spent on projects[105] and consequently €177 M used for institutional funding in 2020. Since 2014, the institutional funding has comprised between 38 and 45.8 % of the total expenditures of the states on non-nuclear energy research.

[104] Federal Ministry of Economic Affairs and Climate Action. 2022 Federal Report on Energy Research. 2022: 2022 Federal Government Report on Energy Research (bmwk.de)

[105] Jessen C. Förderung der nichtnuklearen Energieforschung durch die Bundesländer im Jahre 2020 2022:1–9

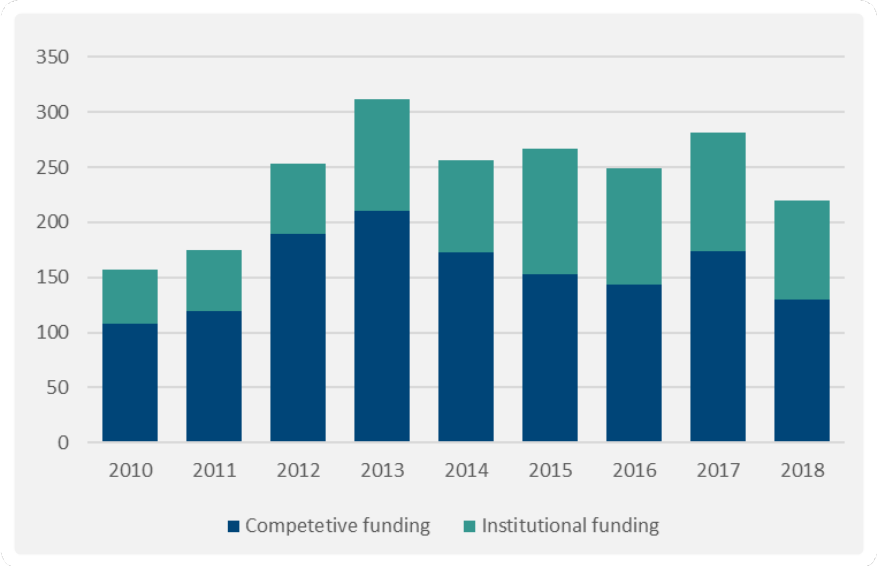

Figure 9.2 Competitive and institutional funding awarded by the 16 German states to non-nuclear energy research, in million Euros[106,107,108,109,110,111,112,113]

Due to the reasons mentioned above, the amounts reported for institutional funding are subject to some uncertainties and it is not possible to determine what share of the institutional funds have been used for research activities of IP8.

As is the case with institutional funding, research institutions can obtain support from their respective home state in addition to funding from the federal government. Furthermore, the use of grants from the European Union for project funding has become an important additional financing option for the German states. For energy research, the European Regional Development Fund is especially important. The data presented in this section do not include EU grants, but only contributions made by the states themselves. It should therefore be noted that the information provided in this chapter does not give a full overview of the energy research situation in the respective states. Mecklenburg-Western Pomerania for example has based its energy research solely on EU subsidies for several years, which is not shown in Figure 9.3.

The expenditures for non-nuclear energy research on state level (all states combined) for the year 2020 are shown in Figure 9.3. The expenditures were originally reported as a combined amount for institutional and competitive funding, with the additional information that competitive funding comprises 54.2% of the total funding expenses. No information about the respective competitive and institutional shares for each category was available. Figure 9.3 shows therefore the total research budget, combining institutional and competitive funding. Jessen has shown that the query of institutional funding is basically difficult. This is due

[106] Jessen C. Förderung der nichtnuklearen Energieforschung durch die Bundesländer im Jahre 2010 2012:1–9
[107] Jessen C. Förderung der nichtnuklearen Energieforschung durch die Bundesländer im Jahre 2011 2013.
[108] Jessen C. Förderung der nichtnuklearen Energieforschung durch die Bundesländer im Jahre 2012 2014.
[109] Jessen C. Förderung der nichtnuklearen Energieforschung durch die Bundesländer im Jahre 2013 2015.
[110] Jessen C. Förderung der nichtnuklearen Energieforschung durch die Bundesländer im Jahre 2014 2016.
[111] Jessen C. Förderung der nichtnuklearen Energieforschung durch die Bundesländer im Jahre 2015 2017.
[112] Jessen C. Förderung der nichtnuklearen Energieforschung durch die Bundesländer im Jahre 2016 2018:1–9.
[113] Jessen C. Förderung der nichtnuklearen Energieforschung durch die Bundesländer im Jahre 2017 2019:1–9.

in particular to the fact that this would require the state's share of expenditures for basic support of university and non-university research institutions to be reported for the respective budget year. Furthermore, a reliable presentation of the purely institutional energy research funding would not always be possible at a reasonable cost due to the broad thematic integration of research topics (especially at the non-university research institutions) and the mixed financing of research and teaching at the universities from global budgets[114] . Out of the reported categories, hydrogen, bioenergy and thermal power plants have been identified as relevant activities for IP8. Without more detailed information, it is not possible to determine to what extent these are relevant and which of the other activities also contribute to the goals of IP8. Due to the uncertainties and assumptions, the description of the funding situation must therefore be considered a simplification and the numbers used with the according care. In 2020, the German states have spent approximately €19.5 M on hydrogen-related projects, €12M on bioenergy projects and €3.4 M on competitive projects connected to thermal power plants (and CO_2 technologies).

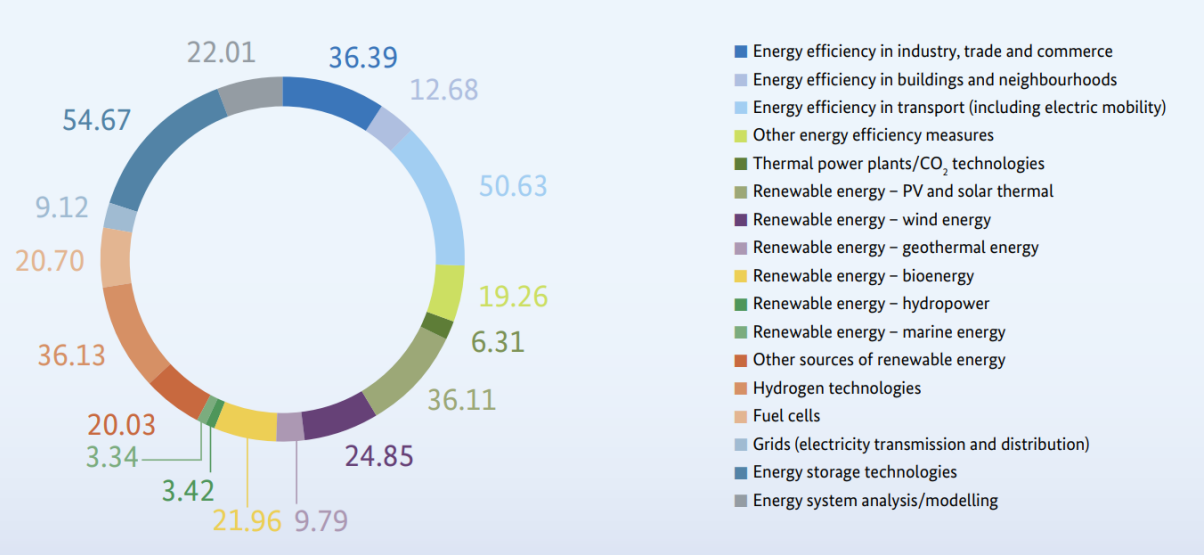

Figure 9.3 Funding from the 16 German states for non-nuclear energy research in 2020, in million Euros. [104]

The research programs and priorities

The 7th Energy Research Program is Germany's main public tool to strengthen and promote research and innovation in the topics of the SET Plan. The program offers both competitive and institutional funding.

The Energy Research Program is mainly providing institutional funding for the institutions of the Helmholtz association. The fourth period for institutional funding via the Energy Research Program started in 2021 and the research institutions involved are FZJ, KIT, HZB, HZDR, IPP and DLR. All but the DLR receive their funding via the Federal Ministry of Education and Research (BMBF), with the DLR being funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK)[104].

The institutional funding provided by the program is aligned with the topics of its competitive funding part, with the exception of nuclear fusion research, which is currently not addressed in projects due to its long-term and fundamental character. The structural distinction from competitive funding is primarily based on

[114] Jessen C. Förderung der nichtnuklearen Energieforschung durch die Bundesländer im Jahre 2020 2022: 3.

the fact that institutional funding ensures the long-term competence and strategic orientation of the German research landscape. Project funding on the other hand provides funding for a limited period of time and focuses on current research needs, setting research policy priorities, especially in the short and medium term. A primary task of the Helmholtz centres receiving institutional funding is to develop, maintain and use large research infrastructure sustainably and make them available to external users from science and industry[104].

The institutional funding provided by the German Energy Research Programs in the last years is shown in Figure 9.4. The reported numbers do not allow any conclusion as to how much institutional funding has been directed towards the activities of IP8. It can be assumed that the respective activities lie within the category of renewable, which however includes much more than bioenergy and renewable fuels. A more detailed assessment would involve evaluating the activities and infrastructure of each of the institutes, which is beyond the scope of the current report. In 2020, a total of €62.9 M in institutional funding was spent on renewable energy research.

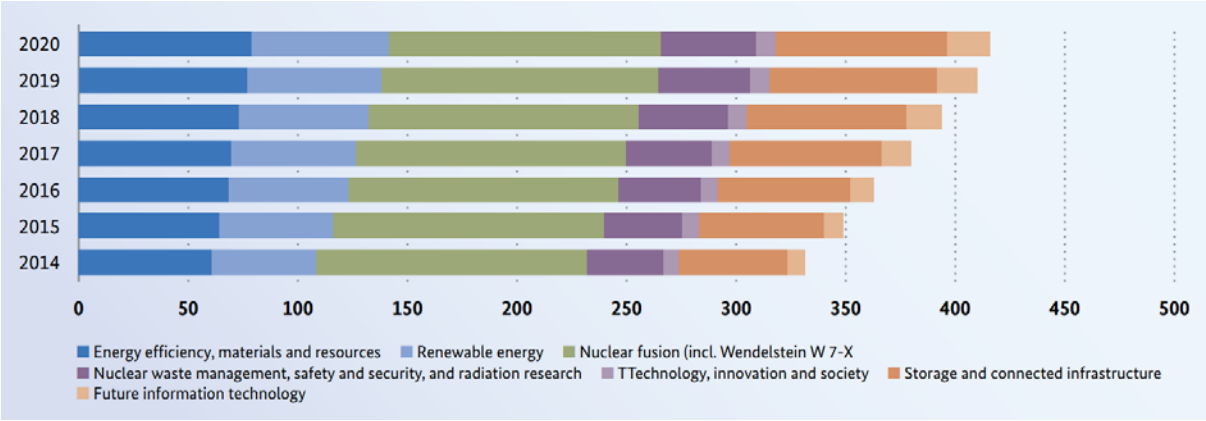

Figure 9.4 Institutional funding via the Energy Research Program in million EUR[104]

In order to assess the effects and results of the institutional funding and to develop energetic research in Germany, the funding agencies provide continuous monitoring and support of the involved research centres. Three panels have been established for this task. A management board serves as a platform for communication, information, and strategy between the participating research centres. In a research-area specific platform, the funding agencies and recipients discuss and decide expenditures and purchases. An external strategic advisory board creates independent scientific support. Currently, institutional funding is in its implementation phase as the funding phase started in 2021. The upcoming funding phase to be implemented within the 8th Energy Research Programme is currently under planning. Therefor a consultation process is being implemented by BMWK. The future Energy Research Programme will start in summer 2023.

The German government has aimed to fund energy research within perennial funding programs since the 1970s. These programs are continuously developed in order to account for energy politics, technological advances and thematical extensions. Within the context of the SET-Plan, Germany is involved in all of the implementation activities and the 7th Energy Research Program is a major tool to support research and innovation in all the SET Implementation Plans. The currently running 7th edition of the funding program targets the energy transition. As this topic is highly important in numerous applications, the funding program has been designed as a cross-ministerial program, ensuring a better alignment of activities and avoiding fragmentation of research efforts. The program is based in and coordinated by the Ministry for Economic

Affairs and Climate Action, but developed with the contribution of other ministries, industry, research and societal organs. The program is also coordinated with research efforts of the federal states (cf. Figure 9.5)[104].

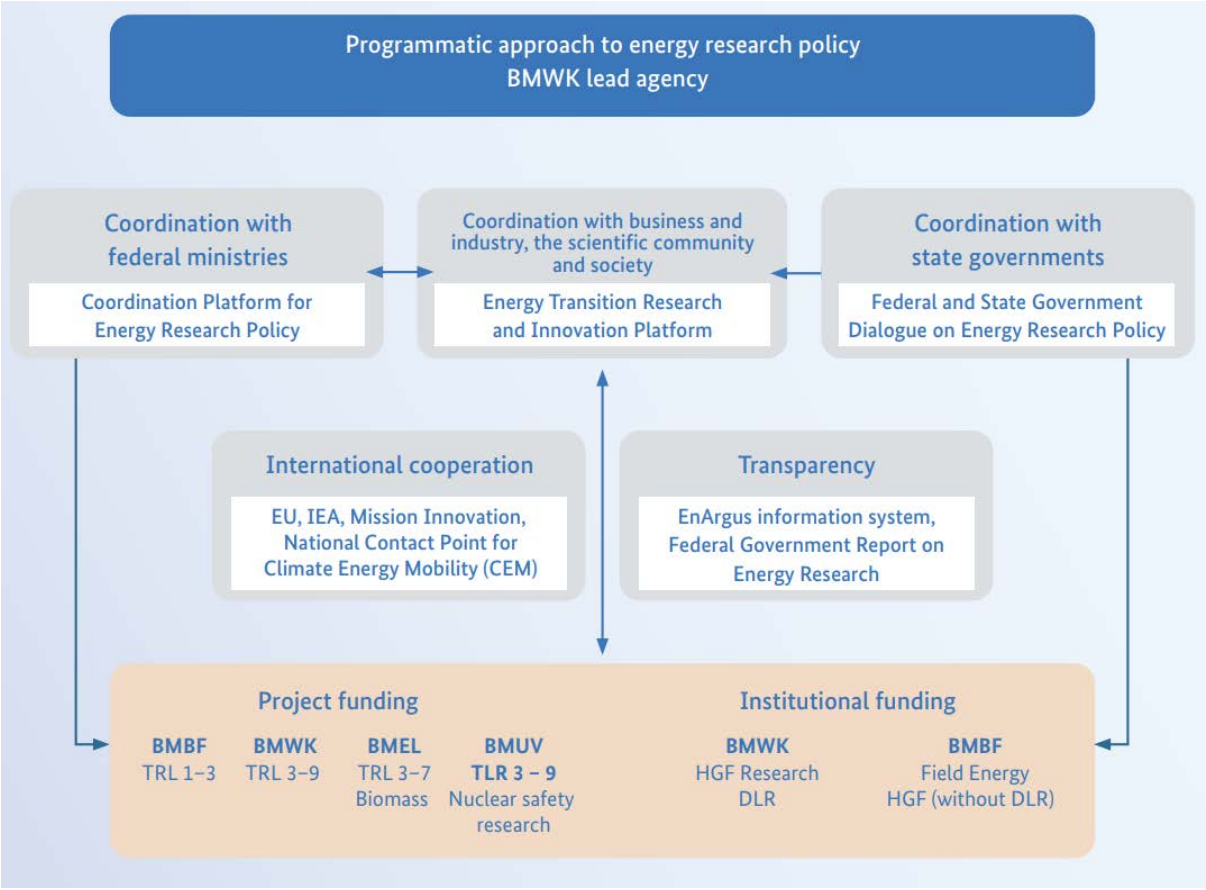

Figure 9.5 Anchoring of the 7th Energy Research Program [104]

As a major tool in promoting energy research and innovation, the program focuses on various topics, including those of IP8. The funded areas are categorized into five larger research areas with several subcategories, the areas relevant to IP8 are marked in bold[104]:

Energy transition in consumer sectors

- Energy efficiency in buildings, quarters and cities
- Energy efficiency in industry, trade, commerce and services
- **Energy transition in transport**

Energy transition in energy production

- Photovoltaics
- Wind energy
- **Bioenergy**
- Geothermal energy
- Hydropower and marine energy
- **Thermal power plants**

System integration

- Power grids
- Power storage
- **Fuel cells and hydrogen**

Cross-system research topics

- Energy system analysis
- Digitalization
- Resource efficiency
- CO_2 technologies
- Energy transition and society
- Material science in energy transition

Nuclear Science

- Reactor safety
- Disposal and final storage
- Radiation research

Whereas the 7th Energy Research Program provides the overall framework for energy research in Germany, each of the involved ministries together with its project management organization issue their own funding programs with specifically targeted research areas, to which the applicants send their project proposals.

The 7th Energy Research Program is based on a dual strategy. Complementary to competitive funding, the program also provides institutional funding channeled via the Helmholtz Association of German Research Centres (HGF). The financial support given out in previous years as well as allocated budget for the next years, both in total and for each of the involved ministries, are shown in Table 9.1. An annual spending in the range of €1.2 to 1.3 B is planned within the running program. Table 9.2 shows the realized spending figures for 2020 and 2021. It shows that the overall spending targets planned for these years have been met.

Table 9. 1 Spending in the Energy Research Programs of the German government[104]

Amounts in million EUR	spending						planned		
	2014	2015	2016	2017	2018	2019	2020	2021	2022
BMWK	400.53	426.59	426.07	529.15	510.62	576.81	725.79	723.80	723.75
Competitive funding	376.82	401.74	399.83	501.37	481.26	545.81	682.98	682.98	682.98
Institutional funding*	23.72	24.85	26.25	27.78	29.36	31.00	42.79	40.82	40.76
BMEL									
Competitive funding	25.78	27.51	28.05	25.73	24.13	29.57	46.80	46.80	46.80
BMBF	392.93	420.03	444.96	484.19	494.24	507.57	528.01	521.81	521.81
Competitive funding	85.05	96.19	108.40	132.35	129.86	128.28	133.36	133.36	133.36
Institutional funding*	307.89	323.85	336.56	351.85	364.38	379.29	394.66	388.45	388.45
Total	**819.25**	**874.14**	**899.09**	**1 039.1**	**1 029.0**	**1 113.9**	**1 300.6**	**1 292.4**	**1 292.4**

Table 9.2 Spending in the Energy Research Programs of the German government 2020 and 2021 [104]

Ministry[1] topic	Actual outlays in € million 2020	2021
Federal Ministry for Economic Affairs and Climate Action	**597,18**	**659,14**
Project funding and accompanying measures	566.19	610.59
Institutional funding (German Aerospace Centre)	30.99	48.54
Federal Ministry of Food and Agriculture	**37.83**	**42.11**
Project funding and accompanying measures	37.83	42.11
Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection	**38.33**	**40.33**
Project funding and accompanying measures	38.33	40.33
Federal Ministry of Education and Research	**542.66**	**569.39**
Project funding and accompanying measures	157.87	303.51
Institutional funding (Helmholtz Association excl. German Aerospace Center)	384.79	265.88
Total	**1,216.00**	**1,310.97**

1...Responsibility in line with organisational decree of Federal Chancellor of 8 December 2021, where title expired, current responsible ministry is cited

The program does not specifically allocate shares of the budget to the activities of each implementation plan, but it is well documented to what research activities the money has been distributed in past years. The respective amounts for the abovementioned subcategories relevant for IP8 are shown in Figures 9.6-9.9 (competitive funding only; research areas relevant to IP8 marked in bold).

For the research area energy transition in transport, competitive funding has been given out to activities within batteries and synthetic fuels, the latter being an activity of IP8. Current funding requirements focus on the production and use of gaseous and liquid fuels based on renewable electricity and the testing of these alternative fuels in engines. The fuel candidates researched within past and ongoing initiatives include methanol, ethanol, OME, kerosene, synthetically produced natural gas and biogas with hydrogen components. In 2021, a total amount of €40.85 M has been used to fund projects on energy transition within transport, €16.59 M thereof have been given to synthetic fuel research (cf. Figure 9.6)[104]. Whether all activities funded within synthetic fuel research can be attributed to IP8 can only be determined with more in-depth research of the individual projects and is beyond the scope of this report. For simplification, the respective funding is assumed relevant for IP8, but this assumption is subject to some uncertainty.

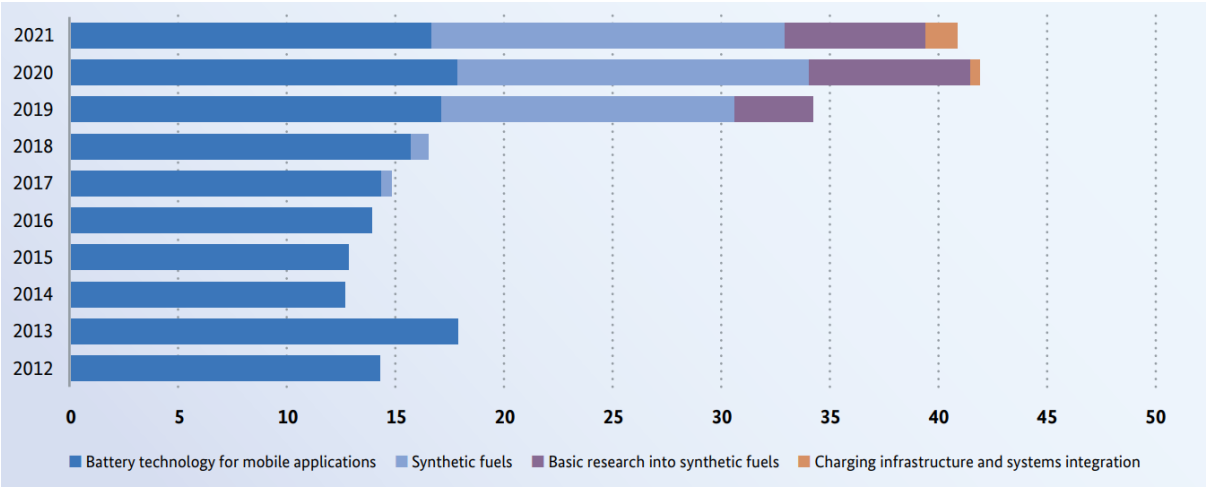

Figure 9.6 Funding for energy transition in transport within the German Energy Research Program, in million EUR[104]

Due to its flexibility, bioenergy is an important contributor to the energy transition. Currently, 54 % of the total energy production from renewables in Germany is based on bioenergy, which is mainly due to its extensive use in heat generation but also in the transport sector. Bioenergy contributes only 7 % to the provision of primary energy. Funding within the bioenergy sector targets the efficient and sustainable use of biomass for energy and fuel provision. The utilization of biogenic wastes and residues, including their conversion to transportation fuels, has been a focus in the Energy Research Program since 2018. Figure 9.7 shows the funding given out to bioenergy projects since 2012. Activities relevant for IP8 may to some extent be influenced by all of the subcategories given in the figure. To what extent the respective funding would count towards IP8 can only be determined in a detailed evaluation on a single-project level, which is beyond the scope of this report. As a simplification, the categories conversion of gaseous and liquid biofuels are included as activities relevant for IP8. In 2021, a total of €63.72 M was awarded to bioenergy research, thereof €6.46 M and €0.78 M to research within gaseous and liquid conversion, respectively.

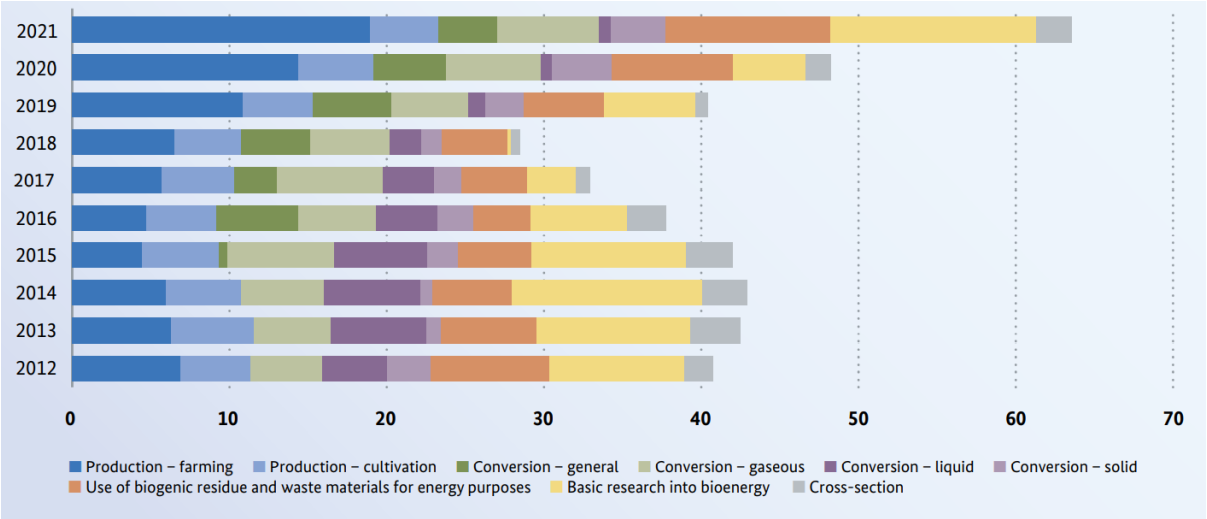

Figure 9.7 Funding for bioenergy within the German Energy Research Program, in million EUR[104]

Conventional power plants will remain an important part of energy provision as they deliver heat and power in times where weather conditions do not allow photovoltaic and wind energy systems to do so. The Energy Research Program promotes activities that utilize biomass and/or wastes for heat and power generation, especially in existing plants for fossil fuels. The respective funding activity is therefore considered relevant for IP8. Figure 9.8 shows the funding given to projects on thermal power plants. In 2021, a total of €29.77 M was spent promoting research in this area, €17.41 M thereof for projects on developing and demonstrating flexible power plants based on biomass.

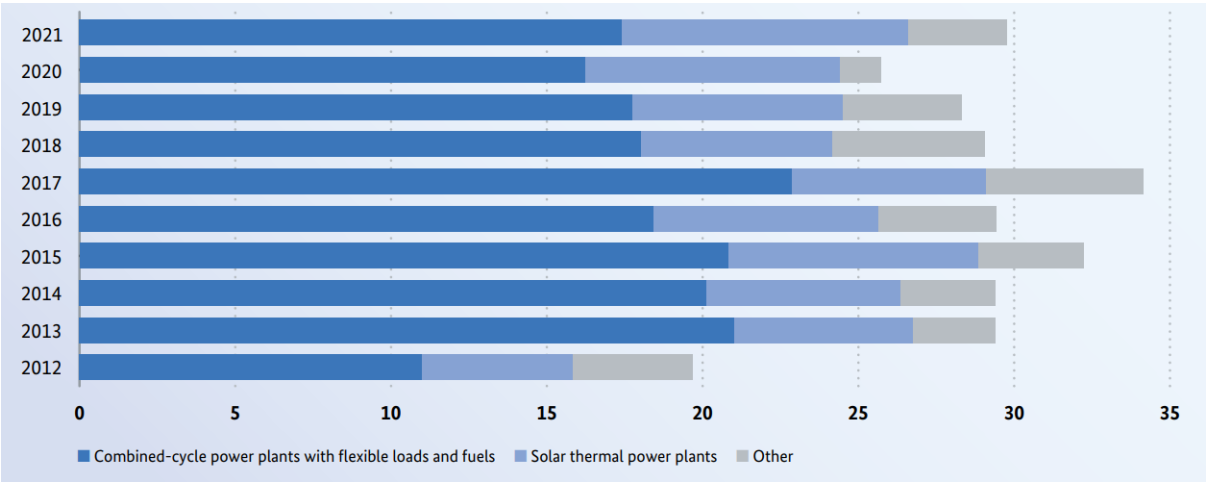

Figure 9.8 Funding for thermal power plants within the German Energy Research Program, in million EUR[104]

The last research area of the Energy Research Program identified as relevant for IP8 focuses on fuel cells and hydrogen. The area includes funding for Power-to-X technologies, which utilize electricity from regenerative sources to produce gases, liquids, and heat. A special focus therein are technologies that produce hydrogen as an energy carrier. As with the previously mentioned funding categories, the identification of IP8 activities funded by the Energy Research Program is not straightforward as the exact content of the projects is not known. Hydrogen production and Power-to-X were identified as the most relevant categories for IP8. In 2021, hydrogen production received €2.36 M in competitive funding, Power-to-X projects €1.58 M, out of a total of €106.64 M awarded to the entire area of fuel cells and hydrogen (cf. Figure 9.9).

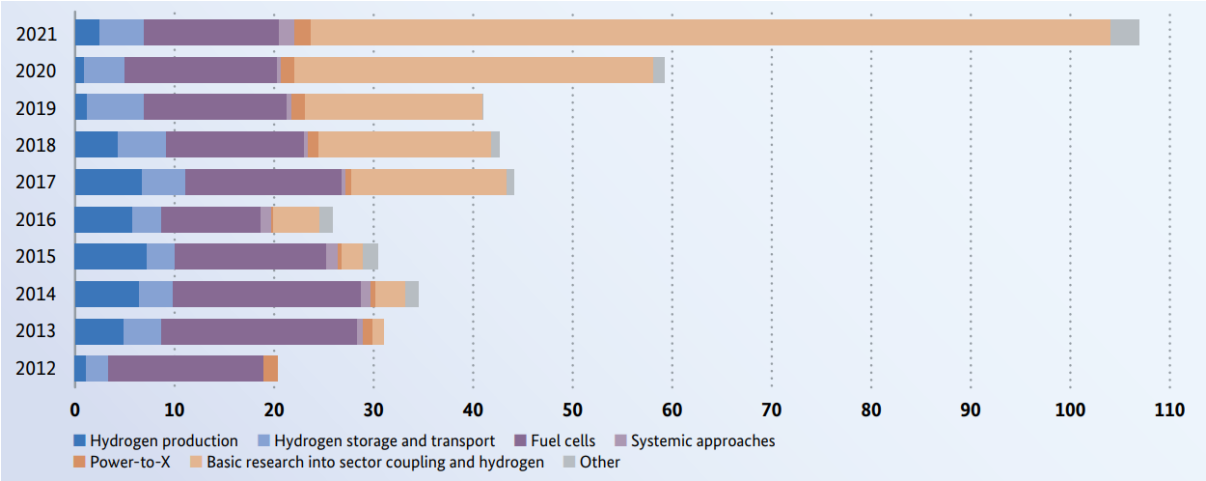

Figure 9.9 Funding for fuel cells and hydrogen within the German Energy Research Program, in million EUR[104]

German funding schemes and grant types

Some examples of currently relevant calls:

- BMDV: National Innovation Programme Hydrogen (Nationales Innovationsprogramme Wasserstoff und Brennstoffzellen)
    - Hydrogen and Fuel Cell - NOW GmbH (now-gmbh.de)
- Development of renewable fuels:
    - https://www.now-gmbh.de/foerderung/foerderfinder/entwicklung-regenerativer-kraftstoffe-08-2021/
- BMWK: Energetic Utilization of biogenic residues and wastes *[Energetische Nutzung biogener Rest- und Abfallstoffe*]
    - https://www.energetische-biomassenutzung.de/foerderung/
- BMEL/FNR: Renewable Resources *[Nachwachsende Rohstoffe]*
  This programme has key topics with specific calls and respective deadlines (currently none of these target IP8 activities), but applicants are free to submit proposals outside the suggested topics and without a specific deadline. A new programme will be approved in late 2023/early 2024.
    - https://www.fnr.de/projektfoerderung/foerderprogramm-nachwachsende-rohstoffe
- BMBF/PTJ: Hydrogen republic Germany *[Wasserstoffrepublik Deutschland]*
    - *https://www.ptj.de/projektfoerderung/anwendungsorientierte-grundlagenforschung-energie/ideenwettbewerb-gruener-wasserstoff*

10. Public funding in Italy

The yearly ordinary institutional funding amounts to circa €4,000 M. Recipients of institutional funding are public research institutions (Fondo Ordinario degli Enti, FOE) and public and private universities (Fondo di finanziamento ordinario, FFO). As the latter however also receive a significant amount of public funding to support teaching activities, the separation between teaching and research is not always easy. However, the FFO includes a specific funding to finance PhD positions (€161 M in 2020), which is distributed to the universities according to different merit criteria[115].

Italy is constituted by 20 regions, which have a certain degree of autonomy. Each region has its own strategic research plan, and support for research and innovation can also be obtained at the regional level. Regional funding is generally only granted to applicants from that particular region.

The Italian stakeholders

In December 2019, the National Research Agency (Agenzia Nazionale per la Ricerca, ANR) was established with the scope of promoting research and innovation in universities and in public and private entities and institutions. Another important role is to coordinate the different schemes for competitive funding, which were previously managed by different ministries, to avoid overlapping. The ANR is planned to receive €200 M in 2021 and €300 M per year from 2022 to distribute through competitive funding calls[116]. Up to now different ministries have been responsible for managing research funding, such as The Ministry of University and Research (Ministero università e ricerca, MUR), Ministry for Economic Development, and Ministry of the Environment.

The budget for R&I

The Italian public budget for research and development (see Figures 3.1 and 3.2) is rather low in comparison to the European average, and it is around 0.3% of the GDP. The budgeted funds are made available from the national budget through the different ministries.

According to the OECD Science, Technology and Innovation scoreboard the gross domestic expenditure on R&D for Italy in 2021 was 1.48% of the country's GDP. This amounts to approximately

The research programs and priorities

The MUR has been so far responsible to draw a Research National Plan (Piano Nazionale delle Ricerca, PNR), which has the scope to lead the industrial competitiveness and development of the country. In the 2015-2020 PNR, twelve focus areas for applied research were defined[117]. The twelve areas are not only a way to define priorities, but they also organize the competences relevant for the national research system. They are developed taking into account the priorities set by the Horizon 2020 plan, but they take national characteristics and priorities into consideration. The defined focus areas are as follows (the most relevant focus areas for the activities of the IP8 are in bold and are described in further detail):

- Aerospace

[115]https://www.miur.gov.it/documents/20182/4212032/DM+n.442+TABELLA+8+-+Dottorato+e+Post+Lauream+2020+-+Statali.pdf/3ac290df-3cd2-b1ad-c8e8-5f3952159a0c?version=1.3&t=1603184389390

[116] https://aca-secretariat.be/newsletter/italy-likely-to-get-its-first-national-agency-for-research-anr/

[117]https://www.miur.gov.it/documents/20182/71637/II+Programma.pdf/2faf018a-b63d-454b-96a4-6b55fd3a6955?version=1.0&t=1495038747623

- Agrifood
- Cultural heritage
- **Blue growth:** The area includes the production and use of innovative and environmentally friendly materials in the sectors of the marine extraction industry, the shipbuilding industry and research, regulation and environmental protection activities. The area also includes activities related to the **blue energy**, aquaculture, marine mineral resources, blue biotechnologies, as well as actions related to the testing of control and monitoring systems and navigation safety.
- **Green chemistry:** The Area refers to product and process innovations relating to **biorefineries**, the production and use of **bio-based products**, biomaterials and **new or innovative fuels** from dedicated forest or agricultural biomass and from by-products and waste from their production, as well as from by-products and waste from animal production and processing.
- Design, creativity and Made in Italy
- **Energy:** The Area refers to innovative components, technologies and systems for the production, storage and distribution, in an efficient management logic, of sustainable and **low-CO_2 energy forms** as well as their energy efficiency and their integration with traditional and distributed sources according to the principles of energy saving and energy reduction. It also refers to the production, storage and management of electricity and heat according to the concept of smart grids and to systems and technologies for water and waste treatment.
- Smart factory
- **Sustainable mobility:** the area aims at promoting the development of technologies, means and systems for sustainable and accessible, intelligent and interconnected mobility, both land and waterways, to increase the competitiveness of production and management companies in full respect of the environment and of natural resources. It includes the technological domains related to the design, production and management of propulsion systems (powertrain); materials and components for vehicles and transport systems; sensors, logistics and specific ICT applications for Intelligent Transport Systems (ITS), also in urban areas; **technologies and systems for decarbonisation, energy efficiency, environmental sustainability**; technologies and systems for the safety of vehicles, of infrastructure and users; technologies, systems for the development of circular economy models, in the fields of land and sea mobility.
- Health
- Smart, Secure and Inclusive Communities
- Technologies for Living Environments

The MUR together with the Ministry for Economic Development has also defined the National Strategy for Smart Specialization (Strategia Nazionale di Specializzazione Intelligente, SNSI), based on the competences included in the PNR twelve areas and on competences required by the national industries and for national industrial development. The SNSI identifies five areas of specialization:

- Aerospace and defense
- Health, Diet, and Life quality
- Smart and sustainable industry, and Energy and environment
- Tourism, Cultural heritage and industry of creativity
- Digital agenda, Smart Communities, and Smart mobility systems

According to their characteristics and their degree of development, the twelve areas have been categorized into four groups (Fig.10.1), for which different support and development tools have been defined.

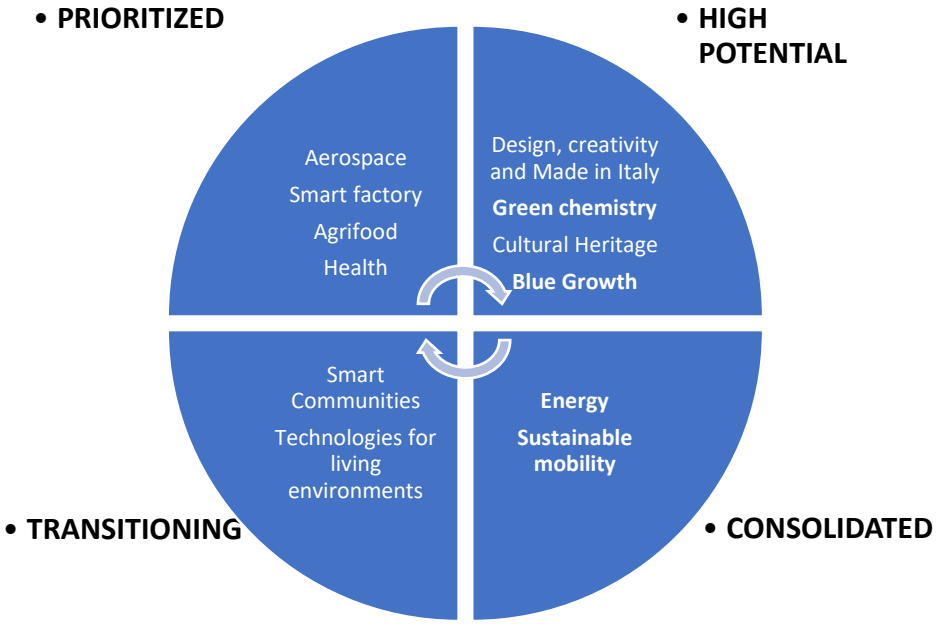

Figure 10.10.1: Classification of the 12 focus research areas

Prioritized areas: Research areas that directly correspond to the national industrial priorities highlighted in the SNSI. For this group, funding is mostly devoted to support industrial research and innovative companies, through the identification of specific strategic programs linked to well-defined technological roadmaps.

High potential areas: Research areas where Italy has distinctive assets and competences. Funding is mostly devoted to consolidating competences, promoting measures to attract knowledge and new technologies, and promoting open innovation and living labs.

Transitioning areas: Emerging areas where public demand can play an important role in determining the establishment of new competences and in promoting a new market for innovation. In this case, supporting tools are mostly based on the leverage by public demand and on strategic regulation.

Consolidated areas: Areas with a high level of competition and innovation, where it is necessary to identify sectors for specialization where to focus resources. In these areas, there is an extensive use of negotiated planning tools, which include the promotion of technological clusters, which make it possible to identify specific subsystems on which the exercise of research and innovation policies can significantly contribute to promoting the competitiveness of Italian industry.

The PNR for 2021-2027 was approved in December 2020, but it is not available yet. Its structure is as follows:

- Research and innovation in Italy, with a presentation of the context
- The novelties of PNR 2021-2027, including coordination between national and regional administrations, consultation with the national community, new research approaches, such as the connection with the European Research and Higher Education Area, mission-oriented initiatives, etc.
- Priorities set to consolidate the strengths and overcome the weaknesses of our research system
- The Major Areas of Research and Innovation and the related Thematic Areas
- National Plans, which represent a coherent set of dedicated actions

- The Missions (coordinated policies) guided by research and innovation actions and aimed at achieving an ambitious goal of social relevance, which is realistic, measurable and achievable
- Financing instruments (under definition)
- The governance and monitoring system

The Italian Bioeconomy Strategy[118] is also relevant for the activities of the IP8. The strategy deals with sustainable production of renewable biological resources, and conversion of these resources and waste streams into value-added industrial products such as food, feed, bio-based products (among which biofuels), and bioenergy.

In December 2020, the Ministry for Economic Development opened a public consultation to define a National Strategy about (Green) Hydrogen[119]. The plan defines the vision for the role that hydrogen can have in the transition to a low carbon society. The plan sets the goal of 2% hydrogen penetration in final energy demand by 2030 and 20% penetration by 2050. The plan foresees circa €10,000 M to be invested in the next ten years to start the hydrogen economy (€5-7 B for investments in production, €2-3 B in infrastructures, and €1 B in research and development), which will be provided through different funding schemes.

Italian funding schemes and grant types

Until now, different ministries have been in charge of distributing funding and grants for research activities. Information is therefore not straightforward to retrieve. Most of calls and information are available in Italian only.

The National operational program for research and innovation (Programma Operativo Nazionale Ricerca e Innovazione, PON R&I) has the objective to develop the strategic goals of the Horizon 2020 program and keeping in mind the twelve research areas, with focus on eight Italian regions characterized by lower development. The goal is to promote the competitive repositioning of the most disadvantaged regions (Abruzzo, Molise, Sardegna, Basilicata, Calabria, Campania, Puglia and Sicilia). This is to be achieved through different actions:

- Innovative doctorates with industrial characterization: competitive funding scheme to assign PhD grants with topics of relevance to the industry and within the twelve fucus areas. In 2020 (deadline 28.09.20), €16 M were reserved to applicants from university located in the eight low developed regions, while €10 M were open to applicants from the whole Italy.
- Industrial research and experimental development projects within the twelve specialization areas: competitive funding scheme for industries, universities, and public and private research institutes. Applicants should be based in the less developed regions or should demonstrate that the project benefits such regions. Project budgets should be between €3 M and €10 M. The total budget allocated to this type of funding was €497 M for the period 2014-2020. The most recent deadline was in November 2017.
- Strengthening of research infrastructures: For funding of research infrastructures functional to the implementation of projects within the twelve research areas which can prove to be beneficial for the

[118] https://www.agenziacoesione.gov.it/wp-content/uploads/2019/06/bioeconomia_eng.pdf
[119]https://www.mise.gov.it/images/stories/documenti/Strategia_Nazionale_Idrogeno_Linee_guida_preliminari_nov20.pdf

eight low developed regions. The total budget for the period 2014-2020 was €326 M (most recent deadline June 2018).

Special commissions are responsible for the evaluation of the project proposals. It is not clear how the budget is distributed between the twelve research areas. The Regional operational programs (Programma operativo regionale, POR) are similar to the PON but at the regional level. Their primary objective is the economic, productive, and social growth of the region. The content and objectives of the PONs are specific to each region.

The Fund for investments in scientific and technological research (Fondo per gli Investimenti nella Ricerca Scientifica e Tecnologica, FIRST) provides grants, subsidized credit, tax credit, provision of guarantees, tax concessions and individual innovation vouchers. Applicants can be companies, universities, research institutions and organizations and any other legal entity in possession of the minimum requirements provided for by the calls, provided that they reside or have a permanent establishment in the national territory. Funding covers:

- 100% of costs for fundamental research
- 50% of costs for industrial research (up to 80% for small/medium enterprises with a wide communication and dissemination plan)
- 25% of costs for industrial development

Private sector engagement

A new national plan called Transition 4.0 (Transizione 4.0) is being developed to stimulate private investments in innovation and research activities[120]. The investments in research and innovation of the private sector have been so far double than those of the public sector.

Different measures also exist to favour private investments:

- Tax credit: This instrument, which forms part of National Industrial Plan 4.0, is for the more immediate use by companies, and is aimed at stimulating private investments in R&D in order to innovate processes and products and guarantee the future competitiveness of the companies (not only in the energy sector). It consists of a 50% tax credit for incremental Research and Development costs. It has a budget of €1,200 M per year.
- Guarantee fund: Increasing the possibility of being granted a loan: supporting companies and professionals unable to readily be granted a bank loan as they lack sufficient guarantees.
- Hyper-amortisation and super-amortisation: Supporting and incentivising companies that invest in new capital goods and tangible and intangible assets (software and IT systems) instrumental in the technological and digital transformation of production processes.

[120] https://www.mise.gov.it/index.php/it/transizione40

11. Public funding in the Netherlands

The Dutch stakeholders

In the Netherlands, the universities, the Dutch Research Council (NWO) and the Netherlands Organisation for applied scientific research (TNO) receive public institutional funding. The responsible ministries for these funds are Ministry of Science and Education for NWO and Ministry of Economic Affairs and Climate for TNO. Other relevant ministries are[121]:

- Ministry of Infrastructure and Water Management
- Ministry of Economic Affairs and Climate Policy
- Ministry of Agriculture, Nature and Food Quality

Topsector Energy (TSE) is responsible for the development and implementation of the public funding for the energy sector in the country. TSE supports implementation of innovations needed to make the transition to an affordable, reliable, safe, and sustainable energy system. TSE supports business, knowledge institutes, government, and social institutions to collaborate towards the energy system of the future. They are responsible for the energy research programs, including the institutional funding. Separate programs exist for Renewable Energy Research (HER) and Demonstration of Energy and Climate Innovations (DEI+) grants.

The Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO) is responsible for management of Research and Implementation programs: e.g. WBSO (tax credit for research and development) as well as operating aid for the promotion of energy from renewable sources (SDE++).

The budget for R&I

The budget is set after a tripartite negotiation between industry, research community and government: the Ministry of Economic Affairs and Climate and the Ministry of Research and Education. Thereafter, the budget is endorsed by the Parliament. The budgeted funds are made available from the national budget through the Ministry of Finance. The development of public funding schemes is based on added value for the Netherlands, innovativeness and GHG reduction, and are reviewed every year.

The Dutch government allocates a WBSO budget as part of the Tax Plan every year. For 2023, the overall WBSO budget is €1437 M for Research and Development in total.

TSE distributes on average €150 M annually and the different programs and subsidy schemes for 2023 and their budgets are presented below.

Please note, the budgets above indicate overall ceiling numbers and include other technologies, not only the ones relevant for IP8.

The research programs and priorities

There is a set of R&I programs supporting research and development in the Netherlands. All TRLs are covered. WBSO, TSE studies, MOOI and TSE O&O cover research support, the DEI and HER programmes cover

demonstration activities and the SDE++ scheme covers the market introduction. In the Netherlands, all the IWG8 chains are covered as well to a certain extent.

TSE focuses on the following themes:

- Offshore Wind
- **The production of sustainable gasses through fermentation and gasification**
- **The production of sustainable hydrogen**
- Carbon Capture, Utilization and Storage (CCUS).
- A sustainable Urban Environment
- Sustainable Energy and Industry, including energy efficiency, **sustainable feedstocks** and waste recycling
- Energy System Integration
- Socially Responsible Innovation

Dutch biomass policy

On the basis of the sustainability framework and the projected national and international availability of bio-based raw materials, the government has designed a policy approach aimed at a balanced use of bio-based raw materials in high-value applications in order to achieve the agreed goals. The first consideration in every case will be whether the use of sustainable bio-based raw materials is essential. The three main policy principles are timely phasing out of low-value applications, transition-driven applications in sectors where no alternatives are available in the medium term and scaling up of high-value applications.

The government will focus on phasing out low-value applications of bio-based raw materials. This will mean timely phasing out of grants for electricity generation with bio-based raw materials, given the fact that this use is not consistent with the desired end state.

There is public concern about burning woody biomass for heat production in particular. These concerns relate to the impact on air quality and biodiversity, and the sustainability of the feedstock. There is also concern about excessive dependence on woody biomass and possible lock-in effects. Nevertheless, to meet the sustainability challenge, we will need to use all the resources at our disposal. The use of woody biomass will play an important role in generating low-temperature heat for a time.

This applies specifically to the built environment, where the government wants to phase out the use of natural gas for heating by 2050. As an intermediate target, the government aspires to have made 1.5 million buildings sustainable by 2030, in line with the National Climate Agreement. To achieve these ambitions, the government will employ a wide range of sustainability strategies, including electric heating, district heating systems and green gas. Bio-based raw materials play a role in all of these strategies: 1) in generating electricity, 2) for collective heat production and 3) as a feedstock for green gas production. Use of bio-based raw materials in the first two strategies will be progressively phased out. The government aims to end grants for burning woody biomass for low-temperature heat generation as quickly as is feasible and affordable.

In sectors where there are insufficient alternatives for the sustainable application of bio-based raw materials, the government will focus on conversion, i.e., transition-oriented use of bio-based raw materials and investment in alternatives.

The government concurs with the SER's analysis that, given the lack of viable alternatives, aviation, shipping, heavy goods transport and high-temperature heat generation will continue to depend on biofuels in the foreseeable future. SER is an advisory board for the Dutch Government on social and economic policy. In accordance with the SER's recommendations, the government will therefore opt in the first instance for

phasing in the use of bio-based feedstock for these purposes. At the same time, it will focus on further energy efficiency gains and on accelerating the development and availability of alternative energy sources. In the longer term, once alternatives do come onto the market the use of biofuels in these sectors can be phased out.

The future of the basic chemicals industry in the Netherlands, and globally, depends to an important extent on our success in replacing fossil carbon with alternatives, particularly renewable carbon. This is a long-term challenge on which we must actively cooperate with industry and science, while also following international developments. The transition to using bio-based raw materials in the chemicals industry has barely begun, despite the many technological advances that have been made over the past few decades and the many new production processes for bioplastics and biomaterials which are reaching the market launch stage. One major problem is the low price of crude oil and the glut of virgin plastics in the plastics market. Given the international nature of these commodity markets, there are currently too few incentives for industry to switch to renewable carbon. The government will therefore focus on improving these incentives.

An increase in the use of bio-based raw materials in the construction industry can help reduce carbon emissions. After all, the carbon in bio-based raw materials remains sequestered in the product throughout its lifespan. It is not released until the waste stage, postponing emissions for several decades. These products are also generally readily recyclable at the end of their lifespan. The envisaged halving of the environmental burden of buildings by 2030, laid down as a statutory environmental performance requirement in building regulations, will boost the use of bio-based building materials, including timber.

Dutch funding schemes and grant types

The WBSO scheme is a tax credit for companies liable for corporation tax or entrepreneurs liable for income tax. The scheme targets fundamental research and research and development in the lower TRL ranges. Two types of projects are supported:

- Development projects (development of new products or services)
- Technical-scientific research (explanatory research)

The project period must be within 3 and 12 months. The applicants must document at least 500 hours used for R&D in the calendar year.

The Top Sector Energy schemes[122] are part of the national subsidy scheme. Funds are given to industrial research, experimental development and demonstration projects. An annual subsidy of approximately € 126 million is available within the Top Sector Energy for innovations in the field of sustainable energy production, energy saving, flexibility of the electricity system (including hydrogen), CO_2 reduction in industry, circular economy and natural gas-free homes, neighbourhoods and buildings.

The relevant funding Tops Sector Energy schemes are (2023):

- Demonstration of energy and climate innovations (DEI+), budget €65 M
- DEI + Natural gas-free homes, neighbourhoods and buildings, budget €9 M
- Renewable energy (HER+), budget €25 M
- Mission-driven research development and innovation (MOOI), budget €0 M

[122] https://www.rvo.nl/subsidie-en-financieringswijzer/subsidies-energie-innovatie-topsector-energie

- TSE industry R&D €2 M
- TSE industry feasibility studies €20 M

Besides, a separate DEI+ call for proposals on hydrogen production is expected for Summer 2023. The expected budget will amount to €70 million.

A new call for proposals for the 'MOOI' funding scheme is expected in 2024. The MOOI-budget for 2022 amounted to €81 M.

Please note, the budget above indicates overall ceiling numbers and includes other technologies, not only the ones relevant for IP8.

Proposals are evaluated through a team of experts with the following criteria:

- Innovative approach
- Contribution to GHG reduction
- Cost efficiency
- Quality of the proposal
- Quality of the consortium

The projects are evaluated after completion based on the financial declaration.

From the list of relevant Tops Sector Energy schemes, the largest one and most important is DEI+. This grant type focuses on piloting and demonstration activities. The projects must include energy technologies that are beneficial for the green growth in the country and have the potential of strengthening the Dutch economy by turnover, employment and exports. Investment projects on biofuels under the blending obligations are exempted. However, pilot projects on biofuels are eligible for funding.

The themes of the 2023 DEI+ scheme are the following:

- Energy efficiency
- **Renewable energy** (incl. Flexibilization of the electricity system, including hydrogen and spatial integration)
- Local infrastructure
- **Circular economy, including waste recycling, re-use of waste and biobased economy**
- CCUS (Carbon Capture, Utilization and Storage)
- Other CO2-reducing measures in industry or the electricity sector
- Natural gas-free homes, neighbourhoods and buildings
- **Hydrogen production from water electrolysis and green chemistry**

The DEI+ program does not have a call deadline; the projects are evaluated on the "first come first serve" as long as the budget lasts.

The mission driven research program (MOOI)[123] is intended to stimulate innovation to reduce the Dutch CO2 emissions with an emphasis on cooperation between at least three consortium members and integrated multidisciplinary approach. The scheme focuses on project development in the fields of 'Offshore wind', 'Renewable electricity on land', 'Built environment' and 'Industry'. The first MOOI call was launched in 2020, the second in 2022 and the next one is expected to open in 2024.

[123] https://www.topsectorenergie.nl/en/mooi

The and SDE++ are incentive schemes[124] for the production of renewable energy (gas, heat, and power) in the Netherlands. These schemes are operating (feed-in-tariff) subsidies for bridging the price gap between fossil and renewable energy production. The approved energy producers will receive a guaranteed payment (subsidy) for the energy they generate from renewable sources. Subsidies are allocated for periods of 12 or 15 years depending on the renewable technology and amount of renewable energy produced. A new call for proposals is announced for September 2023.

The Renewable Energy Transition (HER +) program[125] focuses on CO2 reduction, not only renewable energy production, hence it includes CCUS, hydrogen production and various heating options. The funding scheme is based on subsidies in a similar way as SDE++.

In 2022, IPCEI-funding was attributed to 7 projects involving large scale hydrogen production from water electrolysis on a 100-250 MW scale each. Funding bridges the funding gap for CAPEX and OPEX costs.

[124] https://english.rvo.nl/sites/default/files/2020/03/Brochure%20SDE%20Spring%202020.PDF accessed 21-10-2020
[125] https://www.rvo.nl/subsidie-en-financieringswijzer/hernieuwbare-energietransitie

12. Public funding in Poland

Polish stakeholders

The Ministry of Education and Science (MSHE) is responsible for financing research in Poland. Its financing covers basic and applied research projects, experimental development and research infrastructure, implemented through two national funding agencies: the National Centre for Research and Development (NCBR) and the National Centre of Science (NCN). Other sectoral ministries, such as the Ministry of Climate and Environment[126] and the Ministry of Agriculture and Rural Development[127], are responsible for the implementation of demonstration projects, including scale-up, and for the deployment of new technologies in their respective areas such as climate, environment, and agriculture.

The NCBR was established in 2007 with the main goal of supporting the management and implementation of scientific and innovative state policies. NCBR's mission is "to support the Polish research units and enterprises in developing their abilities to create and use solutions based on scientific research results in order to encourage economy development and to the benefit of society"[128]. Transfer of scientific results such as commercialization, managing applied research programs, providing training and career development for young scientists are among tasks of NCBR[129].

The NCN is a government agency that started to operate in 2011 under the supervision of MSHE with the aim of supporting basic research in Poland by funding Arts, Humanities and Social Sciences, Life Sciences and Physical Sciences and Engineering projects. Funding research projects in all fields of science and humanities for scientific excellence, providing doctoral and postdoctoral funds, supporting international research cooperation, and supervision for funded projects' implementation are among NCN's goals[130].

The Polish National Agency for Academic Exchange (NAWA) is an institution in operation since 2017 which has the aim of coordinating state activities while promoting internationalization of academic and research institutions in Poland. Supporting international mobility of students, academics, and researchers as well as internationalization of academic and research institutions in Poland, promoting Polish science, higher education and the Polish language are among the goals of NAWA[131].

The Foundation for Polish Science (FNP) is a non-governmental, non-political, non-profit institution that was established in 1991 with the mission of supporting science by means of providing support for distinguished scholars and research teams in all fields, assisting innovative ventures and helping with the commercialization of scientific discoveries and inventions. FNP provides funding for scholars including foreign citizens, and research teams in forms of grants, prizes and stipends based mainly on scientific excellence criteria[132].

The National Fund for Environmental Protection and Water Management (NFOŚiGW) [133] was established in 1989 with an aim of supporting environmental protection and water management in an efficient manner. It generates incomes from charges and fines generated by the "polluter pays" principle as well as foreign funds which amounted to 60 billion PLN in the period of 1989-2014. NFEPWM has a broad selection of financing instruments available for various beneficiaries, such as local authorities, business, public entities, social

[126] https://www.gov.pl/web/climate
[127] https://www.gov.pl/web/agriculture
[128] https://archiwum.ncbr.gov.pl/en/about-the-centre/mission/
[129] https://archiwum.ncbr.gov.pl/en/about-the-centre/tasks/
[130] https://ncn.gov.pl/o-ncn/zadania-ncn?language=en
[131] https://nawa.gov.pl/en/nawa
[132] https://www.fnp.org.pl/en/o_fundacji/mission-and-statute/
[133] https://www.gov.pl/web/nfosigw-en/nfepwm73

organisations/NGOs and individuals. The financial instruments include the following: subsidies, loans, bank credits from NFEPWM funds, partial redemption of loans, capital investment projects, various surcharges and partial repayment of capital of the credits. Justified by

The budget for R&I

R&D expenditures of Polish government was obtained through the country representative from Department of Innovation and Development, Ministry of Science and Higher Education in 2021. As this person shifted jobs, updated information could not be retrieved. This represents the costs for R&D projects within the energy sector (demonstration projects are not included) divided in categories and subcategories, as shown in Tables 12.1-3[134] from 2010 to 2019 (2018 and 2019 are estimations for ongoing and planned projects.). Only funding from the MSHE, NCBR and NCN are considered in the tables (funding from other Polish ministries and institutes supervised by those ministries are not included).

*Table 12.12-1 R&D expenditures in **renewable energy sources** by Polish government (in million PLN) from 2010 to 2019 (estimated).*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Solar	17.978	35.138	20.450	12.394	25.587	15.734	11.335	11.985	22.648	24.487
Wind	4.291	5.098	5.225	2.791	3.383	7.938	4.102	6.356	2.977	10.102
Ocean		-	-	-		-	-	0.064	0.047	0.007
Biofuels	31.402	35.347	26.436	24.200	26.772	37.941	25.513	29.514	22.088	8.278
Geothermal	0.339	0.262	0.135	1.201	1.580	1.565	1.042	0.834	0.330	0.325
Hydroelectricity	30.794	27.990	6.440	4.249	2.218	1.066	0.491	-	0.252	5.895
Other renewables		-	-	0.336	2.422	2.968	2.240	3.219	3.497	3.247
Unallocated renewables	5.112	5.563	4.905	3.453		1.161	5.844	4.550	6.964	4.695
Total	89.916	109.398	63.591	48.624	61.9620	68.3731	50.5661	56.522	58.803	57.036

[134] Source: Polish country representative

The most relevant expenditure category shown in Table 12.1 is biofuels which includes both solid and liquid biofuels and biogas for IP8 activities; however, other renewables and unallocated renewables can be relevant for IP8 as well.

*Table 12.12-2 R&D expenditures in **hydrogen and fuel cells** by Polish government (in million PLN) from 2010 to 2019 (estimated).*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Hydrogen	2.471	19.572	19.392	21.587	6.530295	1.589	1.79	0.446	0.532	0.655
Fuel cells	1.672	2.914	1.63	0	0.15808	1.17	1.326	1.935	1.773	1.332
Unallocated hydrogen and fuel cells	3.143	1.454	2.082	2.093	0.996	0	0	0.255	0.032	0.018
Total	7.286	23.94	23.104	23.68	7.684375	2.759	3.116	2.636	2.337	2.005

The most relevant expenditure category for IP8 value chains, shown in Table 12.2 is hydrogen; however, unallocated hydrogen and fuel cells can be relevant for IP8 as well.

*Table 12-3 R&D expenditures **other cross-cutting technologies** by Polish government (in million PLN) from 2010 to 2019 (estimated).*

	(20)10	11	12	13	14	15	16	17	18	19
Basic energy research that cannot be allocated to a specific category	0.429	0	0	0	0.513588	4.096	2.856	5.371	5.122	8.465

Table 12.3 shows the R&D expenditure of cross-cutting technologies and research which cannot be allocated to a specific category; therefore, it can include funding for IP8 relevant activities.

However, due to the nature of the Polish research budget, not all the expenses on the above fields are accounted for in the tables. Indeed, a part of the Polish research budget (ca 50%) is directly assigned to research institutions and universities, which decide the topic of the projects and tasks to allocate the funding to. Since institutions are not required to provide information on this, it is not possible to estimate how funds are allocated.

The research programs and priorities

The latest National Research Program (Krajowy Program Badań)[135] was approved by the Polish government in August 2011. The programme defined Priority Research Areas, and within these areas proposed Priority Research Directions. This was used as the basis for the development of the Strategic Research and Development Programs.

The Priority Research Areas were implemented through strategic research and development projects, which were managed by the NCBR (industrial research) and the NCN (basic research). The National Research Programme was planned to be updated in 2021. However, the authors could not find updated information regarding this at the time of writing this report.

[135] https://archiwum.ncbr.gov.pl/en/programmes/strategic-programmes/

Polish funding schemes and grant types

The Committee of Evaluation of Scientific Units has an executive and supervisory role in the development of institutional funding schemes. The committee is responsible for every aspect of evaluation for R&D activities. The evaluation is performed at least every 4 years by field experts of that particular research activity. The adopted strict solutions for financing of scientific units aim to stimulate the necessary changes within the scientific units and to enable the selection of the units in which the state should invest more. The emergence of stronger scientific units and their increased competitiveness both at the European and international level is expected due to a higher research quality. The reinforced Polish scientific units are anticipated to apply for scientific research and development funds more efficiently from the state budget but also from the European institutions. Cooperation with industry (applied research) and international partners (e.g. Horizon 2020) is a very important evaluation factor as well[136].

NCN has four calls in a year for competitive funding of fundamental research projects. NCN grantee is required to be employed at a Polish host institution. Additional conditions applicable to each call are set forth by the Council of the NCN[137]. The NCN has the following funding schemes[138] :

- OPUS: competition for research projects open to all scientists, deadlines in June and December.
- PRELUDIUM: competition for research projects carried out by people without a doctoral degree, deadlines in June.
- PRELUDIUM BIS: competition for research projects carried out by doctoral students at doctoral schools, deadline in December.
- SONATINA: for research projects carried out by people with a doctoral degree obtained within 3 years before the year of submitting the application, deadline in March.
- SONATA: competition for research projects carried out by people with a doctoral degree, deadline in December.
- SONATA BIS: competition for research projects carried out by people with a doctoral degree, deadline in September.
- MAESTRO: a competition for experienced scientists for research projects aimed at the implementation of pioneering scientific research, including interdisciplinary research, important for the development of science, going beyond the current state of knowledge, which may result in scientific discoveries, deadline in September.
- TANGO: competition for researchers who have already received funding for projects in basic research which show promise of successful implementation. Last call in 2020.
- POLONEZ BIS: fellowship programme for experienced researchers, co-funded by the European Commission under the prestigious Marie Skłodowska-Curie COFUND grant
- MINIATURA: competition for scientific activity as part of larger basic research, deadline in July.
- DIOSCURI: competition to establish Dioscuri Centers of Scientific Excellence (call in collaboration with Max Planck Society), last call in 2021.
- GRIEG: Polish-Norwegian research projects, EEA and Norway Grants - allocated €37.34 M for collaborative Polish-Norwegian research projects

[136] Information obtained from country representative.
[137] https://www.ncn.gov.pl/en/finansowanie-nauki/konkursy/typy
[138] https://www.ncn.gov.pl/en/finansowanie-nauki/konkursy/typy

- IdeaLab: ground-breaking, interdisciplinary research projects, EEA and Norway Grants - allocated €4 M for projects developed at the IdeaLab
- International programmes

All the national funding schemes are specific to the project type such as PhD project, post-doctoral project etc., not specific to the topic or discipline. Topics are organized into 3 main categories (with a total of 26 subcategories, of which the relevant ones are reported in parenthesis): Humanities, Social Sciences and Arts; Exact and Technical Sciences (Chemistry, Process and production engineering); Life Sciences[139]. Some of the international programmes have specific themes such as Solar-Driven Chemistry that supported projects using solar energy for various applications such as hydrogen production that is relevant for IP8 activities[140].

Evaluation criteria for the above listed schemes are given below for OPUS[141], the proposal evaluation criteria of other schemes are very similar to that of OPUS, listed below.

- proposals from within NCN Panels, involving basic research,
- scientific excellence and the innovative nature of the research project,
- evaluation of the results of research projects conducted by the Principal Investigator, funded from the budget for science
- the research portfolio of the Principal Investigator,
- impact on the development of the research discipline,
- justification of the planned costs."

The NCBR manages different competitive funding schemes, directed at both research institutions and enterprises. The schemes use both national funds and European structural funds. The ongoing and most recent calls managed by NCBR can be found here:

https://www.gov.pl/web/ncbr/platforma-konkursowa

The funding scheme managed by NCBR are (the relevant ones are described in detail):

- Strategic programs[142]: are prepared based on the National Research Program within the Priority Research Areas. The programs are based on the assignation of projects targeted to specific issues. Projects are assigned through competitive calls. The different programs are:
  - Prevention Practises and Treatment of Civilization Diseases – STRATEGMED
  - **New energy technologies**: aimed to achieve climate neutrality by implementing solutions that increase the country's energy security and increase the competitiveness of the Polish economy. Furthermore, increase the share of energy from RES in the overall energy mix of the country by 20-50% (compared to the level from 2020). One of the specific objectives of the program is to decarbonize the energy sector by increasing the use of biodegradable raw materials and waste products.
  - "Advanced information, telecommunications and mechatronic technologies" - INFOSTRATEG
  - **Natural environment, agriculture and forestry (BIOSTRATEG)**: strategic research programme concerning environmental issues, agriculture and forestry. The program includes safety of food, rational use of natural resources including water, mitigation and adaptation to climate change including agriculture, protection of biodiversity, forestry including wood and timber sector, renewable energy sources in agriculture.

[139] https://ncn.gov.pl/finansowanie-nauki/panele-ncn
[140] https://www.ncn.gov.pl/wspolpraca-zagraniczna/wspolpraca-wielostronna/solar-driven-chemistry
[141] https://www.ncn.gov.pl/finansowanie-nauki/konkursy/typy/1
[142] https://www.gov.pl/web/ncbr/programy-strategiczne

- Social and economic development of Poland in the conditions of globalizing markets - GOSPOSTRATEG
- Modern material technologies – TECHMATSTRATEG
- Innovations for water management and inland navigation – HYDROSTRATEG

- Programmes and Projects – Defense, Security[143]
- National programs[144]:
  - Tango, Social Innovation, LEADER, RID, CuBR, INNOMED, INNOVATION WIZARD, BRIK II, CyberSecIdent, Improvements of safety and working conditions, Innotech, Things are for people, INNOLOT, PATENT PLUS, NUTRITECH and NEON are the national programmes listed under NCBR. Only NEON has specific objective relevant for the IP8: **Development of solutions and technologies related to the acquisition and processing of biomass.**
- European funds in new R&D formulas (focuses currently on the implementations of the assumptions of the European Green Deal)[145]
  - Treatment plant of the future
  - **Innovative biogas plant -** The aim of this project is to develop a universal agricultural biogas plant utilizing a wide range of wastes and residues. The main product is to be fed into the gas distribution network in Poland or compressed and used for transport.
  - Heat plant of the future
  - Combined heat and power plant in the local energy system
  - Electricity storage
  - Heat and cold storage
  - Home retention Technologies
  - Ventilation for schools and homes
  - Energy and process efficient construction
- European funds[146]
  - Smart Growth Operational Programme
  - Digital Poland Operational Programme
  - Knowledge Education Development Operational Program
  - Technical Assistance Projects
  - European Funds for Modern Economy
  - European funds in new R&D formulas
  - European Funds for Social Development

The Foundation for Polish Science supports outstanding scientists and research teams in all fields of science, as well as innovative ventures and commercialization of scientific discoveries and inventions. The funding schemes from the FNP are listed below[147].

- START: Annual scholarships for outstanding young scientists at the beginning of their scientific career with proven achievements in their field of research. Deadline in December.

[143] https://www.gov.pl/web/ncbr/programy-i-projekty---obronnosc-bezpieczenstwo
[144] https://www.gov.pl/web/ncbr/programy-krajowe
[145] https://www.gov.pl/web/ncbr/fundusze-europejskie-w-nowych-formulach-br
[146] https://www.gov.pl/web/ncbr/fundusze-europejskie
[147] https://www.fnp.org.pl/en/kategoria_szkolenia/our-programmes/

- For Ukraine: an initiative of the FNP taken in the face of the military aggression against Ukraine and as its direct consequence the arrival of scientific employees from Ukraine to Poland. The programme provides support for scientists from Ukraine realizing research projects together with scientists from Poland in social sciences and humanities.
- The Leszek Kołakowski Honorary Fellowship
- Maria Skłodowska and Pierre Curie – French-Polish Scientific Award
- The FNP Prize
- TEAM-NET: The TEAM-NET program offers research units funds to finance interdisciplinary scientific research carried out by a network of collaborating research teams led by outstanding scientists.
- MONOGRAPHS: Funding of publication of original and previously unpublished works in the humanities and social sciences selected by competition.
- MASTER/MISTRZ: Professorship subsidies aimed at supporting outstanding scientists: enabling them to intensify their research work so far or to undertake new research directions.
- Sabbatical Fellowships for MASTER/MISTRZ winners
- The Poland – U.S. Science Award: he Polish-American Science Award is a joint project of the American Association for the Advancement of Science (AAAS) and the Foundation for Polish Science (FNP).
- MONOGRAPHS – Editing/Adiustacje: Financing of the linguistic revision of works prepared for publication in one of the congress languages by a foreign publisher. The competition is carried out as part of the MONOGRAPHS program.
- The COPERNICUS Award: The Polish-German Scientific Award recognizes the most active participants of Polish-German scientific cooperation, who can demonstrate outstanding joint research achievements. The award is given every two years.
- Alexander von Humboldt Polish Honorary Research Scholarship: Polish Honorary Research Scholarship Aleksander von Humboldt for outstanding German scientists planning a research stay in a Polish research unit.
- The Leszek Kołakowski Honorary Fellowship
- IDEAS FOR POLAND: Scholarships for ERC Starting Grant winners - competitions run by the European Science Council (ERC) - who intend to conduct research in Poland.

All the above-mentioned programmes are specific to the project type, not specific to the topic or discipline. Therefore, several programmes can be relevant for IP8 activities. Excellence of the application and applicant determines how projects are assigned.

The NFOŚiGW offers loans, subsidies and other forms of co-financing of projects. It has different funding schemes:

- National measures: they are based on a list of Priority Programs which is approved annually by the Supervisory Board of the NFOŚiGW. The updated Priority Programs are listed in a document available on their website[148]:
- Green Investments System[149]: is a derivative of the emissions trading mechanism set by the Kyoto protocol. The goal is to strengthen the pro-ecological effect resulting from the disposal of surplus Assigned Amount Units.
- State Budget Units[150]

[148] https://www.gov.pl/web/nfosigw/informacje-ogolne /
[149] https://www.gov.pl/web/nfosigw/system-zielonych-inwestycji-gis
[150] https://www.gov.pl/web/nfosigw/panstwowe-jednostki-budzetowe

- Public Aid[151]

Private sector engagement

Pre-Commercial Procurement (Zamówienia przedkomercyjne, PCP)[152] is a program where NCBR acts as an ordering party of research and development works that will result in the creation of a demonstrator of an innovative product or technology. A current relevant call under this program is "**Innovative biogas plant**"[153], which has the goal to develop a universal, automated biogas plant that reduces or eliminates the need for specialized supervision. The call closed on 22.02.2021.

Relevance to IP8 activities

Two of NCBR's research tasks located under the strategic research programme New Energy Technologies are most relevant for IP8 activities: **Technologies for the production and use of hydrogen, and Energy use of waste and heat from post-process gases**.

Most of NCN's funding schemes do not have any specific topic or discipline, meaning that they can cover IP8 related activities. However, some of the international programmes have specific themes such as Solar-Driven Chemistry that supported projects using solar energy for various applications such as hydrogen production that can have IP8 value chains of **HP1: Hydrogen from green power** and **HP2: Power-to-X**.

Similar to NCBR and NCN, Foundation for Polish Science's programmes do not have any funding specific to a theme or topic; therefore, all grant types can be relevant for IP8.

[151] https://www.gov.pl/web/nfosigw/pomoc-publiczna2
[152] https://www.gov.pl/web/ncbr/fundusze-europejskie-w-nowych-formulach-br
[153] https://www.gov.pl/web/ncbr/innowacyjna-biogazownia

13. Public funding in Portugal

Information on the institutional funding in Portugal was provided by a contact at the FCT. The FCT is the main public body responsible for institutional funding. Institutional funding through FCT is provided following an international assessment of the research units in the country, mostly based on the scientific merit and background, associated to scientific capability. These periodical international assessments allow to collect a very dense pool of information on both the research institute and research needs as well as the monitoring of the R&D projects funded by FCT programs. The initial budget allocated to institutional funding in 2020 was €98.5 M. Institutional funding schemes are typically revised every four years. Criteria included in the revision are positive international assessment of the R&D unit, considering both scientific background as well as qualification of Human Resources. Other criteria are also considered, such as the level of internationalization and scientific employment generation.

Portuguese stakeholders

Fundação para a Ciência e a Tecnologia (FCT) is a public agency in Portugal operating under the Ministry for Science, Technology and Higher Education with the aim of supporting science, technology, and innovation, in all scientific domains. FCT's visions are i) "to establish Portugal as a global reference in science, technology, and innovation", and ii) "to ensure that knowledge generated by scientific research is used fully for economic growth and well-being of citizens"[154]. FCT's mission aims at contributing to the Portuguese progress in science and technology to bring it to international levels. FCT promotes the international involvement of the scientific community as well as knowledge transfer between research groups and industry.

Portugal 2020 is the partnership agreement between Portugal and the European Commission, which has the aim of bringing together the activities of the five European Structural and Investment Funds that are European Regional Development Fund, Cohesion Fund, European Social Fund, European Agricultural Fund for Rural Development and European Fund of Maritime Affairs and Fisheries. These have the scope of establishing the economic, social and territorial development policies in Portugal, for the period between 2014 and 2020. The program is in line with Smart, Sustainable and Inclusive Growth, pursuing the EUROPE 2020 STRATEGY[155].

The Innovation Support Found (FAI)[156] was created in December 2008 by the Ministry of Economy and Innovation. The FAI was initially directed towards the financing of the national scientific system and the financing and promotion of research and technological development projects, including doctoral grants, with a particular focus on the field of renewable energies (namely wind energy) and energy efficiency. Its scope was later extended to support demonstration projects and, more recently, to support investment projects in energy efficiency.

The National Innovation Agency (Agência Nacional de Inovação SA, ANI)[157] aims to develop actions aimed at supporting technological and business innovation in Portugal, contributing to the consolidation of the National Innovation System and to strengthening the competitiveness of the national economy in the global markets.

[154] https://www.fct.pt/fct/
[155] https://www.portugal2020.pt/content/o-que-e-o-portugal-2020
[156] https://www.fai.pt/p%C3%A1gina-inicial
[157] https://www.ani.pt/

The budget for R&I

FCT's budget covers funds from the Portuguese state budget and European structural funds, mostly on a multiannual basis. FCT's budget and funding are shown in Figure 13.1 below.

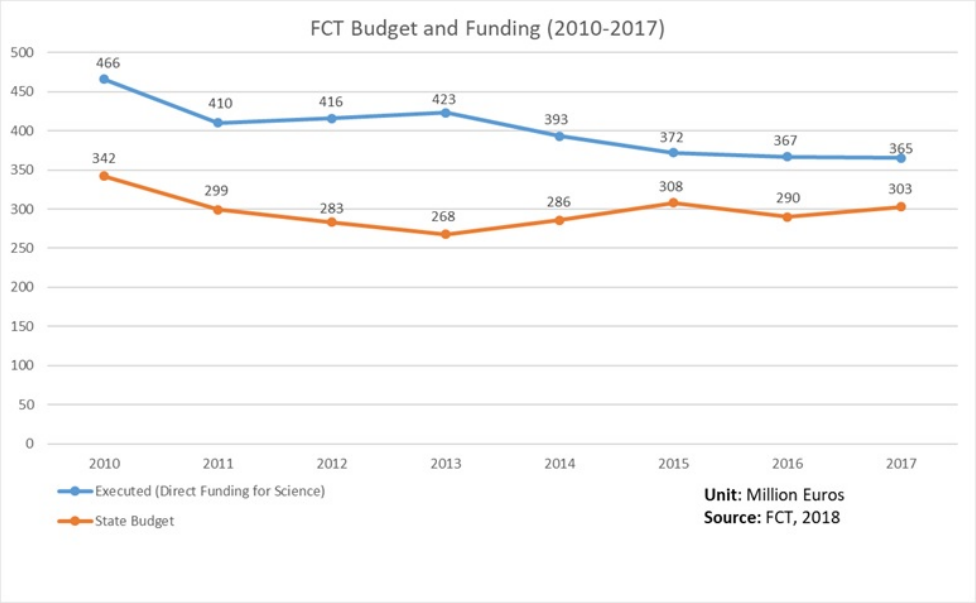

Figure 13.1: FCT's budget and funding[158].

FCT allocates funding to different types of activities and through various instruments, namely research projects, advanced training, scientific employment, research units, international cooperation, which are shown in Figure 13.2 for the period of 2015-2019.

[158] https://www.fct.pt/images/Orcamento_Execucao_2010a2017ENG.jpg

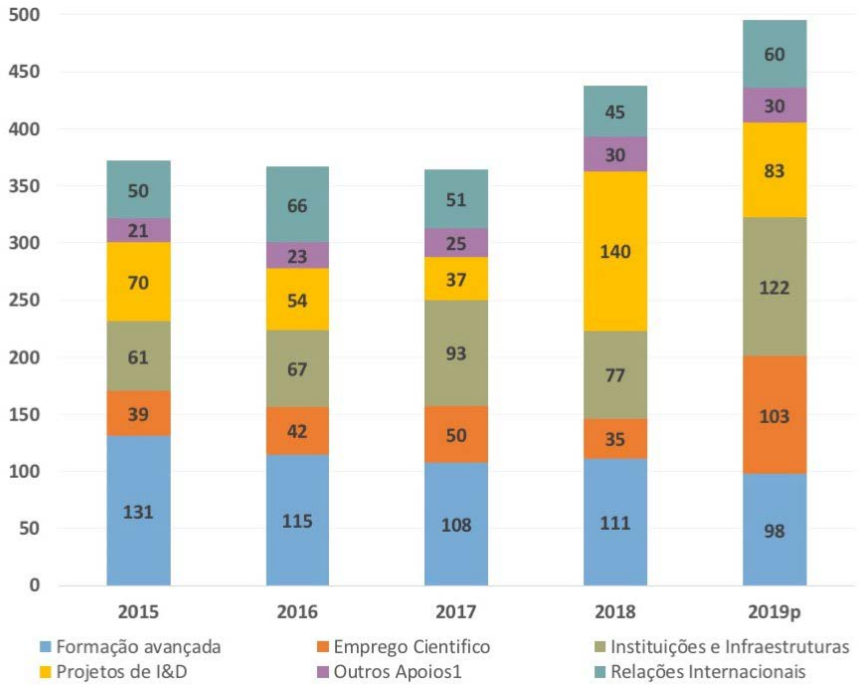

Figure 13.2: Evolution of FCT financing in the period of 2015 to 2019 in each intervention area from bottom to top in each bar: advanced training (blue), scientific employment (orange), research institutions and infrastructures (brown), research projects (yellow), other support (purple) and international cooperation (green)[159].

FCT's investment in research projects was approximately €83 M in 2019 (in yellow in Figure 13.2). The advanced training grants amounted to €98 M in 2019 that covered the support of around 5560 PhD, post-doctoral and other scholarship grant holders (in blue in Figure 13.2). FCT awarded 800 contracts to doctoral researchers through the individual grants under Competition for the Stimulation of Scientific Employment which represented a total of €103 M in 2019 (in orange in Figure 13.2). FCT directly finances 307 R&D Units, which bring together more than 26,000 PhD researchers through the funding to R&D Units and Associated Laboratories which was €122 M in 2019, which represented an increase of 58% compared to the amount transferred in 2018 (in brown in Figure 13.2). FCT ensures international partnerships within the scope of the "GoPortugal - Global Science and Technology Partnerships Portugal" initiative, valuing the participation of the national scientific community in bilateral and multilateral research programs, and contributions to international scientific organizations such as CERN, ESA, EMBO and EMBL, which has an investment of €60 M in 2019 (in green in Figure 13.2)[160].

Portugal 2020 receives €25 B until 2020 with the thematic objectives of promoting growth and job creation, in addition to the interventions necessary to achieve them. Distribution of funds between thematic areas are shown in Figure 13.3. "Sustainability and Efficiency in the Use of Resources" is the most relevant theme for IP8 activities with a budget of € 6,259 M.

[159] https://www.fct.pt/linhasatividadefct.phtml.en
[160] https://www.fct.pt/linhasatividadefct.phtml.en

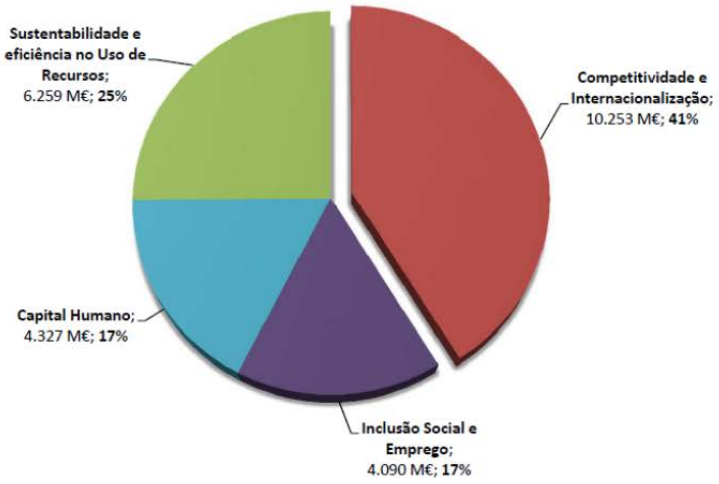

Figure 13.1: Distribution of Portugal 2020's funds according to thematic area: Competitiveness and Internationalization (red), Sustainability and Efficiency in the Use of Resources (green) Social Inclusion and Employment (purple), Human capital (blue)[161].

The research programs and priorities

FCT provides funding for fellowships, studentships and research contracts for scientists, research projects, competitive research centres and state-of-the-art infrastructures as well as networking and international collaborations, conferences and meetings, science communication and interactions with industry[162]. This is done through competitive calls with peer review. FCT has the following thematic agendas:

- Agrifood, Forests and Biodiversity
- **Climate change**
- Portuguese Architecture
- Urban Science and Cities for the Future
- Culture and Cultural Heritage
- Circular Economy
- Space and Earth Observation
- Social Inclusion and Citizenship
- Industry and Manufacturing
- Sea
- Health, Clinical and Translational Research
- Cyberphysical Systems and advanced forms of Computing and Communication
- **Sustainable Energy Systems**
- Work, Robotization and Job Qualification in Portugal
- Tourism, Leisure and Hospitality

In line with the EU strategy, Portugal developed a National Integrated Energy and Climate Plan (PNEC) [163] with 2030 as horizon. This Plan aims at establishing goals and objectives in terms of greenhouse gas emissions, renewable energies, energy efficiency, energy security, market research, innovation and

[161] https://www.portugal2020.pt/content/o-que-e-o-portugal-2020
[162] https://www.fct.pt/apoios/
[163] https://www.portugalenergia.pt/setor-energetico/bloco-3/

competitiveness, as well as a clear approach to achieving them. The PNEC will be the main instrument of energy and climate policy for the decade 2021-2030.

The FCT has elaborated 15 thematic agendas on R&I[164]. Among them, the R&I Agenda on Sustainable Energy Systems[165] seeks to reflect the national R&I effort necessary to achieve decarbonization objectives, especially in terms of reducing the use of fossil fuels. The agenda is developed considering four dimensions to reach the goals and lines R&I relevant to the country in a medium- and long-term perspective (2030). The reflection takes place around the following dimensions:

- Reduction of energy needs/energy efficiency
- Electricity: 100% from renewable sources
- Sustainable transport: 25% reduction in GHG emissions compared to 2005
- Heat and cold: 100% replacement of fossil technologies with low carbon technologies.

While it remains an important strategic initiative, involving the academia and other stakeholders, namely business enterprises and policy makers, no dedicated funding program is associated to the actuation of the agenda.

Portuguese funding schemes and grant types

In 2020, there were three main calls for funding research projects (listed below), the latter being the relevant one for IP8 activities.

- "IC&DT projects to promote interdisciplinary and multidisciplinary R&D activities to be carried out in the Montesinho Natural Park region
- AI 4 COVID-19: Data Science and Artificial Intelligence in Public Administration to strengthen the fight against COVID 19 and future pandemics
- Call for Financing of Scientific Research and Technological Development Projects in All Scientific Domains"

Portugal 2020 has four thematic domains (the domain relevant for IP8 activities is provided with its subtopics):

- Competitiveness and Internationalization
- Social Inclusion and Employment
- Human capital
- **Sustainability and Efficiency in the Use of Resources**
    - Moving towards a low carbon economy
    - Investing in the use of renewables, energy efficiency and smart grids
    - Increase the capacity to adapt to climate change
    - Protect the coast from erosion, reduce fires and prevent flooding
    - Reduce and recycle waste and promote efficient water management"

Portugal 2020 has the following IP8 relevant open calls under the thematic area of Sustainability and Efficiency in the Use of Resources[166].

- POSEUR-01-2020-19
    - Application date: From December 18, 2020 00:00 to April 30, 2021 18:00

[164] https://www.fct.pt/agendastematicas/index.phtml.pt
[165] https://www.fct.pt/agendastematicas/sissusenerg.phtml.pt
[166] https://poseur.portugal2020.pt/pt/candidaturas/avisos/

- Aim: Destined to support projects for the production of gases of renewable origin for self-consumption and / or injection into the network
- POSEUR-11-2020-15
  - Application date: From October 20, 2020, 00:00 to January 29, 2021, 18:00
  - Aim: Investments with a view of valorisation of bio-waste in mainland Portugal

Project proposals are evaluated on the basis of both the scientific merit of the project and the scientific background of the team (beyond eventual additional criteria specified in the call for applications).

The most recent call for proposals from FAI (2019)[167] aimed at contributing achieving the goals defined in the National Energy and Climate Plan, promoting the use of advanced biofuels, produced using innovative technologies, through the use of sustainable use of residual biomass or with low economic value, in a perspective of circular economy and generation of new value chains around biomass. The call offered the allocation of financial incentives, for pilot or demonstration projects, of an innovative character, focused on the production, storage and availability of advanced biofuels, including biogas, for the transport sector.

Relevance to IP8 activities

Even though there is no specific thematic area relevant for IP8 activities, the domains listed below funded IP8 related projects as part of "Call for Financing of Scientific Research and Technological Development Projects in All Scientific Domains"[168].

- Chemical Engineering
- Environmental Biotechnology and Engineering
- Environmental Sciences
- Agriculture, Forestry and Fisheries
- Bioengineering and Biotechnology
- Biological Sciences

The domains above cover a range of biological feedstock and conversion technologies for heat and power, energy medium and biofuel production; therefore, relevant for all IP8 value chains.

Unlike FCT's calls, Portugal 2020 has calls with specific themes some of which directly cover IP8 value chains: POSEUR-01-2020-19 (gas from renewable feedstock) can be relevant for IP8 value chains of **PVC2: Power and heat via gasification** and **EVC4: Anaerobic digestion to biogas**, and POSEUR-11-2020-15 (bio-waste valorisation) can be relevant for all **Priority Value Chains** and **Established Value Chains** as well hydrogen pathway of **HP2: Power-to-X**.

Evaluation of projects after completion

The results are evaluated by experts on the bases of a final report.

Private sector engagement

The projects granted through competitive funding may integrate private entities, with a ceiling on the funding for the private sector actor (50% of the business enterprises budget).

[167] https://www.fai.pt/concursos/aviso-062019
[168] https://www.fct.pt/apoios/projectos/consulta/painel?idconcurso=404

Moreover, the ANI offers a series of tax deductions and incentives to increase the competitiveness of companies, supporting their efforts in Research and Development[169].

2021-2023 – UPDATE ON PUBLIC FUNDING on R&I in PORTUGAL LINKED TO IP8 SET PLAN

Financing program:	Name of financing program
Financing organisation:	FAI-Fundo Ambiental (funds from the Recovery and Resilience Programme).
Weblink	Fundo Ambiental, Ministério do Ambiente
Eligible organisations:	Public and private.
Eligible projects:	Production plants (TRL 8 or higher) of renewable gases, mainly green hydrogen and biomethane. Mature biogas plants through anaerobic digestion are not eligible. Biogas upgrading to biomethane is eligible. As well as other innovating technologies for biogas production. Thermochemical and hydrothermal technologies from biomass gasification are also eligible.
Eligible time period:	First Call (2021/2022); 2nd Call (2023)
Type of financing program:	Non-refundable fund
Financing volume per project:	5 M€ per project (production plant only) or 10 M€ per production plant and renewable gases distribution investment.
Financing rate:	It depends of the real CAPEX cost of the proposed technology compared to the standard CAPEX cost of fossil based renewable gases production.
Total financing volume:	102 M€ (2022) and 83 M€ (2023)
Description:	Renewable gases production projects, mainly green hydrogen and biomethane. It might be also including storage, transportation and distribution. In the First Call, it was funded 24 Projects, being 2 of them for Biomethane production (upgrading of Biogas) and the remaining concerning green Hydrogen production. Specific advanced biofuels, other than biomethane are not active in Portugal.

[169] https://www.ani.pt/pt/financiamento/

14. Public funding in Spain

Spanish stakeholders

In Spain, the Ministry of Science and Innovation (MCIN) is responsible for developing the R&D and Innovation policy and its implementation on scientific research, technological development and innovation in all sectors operating under the General Administration of the State.

There are two policy documents constituting the framework for action on R&D&I:

1. The Spanish Strategy of Science, Technology, and Innovation (updated every 7 years). It covers the vision and main objectives of science, technology, and innovation policies in Spain.
2. The Scientific and Technical Research and Innovation State Plan (updated every 4 years). The Plan constitutes the multi-year frame of reference of the actions of the General State Administration aimed at achieving the objectives of the Spanish Strategy of Science, Technology, and Innovation.

The MCIN has two **funding** affiliated institutions:

1. The Spanish State Agency for Research (AEI - Agencia Estatal de Investigación) is a public funding agency operating under the Ministry of Science and Innovation since 2015 whose Mission is to promote scientific and technical research in all areas of knowledge through the efficient allocation of public resources, boosting the collaboration between the agents of the System.
2. The Spanish Agency for Business Innovation (CDTI - Centro para el Desarrollo Tecnológico y la Innovación), is a public funding agency for innovation, operating under the Ministry of Science and Innovation. Since 1977 its main objective has been to foster innovation and research, experimental development, and the incorporation of new technologies within the business world in order to increase the competitiveness in the country. It is the entity that channels the funding and supports applications for national and international R&D&I projects of Spanish companies.

Both AEI and CDTI undertake the financing activities in a coordinated manner, in their own areas, and in accordance with the principles of autonomy, objectivity, transparency, accountability and efficiency in management in terms of resource and time used by the executing agents in the formalization, processing and justification of the proposals.

AEI and CDTI manage their own R&I funding programmes covering the entire TRL range. CDTI usually covers mid-high TRLs (from TRL 4 to 7) and AEI covers low TRLs (up to TRL 5).

As Spain has autonomous regions, most of the Autonomous Communities have their own regional funding agencies covering the implementation their regional R&D strategies through funds and calls.

The research programs, priorities and funding schemes

The Spanish Strategy for Science, Technology and Innovation 2021-2027 has been designed:

- ✓ to maximize coordination between national and regional planning and programming
- ✓ to facilitate the articulation of our R&D&I policy with the science and innovation framework program of the EU, Horizon Europe (2021-2027).

The national strategic sectors addressed are:

- Health,
- Culture, creativity and inclusive society,
- Security for society,
- Digital world, industry, space and defense,
- Climate, energy and mobility,
- Food, bioeconomy, natural resources and environment.

Activities related to the bioenergy, biofuels and alternative renewable fuels are including mainly in the sectors: “Climate, energy and Mobility” and “Food, bioeconomy, natural resources and environment”

Specific R&D&I actions in both sectors are the result of also integrating the needs of:

- ✓ The National Energy and Climate Plan 2021-2030 (NECP)
- ✓ The Long Term Decarbonization Strategy (EDLP) 2050 and
- ✓ The National Plan for Adaptation to Climate Change (PNACC)

The State Plan (2021- 2023) Is implemented through 4 State Programs and 13 Subprograms:

A. ADDRESSING THE PRIORITIES OF OUR ENVIRONMENT

1. Internationalisation
2. Territorial Synergies
3. Strategic Accions

B. **PROMOTE SCIENTIFIC-TECHNICAL RESEARCH AND ITS TRANSFER**

4. Knowledge Generation
5. Knowledge Transfer
6. Institutional Strengthening
7. Infrastructures and Equipment

C. **DEVELOP, ATTRACT AND RETAIN TALENT**

8. Skills
9. Inclusion
10. Mobility

D. **CATALYZE INNOVATION AND BUSINESS LEADERSHIP**

11. I+D+I Business
12. Innovative Growth
13. Public-Private Collaboration

The instruments and modalities of aid that make up the previous mentioned State programs and sub-programmes are numerous and varied. The following are the most relevant ones for R&I, and the national funding agencies involved in their implementation.

State Agency for Research:

STATE PROGRAMME: *B PROMOTE SCIENTIFIC-TECHNICAL RESEARCH AND ITS TRANSFER*

4.State subprogram for Knowledge Generation

- PID 2021: Knowledge Generation Projects

  General description: The call seeks to promote the generation of scientific and technological qualified knowledge, financing two types of projects: non-oriented research projects and oriented to the challenges of our society.

  - Budget: 425.000.000 €
  - Type of financing: Grant/Reimbursable advance
  - Rules of the call: Competitive concurrency

- TED 2021: Strategic Projects Oriented to the Ecological and the Digital Transitions

  General description: The call aims to promote R&D&I activities to increase the competitiveness and international leadership of Spanish S&T through the generation of scientific knowledge, oriented towards the ecological and the digital transitions.

  - Budget: 296.072.000 €
  - Type of financing: Grant from NextGeneration EU
  - Rules of the call: Competitive concurrency

- PLE: R&D&I Projects in Strategic Areas 2022

  General description: The call aims to support industrial research projects carried out in cooperation between companies and R&D agents, both public and private.

  - Budget: 70.000.000 € (50% grant and 50% loan)
  - Type of financing: Grant from NextGeneration EU and loans
  - Rules of the call: Competitive concurrency

5.State subprogram for Knowledge Transfer

- PDC 2022: Proof of Concept Projects 2022

  General Description: The call aims to finance projects that accelerate the transfer or exploitation of the results generated in research projects, in the form of products, goods, services or other applications, that are beneficial for the economy, society, culture or public policy.

  - Budget: 40.000.000 €
  - Type of financing: Grant from NextGeneration EU
  - Rules of the call: Competitive concurrency

- CPP 2021: Projects in public-private collaboration 2021

  General description: The call aims to support experimental development projects in cooperation between companies and research organizations, to promote the development of new technologies, the business application of new ideas and techniques, and to contribute to the creation of new products and services.

  - Budget: 375.000.000 €
  - Type of financing: Grant from NextGeneration EU
  - Rules of the call: Competitive concurrency

- Grants for Technological and Innovation Platforms 2022

  General Description: The objective of this call is the creation and consolidation of national Technological and Innovation Platforms.

  - Budget: 6.000.000 €
  - Type of financing: Grant
  - Rules of the call: Competitive concurrency

12 national Technological Platforms on energy sectors, relevant to our economy are supported under this call.

Spanish Agency for Business Innovation (CDTI):

CDTI's main R&I funding programs are managed with open and continuous in time calls for R&D&I projects.

CDTI funded R&I projects can be executed by one or more companies. Research Centres, Universities or Technology Centres as R&D stakeholders can be included as subcontractors for executing the specific work packages within the proposed objectives.

Most CDTI projects are expected to originate from business initiatives, including those carried out by regional business consortiums as well as multilateral and bilateral international technological collaborations such as EUREKA, IBEROEKA, Bilateral programmes. CDTI project activities cover both industrial research activities and

experimental development for the creation and significant improvement of a production process, product, or service[170]. CDTI provides sustained support for business RTDI in every innovative phase for all kind of companies.

In 2019 CDTI launched 2 new programs called "Cervera" and "Science and Innovation Missions", both with an issue-oriented approach:

- "Cervera Programme" is a technology-oriented programme. This programme is implemented through two different calls:
    - Call CERVERA Grants for Technology Centres

      Description: Strategic RTDI programs developed by Technology Centres and Innovation Support Centres. Cervera Program considers 27 priority technologies, being one of them ENERGY TRANSITION.

        - Beneficiaries: Technology Centres and Innovation Support Centres (3 a 5)
        - Budget 2021: 35 M€ (9 funded programmes, 1 in Energy Transition: 3,8 M€)
        - Subsidy up to 100% Budget.
        - Competitive concurrency with submission deadlines

    - Aids for RTDI: CERVERA R&D Transfer Projects

      Description: Aid to individual R&D projects for companies that collaborate with technology centres in some of the 27 priority technologies for the Cervera program, including ENERGY TRANSITION

        - Beneficiaries: Spanish SMEs and MIDCAPS
        - Partially repayable aid (with a non-reimbursable tranche: 33%)
        - Competitive concurrency with submission deadlines

- "Science and Innovation Missions Programme" is a challenge-oriented programme.

  Description: Grants for large industrial research consortium projects that address certain challenges / missions (Sustainable Energy, among them)

  Collaborative projects under 2 modalities: i) Large Companies Missions: Consortium led by a Large Company. 3 – 8 companies, at least one SME and ii) SME Missions: Consortium led by a Medium Enterprise. 3 – 6 companies, all SMEs

    - Budget 2022: 125 M€
    - Subsidies: up to maximum intensity: 65% Large companies, 75% Medium Enterprise, and 80% Small companies.
    - Competitive concurrency with submission deadlines

(1) https://www.cdti.es/index.asp?MP=100&MS=898&MN=1&r=1920*1080

Relevance to IP8 activities

Energy sector is addressed among the major challenges identified in the Spanish Strategy within the "Climate, Energy and Mobility" national strategic sector. In addition, "Food, bioeconomy, natural resources and environment" are relevant for IP8. The State Plan facilitates R&D and Innovation activities to address these challenges, in line with the European agenda, especially SET plan, and in collaboration with member states.

CDTI's MISSIONs programme has a mission of "Sustainable Energy" among others, which covers IP8 related activities.

CDTI's CERVERAs programme has a thematic area of "Energy Transition" among others, which also covers IP8 related activities.

There are two National Technology Platforms covering the themes included in the IWG-8 of SET-PLAN: BIOPLAT (https://bioplat.org/), in the field of Bioenergy, Biofuels and Renewable fuels and PTE-HPC (http://www.ptehpc.org/) covering all themes related to Clean Hydrogen. Both platforms promote the increasing incorporation of all the agents of the value chain, identifying the agendas of applied research and experimental development that, responding to their sectoral demands, allow to approach their scientific-technical challenges.

15. Public funding in Sweden

The Swedish stakeholders

The majority of the research financed and performed in Sweden is accounted to the Business enterprise sector. The higher education sector is primarily publicly funded and accounts for approximately 25% of the total Swedish R&D budget. Funding for research institutes (mainly RI:SE, ri.se) goes through the Ministry of Enterprise.

In Sweden, universities and research institutes can receive public institutional funding. All institutional funding for universities is handled by the Ministry of Education. The public institutional funding schemes are based on the research funding proposition to the parliament which is created by the ministry of education based on the input from over 200 universities, institutes, government agencies and other organizations. The funding schemes are reviewed every four years. The annual budget allocated to the IP8 activities is about 1.6 billion euro. The budget is decided through a parliamentary process.

The relevant government agencies[171] which fund research in the energy field are the following:

- The Swedish Research Council: responsible for research funds in the higher education sector
- The Swedish Energy Agency: responsible for research funding within energy related research
- Vinnova: promoting innovation and sustainable growth
- Energiforsk: research and knowledge institute that advances and coordinates energy research

The budget for R&I

Sweden uses slightly more than 3% of its GDP on R&D[172] of which approximately 4%[173] is allocated to energy research and innovation (not exclusively IP8 relevant energy research). The sectorial research financing and expenditures is shown on Figure 15.1.

[171] https://mp.uu.se/en/web/info/forska/forskningsfinansiering/forskningsfinansiarer/svensk-finansiering

[172] Swedish Research Barometer 2019 https://www.vr.se/english/analysis/swedish-research-in-figures/the-swedish-research-barometer.html accessed 22-10-2020

[173] Swedish Energy Agency http://www.energimyndigheten.se/forskning-och-innovation/forskning-och-innovation-2021-och-framat/ accessed 22-10-2020

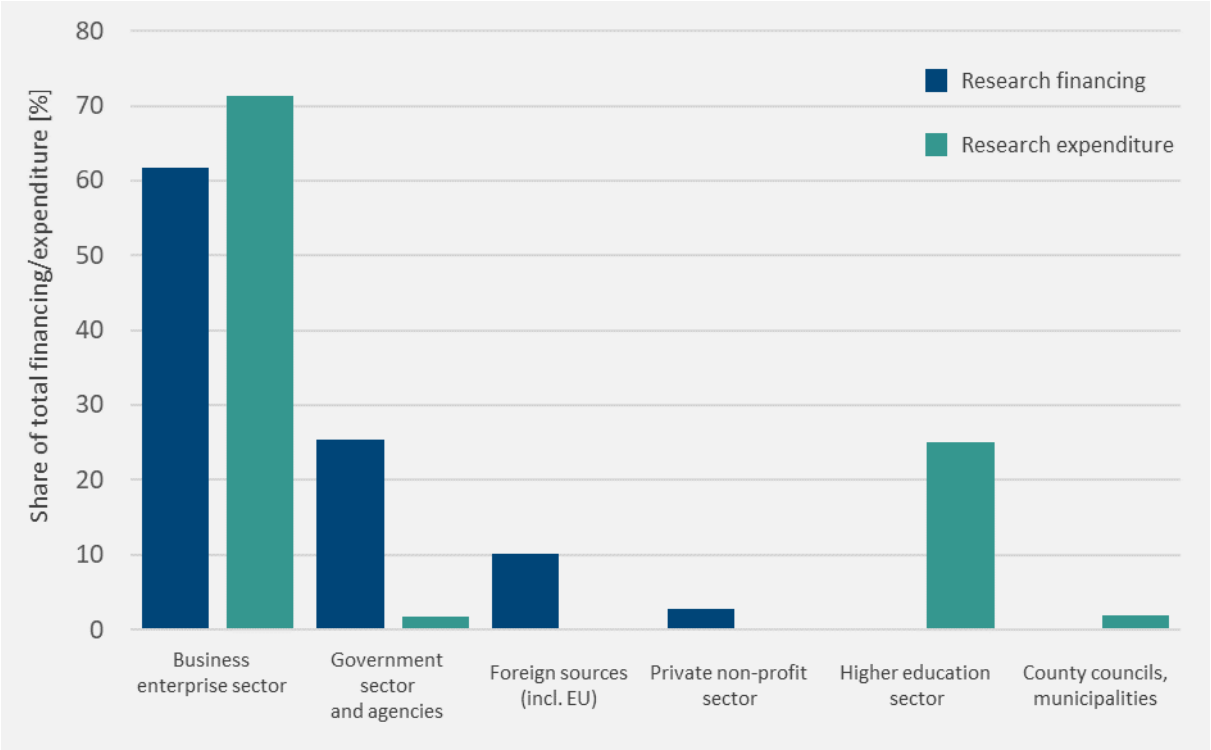

Figure 15.1 Sectorial research financing and expenditures in Sweden percentual of the total research financing of 153 billion SEK and research expenditures of 155 billion SEK. 2017 data. Data source: The Swedish Research Barometer 2019

The total budget for competitive public funding in Sweden is about 2 billion euro but much of it is handled by funding agencies funding a particular research area such as medicine, fundamental research etc. Typically, the funding for IP8 related activities is in the range of €10-15 M per year.

The process for setting the budget and the focus areas for research in Sweden has two main steps. The funding agencies and other actors provide input on prioritized research areas and topics to address. Based on this the government presents a proposition with a suggested budget to the parliament as a part of the main budget process and the parliament makes a decision. There are two main propositions that are relevant to the IP8 activities. The research proposition and the energy research proposition. Most of the funding for the IP8 activities falls under the energy research proposition. The total budget connected to this proposition is typically around 130 M€ per year but no money is directly allocated for a specific research area. The decision regarding funding of biofuels research is made by an external board (Energiutvecklingsnämnden, The Energy Development Board) appointed by the government. The board makes decisions based on a strategy and recommendations from the Swedish Energy Agency. Typically, the funding for IP8 related activities is in the range of €10-15 M per year.

The research programs and priorities

The Swedish Energy Agency is the main funding body related to energy and thus IP8. They have a wide portfolio of financed projects which are contributing to the green transition. The portfolio includes projects covering the innovation, basic research, applied research and experimental development, demonstration, commercialization and dissemination of research-based knowledge and results. Most programs cover almost the entire TRL range except TRL 1 which is handled in more general fundamental research programs. The Swedish Energy Agency reviews the overarching research strategy every four years but in the individual

research programs there are often a yearly update. Figure shows the percentual share of energy research areas funded by the Swedish Energy Agency between 1998 and 2014.

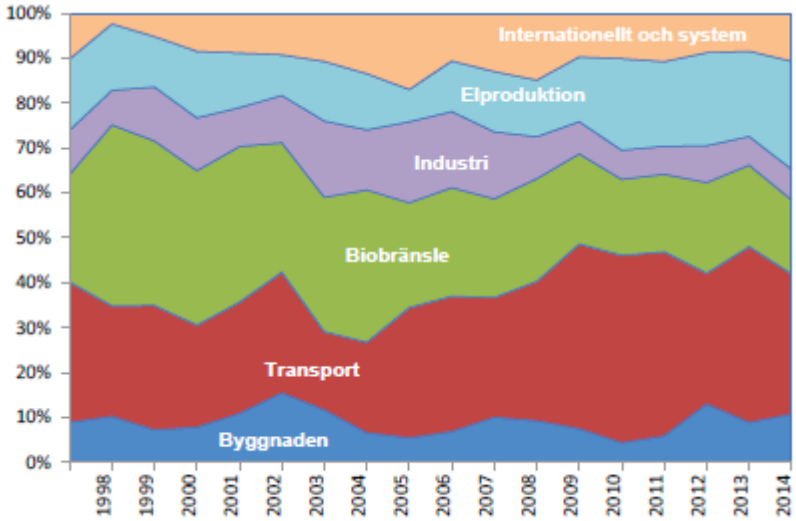

Figure 15.2 Research areas under energy research and their share between 1998 and 2014[174]

Swedish funding schemes and grant types

There are 3-4 funding schemes specifically aimed at activities relevant to IP8 and a few more that have some activities relevant to IP8:

- The Biofuels Program
- Bio+
- Bio-based electricity and heat production
- A Challenge from Sweden
- Strategic innovation programs

The programs have yearly calls which are formed by the funding agency after inputs from several stakeholders such as researchers and industry, participation in IEA activities and EU activities, input from government agencies etc. The programs are evaluated based on their effects in industry and society. The individual projects are always evaluated financially as well as based on the following criteria (which might vary between the calls and funding agencies):

- Achievement of set goals and aims
- Energy efficiency and yields
- Costs and economy
- Availability of feedstocks
- Industry involvement and co-financing
- Potential for IPR and commercialization

[174] Helhetssyn är nyckeln, Energimyndigheten, https://energimyndigheten.a-w2m.se/FolderContents.mvc/Download?ResourceId=109649

The Biofuels Program[175] is to develop knowledge and technology to aid market introduction of biofuels produced from lignocellulose or residual products. The program targets mainly academia, businesses and research institutes. The program is planned to run in 2017-2021 and the budget framework for the period is SEK 180 million.

The main areas of the program are:

- Thermochemical conversion processes
- Biochemical transformation processes
- System issues, integration and biorefinery concepts

The following goals are set for the program:

- The research and development conducted within the program leads to the commercialization and dissemination of new technology.
- The national competence at the doctoral level in the field of biofuels is strong and adapted to meet an expected increased need for competent personnel.
- Swedish research and development activities in the area are efficient and of high quality through synergies and knowledge transfer between different projects.
- Research and industrial experiences from other countries are utilized in Sweden by researchers within the program collaborating and interacting with international actors in the field of academia and industry.

Bio+[176]

Bio+ is a research and innovation programme with a focus on the contribution of biomass, bioenergy and the bioeconomy to the goals of the following policy areas: energy and climate, research and economy. Bio+ stands for the three pillars of energy policy: security of energy supply, competitiveness and ecological sustainability. The program focuses on four areas:

1. biomass and bio-based solutions
2. sustainability, the societal perspective, and systems analysis
3. market and commercialization
4. international cooperation

The Bio + program is planned to run from 2021–2027 and the budget framework for the period is SEK 511 million. The open calls can be retrieved from the Bio+ homepage[177] (the English version appears to be outdated; therefore readers are advised to the Swedish one).

A Challenge from Sweden[178]

A Challenge from Sweden is an initiative by the Swedish Energy Agency promoting challenge-driven innovation in public and private organisations. The aim is to accelerate the shift towards a zero-carbon growth economy and reach the goals of the 2015 Paris Climate Agreement. Through a series of competitions, events and other initiatives, A Challenge from Sweden encourages collaboration in innovation procurement, testing and implementation and provides innovators and entrepreneurs with access to investors and opportunities to commercialise sustainable solutions. The key goals are fossil-free transportation and 100%

[175]http://www.energimyndigheten.se/forskning-och-innovation/forskning/omraden-for-forskning/bioenergi/?currentTab=2#mainheading
[176] https://www.energimyndigheten.se/forskning-och-innovation/forskning/bioenergi/bio/
[177] https://bioplusportalen.se/utlysningar/
[178] https://www.energimyndigheten.se/en/klimat--miljo/a-challenge-from-sweden/

renewable energy. A Challenge from Sweden is a long-term initiative where the focus of the underlying projects varies over time.

Strategic innovation programs

In Sweden, there are examples of coordinated research support. One example is the Strategic Innovation Programmes, which are coordinated by three national agencies, Swedish Innovation Agency (Vinnova), the Swedish Energy Agency (Energimyndigheten) and the Swedish Research Council for Sustainable Development (Formas). They jointly finance collaborative work in selected areas of strategic importance. Long-term objectives, research investment prioritization and the instruments (calls for proposals, innovation competitions, etc.) used are set jointly among the stakeholders. The Strategic Innovation programmes are evaluated every third year. The evaluations assess the strength, improvement potential and early effects and give basis for development of the next phases, decision on further financing, etc.

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16. Public funding in Türkiye

Turkish stakeholders

The Scientific and Technological Research Council of Türkiye (Türkiye Bilimsel ve Teknolojik Araştırma Kurumu, TÜBİTAK) is a national agency established in 1963 in Türkiye with aims "to develop science, technology and innovation (STI) policies, to support and conduct research and development, and to play a leading role in the creation of a science and technology culture in the country". TÜBİTAK is responsible of making policies related to science and technology, and management of R&D institutes, and conducting research, technology and development studies in accordance with the national priorities. TÜBİTAK has a supervisory role as well for the Turkish government and a role as the secretariat of the Supreme Council for Science and Technology that is the highest policymaking body in the country. TÜBİTAK develops STI policy proposals in accordance with the national and international STI policies and conducts science[179].

TAGEM (Agricultural Research and Policy General Directorate) (TAGEM (Tarımsal Araştırmalar ve Politikalar Genel Müdürlüğü) is the largest research organization in Türkiye with a yearly budget of 376 million TL (~41.5 M Euro; 2018). TAGEM is part of the Ministry of Agriculture and Forestry (Türkiye Cumhuriyeti Tarım ve Orman Bakanlığı) and has 50 research institutes with 6425 employees.

The Turkish Development Agencies are part of the Ministry of Industry and Technology (Türkiye Cumhuriyeti Sanayi ve Teknoloji Bakanlığı) that supports research and infrastructures that are consistent with the principles and policies as proposed in the national development plan and the programs, aiming to accelerate regional development, to ensure sustainability, to reduce regional disparities between regions.

The budget for R&I

Türkiye has recently adopted the 11th National Development Plan with a 5-year perspective covering the years 2019-2023, in July 2019. The Plan, which has been prepared by the Presidency of Strategy and Budget and put into force with the Grand National Assembly's Decision, lays down the main pillars of science, technology, and innovation policies. Türkiye has been preparing development plans for five-year periods on a regular basis since the early 1960s. The 11th Development Plan of Türkiye, covering the 2019-2023 period, has recently been accepted at the Grand National Assembly of Türkiye following the approval of the President of Türkiye. The strategies for STI are reviewed and updated each 5 years, accordingly[180]. According to the statistical data from "Research and Development Activities Survey, 2021" which was revised on March 2023

[179] https://www.tubitak.gov.tr/en/about-us/content-who-we-are

[180] https://www.sbb.gov.tr/wp-content/uploads/2020/06/Eleventh_Development_Plan-2019-2023.pdf

by Turkish Statistical Institute (TURKSTAT), the latest finding on the gross domestic expenditure on R&D reached to 101 billion 738 million TRY (approximately 5 billion €[181]) in 2021.

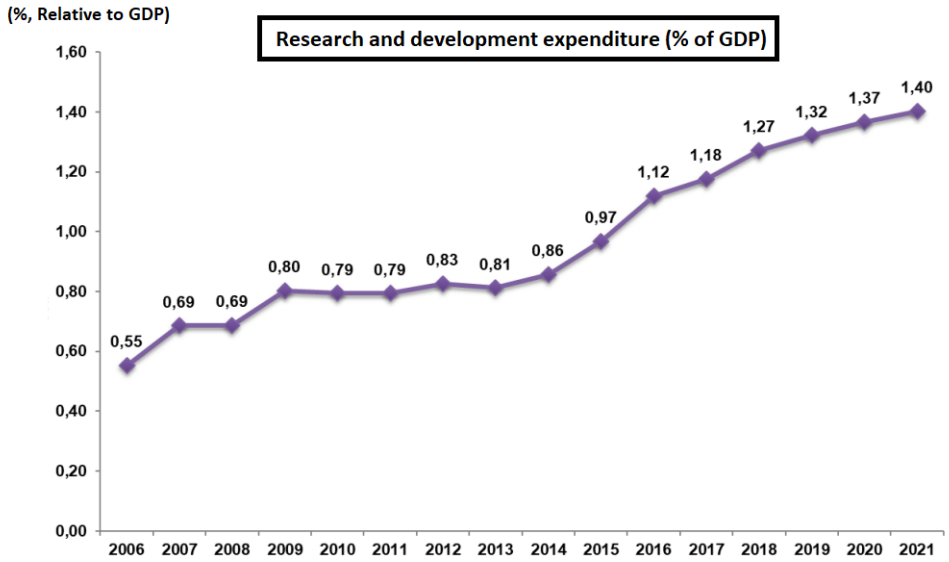


Figure 2: Gross Domestic Expenditure on Research and Development in Turkiye, 2006-2021

The research programs and priorities

Considering the year 2023, which marks the 100th anniversary of the Republic of Türkiye, the targets for Industry and Technology are determined within the scope of the 2023 Industry and Technology Strategy, which has been prepared and published by the Ministry of Industry and Technology in September 2019.

The Science Technology and Innovation Policies Council (STIPC) is the highest-ranking advisory body on STI policy; affiliated directly to the President. The Council reports directly to the President himself on developments in STI policy, monitors the national STI ecosystem and introduces STI policy strategies & recommendations in accordance with national goals for economic & social development and national security, as well as fulfils the entrusted tasks by the President.

TUBITAK has been conducting call planning studies, together with needs and trend analysis, to determine the priority RDI themes of calls to be published within mission-oriented support programs of TUBITAK. In this process, experts responsible for gathering information on the research needs derive contribution of stakeholders who are senior academicians, prominent representatives of private sector conducting R&D and innovation actively, experts from public bodies and NGOs by using various methods such as Delphi analyses, workshops and consideration meetings etc.

In Türkiye, a sector-oriented standpoint has been adopted in 2012 with the introduction of TUBITAK's mission oriented RDI support programs. Under the coordination of TUBİTAK, 14 technology roadmaps and

[181] According to the European Central Bank March 2023 average: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-try.en.html

prioritization studies have been conducted between 2012-2016, and 6 different roadmaps have been determined, as well as for 2022-2023. During the preparation process of technology roadmaps, Focus Groups have played a major role besides the Delphi Surveys and Questionnaires to set the future sub-priorities and a timeline included action plan for each R&D target. The recent call planning for TUBITAK has been conducted for 2022-2023 period. Three main pillars have been defined to put forth the call themes:

- "R&D and Innovation Issues in Priority and Key Technologies" has been created according to the six New Technological Roadmaps mentioned above which are determined by current technological competency.
  These six roadmaps are: Artificial intelligence, Advanced Material, Big Data and Cloud Computing, Engine Technologies, Cyber security and Biotech Pharmaceuticals.
- "R&D and Innovation Issues for European Green Deal and Adaptation to Climate Change" has been constituted according to the global trends and requirements.

  Türkiye ratified the Paris Climate Agreement in 2021 and committed to a zero-emissions target by 2053. Within the scope of the "European Green Deal Action Plan" under the coordination of the Ministry of Trade of the Republic of Türkiye, the Green Growth Technology Roadmap has been carried out in cooperation with the Ministry of Industry and Technology of the Republic of Türkiye and TUBITAK to meet these objectives. As part of the Roadmap, the R&D and innovation priorities have been elaborated to enable private sector organizations in Türkiye to adapt to green growth and to produce domestic solutions for their technological needs and five main themes have been determined: Climate Change, Environment and Biodiversity, Clean and Circular Economy, Clean Accessible and Safe Energy Supply, Green and Sustainable Agriculture, Sustainable Intelligent Mobility.
- "Strategic and Needs-Oriented R&D and Innovation Issues" has been identified according to the mapping of national needs which has been realized by extraction of technological needs from national strategies, policies, and sectoral studies of public bodies. The main topics determined in this context are earthquake research, chemical and biological defence, valuable chemicals from plant sources, monitoring of national biological diversity, biomedical equipment technologies, and epidemiological studies.

These three pillars have been evaluated and consolidated to produce call themes for 2022-2023 period. 264 R&D and innovation topics created together with all ecosystem stakeholders can be found here (in Turkish).

If the project proposals submitted to TÜBİTAK serve at least one of the priority issues, and if the projects are planned to carry out studies within the technological readiness level of the priority issue, they are prioritized during the evaluation phase of the support programs.

Turkish funding schemes and grant types

The Scientific and Research Council of Türkiye is the main funding body in Türkiye. The Call Planning of TUBITAK provides an insight on the technological focus areas until the forthcoming STI Strategy period. Priorities are given to critical technologies which will enable advancements in SDGs in energy; notably renewable energy technologies and low carbon technologies are included in the TUBITAK's Call Planning for 2019-2020. In addition, Energy Storage has been one of the highest priority technologies which is both the

most feasible and efficient one by means of economic return, social benefits, and national security. Here are the funding opportunities for international researchers[182]:

- 1000 - Support Program for Increasing Research and Development Potential of Universities
- 1001 - Scientific and Technological Research Projects Funding Program
- 1002 - Short Term R&D Funding Program
- 1003 - Primary Subjects R&D Funding Program
- 1004 - Center of Excellence Support Program
- 1005 - National New Ideas and New Products Research Funding Program
- 1007- Public Institutions Research Funding Program
- 1501 - Industrial R&D Projects Grant Program
- 3501 - Career Development Program (CAREER)
- 3001 - Starting R&D Projects Funding Program
- COST (European Cooperation in Science and Technology)
- 1071 - Support Program for Increasing the Capacity of Benefiting from International Research Funds and Participation in International R&D Collaborations
- 1704– Industrial Innovation Networks Mechanism (SAYEM)

Since 2018, public RDI supports have transformed into a more output and impact-oriented structure by improving evaluation and monitoring system, which has the basis of peer and panel reviews. Total number of project proposals and funded projects together with the allocated sources, application times/periods and evaluation criteria are given below for some of the selected programmes.

1000 - Support Program for Increasing Research and Development Potential of Universities**:** This call under this programme are upon a specific call, not periodical or regular.

1001 - Scientific and Technological Research Projects Funding Program**:** 2 billion TRY (approximately 290 million €[183]) support to 2983 projects out of 19887 applications 2017-2021. This call is periodical with two application deadlines in a year, March and September. Project proposals are evaluated under the following four dimensions:

- Scientific Excellence
- Methodology
- Project Management
- Impact

1002 - Short Term R&D Funding Program**:** 103 million TRY (approximately 15 million €[184]) support to 2348 projects out of 14965 applications between 2017-2021. This call has ongoing applications. Project proposals are evaluated under the following five dimensions:

[182]https://www.tubitak.gov.tr/en/funds/academy/national-support-programmes#fund_academy_ana_sayfa_akordiyon-block_1-0

[183] According to the European Central Bank between March 2017 and September 2021 average: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-try.en.html

[184] According to the European Central Bank between January 2017 and December 2021 average: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-try.en.html

- Significance and Scientific Excellence
- Aims and Goals
- Methodology
- Project Management
- Impact

1003 - Primary Subjects R&D Funding Program: 450 million TRY (approximately 65 million €[185]) support to 244 projects out of 3351 applications between 2017-2021. This program had priority areas of ICT, manufacturing, automotive, food, energy, water, space, health, defence. This call is upon a specific call. Project proposals submitted for the 2nd phase are evaluated under the following five dimensions:

- Original Value
- Method
- Project Management, Team and Research Opportunities
- Impact
- Contribution to Call Program Goals and Objectives

As of 2020, 1003-type of calls were not open. For this reason, there are no applications and support in 2021 and 2022.

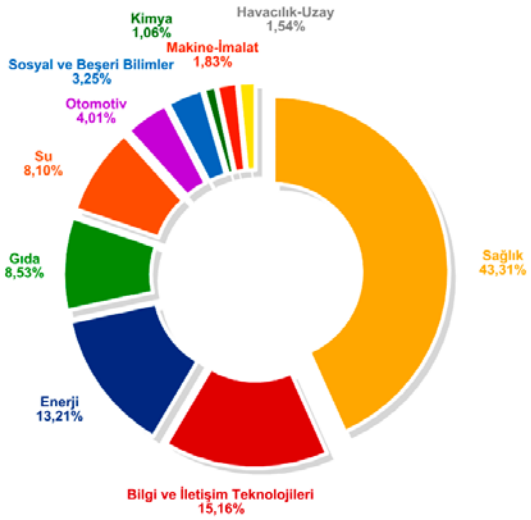


Figure 16.1: Sectoral distribution of the funded projects under the program 1003, where health (yellow), ICT (red), energy (dark blue), food (green), water (orange), automotive (purple), social science and humanities (blue), manufacturing (dark orange), aerospace (gray), and chemicals (dark green) industries received 43.31%, 15.16%, 13.21%, 8.53%, 8.10%, 4.01%, 3.25%, 1.83%, 1.54% and 1.06% of allocated funds[186] (with permission from TÜBİTAK).

[185] According to the European Central Bank between January 2017 and December 2021 average: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-try.en.html

[186] https://tubitak.gov.tr/sites/default/files/19970/ardeb_tanitim_sunumu_2020.pdf

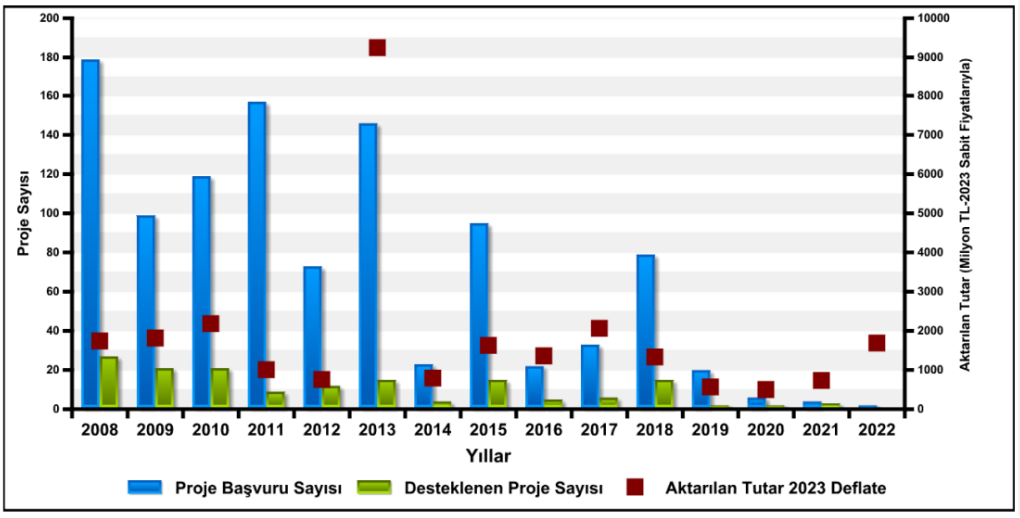
1004 - Centre of Excellence Support Program: 475 million TRY (approximately 69 million €[187]) support to 26 projects out of 29 applications between 2017-2021. The calls under this programme are upon a specific call, not periodical or regular.

1005 - National New Ideas and New Products Research Funding Program: 63.5 million TRY (approximately 9 million €[188]) support to 165 projects out of 1401 applications between 2017-2021. This call has ongoing applications. Project proposals are evaluated under the following six dimensions:

- National Gain
- Aims and Goals
- Innovation level
- Methodology
- Project Management
- Impact

1007 - Public Institutions Research Funding Program: 27.4 billion TL support to 143 projects out of 1042 applications between 2008-2022. This call is upon a specific call. Project proposals submitted for the 2nd phase are evaluated under the following four dimensions:

- Original Value
- Method
- Feasibility
- Budget suitability



[187] According to the European Central Bank between January 2017 and December 2021 average: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-try.en.html

[188] According to the European Central Bank between January 2017 and December 2021 average: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-try.en.html

Figure 16.2: Total number of project applications (in blue) and the projects that received funding (green) and the total funding allocated to the projects per year from 2007 to 2022 under the program 1007[189] (with permission from TÜBİTAK).

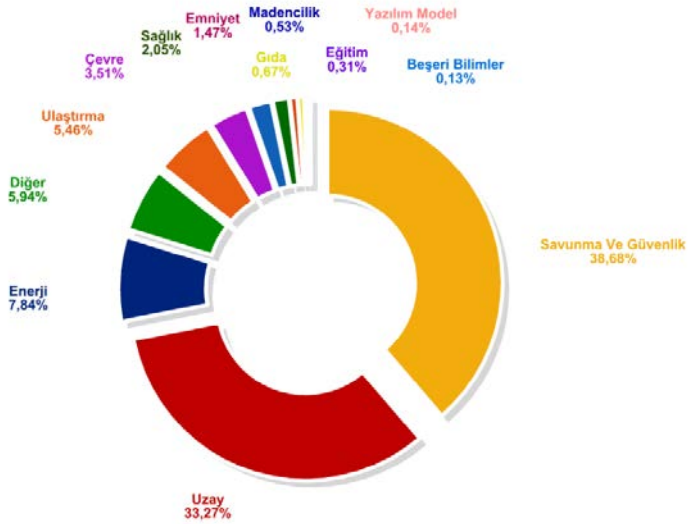


Figure 16.3: Sectoral distribution of the funded projects under the program 1007, where defense and security (yellow), space (red), energy (dark blue), health (purple in pie chart), transport (orange), food (dark green), other (green in pie chart), ICT (text in pink, no section in pie chart), safety (text in magenta, no section in pie chart), mining (text in dark blue, no section in pie chart), social science (text in pale bleu, no section in pie chart),and education (text in purple, no section in pie chart)[190] (with permission from TÜBİTAK).

1071 - Support Program for Increasing the Capacity of Benefiting from International Research Funds and Participation in International R&D Collaborations: 830 million TL support to 1521 projects out of 7120 applications between 2007-2019. These calls are upon specific calls. This call aims to increase the capacity of the researchers of our country to apply to international RDI support funds and to improve their performance, as well as to increase participation in bilateral and multilateral international R&D collaborations. TUBITAK also extensively participates in ERANET Projects (H2020) and co-funded partnerships projects of Horizon Europe Programme.

During 2022, 41 calls were published in different thematic areas within the scope of TÜBİTAK 1071 Support Program. While some of these calls were bilateral cooperation with different countries, some of them were old ERANET and new co-funded partnership calls.

TAGEM**,** with a yearly budget of 376 million TL (2018), has two joint research programs regarding energy production from biomass in collaboration with United Nations Industrial Development Organization (UNIDO) under the GEF-6 financing mechanism where the programs cover up to 50% of total project costs. These programs are

- 3A - Sustainable Biomass Supply Chain Support Program (Sürdürülebilir Biyokütle Projesi Tedarik Zinciri Destek Programı)
- 3B - Sustainable Biomass based Energy Production Plant Support Program (Sürdürülebilir Biyokütle Projesi Biyokütle Enerji Tesisi Destek Programı).

In Law No. 5346; biomass is defined as, in addition to organic wastes, vegetable oil wastes as well as the resources obtained from agricultural and forestry products and by-products resulting from the processing of these products, including agricultural harvest residues. For both funding programs, the project owners and

[189] https://tubitak.gov.tr/sites/default/files/19970/ardeb_tanitim_sunumu_2020.pdf
[190] https://tubitak.gov.tr/sites/default/files/18842/ardeb_tanitim_sunumu.pdf

stakeholders can be agricultural producer unions/cooperatives, energy cooperatives, municipalities, farmers, private sector companies and organized industrial zones/clusters.

As part of the 3A - Sustainable Biomass Supply Chain Support Program, it is aimed to collect, transport, store biomass sources and make them usable in energy facilities that will benefit from other industrial facilities. Priority biomass sources are hazelnut husk, sunflower stalk, cotton stalk, paddy husk, vineyard and pruning wastes, greenhouse wastes. The supply chain should include the collection of selected waste / wastes from the field, their transportation to the energy facility that will serve the industrial facility and / or the district heating center, their preparation to be used in the energy facility (making pellets, briquettes, etc.) and storing them in a way that does not lose their energy content.

As part of 3B - Sustainable Biomass based Energy Production Plant Support Program, two main types of plants are funded:

- heat production
- heat and power production plants.

The projects with a lifecycle analysis, carbon cycle analysis, carbon trading scheme or a similar environmental assessment will be prioritized[191].

Relevance to IP8 activities

Some of TÜBİTAK's funding programmes, schemes and calls have thematic areas or priority topics at the sectoral level, not at the level of IP8 activities or value chains. Sectoral distributions of previously funded projects (Figures 16.1 and 16.3) show that the energy sector (which is the most relevant for IP8 activities), received 13.21% and 5.92% of all the allocated funds under 1003 and 1007 programmes, respectively. Even though the energy sector covers IP8 activities, the exact number of funded projects relevant to IP8 activities were not provided in the funding statistics.

On the other hand, as in many countries, TÜBİTAK supports its stakeholders by establishing both bilateral and multilateral collaborations with its equivalent institutions. In this context, there are both Horizon Europe projects, transnational and bilateral cooperation projects, which coincide with the activities of IP8 and where organizations from Türkiye are the coordinators.

TAGEM's funding programmes, schemes and calls have more specific thematic areas and priorities compared to TÜBİTAK's. 3A - Sustainable Biomass Supply Chain Support Program covers **PVC4: Intermediate bioenergy carriers for power and heat** value chain as part of its thematic scope i.e., making pellets, briquettes etc. from biomass for utilization in energy production. 3B - Sustainable Biomass based Energy Production Plant Support Program covers **PVC2: Power and heat via gasification**, **EVC5: Small-scale combustion for residential heat**, **EVC6: Large-scale combustion for heat and power**, **and EVC7: Biomass co-firing for heat and power** value chains as part of its thematic scope.

Evaluation of projects after completion

The Scientific and Technological Research Council of Türkiye (TÜBİTAK) has conducted a comprehensive series of online surveys on RDI projects which have been supported financially through TÜBİTAK's support

[191] https://www.tarimorman.gov.tr/TAGEM/Sayfalar/EN/AnaSayfa.aspx

mechanisms between the years 2012-2017. They were dedicated to 8 sectors (automotive, machine manufacturing, ICT, energy, health, food &agriculture) and covering more than 100 critical technologies.

The Surveys have been conducted online subjected to all project coordinators; namely 13000 experts for the 2012-2017 period and the participation of more than 4000 project coordinators. The funded RDI projects have been evaluated through these surveys comprehensively; by means of their technological readiness levels, development of critical products/technologies and fulfilment of the targets set within the former period, intellectual property rights, the level of product development and commercialization of projects' outputs.

Starting from 2019, projects are monitored after the funding period in terms of value created by employment, tax, income, exports, etc. Accordingly, as indicated in the 11th Development Plan, public funds for RDI will be subjected to impact assessments in the upcoming years.

Private sector engagement

Türkiye has developed new policies to increase the country's global competitiveness and to become more independent economically and technologically. These policies are structured under the "National Technology Move - NTM" (Milli Teknoloji Hamlesi) approach. This approach was successful in defense industry recently as the local companies have gained important technological capabilities and succeeded in cost effectiveness. This successful approach in defense industry will be extended to other industries with this movement.

Numerous tools have been designed for the engagement of private sector to the public R&D&I support programmes in order to increase technology and innovation capability, product quality and productivity in the industry, as well as to transform the industrial capacity into a more competitive and high value-added structure.

Acceleration of technology transfer and commercialization activities have a special emphasis in this respect. Supporting the technology development and commercialization projects of high technology platforms composed of firms and other stakeholders and initiating a new program that enhances the collaboration between small- and large-scale firms are some of the measures for this goal.

In Türkiye, techno parks are one of the primary policy instruments to support innovative entrepreneurs. During the Plan period (2019-2023), the institutional capacities of techno parks, and technology transfer offices have been improved. Additionally, the 11th Development Plan aimed to launch the Model Factory (SME Competency Centre) Consultancy Support Program to increase the efficiency of SMEs and contribute to their digital transformation. In the 11th Development Plan, an industry-oriented strategy was adopted to increase competitive production and productivity. In this context, a sectoral and conceptual prioritization approach has been developed to accelerate the technological transformation that stimulates productivity growth and to ensure a structural transformation in the manufacturing industry. Additionally, an innovation and technology transfer oriented public procurement strategy are adopted.

17. Public funding in the EU

European stakeholders

The European Commission (EC) is responsible for proposing and implementing the EU budget and managing the EU funding scheme[192]. Approximately 80% of the EU funding is managed jointly by the EC and authorities in the EU countries, which are generally responsible for organizing calls for proposals and granting the funding. The remaining 20% is directly assigned by the EC through grants and tendering procedures.

The Research Executive Agency (REA) is responsible for managing the EU research grants[193] such as individual research grants and a part of larger programmes. Currently these are:

- Horizon Europe (further described below)
- Research Fund for Coal and Steel
- Promotion of agricultural products

The Executive Agency for Small and Medium-sized Enterprises (EASME) ceased its operations as of April 1st 2021 and a new agency EISMEA was established[194]. The EASME managed part of the Horizon 2020 program, in particular within:

- Industrial leadership
- Societal challenges
- The SME instrument
- Fast Track to Innovation (FTI).

The European Innovation Council and SMEs Executive Agency (EISMEA)[195] groups together in one agency all the activities of the European Innovation Council (EIC) and the programmes related to SMEs. EIC was established under the Horizon Europe programme to support innovations from early research stages to proof of concept, technology transfer and the financing and scale up of start-ups and SMEs.

The Innovation and Networks Executive Agency (INEA) ceased its operations as of 31st of March 2021 and a new agency CINEA was established[196]. INEA managed parts of Horizon 2020: Smart, green and integrated transport and Secure, clean and efficient energy.

The European Climate Infrastructure and Environment Executive Agency (CINEA)[197] manages part of the Horizon Europe programme. Their mission is to support stakeholders to implement projects contributing to decarbonisation and sustainable growth.

The European Research Council (ERC) supports investigator-driven and bottom-up frontier research in any field of research[198].

[192] https://ec.europa.eu/info/about-european-commission/what-european-commission-does/budget-and-funding_en
[193] https://ec.europa.eu/info/departments/research-executive-agency_en#responsibilities
[194] https://ec.europa.eu/easme/en
[195] https://eismea.ec.europa.eu/index_en
[196] https://ec.europa.eu/inea/
[197] https://cinea.ec.europa.eu/index_en
[198] https://erc.europa.eu/about-erc/mission

The budget for R&I

The budget information of specific calls and/or programs are provided in the sections below.

The research programs and priorities

The EC has developed 6 priorities for 2019-24[199]:

- "A European Green Deal: Europe aims to be the first climate-neutral continent by becoming a modern, resource-efficient economy.
- A Europe fit for the digital age: The EU's digital strategy will empower people with a new generation of technologies.
- An economy that works for people: The EU must create a more attractive investment environment, and growth that creates quality jobs, especially for young people and small businesses.
- A stronger Europe in the world: The EU will strengthen its voice in the world by championing multilateralism and a rules-based global order.
- Promoting our European way of life: Europe must protect the rule of law if it is to stand up for justice and the EU's core values.
- A new push for European democracy: We need to give Europeans a bigger say and protect our democracy from external interference such as disinformation and online hate messages."

European Green Deal promotes activities including IP8 relevant topics. According to this, "the EU will be climate neutral in 2050 by i) decarbonizing the energy sector, ii) renovating buildings to help people cut their bills and energy use, iii) supporting industry to innovate and to become global leaders in the green economy, and iv) rolling out cleaner, cheaper and healthier forms of private and public transport[200]." The European Green Deal is working in different policy areas[201]:

- **Climate**: includes the "2030 climate & energy framework[202]" and the "2050 long-term strategy[203]"
- Environment and oceans
- Transport
- Research and Innovation
- **Energy**: that includes the "EU Energy System Integration Strategy", where one of the main points is to "unlock the potential of sustainable biomass and biofuels, green hydrogen, and synthetic fuels" and the "A Hydrogen Strategy for a climate neutral Europe"
- Agriculture
- Industry
- Finance and regional development

The just concluded EU research and innovation programme Horizon 2020 was the largest EU research and innovation programme between 2014 to 2020 with a budget of approximately €80 B available. FP7 (2007-2013) was its predecessor and Horizon Europe is its successor with €100 B of funding. Horizon 2020 was organized into Work Programs. The Work Program 2018-2020 defined four Focus Areas:

- Building a low-carbon, climate resilient future (LC): budget €4,707 M
- Connecting economic and environmental gains – the Circular Economy (CE): budget €1,044 M

[199] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024_en
[200] https://op.europa.eu/s/ou8b
[201] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
[202] https://ec.europa.eu/clima/policies/strategies/2030_en
[203] https://ec.europa.eu/clima/policies/strategies/2050_en

- Digitising and transforming European industry and services (DT): budget €1,796 M
- Boosting the effectiveness of the Security Union (SU): budget €1,032 M

The Innovation Fund is a funding program for demonstration of innovative low-carbon technologies[204]. It has a budget of €40 B for the period 2020-2030. Funded projects are divided into small-scale and large-scale projects. The focus is on:

- Innovative low-carbon technologies for energy intensive industries
- carbon capture and utilization
- carbon capture and storage
- innovative renewable energy generation
- energy storage.

European funding schemes and grant types

The EU makes funding available in different forms, including grants, loans and guarantees, subsidies, prizes, and public contracts[205]. Grants are the relevant type of funding for this deliverable.

Overview of funding programmes that support research and innovation projects are listed below[206].

- Horizon Europe
- Environment and climate action (LIFE), to contribute to the implementation of climate policies
- Health Programme
- Cohesion Fund, to reduce social disparities (managed at country level)
- European Regional Development Fund (ERDF), to correct imbalances between regions (managed at country level)
- Structural Reform Support Programme (SRSP)
- European Structural and Investment Funds (ESIF), to support job creation (managed at country level)
- Research Fund for Coal and Steel (RFCS)

[204] https://ec.europa.eu/clima/policies/innovation-fund_en
[205] https://commission.europa.eu/funding-tenders/find-funding/financial-instruments-equity-guarantees-and-loans_en
[206] https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls_en

Horizon Europe is the EU flagship program for research and innovation and is the successor of Horizon 2020 to support EU's policy priorities. The program is structured in 4 subcategories:

- Pillar I: Excellent Science
  - Marie Skłodowska-Curie Actions
  - Research Infrastructures
- Pillar II: Global Challenges and European Industrial Competitiveness
  - Cluster 1: Health
  - Cluster 2: Culture, Creativity and Inclusive Society
  - Cluster 4: Digital, Industry and Space
  - Cluster 5: Climate, Energy and Mobility
  - Cluster 6: Food, Bioeconomy, Natural Resources, Agriculture and Environment
- Pillar III: Innovative Europe
  - European Innovation Ecosystems
- Widening Participation and Strengthening the European Research Area
  - Widening Participation and Spreading Excellence

The work program for 2023-24 can be downloaded from the European Commission's website [207]. Examples of calls for funding relevant for the IP8 is listed below:

HORIZON-CL4-2024-TWIN-TRANSITION-01-01: Bio-intelligent manufacturing industries

HORIZON-CL5-2023-D2-01-06: Open Pilot Line/Test Bed for hydrogen

HORIZON-CL5-2023-D3-01-06: Demonstration of advanced biofuel technologies for aviation and/or shipping

HORIZON-CL5-2023-D3-02-01: Development of near zero-emission biomass heat and/or CHP including carbon capture

HORIZON-CL5-2023-D3-02-07: Development of next generation advanced biofuel Technologies

HORIZON-CL5-2024-D3-01-03: Demonstration of improved intermediate renewable energy carrier technologies for transport fuels

HORIZON-CL5-2024-D3-02-02: Development of next generation synthetic renewable fuel technologies

HORIZON-CL5-2024-D3-02-03: Development of smart concepts of integrated energy driven bio-refineries for co-production of advanced biofuels, bio-chemicals and biomaterials

The overall ERC budget from 2021 to 2027 is more than €16 billion, as part of the Horizon Europe program. The ERC awards funding through different types off grants[208]:

- ERC starting grants, for researchers with 2–7-year activity since their PhD completion
- ERC consolidator grants, for researchers with 7–12-year activity since their PhD completion
- ERC advanced grants, for active researchers with more than 10-year activity
- ERC proof of concept, for previous ERC grant receivers that want to explore the commercial potential of their research

[207] https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/horizon-europe-work-programmes_en

[208] https://erc.europa.eu/funding

- ERC synergy grants, for two to four researchers having different skills and resources.

Grants can be granted within any field of research. Applications are organized into three main research domains:

- **PE - Physical sciences and Engineering**, among which PE8_2 Chemical engineering, technical chemistry, PE8_6 Energy processes engineering
- **LS - Life sciences**, among which LS9_11 Biomass production and utilization, biofuels
- SH - Social sciences and humanities

Private sector engagement

Most of the forms of EU funding have among their goals to attract private investments. Consortia including actors from the private sector are eligible to apply for most of the funding schemes. Some EU funding schemes are specially dedicated to SME. The SME Instrument offers funding to SMEs for:

- Innovation projects in: Phase 1 - Concept and feasibility assessment phase, and Phase 2 - Innovation project
- Commercialization (Phase 3)
- Coaching

The Innovation Fund has also the purpose of sharing the risk with promoters of first-of-a-kind innovative low-carbon solutions, by covering up to 60% of investment costs.

18. Conclusions and Outlook

The efforts of Tasks 1.2 and 1.3 in the first 12 months of the project focused on acquiring information about the public funding situation in the IWG8 countries. Thereafter, each country's representants were contacted with the first version of their country's descriptions and asked for quality assurance as well as further updates were sought for in the last months of the project period. The present version is the final one: the report summarizes the funding situation in the IWG8 countries and gives a basic analysis of the overall funding situation and challenges. The allocation of the funds to activities of IP8 is not easy to track, as the spending is not reported according to the Set Plan Implementation Plans. In addition, the relevant information is not found easily. A number of assumptions and simplifications was therefore necessary, and thus, the presentation of countries is simplified. This means also that the energy research budget numbers reported do not show the exact situation for IP8 topics, but for more inclusive categories.

Throughout the course of the project, this report was updated several times with additional and refined data. The quality of the assessments is highly dependent on the quality and the amount of information provided to the authors. The authors made considerable effort to retrieve information from the country contacts as well as the internet but overall, there can be huge differences between the quality of the country descriptions.

The IWG8 member countries use 0.05-0.7% of the countries' GDPs to finance energy-related R&D. Please note, this number includes R&D for all energy topics and not exclusively IP8. It is not possible to derive information on IP8 relevant expenditures without much more detailed research, hence it is not advisable to draw final conclusions on those numbers.

For institutional funding, there is no earmarked budget for IP8 topics in any of the investigated countries, therefore the institutional funding situation is only presented generally where information was available. For competitive public funding, no calls are specified exclusively for IP8. In most of the cases, when the research and implementation topics are defined, the hydrogen topics and bioenergy related ones are found in separate calls. Hydrogen and power-to-X topics might have their own calls or included in other renewables' calls. In case of the latter, it is almost impossible to know whether hydrogen is included in the specific call without having access to the call text. As most of the IWG8 group members are active in the bioenergy field, bioenergy R&D coverage is comparatively better in this document, although, due to the increased interest in hydrogen research in the last year, hydrogen is covered somewhat better in the current final version.

Appendix A – Institutional funding questionnaire

The following information and questions were sent to each of the country contacts in order to assess the national institutional funding situation.

Information needed for assessing the institutional funding mechanisms in your country

This questionnaire looks into the institutional funding mechanisms, typically referring to base funding that academia and research organizations receive directly from the ministries.

Please answer the questions below. If you choose to refer to a homepage for any of the questions, please make sure the information is available in English there.

1. How many ministries cover the 13 activities of IP8? Is the funding distribution aligned if there are several ministries involved?
2. Who is responsible for the development and implementation of institutional research funding in your country?
3. How do the responsible staff gather information on the research needs or the institutes that is funded?
4. How do the institutional funding schemes are formed in the country, which strategies are they based on?
5. What is the annual total budget and how is the budget set? How much of this budget is dedicated towards institutions active in one or more of the 13 activities of IP8?
6. How often are the funding schemes reviewed and updated?
7. What are the requirements of receiving the institutional funds?
8. Which institutions are distributed base funds and how is the budget distributed among these?
9. Are the funding schemes aligned with other countries or EC?
10. In your experience what works especially well in your country?
11. Are there any challenges or improvement needs?
12. Do you have any other experiences with the institutional funding schemes that is worth mentioning?
13. Do you agree to present your name together with the information given?
14. Your contact information for follow up questions and discussions only, this point will be deleted from the report

Appendix B – Competetive funding questionnaire

The following information and questions were sent to each of the country contacts in order to assess the national competitive funding situation.

Information needed for assessing the institutional funding mechanisms in your country

This questionnaire looks into the public competitive funding mechanisms, i.e. funding distributed through competitive calls launched by national and European funding agencies. For this questionnaire, please refer to your national practice.

Please answer the questions below. If you choose to refer to a homepage for any of the questions, please make sure the information is available in English there.

1. In your country who is responsible for development and implementation of the national research funding strategies, and who sets the budget?
2. How large is the budget for competitive funding schemes in total and how much is allocated for funding of one or more of the 13 activities of IP8?
3. How often are the strategies reviewed and updated?
4. How many programs cover the 13 activities of IP8 (see at the background section of the document)? Are the programs aligned?
5. How many programs cover the entire TRL range? Are the programs aligned?
6. How does the responsible staff gather information on the research needs?
7. How do the public competitive funding programs/calls are formed in the country?
8. How often do you have call deadlines?
9. How do you evaluate proposals, by which criteria?
10. How do you evaluate projects after completion?
11. How do the programs/calls engage the private sector? What are the requirements?
12. Are the programs aligned with other countries or EC, if yes which ones?
13. Which funding strategies work especially well in your country?
14. Which strategies could be improved and what are the challenges with those?
15. Do you have any other experiences with the national funding schemes that is worth mentioning?
16. Do you agree to present your name together with the information given?
17. Your contact information for follow up questions and discussions only, this point will be deleted from the report

Appendix C – Regional funding agencies in Spain

Region/ Autonomous Community	Regional Funding Agency	webpage
Andalucía	Agencia de Innovación y Desarrollo de Andalucía (IDEA)	https://www.juntadeandalucia.es/
Aragón	Departamento de Ciencia, Universidad y Sociedad del Conocimiento	https://www.aragon.es/tramitador/-/tramite/ayudas-desarrollo-proyectos-investigacion-desarrollo-innovacion
Balears, Illes	Consejería de Educación, Universidad e Investigación	https://www.caib.es/seucaib/es/tramites/tramite/3394260
Canarias	Agencia Canaria de Investigación, Innovación y Sociedad de la Información (ACIISI)	https://sede.gobcan.es/aciisi/tramites/6014
	Sociedad para el Desarrollo Económico de Canarias (SODECAN)	https://www.sodecan.es/linea-innovacion-pymes/
Cantabria	Sociedad para el Desarrollo de Cantabria (SODERCAN)	https://ayudas.sodercan.es/ayudas/mVxaeDWYEmWMgQZMbyKw
		https://ayudas.sodercan.es/ayudas/rVlbYaqmEqeVEjDNkoQB
Castilla - La Mancha	Consejería de Educación, Cultura y Deportes	http://www.educa.jccm.es/idiuniv/es/investigacion/convocatorias-ayudas-proyectos-investigacion/ayudas-proyectos-investigacion-transferencia-tecnologia/convocatoria-ayudas-proyectos-investigacion-cientifica-tr-1
		https://iti.castillalamancha.es/bases-reguladoras/ayudas-los-centros-tecnologicos-de-la-region-destinadas-al-desarrollo-por-parte
	Consejería de Economía, Empresas y Empleo (CLM)	https://adelante-empresas.castillalamancha.es/adelante/innova-adelante

Castilla y Léon	Instituto para la Competitividad Empresarial (ICE)	https://www.tramitacastillayleon.jcyl.es/web/jcyl/AdministracionElectronica/es/Plantilla100Detalle/1251181050732/Ayuda012/1284804790092/Propuesta
Cataluña	Agencia para la Competitividad de la Empresa (ACCIÓ)	https://www.accio.gencat.cat/es/serveis/innovacio/innovacio-empresarial-i-rd/tecniospring-plus/index.html
Comunitat Valenciana	Agencia Valenciana de la Innovación (AVI)	https://innoavi.es/wp-content/uploads/2019/12/convo2020.pdf
	Instituto Valenciano de Competitividad Empresarial (IVACE)	http://www.dogv.gva.es/datos/2020/01/21/pdf/2020_467.pdf
Extremadura	Consejería de Economía e Infraestructuras	http://doe.gobex.es/pdfs/doe/2017/1410o/17040121.pdf
	Consejería de Economía, Ciencia y Agenda Digital	https://extremaduraempresarial.juntaex.es/web/guest/subvenciones?idContenido=7482501&redirect=/su
Galicia	Axencia Galega de Innovación (GAIN)	http://gain.xunta.gal/artigos/
	Instituto Galego Promoción Económica (IGAPE)	http://www.igape.es/es/base-xeral-de-axudas/ficha/IGAP409
Madrid, Comunidad de	Consejería de Ciencia, Universidades e Innovación	https://www.comunidad.madrid/inversion/innova/ayudas-startups-pymes-alta-intensidad-innovadora
Murcia, Región de	Instituto de Fomento de la Región de Murcia (INFO)	https://www.institutofomentomurcia.es/web/portal/linea-invierte
		https://www.institutofomentomurcia.es/web/portal/linea-emprendia
		https://www.institutofomentomurcia.es/web/portal/linea-expansion
Navarra, Comunidad Foral de	Departamento de Desarrollo Económico y Empresarial	https://bon.navarra.es/es/anuncio/-/texto/2018/232/4/
		https://bon.navarra.es/es/anuncio/-/texto/2020/27/4

País Vasco	Sociedad para la Transformación Competitiva S.A. (SPRI)	https://www.euskadi.eus/ayuda_subvencion/2020/elkartek-2020/web01-tramite/es/
		https://www.euskadi.eus/ayuda_subvencion/2020/emaitek-plus-2020/web01-tramite/es/
		https://www.euskadi.eus/ayuda_subvencion/2020/bikaintek_2020/web01-tramite/es/
		https://www.euskadi.eus/ayuda_subvencion/2020/hazitek/web01-tramite/es/
		https://www.euskadi.eus/ayuda_subvencion/2020/gauzatu-industria-2020/web01-tramite/es/
		https://www.euskadi.eus/web01-tramite/es/contenidos/ayuda_subvencion/spri_innob_lehiabide_2019/es_spri_i/es_arch.html
		https://www.spri.eus/es/ayudas/hazinnova/
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