MISSION INNOVATION

DECEMBER 2023

Member Insights 2022-2023

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Mission Innovation Insights Module

Contents

Introduction

The Mission Innovation membership accounts for over 90% of global public sector spend on clean energy innovation, this report gives a snapshot of the global innovation landscape, and shows how MI Members are supporting the delivery of the Mission Innovation 2.0 Vision Statement agreed at the 6th MI Ministerial in 2021[1].

The Mission Innovation Member Insights Report 2022-23 presents information on clean energy research, development and demonstration (RD&D) activities covering the period October 2022 to November 2023. The information provides a unique insight into each MI Member's national innovation programmes and initiatives that have taken place over the past year, where they are collaborating with the private sector and internationally, and how they interact with Mission Innovation.

The Member Insights Report contains a section on each MI Member Country. The core elements covered in each country section are:

- **Clean energy innovation activities**: a summary of RD&D funding and programmes announced or implemented in the previous year.
- **Public RD&D data:** Mission Innovation has worked alongside its collaborating partner, the International Energy Agency (IEA), to ensure a standardized approach to collecting data on national RD&D spend. For MI members who are also IEA members, all data is taken from the IEA Energy RD&D Database[2].MI members who are not IEA members were asked to complete a simplified version of the IEA RD&D questionnaire and submitted this to MI and the IEA for inclusion. The data presented is in Million USD (at latest year prices and exchange rates), and where available, data is presented for each year back to 2018 so that trends over time can be seen. The Public RD&D spend for each member is included here as it helps us track progress by MI members to sustain and, where possible, enhance RD&D commitments made in the MI2.0 member statement[3].
- **Public-private collaborations**: A summary of major programmes or initiatives that leverage private sector expertise and funding to tackle clean energy innovation challenges.
- **Involvement in Mission Innovation**: Members have described how they have contributed to and met their member commitments since MI 2.0 (June 2021).
- **International collaborations (collated together in Annex A):** MI Members have provided information on bilateral and multilateral collaborations with MI and non-MI countries that have taken place over the past year (existing or new collaborations). These include engagement with MI partners in the clean energy landscape including the Breakthrough Agenda (a commitment to work together to accelerate the innovation and deployment of clean technology in key emitting sectors, ensuring they are affordable and accessible for all, which was launched at COP26) and Clean Energy Ministerial (a unique partnership of the world's key economies working together to accelerate the global clean energy transition with a focus on deployment). These tables are collated together in Annex A.

[1] http://mission-innovation.net/about-mi/overview/2021-joint-launch-statement/
[2] The IEA Energy RD&D database can be found here: https://www.iea.org/data-and-statistics/data-product/energy-technology-rd-and-d-budget-database-2
[3] http://mission-innovation.net/about-mi/overview/2021-joint-launch-statement/

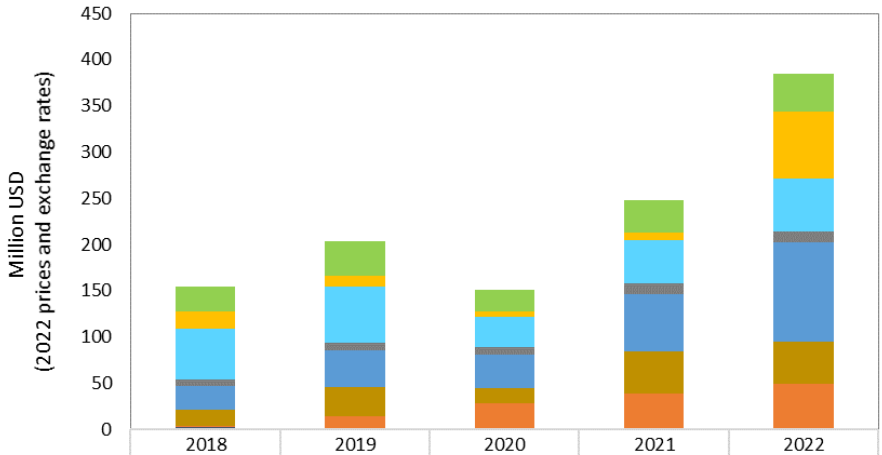
- **Other Clean Energy Innovation Activities (optional)**: Information on other clean energy activities that they are involved in and might be of interest to over MI members.

Where an MI member has been unable to return the MI Member Survey in the required timeframe, we have either omitted the country section or presented the publically available information (via reporting to the IEA).

Australia

Public RD&D Data

Australia's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	27.0	36.9	24.2	35.0	40.8
CCS	18.8	11.9	5.5	8.3	71.7
Renewables	54.7	60.4	32.6	46.5	57.3
Nuclear	7.2	7.8	8.1	11.5	12.5
Hydrogen and fuel cells	26.5	39.7	36.3	61.3	107.3
Other power and storage technologies	16.7	31.5	17.0	45.5	45.5
Other cross-cutting technologies/research	2.0	14.9	28.0	39.4	49.3
Unallocated	2.2	0.0	0.0	0.0	0.0
Total Budget	155.1	203.1	151.6	247.5	384.4

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
International Clean Innovation Researcher Networks (ICIRN)	Grant	AUS$12.4 million	Renewable energy and clean technologies	2023/24 – 2026/27	Solar panel reuse and recycling; renewables and EVs electricity grid integration; low-carbon materials production.	$12.4 million awarded for International Clean Innovation Researcher Networks - DCCEEW
Quad Clean Energy Supply Chain Diversification Program	Grants	AUS$50 million	Clean energy supply chains	Announced July 2023	Clean energy activities such as solar ingots, wafer production or battery cell component manufacturing	$50m funding to boost clean energy supply chain projects - DCCEEW
Powering Australia Technology Fund	Grants; equity investments; loans, debt financing and loan guarantees; business accelerators / incubators	AUS$500 million	Early and growth stage businesses across all technologies	Announced Nov 2022	Investment in businesses and entities that are developing, commercialising and supporting the deployment of technologies with the potential to accelerate Australia's transition to net zero emissions by 2050.	$500m to establish Powering Australia Technology Fund through the CEFC | Ministers (dcceew.gov.au)
Powering the Regions Fund – delivered through 3 funding streams: • Safeguard Transformation Stream • Industrial Transformation Stream • Critical Inputs to Clean Energy Industries	Grants	AUS$1.9 billion	New clean energy industries	2022/23-2026/27	Decarbonising existing industries, (eg cement, lime, alumina and aluminium sectors) and supporting the development of new clean energy industries	Powering Australia | energy.gov.au
Hydrogen Headstart	Production credits	AUS$2 billion	Large-scale renewable hydrogen projects.	Opened for EOI on October 10, 2024. Funding	Hydrogen Headstart will provide revenue support for large-scale renewable hydrogen projects	Hydrogen Headstart - Australian Renewable Energy Agency (ARENA)

				to projects will be delivered over 10 years beginning in 2026-27.	through production credits designed to bridge the commercial gap between renewable hydrogen production costs and expected sales prices. .	
Rewiring the Nation – Clean Energy Finance Corporation	Loans, debt financing and loan guarantees	AUS$19 billion	Electricity grid and infrastructure modernisation	2022-23	Capital to overhaul Australia's energy transmission and distribution network infrastructure. Will range from investments in electricity grid infrastructure, hydrogen hubs and offshore energy generation.	Rewiring the Nation - DCCEEW
Australian Renewable Energy Agency (ARENA) funding programs: • Advancing Renewables Program • Driving the Nation • Sustainable Aviation Fuel (SAF) initiative	Grants	• Up to AUS$120 million for community batteries • AUS$70 million • AUS$30 million	• Includes ultra-low cost solar, large scale battery storage, and community batteries. • Electric vehicles 2023 focus area: innovation in charging. • Sustainable aviation fuel from renewable Australian feedstocks	Ongoing – new funding rounds announced throughout 2023	• Low emissions projects and activities that involve a renewable energy technology or technologies that increase the supply of, or improve the competitiveness of, renewable energy in Australia and have a clear nexus to renewable energy and its enabling technologies. • Innovation in public charging and management of charging infrastructure. • Development of domestic SAF production from agricultural feedstocks.	Advancing Renewables Program - Australian Renewable Energy Agency (ARENA) https://arena.gov.au/funding/driving-the-nation-program/ Joint media release: Sustainable aviation fuels set for take-off | Ministers (dcceew.gov.au)
Carbon Capture Technology Program	Grants	AUS$65 million	• Emerging carbon removal and carbon utilisation technologies	2024-25 to 2030-31	• Research, development, and demonstration of emerging technologies including DACs, BECCS and carbon utilisation.	Carbon Capture Technologies Program | business.gov.au

CCUS Development Fund	Grants	AUS$50 million	• Pilot and pre-commercial CCUS projects	2020-21 to 2022-23	• Progress pilot and pre commercial CCUS projects in regional Australia towards commercial operations.	https://business.gov.au/grants-and-programs/carbon-capture-use-and-storage-development-fund

* Type categories: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.

**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

Australia joined the **First Movers Coalition** during the Clean Energy Ministerial in July 2023 in Goa, India. By joining this coalition as a Government Partner, Australia is signalling its dedication to fostering innovative solutions to accelerate the supply of clean energy and address critical policy levers to effectively combat climate change.

In October 2022, the Australian Government committed $15 billion to establish **the National Reconstruction Fund (NRF).** The NRF will provide finance for projects that diversify and transform Australia's industry and economy, including in clean energy manufacturing such as renewables and low emissions technologies.

In 2022-23, **the Clean Energy Finance Corporation** (CEFC), Australia's 'green bank', made $1.9 billion in new investment commitments, including a record $1.2 billion in renewable energy and grid-related commitments. In addition, the Government provided $500 million to CEFC for the Powering Australia Technology Fund to help business progress innovative projects and technologies to reduce emissions. The fund aims to leverage off another $500 million from the private sector.

In 2022-23, **the Australian Renewable Energy Agency** (ARENA), gave $544 million to new clean energy projects, and committed a further $358 million to new projects. ARENA has also been tasked with delivering the $2 billion Hydrogen Headstart initiative fund green hydrogen projects and technologies to reduce emissions. ARENA has successfully leveraged $3.32 of co-funding from the private sector for every $1 invested.

Green Iron Ore demonstration hub
The Minerals Research Institute of WA provided $450,000 in funding for CSIRO and Climate-KIC to progress a pre-feasibility study for a common user research facility which can support the piloting and demonstration of Australian iron ore processing for green steel in the future. The study on an iron ore processing and iron making pilot facility with low emissions will help identify the research capability and demonstration infrastructure needed to make key breakthroughs for enabling decarbonisation pathways for West Australian ores.
Based on interim data[4], the Australian Government invested at least A$1.6 billion in a range of programs to support low emission technologies in 2021-22. This included investments through: the Australian Renewable Energy Agency; the Clean Energy Finance Corporation; the Clean Energy Regulator; the Department of Industry, Science, Energy and Resources; the Department of Agriculture, Water and the Environment. Many of these programs are designed to attract co-investment from other parties including private sector entities. Alongside the Government's investment of AUD $1.6 billion, other co-investors contributed an additional AUD $4.2 billion in these programs to support low emissions technologies in 2021-22.

Contribution to Mission Innovation work programme in 2022/23

Mission Innovation Steering Committee
The Australian Government has two representatives on the Mission Innovation Steering Committee: Kushla Munro, Head of the International Climate and Energy Division, is Vice Chair and Peta Olesen as MISC delegate. As Australia's representatives on the Steering Committee, Kushla and Peta provide high-level strategic guidance to MI, including its strategic direction, and work program.

[4] At the time of preparation, data for the full 2021-22 financial year was not yet available or only partially available from some Australian Government agencies. The figures provided here are likely to increase once all remaining data is collected and compiled.

Net Zero Industries Mission
As co-lead of the NZIM, the Australian Government provides the Global Mission Coordinator (Dr Alan Monaghan) to coordinate and promote engagement with the NZIM across MI and industry.

Clean Hydrogen Mission
Australia is a co-lead of the CHM, sharing this role between the Department of Climate Change, Energy, Environment and Water and the CSIRO as the technical lead. As part of our activities under the mission we have developed a global Hydrogen Storage and Distribution interactive case studies map, which was released at MI-8 in Goa, July 2023. We have also hosted a series of workshops on the storage and distribution of hydrogen.

Green Powered Futures Mission, Carbon Dioxide Removal Mission, Zero Emissions Shipping Mission
Australia continued to provide valuable contributions as core members of the GPFM, the CDRM and the ZESM. CSIRO leads Australia's engagement in the GPFM, where we contributed to the National Pilots Report released in July 2023, and the CDRM, where we co-lead the Enhanced Mineralisation Technical Track. The Department of Industry, Science and Resources leads Australia's engagement in the ZESM.

Innovation Community on Affordable Heating and Cooling (IC-AHC)
Australia, through CSIRO, participates in the IC-AHC. CSIRO has been leading the development of the MI Grid Integrated Cooling of Buildings Initiative, due for launch by the end of 2023.

International Clean Innovation Researcher Networks (ICIRN)
The Australian Government is delivering $12.4 million to support five major projects through the ICIRN grant program. The ICIRN grants support technologies needed to deliver Australia's emissions reduction and renewable energy goals by supporting Australian researchers to build networks with global experts to develop renewable energy and clean technologies. These include solar, wind, storage, green metals and their supply chains. Projects funded include:

- $2.59 million to CSIRO for research on the integration of renewable energy into the electricity grid, supporting Australia's engagement in the GPFM.

- $1.97 million for CSIRO to advance its international leadership on energy efficient 'smart buildings' to use energy more efficiently and effectively in buildings, supporting Australia's engagement in the MI Innovation Community for Affordable Heating and Cooling.

International clean energy collaborations in 2022/23

See Annex A, page 132.

Other clean energy innovation activities in 2022/23

Australian Technologies Competition
The Australian Government supported the Clean Technology Award as part of the Australian Technologies Competition (ATC). The ATC is a growth and awards competition for innovative Australian technologies with global growth potential, with 15 categories across all sectors including clean energy technologies. The 2023 winner of the Clean Energy Award was ONVOL for its technology to turn movement into electricity to supply endless power to industrial internet of things (IoT) sensors in critical applications like wind turbines. Additional winners include Adiona Tech (Sustainable Cities, Communities & Transport Award Winner), an innovative

technology company providing a robust and scalable delivery route planning platform, and Raygen (Victorian Cleantech Alumni Award) for its work combining hi-tech solar with thermal storage.

Clean Energy Ministerial
Australia is an active member of CEM and contributes to a range of activities. In July 2023 Australia joined the International Hydrogen Trade Forum and released its Action Plan for the 21st Century Power Partnership. Currently, Australia is co-developing a new Stationary Battery Storage initiative alongside the US, EU and Canada. This initiative aims to boost global development and deployment of grid-scale battery storage. In September 2023 Australia joined the Biofuture Platform, which aims to accelerate the development, scale-up and deployment of bio-based fuels.

Breakthrough Agenda
In November 2022 Australia endorsed the Breakthrough Agenda on Agriculture, which aims to make to make 'climate-resilient, sustainable agriculture the most attractive and widely adopted option by farmers everywhere by 2030'.

Global Power System Transformation Consortium
Australia, through the Australian Energy Market Operator (AEMO) and CSIRO, continued its membership of the GPST. In 2022-23 CSIRO published Australia's GPST Research Roadmap which outlines Australia's research program on GPST topics including inverter design, new control room technologies and tools to ensure grid stability. The Stage 2 research summary report was published in July 2023.

International Solar Alliance (ISA)
As a founding member of the International Solar Alliance, Australia supports the ISA's contribution to technological solar development, greater access to affordable, reliable energy and broader geopolitical and economic outcomes. Australia is also committed to sharing our solar expertise with ISA Members particularly in the Indo-Pacific region.

Addressing Barriers to Renewable Energy Integration in the Pacific
The Australian Government is deploying technical expertise to the Government of Vanuatu to develop a decarbonisation roadmap for their electricity sector. When decision-makers, energy system planners and regulators can use robust techno-economic assessments and planning tools it allows them to determine least-cost decarbonisation trajectories that ensure the security, resilience, and reliability of energy, while meeting NDC targets.

Pacific Regional Green Hydrogen Strategy
The Australian Government is partnering with IRENA, the University of New South Wales, and the Pacific Community (SPC), to draft a Regional Green Hydrogen Strategy. This responds to calls made at the 2023 Pacific Regional Energy and Transport Ministers Meeting.

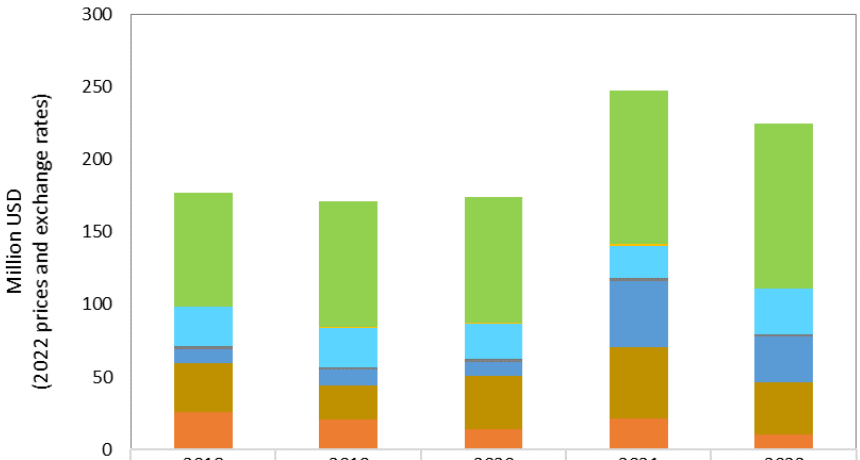
Supporting Pacific regionalism to address the energy transition:
The Australian Government has supported Pacific representatives' participation in regional fora to discuss energy transition issues and the place of emerging technologies, including:

- The 5th Pacific Energy and Transport Ministers Meeting,
- The 30th Pacific Power Association Trade Fair and Conference

Austria

Public RD&D Data

Austria's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	78.4	86.6	86.4	106.1	113.3
CCS	0.3	0.6	1.1	0.8	0.6
Renewables	27.2	27.2	24.2	22.6	31.1
Nuclear	2.1	1.9	1.8	1.7	1.6
Hydrogen and fuel cells	9.5	10.8	9.8	45.5	31.6
Other power and storage technologies	34.0	23.7	36.4	49.8	35.7
Other cross-cutting technologies/research	25.7	20.4	14.2	21.1	10.6
Unallocated	0.0	0.0	0.0	0.0	0.0
Total Budget	177.2	171.3	174.0	247.6	224.6

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Energieforschung 2022	Grants	€17M	• Sector coupling and renewable hydrogen in industry • Field test heat storage • Climate-neutral heating and cooling • Climate change adaptation of energy infrastructure	1 March 2023 – 10 May 2023	With energy innovations "Made in Austria", the Energy Research Programme makes important contributions to climate neutrality in 2040. The aim is to expand technological competencies, strengthen Austria as a location for innovation in clean energy technologies and improve export opportunities.	Energieforschung 2022 | FFG
RTI Initiative for Transforming Industry	Grants	€15M	Industry	19 May 2023 – 15 November 2023	• Establishment of an innovation laboratory as a national and international contact point to help innovations "Made in Austria" in industrial decarbonization achieve a quicker breakthrough. • Cooperative R&D projects funded as part of large-scale innovative projects in combination with transformation of the industry in accordance with the Environmental Promotion Act (UFG).	https://www.klimafonds.gv.at/wp-content/uploads/sites/16/Leitfaden_Transformation_Industrie_2023_EN_v3a.pdf

Technologies and innovations for the climate-neutral city of 2023	Grants	€14M	Climate neutral cities	05 October 2023 – 08 February 2024	The call addresses specific applied research questions and R&D services that will contribute to the development of climate-neutral and resilient cities, neighborhoods and buildings.
					Project proposals for funding can be submitted in the following areas:
					• Urban technologies
					• Urban system innovations
					  ○ Climate neutrality solutions for (pioneer) cities
					  ○ Transformative and social innovations in the urban system
					• Urban pilot demonstrations and pioneer quarters
					  ○ Demonstration of climate-neutral buildings
					  ○ Demonstration of climate-neutral districts
					  ○ Pioneer urban districts
						https://www.ffg.at/tiks/AS2023

Austrian Climate Research Programme (ACRP) – 16th Call	Grants	€5M	Climate research	24 May 2023 – 25 January 2024	The ACRP focuses on research on climate change and climate actions, adaptation, mitigation and their mutual interrelation. Projects of oriented basic research are funded in the following three thematic areas: • Understanding the climate system and the consequences of climate change • Specific support for Austria's policymakers • Transformative change	https://www.ffg.at/ACRP_16.Call
Climate and energy model regions 2023	Grants	€12M	Climate and energy model regions	28 July 2023 – 31 January 2024	The program supports Austrian regions in making optimal use of their local renewable energy resources, exploiting the potential for energy savings, and operating sustainably. The commissioning of an implementation concept and its execution by the model region managers are essential components of the program. Supported are: • New model regions • Extensions of existing model regions • Flagship projects	https://www.klimafonds.gv.at/wp-content/uploads/sites/16/202309_Leitfaden_KEM.pdf
100% Renewable Energy Real labs	Grants	20M	integrated, regional energy systems and grids	14. July 2022 – 19 April 2023	The flagship initiative "100% Renewable Energy Reallabs" as part of the BMK's RTI focus on energy transition aims to initiate, promote and support five "reallabs" for different types of regions in Austria, in which prototype system solutions for integrated, regional energy systems are developed, tested and validated ("regionally typical" solutions as a blueprint for the Austrian energy transition).	100% Erneuerbare-Energie-Reallabore | FFG

* Type categories: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.

**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

The federal government's climate and transformation offensive aims to support Austrian industrial companies in making their production processes climate-neutral. On the one hand, this strengthens value creation in Austria and, on the other, leads to greater independence from fossil energy imports. Subsidies totalling around 5.7 billion euros are available until 2030.
Within the framework of this climate and transformation offensive, a total of 2.975 billion euros is available for the transformation of industry under the Environmental Support Act (UFG) until 2030 (175 million euros in 2023, 400 million euros annually thereafter).
Klima- und Transformationsoffensive: Der Plan für eine nachhaltige Industrie (bmk.gv.at)

Contribution to Mission Innovation work programme in 2022/23

Net- Zero Industries Mission: Co-Lead
Austria has been co-leading the Net-zero industries mission together with Australia since its soft launch at COP26 in 2021. Since then, the mission member base continuously expanded, and Austria provided in-kind contributions for the elaboration of the Mission Roadmap, its Action Plan, Governance structure etc. After its launch in September 2022, Austria has secured resources to fill several positions within the Mission Governance (Mission Director, Mission Secretariat & PR, Technical Analysts and Support) and has continued this engagement through 2023.

Clean Hydrogen Mission: Core Member
Provision of national expert to contribute to the Mission activities.

Green Powered Future Mission: Mission Support Group
Provision of national expert to support the Mission.

Urban Transitions Mission: Core Group Member
Provision of national expert to contribute to the Mission activities + provision of expertise from JPI Urban Europe´s management Board Chair (who is financed by The Austrian Research Promotion Agency (FFG))

MI Platform: together with Sweden, Austria initiated two activities within the Collaborate Module: the (a) **Public Funders Dialogue** and (b) **Joint Funding Calls**. At (a): The public funders dialogue provides a forum where interested public funders can connect and participate in the scoping of potential new calls as well as in the process of committing to already planned calls. Public R&I funders can also engage in and initiate joint knowledge sharing and an analysis of existing project portfolios both in national projects and in transnational projects. In this reporting period, 2 funders dialogues were organized. At (b) The MI CALL SERIES is a SERIES of yearly Multilateral RD&I calls initiated through the public funders dialogue and always hosted by one or several funding networks or partners. The MICall21 is hosted by JPI Urban Europe. The upcoming MICall22 will be hosted jointly by the CETPartnership and DUT Partnership.

Finally, Austria also supports the work of the MI Secretariat with an assigned staff member, namely Ms. Irmgard Herold in the extent of 0,5 FTEs.

International clean energy collaborations in 2022/23

See Annex A, page 137.

Other clean energy innovation activities in 2022/23

Climate Ticket

With the Climate Ticket all public transport in Austria can be used at a cost of €1095 for one year. Since its start, 208.000 (till 30th December 2022) tickets have been sold and public transport has significantly increased. The KlimaTicket Ö for 18-year-olds will be available in the course of 2024. Young adults can get a KlimaTicket Ö once free of charge on the occasion of their 18th birthday. From their 18th birthday onwards, young adults have three years to make use of the free KlimaTicket Ö once.

Link: https://www.bundeskanzleramt.gv.at/eu-aufbauplan/aktuelles/bereits-ueber-208000-klimatickets-in-oesterreich-verkauft.html#:~:text=Anzahl%20der%20verkauften%20KlimaTickets%20nach,KlimaTicket%20%C3%96sterreich%20Senior%3A%2024.000; https://www.klimaticket.at/en/

Austrian Circular Economy Strategy - Austria on the path to a sustainable and circular society

The reduction of resource consumption, waste and emissions has a special importance within the context of sustainable development and Climate Protection. The realization requires a fundamental transformation: from the linear "take-make-use-waste" economy to a circular economy.

The Austrian circular economy strategy was developed and led by the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (BMK) together with numerous actors from economics, science, administration and civil society.

The circular economy is an important cornerstone for the location strategy currently being developed and is based on the digital action plan. A significant driver for the transformation is innovation, that should gain additional dynamics through the FTI strategy 2030 of the federal government and the FTI Pact 2021-2023. Spatial planning, soil protection, building, infrastructure and traffic planning also play an important role that has a strong influence on the demand for resources. Press Release: https://www.bmk.gv.at/dam/jcr:427f6f36-1d5a-4ef2-bc84-52a1792ad3db/Austrian_CES.pdf

ÖNIP - Austrian Integrated Grid Infrastructure Plan

On July 7, 2023, the Austrian Ministry of Climate Protection presented a draft of the country's integrated grid infrastructure plan. This plan will delineate the route towards a climate-neutral energy system and the required infrastructure. It combines both electricity and gaseous energy sources to offer a comprehensive overview. A public consultation process is currently underway in which all stakeholders can submit comments on the draft plan.

Press release: https://www.bmk.gv.at/service/presse/gewessler/20230707_NIP.html

Important Projects of Common European Interest (IPCEI) – Active contribution from Austria

Austria is currently participating with a total of 14 companies in four projects of common European interest - one in the field of batteries, one in the field of microelectronics and two in the field of hydrogen. All four projects are making concrete contributions to the implementation of the Twin Transition in Austria, creating jobs, generating sustainable added value, building up additional know-how and expertise, strengthening the research and innovation location and contributing to Europe's resilience and strategic autonomy. Approved IPCEIs (europa.eu)

National Energy and Climate Plan (NEKP)

The National Energy and Climate Plan (NEKP) is a plan with which all EU states must demonstrate their path towards achieving their EU energy and climate targets. This plan must be completed and submitted to the EU Commission by June 2024. Currently it undergoes a public consultation on the update.

In the National Energy and Climate Plan, Austria sets out its path to achieving the targets. An essential basis of the NEKP is the so-called WAM scenario (with additional measures). It calculates how high the greenhouse gas

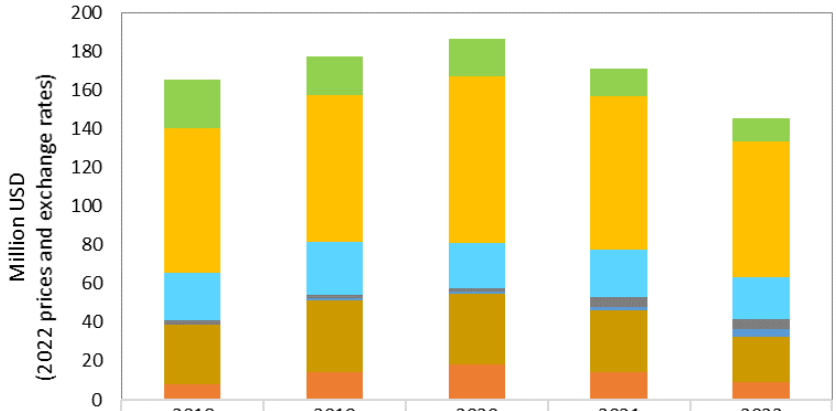
reduction will be on the basis of all adopted and already planned measures. From this, it can be derived which further measures are still necessary.

The WAM scenario shows that with the current measures in sectors that are not subject to the EU Emissions Trading Scheme, a reduction of 35 percent can be achieved by 2030 compared to 2005. This means that another 13 percentage points are missing from the EU target.
Nationaler Energie- und Klimaplan (bmk.gv.at)

Brazil

Public RD&D Data

Brazil's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	25.3	20.2	19.3	14.1	11.8
CCS	74.5	75.8	86.4	79.0	70.2
Renewables	24.9	27.3	23.6	24.8	22.0
Nuclear	1.9	1.9	1.5	5.1	4.9
Hydrogen and fuel cells	0.4	1.0	1.4	1.6	4.0
Other power and storage technologies	30.8	36.9	36.3	32.3	23.8
Other cross-cutting technologies/research	7.7	14.4	18.2	14.0	8.9
Unallocated	-	-	-	-	-
Total Budget	165.4	177.5	186.7	170.9	145.6

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Energy Big Push (2.0): Accelerating clean energy innovation in Brazil and Inova-e Platform	(l) Others: Energy Innovation RD&D/indicators tracking process	https://dashboard.epe.gov.br/apps/inova-e-eng/9	IEA's technology classification	2013-2022	-updating RD&D data until 2022 -patent module development -demonstration data development -webinars with policy makers and experts	Link to project Link to English report.
Strategic Public Call on Renewable Hydrogen	Others: RD&I policy	-The legislation about the RD&I and energy efficiency policy in the electricity sector in Brazil is established by Law 9.991/2000. The budget depends on each project, as well as the electricity company who is submitting the project. - New money from electricity companies.	Renewable hydrogen	2023-2028	- Strategic Call public notice published - Public notice put available for public consultation - Contributions from public consultation under analysis	ANEEL's public consultations (CP 018/2023)
Strategic Public Call on Electric Mobility	Others: RD&I policy	-The legislation about the RD&I and energy efficiency policy in the electricity sector in Brazil is established by Law 9.991/2000. The budget depends on each project, as well as the electricity company who is submitting the project. - New money from electricity companies. This Strategic Call will end in December 2023.	Electric mobility	2018-2023	- 37 projects submitted under this Strategic Call still ongoing during 2022 and 2023	https://www.gov.br/aneel/pt-br/assuntos/pesquisa-e-desenvolvimento/projetos-de-chamada-estrategica

Regulatory Impact Analysis (RIA) on Energy Storage Systems	Others: regulatory roadmap	Not applicable.	Energy Storage Systems, including pumped hydro	2023-2027	- RIA report finished and put available for public consultation.	ANEEL's public consultations (CP 039/2023)
Five-year Innovation Strategic Plan – PEQuI	Others: RD&I policy	Not applicable.	• Tariffs • Economy Electrification and energy efficiency • Digitalization, standards and cybersafety • New supportive techs: AI, VR, AR and blockchain • Low carbon electricity • Storage • Hydrogen	2024-2028	Plan just became effective in October 2023	ANEEL's Documentation Centre – REN 1.074/2023
Energy Efficiency National Olympic Games (ONEE)	Education and training	Not applicable.	Energy efficiency	- Two editions: 2021 and 2022 (pilots). - Organized on a yearly basis.	- ONEE regulation - ONEE 2022 challenges and awards ceremony	ONEE hotsite ANEEL's public consultations (CP 012/2023) ANEEL's public consultations (CP 021/2023) Instagram profile
Hydrogen plant at the Itumbiara Hydro Powerplant	Others: RD&I policy	Around USD 9 million (partially funded using the RD&I policy funding)	Hydrogen		Plant in operation	
Hydrogen Hub at Porto de Pecém	Others: RD&I policy	An estimative of around USD 40 billion (partially funded using the RD&I policy funding)	Hydrogen		Plant under development	

Prioritary Hospital Public Call	Others: EE policy	Around USD 24 million (partially funded using the EE policy funding)	Energy efficiency	2021-2024	• Public call under execution • 14 projects approved so far	-

* Type categories: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.

**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

In Brazil, an important driver of private sector participation in R&D investments in clean energy is the policy that establishes mandatory RD&D clause in all concession, permission and authorization contracts for the generation, transmission, and distribution of electricity, regulated by the Brazilian Electricity Regulatory Agency (ANEEL), as well as for the exploration, development, and production of oil and natural gas, regulated by the National Agency for Petroleum, the Natural Gas and Biofuels (ANP).

In 2022, 81.3% of investments in energy R&D came from ANEEL (21.63%) and ANP (59.7%).

Recently, an example of targeting publicly oriented R&D resources towards clean energy is the Resolution nº 2 from the National Energy Policy Council (CNPE), of February 2021, which establishes guidelines for prioritizing R&D in strategic areas, such as hydrogen, biofuels, energy storage, digital transformation, and others.

In the context of the ANEEL's R&D programme, Public Calls has been an important instrument for mobilizing private investments with a focus on strategic areas such as storage (2017), electric mobility (2018) and hydrogen (CP ANEEL 18/2023). It is important to highlight that ANEEL's regulated RD&D Programme has invested in several improvements to increase the results of investments in R&D of companies in the sector, such as the instrument that consolidates medium and long-term innovation planning (2024-2028) called PEQuI.
The Brazilian Electricity Regulatory Agency - ANEEL approved on September 26th the Five-Year Strategic Plan for Innovation - PEQuI 2024-2028.

PEQuI 2023-2028 aims to increase until the end of 2028 the innovation in the Research, Development, and Innovation Programme - PDI of the electricity companies regulated by ANEEL. It contains the main strategic themes and indicators that will guide the strategic goals for the five-year period, which should be achieved through the innovation portfolios.

The Five-year Plan involves the following strategic themes:

- Modernization and reasonable tariffs
- Economy electrification and energy efficiency
- Digitalization, standards, interoperability, and cybersecurity
- New supportive technologies: artificial intelligence, virtual and augmented reality and blockchain
- Low carbon electricity
- Storage
- Hydrogen

In October 2022, a new framework for ANEEL's R&D programme was approved and became effective July 2023. Bulit using the S3P Model (Strategy, Portfolios, Programs and Projects), the programme will monitor innovation indicators to evaluate the portfolio of innovation initiatives managed by the electricity companies. These portfolios can use an array of innovation instruments, such as RD&I projects, start-ups, innovation platforms and networks, sandboxes and so on. The electricity companies can partner with universities, start-ups and innovation and research centres to develop their initiatives.

Contribution to Mission Innovation work programme in 2022/23

Innovation Platform

From the need to report consolidated data on energy R&D in Brazil and the wide fragmentation of this information in several institutions, Brazil's participation in MI3 was a major motivation for the start of the Energy Big Push (EBP) initiative in Brazil, a partnership with IEA, ECLAC, Ministry of Mines and Energy (MME), Center for Strategic Studies and Management (CGEE) and many other institutions.

One of the axes of this project was dedicated to the consolidation of a database of public and publicly oriented investments in energy RD&D, following the classification of the IEA. In 2020, the final reports of the first cycle of the EBP Project were released and a new phase started, with support from the British government, for the implementation and launch of Inova-e, an energy innovation platform that consolidated information on energy RD&D.

These data have been relevant to support the improvement of policies and governance of science, technology and innovation activities in the Mining and Energy sectors. An example of this is Resolution nº 2 from the National Energy Policy Council (CNPE), of February 2021, that establishes guidelines for prioritizing R&D in strategic areas, such as hydrogen, biofuels, energy storage, digital transformation and others.

From July 2022 to September 2023, the EBP initiative contributed to updating energy R&D data until 2022, which allows Brazil to participate in this MI/IEA survey and in MI innovation Platform.

Clean Hydrogen Mission

Regarding the MI Missions, ANEEL is currently working on the Strategic RD&I Public Call on Renewable Hydrogen, which is strongly aligned with the **Clean Hydrogen Mission**. The strategic call aims to drive electricity companies' investments on RD&I towards projects related to renewable hydrogen pilot plants, as well as the development of parts and components related to the hydrogen production.

Urban Transitions Mission

By the end of 2023, it will come to an end the Strategic Call on Electric Mobility. It has been a very important call aligned with the **Urban Transitions Mission**. An important big number regarding this call: around 80% of every EV charging station in Brazil today is due to investments related to this strategic call.

In 2022 and 2023, around USD 12 million were invested in projects under ANEEL RD&I Programme related to electric mobility.

Other clean energy innovation activities in 2022/23

From July 2022 to September 2023, we can highlight:

- 2023 - National Hydrogen Plan: aims to multiply investments in RD&D by 2x until 2025
- 2023 – "Fuel of the Furure " bill was sign by the government. The proposal creates a set of initiatives to reduce greenhouse gas emissions and encourage the use and production of biofuels
- 2023 – Amazon decarbonization Programme. Investments of R$5 billion reais are planned to replace diesel sources on isolated systems
- 2023 - The regulated carbon market bill was approved by the Senate Environment Committee

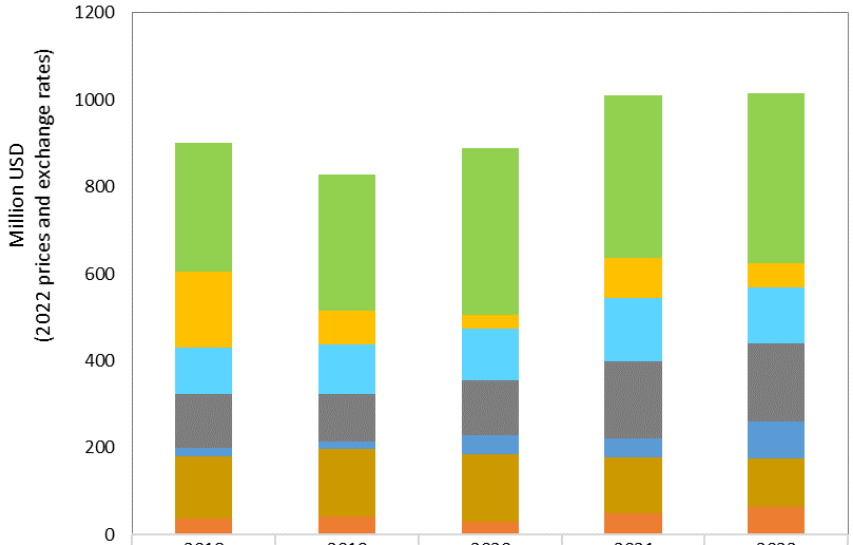
- 2023 -The new PAC - Growth acceleration programme - foresees investments of R$22 billion for wind farms, R$ 41.5 billion for solar photovoltaic plants, R$89 billion in electricity transmission
- 2022/2023 - Continuity of Procel - National Electric Energy Conservation Programne. This Programme resulted in avoided costs of R$4,14 billion in 2022.

In October 2023, during the Biannual Innovation and Energy Efficiency Congress - CITENEEL, organized by the Brazilian Electricity Regulatory Agency (ANEEL), it was launched the report "Results of the Energy Efficiency Programme regulated by ANEEL (PROPEE). The report concluded that the PROPEE program is effective in saving electrical energy, but also pointed out a few aspects that have room for improvement. The report can be accessed here.

Canada

Public RD&D Data

Canada's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	296.9	312.7	382.3	373.1	391.5
CCS	173.0	77.9	33.1	92.4	56.2
Renewables	107.6	112.9	118.8	147.2	126.8
Nuclear	122.8	110.9	126.9	176.2	180.9
Hydrogen and fuel cells	20.7	16.7	43.6	43.1	84.1
Other power and storage technologies	144.1	155.4	154.4	128.7	112.8
Other cross-cutting technologies/research	35.9	41.0	29.6	50.1	63.2
Unallocated	0.00	0.00	0.00	0.00	0.00
Total Budget	900.9	827.5	888.7	1010.8	1015.5

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Suite of Energy Innovation Programming (EIP) – ongoing funding	B, C	$72M/year core ongoing funding as well as $319M over 7 years for CCUS and $45.6M over 3 years for smart grids $51.2 M/year ongoing federal RD&D through the Program for Energy Research and Development and the Energy Innovation Program	Clean energy innovation	Ongoing	The Energy Innovation Program (EIP) has annual core funding of $72M will help Canada meet its climate change targets, while supporting the transition to a low-carbon economy. It funds research, development and demonstration (RD&D) projects, and other related scientific activities. Additionally, the EIP received targeted time-limited funding to advance key priority areas: Budget 2021 invested an additional $319M over seven years for RD&D to advance the development and commercial viability of carbon capture, utilization, and storage; and Budget 2023 provided $45.6M over three years for dedicated smart grid RD&D. In 2022-23, NRCan: • Signed up to $50 million in funding agreements for CCUS Front-End Engineering Design (FEED) projects • Selected 25 projects to receive up to $53 million in funding to target RD&D in Industrial Fuel Switching, Clean Fuels Production, and Hydrogen Codes and Standards • Launched an $81.5 million funding call for CCUS RD&D projects, with focus areas on Carbon Capture and Storage and Transportation (both of which have completed their intake), as well as a final focus area on Carbon Utilization that will open for intake shortly • Launched a call for proposals focusing on Decarbonization of On-Road Transportation, focusing primarily on medium and heavy-duty vehicles, charging and re-fueling infrastructure for zero emissions vehicles, and solutions that support transportation system optimization. In addition to funding targeted grants and contributions, NRCan invests $51.2 M annually in world-class clean energy research and development carried out by 13 federal departments and agencies through the EIP and the Program of Energy Research and Development.	https://natural-resources.canada.ca/science-and-data/funding-partnerships/opportunities/grants-incentives/energy-innovation-program/18876
Emissions Reduction Fund	B	$33M total	Decarbonizing the offshore	2022-23	The offshore RD&D stream of the Emissions Reduction Fund supports RD&D projects that advance solutions to decarbonize Newfoundland and Labrador's offshore oil and	https://www.nrcan.gc.ca/science-and-

(offshore RD&D stream)			oil and gas industry		gas industry. In 2022-23, all 18 funded projects were successfully completed and the program was closed out.	data/funding-partnerships/funding-opportunities/current-funding-opportunities/emissions-reduction-fund/new-offshore-emissions-reduction-fund-helps-economy-and-environment/23091
Electric Vehicle Infrastructure Demonstration	B	$30M total	Electric vehicle infrastructure	2016-2022	The Electric Vehicle Infrastructure Demonstration (EVID) Program supports the demonstration of innovative solutions to technical challenges and other barriers for the deployment of electric vehicle charging infrastructure and hydrogen refueling infrastructure in numerous applications, including in the urban environment, for fleets, and for public transit. The EVID program has supported over 30 projects.	https://www.nrcan.gc.ca/climate-change-adapting-impacts-and-reducing-emissions/green-infrastructure-programs/electric-vehicle-infrastructure-demonstrations-evid/20467
Energy Efficient Buildings RD&D	B	$42.3M total	Energy efficient buildings	2018-2026	The Energy Efficient Buildings RD&D Program funds projects that will accelerate the development and adoption of net-zero-energy-ready codes and cleaner technologies to promote highly energy-efficient building design and construction practices, provide cost-effective building solutions, and validate their applications with real-world demonstrations. As of 2022-23, the program has supported 20 high-efficiency demonstration projects.	https://www.nrcan.gc.ca/netzerobuildings
Smart Grids (demonstration stream)	B	$35M total for demonstration stream	Smart grids	2018-2023	The demonstration stream of the Smart Grid Program promoted the modernization of grid infrastructure by funding the demonstration of promising, near-commercial smart grid technologies across Canada in order to reduce greenhouse gas emissions and foster innovation and clean jobs. In 2022-23, NRCan completed delivery of the program, having successfully funded 22 projects.	https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/smart-grids/19793
Clean Energy for Rural and Remote Communities	B	$136.3M total for demonstrations	Renewable energy, storage, efficiency,	2018-2027	The demonstration stream of the Clean Energy for Rural and Remote Communities (CERRC) program aims to reduce reliance on diesel and fossil fuels in rural and remote communities by demonstrating renewable energy projects.	https://www.nrcan.gc.ca/reducingdiesel

			and smart grid projects			
Clean Growth Program	B, K	$155M total	Focus on three sectors: energy, mining, and forestry	2017-2023 (5 years)	The first-of-its-kind Clean Growth Program (CGP) provided $155 million to co-fund 43 clean technology RD&D projects with provinces and territories in three Canadian sectors: energy, mining, and forestry. The program aimed to advance emerging clean technologies toward commercial readiness, reduce environmental impacts, enhance competitiveness, and create jobs. The program sunset in March 2022. In 2022-23, CGP projects had already achieved their 2027 environmental performance targets, achieving annual reductions of 0.35 Mt CO_2e in GHG emissions (2027 target: 0.3-0.7 Mt/yr), 24,600,000 m^3 in water use (2027 target: 100,000-2,000,000 m_3/yr), and 91,000 tonnes of waste (2027 target: 20,000-30,000 tonnes/yr).	https://www.nrcan.gc.ca/climate-change/canadasgreen-future/cleangrowth-programs/20254
Oil Spill Response Challenge	B	$10M total	Oil spills in aquatic environments	2022-2024/5 (3 years)	The Oil Spill Response Challenge aims to accelerate the development and facilitate deployment of new innovative oil spill response solutions tailored to Canadian conditions and needs. In 2022-23, the 10 Challenge semi-finalists were selected.	https://impact.canada.ca/en/challenges/oil-spill-response
Greener Neighbourhoods Pilot Program	B	Up to $35.5M total	Energy efficient buildings, *Energiesprong* aggregated deep energy retrofits	2023-2028 (5 years)	The $35.5 million Greener Neighbourhoods Pilot Program (GNPP) aims to pilot the Dutch Energiesprong model of aggregated deep energy retrofits in up to six community housing neighbourhoods across Canada. By aggregating similar homes and buildings in an entire neighbourhood, the Energiesprong model creates mass demand for deep energy retrofits, which allows leveraging of new retrofit approaches, such as the use of prefabricated exterior panels, to reduce on-site labour time and overall project costs while reducing the energy use intensity and emissions from each building. The first funding call, which closed in April 2023, will support up to six Market Development Teams (MDTs), also known as retrofit accelerators, with up to $1 million each. The second call, which closed in September 2023, will provide up to $10 million per project to fund demonstrations of whole-building deep energy retrofits in up to six community housing neighbourhoods. Eligible projects must each include at least 100 homes or	https://natural-resources.canada.ca/science-and-data/funding-partnerships/opportunities/grants-incentives/greener-neighbourhoods-pilot-program/24889

					housing units and target reductions of at least 50% in energy consumption and 80% in GHG emissions.	
Canada's Carbon Management Strategy	L		Carbon management (CM)	Launched September 2023	Canada's Carbon Management Strategy, published September 27, 2023, sets out Canada's vision and key priorities for the development of a globally competitive carbon management sector that contributes to climate and economic objectives, including reaching net-zero by 2050 and growing a robust domestic sector that supports inclusive, high-value employment and a more sustainable economy.	https://natural-resources.canada.ca/climate-change/canadas-green-future/capturing-the-opportunity-carbon-management-strategy-for-canada/23721
Critical Minerals RD&D Program	B	$144M total	Mining technologies, inputs for Zero-Emissions Vehicle value chains	2022-2024	The Critical Minerals Research, Development and Demonstration Program aims to advance the commercial readiness of emerging mineral processing unit operations or technologies that will support the development of zero-emission vehicle (ZEV) value chains in Canada by providing raw and refined material inputs for use in batteries and permanent magnets.	https://www.nrcan.gc.ca/mining-materials/resources/specialized-mining-services/critical-minerals-research-development-and-demonstration-program/24288
Sustainable Development Technology Canada – SD Tech Fund	B	$750M total	Cross-sectoral. General focus on technologies to address climate change, clean air and water, and soil quality issues	Current funding ($750M) approved for 2021-2026	The SD Tech Fund supports Canadian firms with innovative projects at the pre-commercial development and demonstration stages that are focused on climate change and clean air, water and soil. Support includes funding for larger industrial decarbonization projects, which have the potential to make significant contributions to GHG reductions. The SD Tech Fund has two main objectives: - Contribute to achieving Canada's environmental objectives, including GHG emissions reductions goals - Contribute to Canada's sustainable economic growth by enabling Canadian entities to compete globally in the clean technology sector	https://www.sdtc.ca/en/
Business Development Bank of Canada – Clean Tech Practice	E, F	$600M total for clean technology companies, a portion of which may include loans supporting clean energy RD&D	Cross sectoral clean technologies	2018-2023; Climate Tech Fund II (announced in 2022)	For high-potential cleantech companies with market-ready technology or products and proven potential to scale, BDC is committing $600 million over the next five years (2018-2023) in both new equity and commercial loans. Through this special initiative, we will take on more risk to help high potential cleantech firms scale and expand, including investing in assets, inventory, talent, R&D, sales growth and market expansion.	https://www.bdc.ca/en/i-am/clean-technology-firms

		An additional $400M announced in 2022, through Climate Tech Fund II		expects to be fully committed within 5 years.	In 2022, BDC announced its new $400M Climate Tech Fund II, a renewed commitment to play a leadership role in creating world-class Canadian cleantech champions. The new envelope brings the Funds committed investments in the innovative cleantech/climate tech sector to $1 billion.	
Export Development Canada	F	$443.3M total for clean technology companies, a portion of which may include loans supporting clean energy RD&D	Cross sectoral clean technologies	2018-2022	Export Development Canada (EDC) is a financial Crown corporation dedicated to helping Canadian businesses make an impact at home and abroad. EDC has the financial products and knowledge Canadian companies need to confidently enter new markets, reduce financial risk and grow their business as they go from local to global. Together, EDC and Canadian companies are building a more prosperous, stronger and sustainable economy for all Canadians.	https://www.edc.ca/en/campaign/cleantech.html
National Research Council of Canada (NRC)	B, C, K	Variable	Energy storage and generation; bioenergy and low carbon fuels; materials for clean fuels; electrification of air and ground transportation; low-carbon construction materials and methods, heating and cooling of buildings	Ongoing	The NRC's Energy, Mining and Environment Research Centre (EME) delivers advanced technology to Canada's mining and energy industries through its world class research facilities focusing on GHG emissions reduction. EME programs accelerate the development and integration of clean energy materials, clean renewable fuels and battery materials and devices that will facilitate the transition to low- and zero-carbon fuel and the electrification of our energy supply, across all sectors. Emissions reduction from buildings, aircraft and surface transportation are targeted by Research Centers for Construction, Aerospace and Automotive and Surface Transportation respectively. Also under the NRC, the NRC-Industrial Research Assistance Program (NRC IRAP) helps small and medium sized businesses (including those focused on clean energy) build innovation capacity and take ideas to market. In February 2023, the Government of Canada NRC-IRAP will be integrated into the new Canada Innovation Corporation (CIC). The CIC will be a new, operationally independent organization solely dedicated to supporting business R&D across all regions and all sectors of the economy.	
Strategic Innovation Fund – Net Zero Accelerator	B	$8B total	Cross sectoral. Initial focus on industrial decarbonization and energy storage.	2021-2028 (7 years)	The Net Zero Accelerator (NZA) initiative supports Canada's net zero goals to help transform the economy for clean and long term growth. This initiative will provide up to $8 billion in support of projects, including some at the demonstration stage, that will enable Canada to reduce its domestic greenhouse gas emissions. The initiative will support projects that promote decarbonization of large emitters; clean technology and industrial transformation, and the development of a Canadian batteries ecosystem.	https://www.ic.gc.ca/eic/site/125.nsf/eng/00039.html

* Type categories: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.
**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

In 2019, Natural Resources Canada partnered with Breakthrough Energy and the Business Development Bank of Canada (BDC) to launch Breakthrough Energy Solutions Canada (BESC), a public-private initiative to support Canadian entrepreneurs and firms in advancing clean energy technologies used for manufacturing, electricity, transportation, and buildings.

BESC ran from May 27, 2019 to March 31, 2023 and resulted in a cohort of 10 companies/innovators being selected for funding, expert advice, and tailored mentorship. This collaborative initiative fostered new financial and in-kind investments into high-risk, high-potential Canadian-made clean energy technologies from leading public and private sector investors.

As of 2023, the cohort had increased their investments with a leverage ratio of 1.50 dollars from project partners for every NRCan dollar spent, and have established 55 collaborations or partnerships. Nearly all BESC companies (90%) were able to advance one or more TRLs as a result of their NRCan funded projects. The BESC also resulted in:

- 41 peer review publications, technical reports or other knowledge products.
- Contributed to the development of 1 code/standard.
- Filing for 51 patents or licences in multiple jurisdictions including Canada, US, EU, UK, China, and Brazil.
- 319 direct job years of employment (over 550 direct and indirect job); supported employment for over 330 individuals.
- Advanced training of 173 highly qualified personnel.
- 5 projects securing follow-on investments, 2 projects reducing cost of production, and 3 projects reporting new revenue by the end of the project.

Contribution to Mission Innovation work programme in 2022/23

Carbon Dioxide Removal Mission (Canada co-leads)

- Canada co-leads the Carbon Dioxide Removal Mission, which was launched in November 2021 at COP26. Since the Mission's launch, Canada has played an important leadership role and has contributed significantly to the Mission's work. Canada co-leads the lifecycle assessment and techno economic assessment (LCA/TEA). Canada leads the coordination of the CDR Mapping Initiative. Canada has played a secretariate function and works alongside members to develop the Mission Stakeholder engagement plan and related workshops. Canada participates in the Biomass carbon removal and storage Enhanced Mineralization technical track activities through case studies and knowledge sharing.

Clean Hydrogen Mission (Canada participates)

- Since its launch in June 2021, Canada has been an active member of the Clean Hydrogen Mission, providing technical expertise and advice as the Mission has developed its strategies and deliverables. In 2023, Canada joined newly launched working groups, contributing to workshops, webinars, reports, and platforms, to advance best practice exchange on topics such as storage and distribution, finance and investment, and end-use applications. Canada attends monthly all-member meetings to discuss opportunities to coordinate action and provide updates on Canada's investments in R&I. A well, Canada

is continuing to support the Mission's goal to identify 100 clean hydrogen valleys on the hydrogen valley platform by 2024.

Integrated Biorefineries Mission (Canada participates)

- Canada has continued to play a leading role in supporting the Integrated Biorefineries Mission since the launch of the Mission in April 2022. Canada led in the development of internal Mission workshops in 2023, engaged in the planning of the June 2023 international stakeholder webinar, and a number of other activities across the Mission's actions. Canada has been an active participant in the mission and is currently the co-leading organization of two additional international stakeholder workshops.

Net-Zero Industries Mission (Canada participates)

- Canada officially joined the Net-Zero Industries Mission at the Global Clean Energy Action Forum in September 2022. Since joining, Canada has played an active role in the Mission, providing input to the Mission's Action Plan, contributing to the delivery and evaluation of the Net Zero Industries Awards, and leading the development of a global knowledge-sharing initiative.

Green-Powered Future Mission (Canada supports)

- Canada has continued to be an active member of the Green-Powered Future Mission, supporting the Mission's flagship projects, reports, collaborations, and Mission events. Canada has committed to contribute to the "5 demos in 5 continents" project, shared knowledge on existing national pilots, and is working to develop dedicated supports to launch new smart grid pilot projects, expected to be strongly aligned with GPFM goals.

Zero-Emissions Shipping Mission (Canada supports)

- Canada joined the Zero-Emissions Shipping Mission in January 2023 in a supporter role. Transport Canada is the lead department for Canada in the mission. To date Canada has been limited in their participation in the mission.

MI Innovation Platform – Collaborate Module Initiatives

- Canada continues to co-lead the Materials for Energy Initiative (M4E), alongside Germany, to accelerate the development and deployment of advanced materials for clean energy technologies via Materials Acceleration Platforms (MAPs)
- Through M4E, Canada plays an important leadership role in promoting the uptake of Materials Acceleration Platforms through the co-ordination of research support action activities, industry engagement & outreach, education & training, and knowledge exchange. To that end, in 2023, Canada hosted three major events:
    - An in-person international M4E symposium to promote knowledge sharing and information exchange
    - A two-day Industry Days webinar (co-hosted with the German Canadian Materials Acceleration Centre) to connect German and Canadian industries and generate awareness for collaboration along the entire value chain
    - A week-long summer school to educate students & researchers (co-hosted with the German Canadian Materials Acceleration Centre)
- In addition, Canada provided contributions to a white paper briefing for EU policy makers on the importance of materials in the clean energy transition, as well as leading the signing of the M4E MoU to develop multi-lateral collaboration between parties and to unlock additional opportunities such as funding and international exchange programs.
- Canada participates as a member of the Innovation Community on Affordable Heating and Cooling of Buildings.

MI Innovation Platform – Insights Module Initiatives

- Canada continues to provide contributions to MI's Insights Module, and in 2022 submitted a National Innovation Pathway alongside annual Member Survey responses.
- Through contributions to the MI Secretariat, Canada has led in the development, launch, and delivery of the MI Think Tank in 2023.

MI Governance, Operations and other Activities

- In addition to contributions to specific MI activities, Canada plays a leading role in MI's governance and operations, serving as a member of the MI Steering Committee and resourcing the virtual MI Secretariat.
- At MI-7 in September 2022, Canada's Minister of Natural Resources announced a commitment of $2 billion CDN in pre-allocated money to the Major Economies Forum's (MEF) $94 billion Clean Energy Technologies Demonstration Challenge.

International clean energy collaborations in 2022/23

See Annex A, page 139.

Other clean energy innovation activities in 2022/23

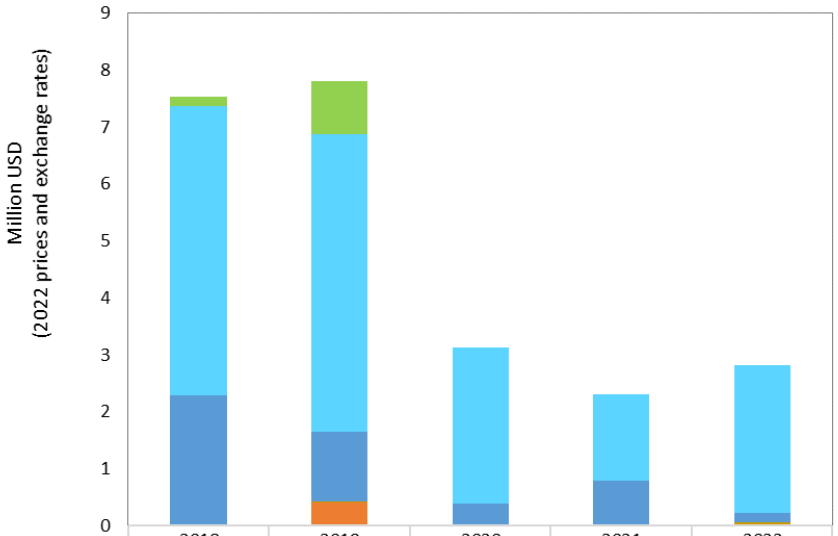
The Office of Energy Research and Development (OERD) at Natural Resources Canada continues to lead the Government of Canada's efforts in delivering energy research, development and demonstration funding, accelerating efforts in energy innovation and cleantech programming. Focusing on influencing the pace and direction of energy system transformation, OERD targets the most impactful technologies and pays particular attention to program design and levers in order to maximize environmental and economic outcomes. All activities accord with one of four outcomes-oriented missions:

- Improve energy efficiency and processes to reduce emissions from energy end use;
- Accelerate electrification and maximize benefits to renewable heat and power;
- Develop cleaner fuels pathways; and
- Reduce reliance on diesel in rural, remote, and Indigenous communities.

Chile

Public RD&D Data

Chile's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	0.2	0.9	0.0	0.0	0.0
CCS	0.0	0.0	0.0	0.0	0.0
Renewables	5.1	5.2	2.7	1.5	2.6
Nuclear	0.0	0.0	0.0	0.0	0.0
Hydrogen and fuel cells	2.3	1.2	0.4	0.8	0.2
Other power and storage technologies	0.0	0.0	0.0	0.0	0.1
Other cross-cutting technologies/research	0.0	0.4	0.0	0.0	0.0
Unallocated	0.00	0.00	0.00	0.00	0.00
Total Budget	7.5	7.8	3.1	2.3	2.8

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Fund for the Development of Green Hydrogen (H2V) and its derivatives in Chile	(i)	US$ 1 billion		Second half of 2024	Catalyze private investment in H2V production and demand projects, through instruments that mitigate risks, reduce costs and contribute to accelerate the materialization of investments in the industry in the country.	https://corfo.cl/sites/cpp/sala_de_prensa/nacional/19_06_2023_fondo_hidrogeno_verde

* Type categories: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.

**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

Green Hydrogen Action Plan: seeks to define a roadmap between 2023 and 2030, which will allow the deployment of a sustainable green hydrogen industry and its derivatives, through coordinated actions between the different government portfolios and related agencies, in accordance with regional and local initiatives. It is being developed through a robust participatory process. The plan will be drafted outlining actions, responsibilities and deadlines, and will be presented for public consultation in December 2023.

Decarbonization Plan: The plan will allow prioritizing actions to 2030 through the political construction of a consensus between the public and private sectors, academia and civil society, so as to guarantee an accelerated retirement and reconversion of coal-fired power plants, anchored to the unrestricted compliance with the conditions that enable it. In this sense, the Plan will be divided into three main axes that will establish these conditions:

Axis 1: Modernization of the grid and the electricity market, and infrastructure.
Axis 2: Thermoelectric reconversion and transition fuels.
Axis 3: Fair energy transition and communities.

Green Hydrogen Strategic Committee: Is responsible for establishing a roadmap to enable the deployment of a sustainable green hydrogen industry and its derivatives within the framework of the Green Hydrogen Action Plan 2023-2030. With a cross-cutting presence from different political sectors, the members of this group have the mission of paving the way for the deployment of the H2V industry.
The committee is made up of a broad contingent of people with extensive work in the public, private and academic sectors. The participation of the former President of the Republic, Michelle Bachelet Jeria, and the former Minister of Energy, Juan Carlos Jobet, stands out in this group, giving a sign of horizontality in the implementation of this State policy. The initiatives seek to accelerate the implementation of the Action Plan, through new sources of funding for projects and support to regional governments, among others.

Contribution to Mission Innovation work programme in 2022/23

In the framework of the **Clean Hydrogen Mission,** where Chile is one of the co-leaders, we have developed a series of workshops during the year 2023, aimed especially at the LAC region, based on the work to be developed by Pillar 2, "Demonstration" in conjunction with Pillar 3, "Enabling Environment". Each session aimed to transfer knowledge and provide access to a global network of experts to provide policy makers with quick information that allows them to initiate and accelerate the development of their hydrogen economy. These activities were done in collaboration with **OLADE** and took place on its educational platform, with a wide audience reach.

International clean energy collaborations in 2022/23

See Annex A, page 141.

China

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget **	Technology focus	Start/end date	Main activities	Link
"Hydrogen energy technology" key project in the National Key R&D Plan	(c)	400 million RMB	Hydrogen energy green production and scale storage system, hydrogen energy safe storage and rapid transmission and distribution system, hydrogen energy easy modification and high efficient power system, comprehensive demonstration of "hydrogen energy use in terminal applications"	2022-	Key generic technologies, fundamental research	https://service.most.gov.cn/kjjh_tztg_all/20220804/5048.html
"New energy vehicles" key project in the National Key R&D Plan	(c)	508 million RMB	Energy power, electric drive system, intelligent driving, vehicle and network integration, support technology, vehicle platform	2022-	Key generic technologies, fundamental research	https://service.most.gov.cn/kjjh_tztg_all/20220804/5049.html
"Hydrogen energy technology" key project in the National Key R&D Plan	(c)	340 million RMB	Hydrogen energy green production and scale storage system, hydrogen energy safe storage and rapid transmission and distribution system, hydrogen energy easy modification and high efficient power system,	2023-	Key generic technologies, application demonstration, fundamental research	https://service.most.gov.cn/kjjh_tztg_all/20230609/5216.html
"New energy vehicles" key project in the National Key R&D Plan	(c)	346 million RMB	Energy power, electric drive system, intelligent driving, vehicle platform	2023-	Key generic technologies, fundamental research	https://service.most.gov.cn/kjjh_tztg_all/20230609/5216.html
"Coal clean and high efficient utilization technology" key project in the National Key R&D Plan	(c)	524 million RMB	Coal high efficient and clean power generation, coal flexible and intelligent power generation, coal cleaning conversion, carbon dioxide capture, utilization and storage	2022/2023-	Key generic technologies, fundamental research	https://service.most.gov.cn/kjjh_tztg_all/20220810/5064.html https://service.most.gov.cn/kjjh_tztg_all/20230609/5216.html

"Energy storage and smart grid technology" key project in the National Key R&D Plan	(c)	687 million RMB	Medium and long duration scale energy storage technology, short-time and high-frequency energy storage technology, super long duration scale energy storage technology, high proportion of renewable energy active support technology, safe and highly efficient operation technology of super large AC-DC hybrid power grid, multi-user supply and demand interaction consumption and energy efficiency improvement technology, energy storage and smart grid infrastructure support technology	2022/2023-	Key generic technologies, fundamental research	https://service.most.gov.cn/kjjh_tztg_all/20220721/5014.html https://service.most.gov.cn/kjjh_tztg_all/20230609/5216.html
"Renewable energy technology" key project in the National Key R&D Plan	(c)	736 million RMB	solar photovoltaic, wind energy, biomass fuel, intersection and fundamental frontiers	2022/2023-	Key generic technologies, application demonstration, fundamental research	https://service.most.gov.cn/kjjh_tztg_all/20220809/5063.html https://service.most.gov.cn/kjjh_tztg_all/20230609/5216.html

* Type categories: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.

**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

In April 2023, the National Key R&D Plan Intergovernmental International Science and Technology Innovation Cooperation Special Project "Green Powered Future Mission (GPFM)" was formally launched. In order to support China's implementation of the GPFM as the co-lead country, this project has objectives to develop technological consultation reports in line with over 30% of the innovation priorities of Pillar1 Renewable Energies, to establish testing platforms or demos for extra-large wind turbine, novel PV cell, full-DC-link power system, and a monitoring system for the ecological environment impact of PV system in marine climate; and to develop the GPFM internet platform. By synergy among project partners, promote technology innovation and multilateral cooperation under GPFM. The total budget of the project is 50 million yuan, including 25 million of special funds from the central government and 25 million yuan of self-raised funds from the units. The project is led by the Institute of Electrical Engineering, Chinese Academy of Sciences, with local partners include Goldwind Sci & Tech Co., Ltd. and LONGi Green Energy Technology Co., Ltd., and international partners include Ricerca sul Sistema Energetico, National University of Singapore, BIA in France, and Aalborg University in Denmark.

Contribution to Mission Innovation work programme in 2022/23

·"Green Powered Future" Mission (GPFM)

In 2023, China, Italy and the United Kingdom jointly led the implementation of GPFM, and released the "Five Demonstrations in Five Continents: National Pilots Report" at the 8th Mission Innovation Ministerial (MI-8), bringing together 80 ongoing or planned national pilot projects. In the meantime, the 2023 GPFM International Workshop was held in Yancheng, Jiangsu, more than 300 experts and scholars from China, Italy, the United Kingdom, Japan, India, Sweden, Denmark, and other countries attended the conference, during which the Asian Demonstration Project was officially launched. Moreover, China has led the publication of a series of strategic research reports on GPFM's innovation priorities such as new photovoltaic and offshore wind. The GPFM Internet platform has been also launched, which integrates experts workplace, cutting-edge information sharing, demonstration projects, multilateral research programs and other functional modules.

·"Sunlight to X" Innovation Platform

During the 8th Mission Innovation Ministerial (MI-8) in 2023, the "Sunlight to X" Innovation Platform jointly led by China and the European Union was officially launched, aiming to create a new integration paradigm for solar fuel, promote relevant science and technology, compile the necessary innovation results, and develop efficient and low-cost solar fuel technology. Moreover, the platform would like to draw a technical roadmap to lead the international research and development of solar fuel science and technology.

International clean energy collaborations in 2022/23

See Annex A, page 142.

Other clean energy innovation activities in 2022/23

To promote open, fair, equitable and non-discriminatory international science and technology cooperation, develop science for the benefit of all regardless of borders, and jointly build a global science and technology community, China puts forward the following International Science and Technology Cooperation Initiative:

-- Staying committed to the pursuit of science. We should approach science and pursue truth in the most appropriate way as it should be. We should uphold scientific integrity, respect research ethics, foster a vision of tech for good, and improve global science and technology governance. We should strengthen protection of

intellectual property rights, and develop and govern emerging technologies in a more inclusive and prudent manner.

-- Pursuing innovation-driven development. We should enhance global STI collaboration, build a global innovation network, promote the adoption and diffusion of emerging technologies, and bolster technological innovation cooperation among enterprises to inject new impetus into world economic recovery and growth. Countries should work together to promote connectivity in the digital age, accelerate global transition toward green and low-carbon development, and achieve sustainable development for all.

-- Adhering to open cooperation. We should be committed to open science regardless of borders and with no barriers imposed, ensure the free flow of STI personnel and resources around the world, increase personnel exchanges and cooperation, and foster an open and free international ecosystem for science and technology cooperation. We will resolutely oppose restrictions or obstacles to science and technology cooperation which undermine the common interests of the international community.

-- Adhering to equality and inclusiveness. We should uphold the principles of mutual respect, fairness, equality and non-discrimination, and encourage all countries and research entities to participate in international science and technology cooperation on an equal footing. We firmly oppose politicizing, instrumentalizing or weaponizing science and technology cooperation, and oppose hegemonic and bullying acts through science and technology under the pretext of national security.

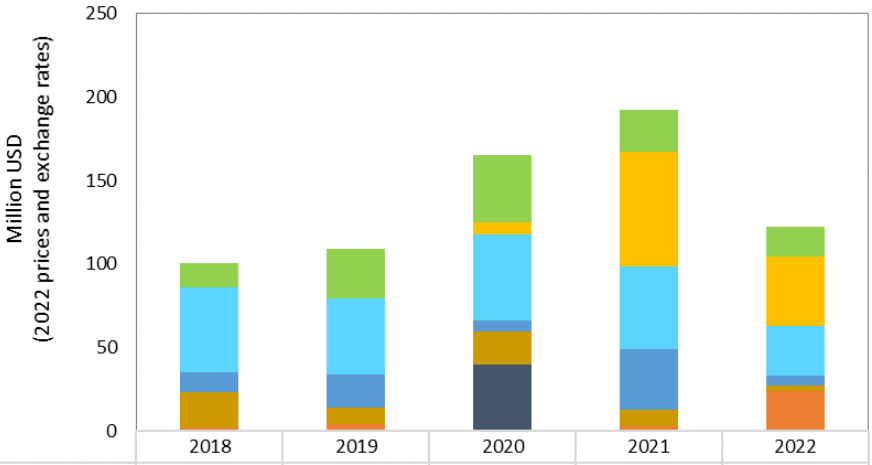
-- Upholding solidarity and coordination. In the face of urgent global challenges such fields as climate change, health, environmental protection, energy security and food security, countries should work together to boost collaboration and mutual learning among STI entities, advance the implementation of major international science programs and projects, and achieve breakthroughs in major scientific and technological challenges concerning the future of mankind.

-- Pursuing win-win outcomes for all. We should uphold genuine multilateralism, explore a new model of win-win global cooperation on STI, and ensure that the STI achievements are shared by all. China will set up a global scientific research fund and increase scientific and technological assistance to other developing countries, so that scientific and technological progress will benefit mankind as a whole.

Denmark

Public RD&D Data

Denmark's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	14.6	30.1	40.4	25.1	18.0
CCS	-	0.1	7.2	68.8	41.4
Renewables	50.9	45.4	51.5	49.3	30.3
Nuclear	-	-	-	-	0.0
Hydrogen and fuel cells	11.6	19.5	6.4	36.8	5.4
Other power and storage technologies	21.66	10.2	20.3	9.5	3.6
Other cross-cutting technologies/research	1.7	3.3	0.1	2.9	23.8
Unallocated	-	0.6	39.4	-	0.0
Total Budget	100.5	109.2	165.3	192	122.5

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Danish Climate Agreement for Energy and Industry 2020	Green transformation of industry and the energy sector	17,4 billion DKK	CCUS fund	2024	Carbon capture and Power-to-X	https://kefm.dk/Media/C/B/faktaarkklimaaftale%20(English%20august%2014).pdf
Green Partial Agreement in regards to 22 in the Finance Act (Technology neutral fund)	Investments in the continued green transition of Denmark	2,6 billion DKK	Negative emissions	2024	Carbon capture	https://fm.dk/media/25389/delaftale-om-investeringer-i-et-fortsat-groennere-danmark_a.pdf
Green Tax Reform	Green Tax Reform for industry etc.	19,2 billion DKK	CCS	2026	Capture and storage of fossil and biogenic sources	https://fm.dk/media/26070/aftale-omgroen-skattereform-for-industri-mv-a.pdf

*The following typology is recommended for consistency across respondents: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.

**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

See Annex A, page 144.

Contribution to Mission Innovation work programme 2022/23

Since its launch in 2021, Denmark has been the Co-Lead of the Zero-Emission Shipping Mission where Denmark actively participate in the secretariat as well as leading the work in the Mission Ships-pillar. The Zero-Emission Shipping Mission has a growing project portfolio where Denmark for example is the project manager for the project on the Process of Alternative Ship Design Approvals.

The Zero-Emission Shipping Mission goal is to support the demonstration of ocean-going ships capable on running on zero-emission fuels by 2030. Coordinated innovation needs to take place across the entire maritime value chain, from the ships to the future zero-emission fuels they will rely on, and the infrastructure that will supply them. Providing tools and knowledge sharing is a key part of the work. For example the Green Shipping Corridors Hub that the Zero-Emission Shipping Mission launched in 2022.

Furthermore, Denmark helped organize side-events at Mission Innovation Ministerial in Goa in July 2023 and Global Clean Energy Action Forum in Pittsburgh in September 2022 as well as at COP26 and COP27.
In addition, Denmark has held the position of Mission Director of the Zero-Emission Shipping Mission. This implies the day-to day management of Zero-Emission Shipping Mission.

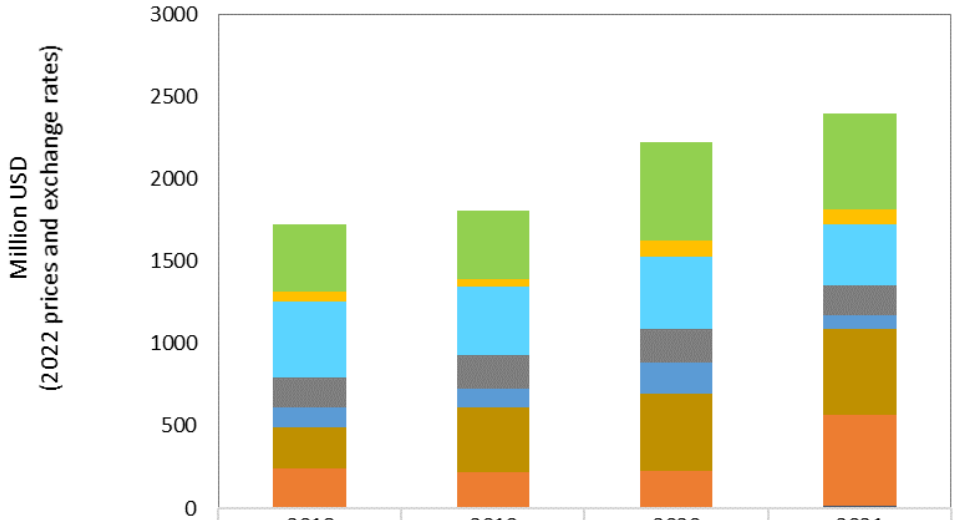
International clean energy collaborations in 2022/23

See Annex A, page 144.

European Commission

Public RD&D Data

The European Commission's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021
Energy efficiency	408.2	421.5	595.6	587.5
CCS	55.4	44.7	98.6	87.2
Renewables	460.1	417.7	436.0	374.1
Nuclear	181.6	199.5	206.4	177.1
Hydrogen and fuel cells	122.5	113.7	193.4	88.5
Other power and storage technologies	251.6	392.2	468.5	520.8
Other cross-cutting technologies/research	241.5	221.5	223.7	548.8
Unallocated	-	-	-	15.502
Total Budget	1,721	1,811	2,222	2,400

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Clean Hydrogen Partnership	b), j)	1.2 billion	Hydrogen	2021-2027	Funding of hydrogen projects pre-market deployment	https://www.clean-hydrogen.europa.eu/index_en

*The following typology is recommended for consistency across respondents: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.
**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

The European Union Emissions Trading System (EU ETS) revenues are feeding the **Innovation Fund**, one of the world's largest funding programmes for the commercial demonstration of innovative low-carbon technologies. It is closely aligned with the priorities of the Clean Energy Demonstration Fund. The Innovation Fund has doubled its 2022 call budget, from EUR 1.5 billion to **EUR 3 billion**.

The EU expects to finance the **world's first hydrogen steel plant** through the Innovation Fund and to expand its investment in electrolysers, carbon capture, storage and utilisation, innovative renewable energy generation, energy storage and processes in energy intensive industries.

The **Recovery and Resilience Facility** already dedicated at least **EUR 19 billion** to accelerate the roll-out of renewables (based on the EU Member States' Recovery and Resilience Plans).
REPowerEU plan gives a new, strong impulse to investment in R&I and deployment, for example:

- Hydrogen Accelerator (10 million tonnes renewable hydrogen produced by 2030),
- Solar Rooftops Initiative (doubling capacity by 2025, tripling by 2030).

The **Solar Strategy** will support the solar ambitions of REPowerEU, with focused R&I and support to skills. The **Solar PV Industry Alliance** will map the availability of financial support at national, EU and private levels, attract private investment and facilitate match-making between producers and off-takers.

Horizon Europe, the EU's research and innovation programme launched in February 2021, will dedicate to climate action at least 35% of its EUR 95.5 billon budget in 2021-2027, enabling the transition to climate neutrality, including of the energy sector. Out of these funds, at least **EUR 5 billion** are estimated to be devoted to research at the high technology readiness level, including demonstrators, through direct grants but also via partnerships, mobilising the private sector. The period from June 2021 till today saw the opening of calls for projects for EUR 1.8 billion, the launches of the **EU Mission on Cities** aiming at 100 Climate-Neutral and Smart Cities by 2030, of the public-private partnership the **Clean Hydrogen Joint Undertaking** and of the public-public **Clean Energy Transition Partnership**.

Following the publication of the REPowerEU Communication, the draft **Cluster 5 Horizon Europe Work Programme 2023-2024** has been reassessed on its alignment with REPowerEU. The overall contribution of the Cluster 5 Work Programme 2023-2024 to the REPowerEU objectives covers a multitude of topics with a total of 1.4 billion EUR. An important R&I contribution to REPowerEU is the Flagship on 'renewable energy valleys', following the approach for hydrogen valleys. Renewable energy valleys aim at ramping up the production of renewable energy, diversifying the energy supplies and consequently reducing the EU demand for fossil fuels, and better exploit local sources of renewable energies for satisfying local needs in priority (therefore also contributing to better resilience of the EU energy system).

The **Clean Hydrogen Joint Undertaking** published its first Call in March 2022, with a budget of **EUR 300.5 million**. In response to the challenge of the REPowerEU Hydrogen Accelerator, the budget of the Clean Hydrogen Joint Undertaking was **topped-up with EUR 200 million** to double the number of hydrogen valleys in the EU with at least one hydrogen valley in each Member State by 2025. A Hydrogen Valleys roadmap will be published until the end of 2023, while the second Call for proposals – with a total budget of EUR 195 million – closed in April 2023.

The **Clean Energy Transition Partnership** is an important instrument to support the objectives of the Strategic Energy Technology Plan (SET Plan). The Co-fund will receive an EU contribution of **EUR 70 million** for the first phase through the Cluster 5 work programme 2021-2022.

The **EU-Catalyst Partnership** serves as a good example of public-private cooperation on the clean energy transition. With the European Investment Bank, using EU budget resources from Horizon Europe and the Innovation Fund, and Breakthrough Energy Catalyst matching EU grants and financial investments, EU aims to mobilise up to **EUR 820 million / USD 1 billion** for innovative projects until 2027. The European Commission and Breakthrough Energy Catalyst will invest in a portfolio of high-impact EU-based projects, initially in four sectors: green hydrogen, sustainable aviation fuels, long-duration energy storage, and direct air capture. The EU contribution comes from Horizon Europe (EUR 200 million) and the Innovation Fund (EUR 200 million). The EU-Catalyst–Partnership contributes significantly to the approach of REPowerEU, bridging the crucial intersection between TRL 7 and 9. Breakthrough Energy issued a first Request for Proposals (RFP) in early January 2022, and the first projects will be selected in 2022 already.

The European Union will join the USD 90 billion **Clean Energy Technologies Demonstration Challenge** which aims to speed the commercialisation of new technologies and enable to break dependence on other unabated, volatile fossil fuels and advance the clean energy transition. The EU has committed over **EUR 28 billion by 2027** to bring new clean technologies to commercial scale, particularly in hard-to-abate sectors.

The EU will provide an estimated financing of **EUR 48 billion by 2030** for **clean energy demonstration projects**: the Innovation Fund – EUR 38 billion (assuming carbon price of EUR 75 per tonne of CO2 using the current ETS model), InvestEU – EUR 4-5 billion (including possible successor programme), the EU-Catalyst Partnership – EUR 820 million, and Horizon Europe – EUR 5 billion (including possible successor programme). Since September 2022, the EU has contributed with over **EUR 7 billion** investment via EU financial instruments in Clean Energy Demonstrator Projects.

Public-private engagement in 2022/23

The **EU-Catalyst Partnership** serves as a good example of public-private cooperation on the clean energy transition. With the European Investment Bank, using EU budget resources from Horizon Europe and the Innovation Fund, and Breakthrough Energy Catalyst matching EU grants and financial investments, EU aims to mobilise up to EUR 820 million (USD 1 billion) for innovative projects until 2027. The European Commission and Breakthrough Energy Catalyst will invest in a portfolio of high-impact EU-based projects, initially in four sectors: green hydrogen, sustainable aviation fuels, long-duration energy storage, and direct air capture. The EU contribution comes from Horizon Europe (EUR 200 million) and the Innovation Fund (EUR 200 million). The EU-Catalyst–Partnership contributes significantly to the approach of REPowerEU, bridging the crucial intersection between TRL 7 and 9. Breakthrough Energy Catalyst has published a request for proposals for large-scale deep green tech projects based in Europe. The request will trigger investments in a portfolio of high-potential projects. The call can remain open for submissions until 31/12/2027. Breakthrough

Energy, the European Investment Bank and the European Commission are expected to announce the first two Catalyst projects at COP28 in December 2023.

Besides the already established **industrial alliances**, i.e. the European Battery Alliance and the European Clean Hydrogen Alliance, to enhance industry's contribution to REPowerEU and reinforce its competitiveness, the Commission will set up **the EU Solar PV Industry Alliance**. It will map the availability of financial support at national, EU and private levels, attract private investment and facilitate match-making between producers and off-takers. These industrial alliances are an important tool to identify technology needs, investment opportunities and regulatory barriers and enablers at all stages of the value chain.

In 2021, the European Union launched the first 37 Horizon Europe institutionalised/ co-programmed/ co-funded public-private **European partnerships**. Clean energy issues are fully or partially addressed in 12 of those partnerships, in which the EU commits to contribute up to EUR 8 billion with the partners adding at least almost EUR 13 billion more. Following are the examples of Horizon Europe's strong focus on partnerships with industry and Member States:

- Clean Hydrogen JU (EUR 1 billion EU contribution, 1 billion EUR private investment),
- Partnerships on transport (road, waterborne, aviation) and clean steel,
- Co-funds with EU Member States / Associated Countries with 1:2 leverage (EU contributes 30%): Clean Energy Transition, Driving Urban Transitions.

Institutionalised partnerships:

Clean Hydrogen Joint Undertaking (JU)

Total estimated budget: At least EUR 2 bn

EU commitments: Up to EUR 1.2 bn

Partners' commitments: At least EUR 1.2 bn

The focus of Clean Hydrogen JU's research and innovation activities is primarily the production of clean hydrogen, as well as the distribution, storage and end-use applications of low-carbon hydrogen in hard to abate sectors.

Clean Aviation Joint Undertaking (CAJU)

Total estimated budget: EUR 4.1 bn

EU commitments: Up to EUR 1.7 bn

Partners' commitments: At least EUR 2.4 bn

The partnership will integrate and demonstrate disruptive aircraft technologies, towards decreasing net greenhouse gases (GHG) emissions by no less than 30 % by 2030, compared to 2020 state-of-the-art technology, while paving the ground towards climate-neutral aviation by 2050.

Europe's Rail (EU-Rail) Joint Undertaking

Total estimated budget: EUR 1.2 bn

EU commitments: Up to EUR 600 m

Partners' commitments: EUR 600 m

The Europe's Rail (EU-Rail) Joint Undertaking will contribute to the achievement of the Single European Railway Area, to a fast transition to a more attractive, user-friendly, competitive, affordable, efficient and sustainable European rail system, and to the development of a strong and globally competitive European rail industry.

Partnership with EIT* InnoEnergy

Total estimated budget: EUR 43 m (2021); EUR 36.58 m (2022)

EIT InnoEnergy defines its mission as 'to build and manage a sustainable, long-lasting operational framework amongst the three actors of the knowledge triangle in the energy sector: industry, research, and higher education, while ensuring that the integration of the three is more efficient and has a higher impact on innovation (talent, technology, companies) than the three standing alone'.

* European Institute of Innovation and Technology

Co-programmed partnerships:

European Partnership for Batteries (BATT4EU)

Total estimated budget: EUR 1.85 bn

EU commitments: EUR 925 m

Partners' commitments: EUR 925 m

The vision of the European Partnership for Batteries (BATT4EU) is to establish by 2030 in Europe the best-in-the-world innovation ecosystem to boost a competitive, sustainable and circular European battery value chain and to drive the transformation towards a carbon-neutral society.

Zero-emission Waterborne Transport (ZEWT) partnership

Total estimated budget: EUR 3.8 bn

EU commitments: EUR 530 m

EU budget already allocated through 2021-2022 Horizon Europe calls: EUR 167.5 m

Partners' commitments: EUR 3.3 bn

The partnership will provide and demonstrate zero-emission solutions for all main ship types and services before 2030, which will enable zero-emission waterborne transport before 2050.

Under the 2021-2022 calls, the twenty-seven projects have received funding, addressing the main areas of the partnership (sustainable alternative fuels, electrification, digital green, energy efficiency, design & retrofit and ports) and main ship types (cruise, long distance, short sea shipping, offshore, ferry and inland waterways transport):

AENEAS, Ammonia2-4, Apollo, CoPropel, DT4GS, GREEN RAY, GreenMarine, HELENUS, HyEkoTank, HYPOBATT, NEMOSHIP, NH3CRAFT, OPTIWISE, Orcelle, POSEIDON, RETROFIT55, sHYpS, SYNERGETICS, V-ACCESS, WHISPER, ZHENIT, FLEXSHIP, SHIP-AH2OY, RESHIP, HEMOS and NEEDS.

Towards Zero-emission Road Transport (2Zero) partnership

Total estimated budget: EUR 1.23 bn

EU commitments: EUR 615 m

Partners' commitments: Up to EUR 900 m

The partnership will set an ambitious research programme to accelerate the development of zero tailpipe-emission road transport in Europe with a system approach. It will develop a common vision and deliver a multi-stakeholders roadmap for a climate-neutral and clean road transport system. It will improve air quality, the mobility safety of people and of goods.

People-centric Sustainable Built Environment (Built4People) partnership

Total estimated budget: EUR 780 m

EU commitments: EUR 380 m

Partners' commitments: EUR 400 m

The partnership brings together the whole value chain to accelerate people-centric innovation in the built environment towards sustainability.

The Clean Steel Partnership (CSP)

Total estimated budget: EUR 1.7 bn
EU commitments: EUR 700 m
Partners' commitments: Up to EUR 1 bn
The partnership will develop lean CO2 technologies, and test these at large scales until 2030. These technologies are required to reduce CO2 from EU steel production by 80-95% compared to 1990 levels, ultimately leading to climate neutrality.

Processes4Planet partnership

Total estimated budget: EUR 2.6 bn

EU commitments: Up to EUR 1.3 bn

Partners' commitments: Up to EUR 1.3 bn

Processes4Planet is a cross-sectorial R&I partnership that aims at transforming the European process industries to achieve the overall climate neutrality at the EU level by 2050 by developing and deploying climate neutral solutions and bringing technological and non-technological innovations to readiness for subsequent deployment.

Co-funded partnerships:

Public-public partnerships between the European Union and EU Member States/Associated Countries represent a peculiar instrument in the EU funding landscape.

Clean Energy Transition (CET) partnership

Total estimated budget: EUR 791.2 m

EU commitments: EUR 210 m

Partners' commitments: EUR 581.2 m

This public-public partnership is a transformative research, development and innovation joint programming and funding programme between the European Union and 32 Member States and Associated Countries fosters the acceleration of the clean energy transition in all its dimensions.

The CET Partnership (CETP) encourages international cooperation beyond the EU/EEA. It collaborates with other international initiatives, such as Mission Innovation (MI) through the MI Calls and by actively connecting

the thematic work to the MI Missions. The upcoming MICall22 will be hosted jointly by the CETP and Driving Urban Transitions towards a Sustainable Future (DUT) partnership.

CETP calls are open to applicants from third countries. However, funding is limited to non-EU/EEA applicants eligible for funding from either Associated Partners to the CETP or Partners that have concluded a funding commitment with the CETP. The US and Canada have already concluded a funding commitment for the 1st joint call of the CETP in the spirit of MI to set up joint research.

The joint call module with CETParnerhip: "Innovative solutions for system flexibility: renewables production, storage and system integration" opened in Sept 2023. Projects with partners outside Europe are expected to foster the CETPartnership approach worldwide, also contributing to link the GPFM Internet-based platform to the CETPartnership knowledge community.

Driving Urban Transitions towards a Sustainable Future (DUT) partnership

Total estimated budget: EUR 435 m

EU commitments: EUR 130 m

Partners' commitments: EUR 305 m

This public-public partnership between the European Union, Member States and Associated Countries addresses the urban dimension across all SDGs with SDG 11 (sustainable cities and communities) and its subgoals as the main entry point. More information can be found in JPI Urban Europe (2019:12) Strategic Research and Innovation Agenda 2.0.

Contribution to Mission Innovation work programme in 2022/23

The European Commission participates in all seven MI Missions, with a particular focus on the Clean Hydrogen Mission and the Urban Transitions Mission where the Commission continues to play a co-leading role.

As co-lead of the Urban Transitions Mission, the Commission has launched a Global Knowledge Exchange Centre for cities and climate in July 2023 with EUR 2 million in EU funding. In addition, in the framework of the European Partnership on Driving Urban Transitions (DUT), the Joint Partnership Initiative (JPI) Urban Europe the European Commission contributed to the MICall22 with international calls for urban R&I with over EUR 37 million in funding and with over EUR 37 million in funding for the 2023 call.

As co-lead of the Clean Hydrogen Mission, the Commission contributes to the Joint Mission Innovation Call 2023 for hydrogen through the Clean Energy Transition Partnership.

The European Commission's science and knowledge service the Joint Research Centre (JRC) leads the Insights module of the MI Innovation Platform. The Commission also participates in the Collaborate module of the MI Innovation Platform by being a member of the Innovation Community on Affordable Heating and Cooling of Buildings and the Innovation Community on International Sustainable Aviation Fuel.

The Commission holds a position of a Vice-Chair in the MI Steering Committee and contributes human resources to the MI Secretariat.

The Commission supports the work of the Green Powered Future Mission, among the other MI Missions. In particular, in July 2023 the GPFM published **National Pilots Report** which includes quite a number of Horizon-funded projects (13 projects) proposed notably by Spain and Italy.

International clean energy collaborations in 2022/23

See Annex A, page 146.

Other clean energy innovation activities in 2022/23

With the European Council Conclusions adopted on the 23rd of May 2023, building on the Commission Communication "Long-term competitiveness of the EU - looking beyond 2030', the European Council calls for advancing work in the research and innovation area:

- To incentivise innovation, focusing on areas with a high growth potential;
- To increase investment in research and development to meet the public and private expenditure target of 3 % GDP;
- To facilitate the placing on the market of innovative products and services, including through the use of regulatory sandboxes.

In line with the EU Hydrogen Strategy, and building on the existing EU Flagship with Africa on renewable energy, the Commission will focus on extending the international cooperation with the Southern Neighbourhood countries and continuing the dialogue with the African Hydrogen Partnership*.

The Cluster 5 'Africa-EU CO-FUND action', to be funded in 2024, now aims to establish links with the Clean Hydrogen Joint Undertaking topic 'Research & Innovation cooperation with Africa on hydrogen' funded in 2022.

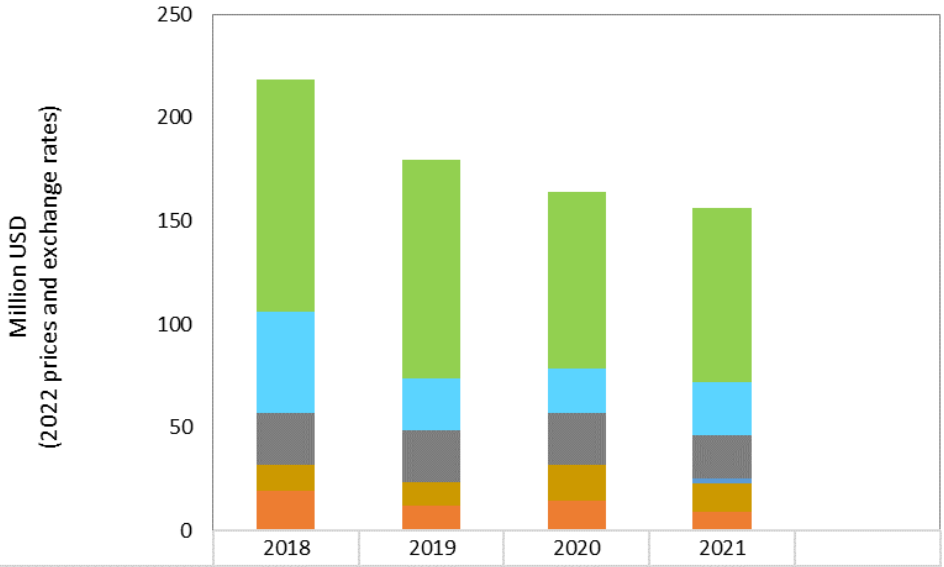
The Commission will explore the development of joint hydrogen research and development programmes in the context of the EU Stabilisation and Association Agreements with the Western Balkans and the Association Agreements with Neighbourhood countries.

* The project LEAP-RE, a long-term EU-Africa Partnership for R&I actions in the area of renewable energy with 83 consortium partners from Europe and Africa, has started in January 2021. In addition, five projects resulting from the Green Deal call on energy solutions for Africa have started in October 2021 and will contribute to the present R&I Partnership on Climate Change and Sustainable Energy of the EU/AU High-Level Policy Dialogue on Science, Technology and Innovation.

Finland

Public RD&D Data

Finland's public spend on clean energy RD&D since 2018 is as follows:



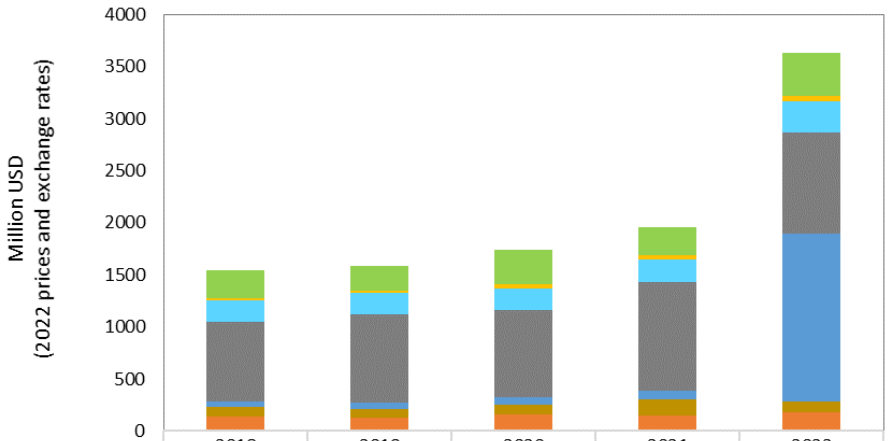
	2018	2019	2020	2021	
Energy efficiency	112.9	105.9	85.8	84.4	-
CCS	-	-	-	-	-
Renewables	48.9	25.0	21.5	25.8	-
Nuclear	25.1	25.4	25.2	20.8	-
Hydrogen and fuel cells	-	-	-	2.2	-
Other power and storage technologies	12.7	11.4	17.2	13.9	-
Other cross-cutting technologies/research	19.1	11.9	14.5	9.0	-
Unallocated	-	-	-	-	-
Total Budget	218.7	179.6	164.2	156.2	0.0

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

France

Public RD&D Data

France's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	273.3	230.3	335.4	267.3	415.5
CCS	23.1	28.2	34.6	40.7	47.2
Renewables	207.6	203.0	214.1	224.2	306.5
Nuclear	759.4	849.2	835.6	1,042.4	962.0
Hydrogen and fuel cells	57.4	61.1	74.1	83.3	1,611.2
Other power and storage technologies	86.5	80.9	93.7	151.4	109.7
Other cross-cutting technologies/research	141.1	129.1	155.3	148.7	179.0
Unallocated	-	-	-	-	-
Total Budget	1,548.5	1,581.7	1,742.8	1,958.1	3,631.1

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
France 2030 – renewable energy	Education and training, Grants, refundable advance	€ 1 bn	Floating wind turbine, Photovoltaic cells, energy network, and others renevable energies	february 2022	Develop and industrialise new technologies for renewable energy production	https://www.gouvernement.fr/secretariat-general-pour-l-investissement-sgpi
France 2030 – decarbonising industry	Education and training, Grants, refundable advance	€ 5 bn	- CO2 capture and storage ; - energy efficiency ; - use biomass, waste as a substitute for the most emissive fossil fuels and biosourced products as resources; - material efficiency and the circular economy	february 2022	Mining-metallurgy, cement, chemicals - improving energy efficiency ;	https://www.gouvernement.fr/decarbonation-de-l-industrie
France 2030 – Nuclear	Education and training, Grants, refundable advance	€ 1 bn	small modular reactors, radioactive waste management : recyclage multiple	february 2022	Develop new reactor technologies: SMR reactor and innovative nuclear reactors. Management of fuel and decommissioning waste : • Develop multi-recycling solutions in pressurised water reactors • Develop a safe process for the treatment and recovery of very low-level metals (VLLM), particularly from dismantling	https://www.elysee.fr/emmanuel-macron/france2030
France 2030 – Zero carbon hydrogen	Education and training, Grants, refundable advance	€ 3,7 bn of which € 3.2 bn IPCEI	All technologies involved in the production of H2	September 2020	development of decarbonised hydrogen for industry, heavy mobility	https://www.gouvernement.fr/hydrogene-decarbone

*The following typology is recommended for consistency across respondents: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.
**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

Achieving carbon neutrality in 2050 requires accelerating the development of energy technologies and translates into a need for additional investment across the innovation continuum. The France 2030 plan, announced by the President of the Republic in October 2021, aims to respond to this problem by preparing the France of tomorrow. The France 2030 plan completes the existing mechanism of the investment programme for the future. It is an unprecedented effort for research, innovation and industry that will enable investments to be strengthened to support highly innovative and groundbreaking projects, particularly in the field of new energy technologies. In concrete terms, France 2030 is a wide-ranging program of grants designed primarily to boost the private sector's ability to leverage innovation to adapt the French economy to the challenges of tomorrow (50 % of the grants targeting the energy transition). The France 2030 calls for projects primarily benefit businesses, and startups play a crucial role in the spirit of the program. For a number of sectors, such as nuclear power, France 2030 aims to foster the creation of an ecosystem of startups to accelerate the innovation process. Sectors such as renewable energies, hydrogen, decarbonization of industry and mobility are also targeted.

Since July 2022, calls for projects have continued to be issued, and a large number of energy-related projects have been funded. New calls for projects have been launched, such as the "Innovative nuclear reactors" call for projects, that supports research and development projects on breakthrough nuclear reactor concepts. France 2030 strategies continue to evolve, and others are being created. One example is different calls for project that aims to decarbonize industry, from small scale compagnies to large industrial areas.

In other respect, ADEME Investissement, a public equity financing tool 100% owned by the State and chaired by ADEME was created in 2019. The company operates alongside private investors, for innovative infrastructure projects serving the Energy and Environmental Transition. Ademe Investissement supports French innovations both in France and abroad, during their construction and operating phases. The company invests according to the same rules as a private investor. The investments tackle projects that are part of the Energy and Ecological Transition: Energy (production, development, storage of renewable energy, renewable heat, wind, wind, solar, marine energy, geothermal, cogeneration, industrial hydrogen, energy efficiency, smart electricity networks etc.), Sustainable mobility (road, rail, river and maritime transport, electromobility, hydrogen mobility, gas mobility, logistics) - Circular economy and renewable gas (treatment and recovery of waste, methanisation and renewable gas, pyrogasification, Power-to-gas) - Fight against greenhouse gases (CCUS) - Environment and biodiversity (green chemistry, eco-efficiency in the building, industry, agriculture, industrial ecology, agroecology, biodiversity protection). Its investment envelope amounts 400 M€.

Last but not least, public-private research partnerships are at the heart of French government’s annually renewed financial support for the Instituts pour la Transition Energétique (ITE), interdisciplinary platforms between public research and industry in the field of low-carbon energies. These campuses of excellence specializing in a particular sector (solar technologies, sustainable mobility, construction, marine energies, etc.) bring together academic research, major corporations and a network of SMEs, to encourage public-private co-investment and strategic convergence between the various players. In this way, ITE-labeled organizations target the industrial development of a complete sector, from technological innovation to demonstrator and industrial prototype.

Contribution to Mission Innovation work programme in 2022/23

France is committed to MI's "Clean hydrogen" mission, its contribution being largely fed by the hydrogen and industrial decarbonization strategy that France is currently building in the framework of the France 2030 investment plan. As a matter of fact, the France 2030 plan defines a "Decarbonated Hydrogen" acceleration strategy that supports the creation of a competitive, renewable, low-carbon hydrogen industry, with the aim of making France one of the world leaders in decarbonated hydrogen through electrolysis. The new solutions offered by hydrogen for decarbonizing the industrial and mobility sectors, as well as for power grid flexibility, contribute to the implementation of the action plan for the “Clean hydrogen” mission on behalf on France. Led by CEA and CNRS (major research french organisms in the field of energy), the "Decarbonized Hydrogen" priority research program and equipments (PEPR) is part of this national strategy. Its aim is to support upstream R&D activities by exploring new avenues that could lead to breakthrough innovations, to support the industry and feed into the strategy.

France also contributes to the “Zero-emission shipping” mission. In parallel, on the French side, an institute for the eco-energy transition of the maritime sector, an offshoot of the French Maritime Cluster, is being set up and is expected to grow in strength. This institute will be able to contribute to the implementation of the action plan of the "Zero-emission shipping" mission on behalf of France, alongside the Ministry of the Sea. With its roadmap for decarbonizing the maritime sector, France is equipping itself with the resources needed to develop new solutions: biofuels, e-fuels, CO2 capture on board, hybridization and electrification of ships and docks, and wind propulsion. French research organizations are mobilized to promote their work to the Mission, and benefit from the international collaboration carried out within this framework.

France is also active in the “Innovation Community on sunlight to X”, through the Atomic and Alternative Energies Commission (CEA). France enhances its R&D efforts in order to build, with the other members of the Mission a new integration paradigm for converting solar energy to chemicals and products. France also follows with interest the “Urban transition”, “Net-Zero Industries” and “Green Powered Future” Missions, in which it could become actively involved in the future.

International clean energy collaborations in 2022/23

See Annex A, page 148.

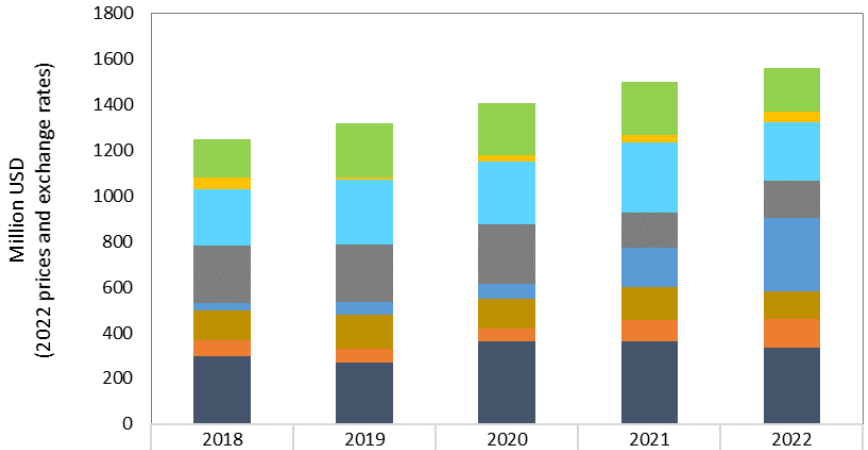
Other clean energy innovation activities in 2022/23

Data for 2022 are currently being consolidated and are therefore not available at this time.
However, in 2021, French public spending on energy research and development (R&D) will reach €1,725 million, following two years of strong growth : +12 % in 2021 and +11 % in 2020 in constant euros. With a very sharp rise in 2021 (+25 %), nuclear power will account for 56 % of public funding. New energy technologies are the second largest area of expenditure, accounting for 36 % of funding. France devotes the highest proportion of GDP of the G7 countries to public R&D in energy. It stands out from other countries for its high proportion of nuclear power. It is also well positioned in marine energies, energy efficiency in transport, hydrogen production and energy storage.

Germany

Public RD&D Data

Germany's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	167.3	240.6	227.4	231.9	192.4
CCS	50.4	6.4	29.1	36.4	47.4
Renewables	246.5	285.9	276.8	307.7	258.1
Nuclear	253.0	254.4	257.6	153.6	160.8
Hydrogen and fuel cells	32.8	52.7	68.7	173.0	323.1
Other power and storage technologies	132.8	149.5	130.4	140.9	118.9
Other cross-cutting technologies/research	66.0	61.9	56.1	96.0	127.1
Unallocated	299.2	269.1	361.4	362.0	335.3
Total Budget	1,248.0	1,320.5	1,407.3	1,501.5	1,563.1

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
7th Energy Research Programme	(b) Grants	1.311 billion € in 2021, 1.216 billion € in 2020, 1.148 billion € in 2019	Energy RD&D in all areas also collected by IEA RD&D report, but excluding conventional mobility technologies (i.e. combustion engines) As an important pillar of energy research the German government has established the "Living Labs for the Energy Transition" as a new funding format to address key challenges in the transformation of climate-neutral energy systems on an industrial scale enabling innovative technologies to be tested in practical applications under real operating conditions.	October 2018 / still under implementation	Activities reported in annual report: https://www.bmwk.de/Redaktion/EN/Publikationen/Energie/federal-government-report-on-energy-research-2019.html **(2019)**; https://www.bmwk.de/Redaktion/EN/Publikationen/Energie/federal-government-report-on-energy-research-2020.html **(2020)**; https://www.bmwk.de/Redaktion/EN/Publikationen/Energie/federal-government-report-on-energy-research-2021.html **(2021)**; https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/bundesbericht-energieforschung-2022.html **(2022)**, English version will be available in autumn	https://www.bmwk.de/Redaktion/EN/Publikationen/Energie/7th-energy-research-programme-of-the-federal-government.html Living Laboratories: https://www.energieforschung.de/spotlights/reallabore

*The following typology is recommended for consistency across respondents: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.
**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme

Overview of project funding for relevant energy research topics in the 7th Energy Research Program in 2022 [1]

Funding topic / Technology areas	Cash outflow in € million (2022)
1. Strategic funding formats: Living labs of the energy transition and hydrogen lead projects	
1.1 Living Labs for the Energy Transition	40.50
1.2 Hydrogen flagship projects	170.14
2. Energy transition in the consumption sectors	
2.1 Energy transition in buildings and neighbourhoods	100.16
2.2 Energy transition in industry, commerce, retail and services	69.80
2.3 Energy transition in the transport sector	28.16
3. Energy generation	
3.1 Photovoltaics	70.14
3.2 Wind energy	89.19
3.3 Bioenergy	48.00
3.4 Thermal power plants	30.72
3.5 Geothermal energy	18.64
3.6 Hydroelectric and marine power	0.31
4. System integration: grids, storage, sector coupling	
4.1 Power grids	61.28
4.2 Energy storage	19.28
4.3 Sector coupling and hydrogen technologies	130.83
5. Cross-system research topics of the energy transition	
5.1 Energy system analysis	19.09
5.2 Digitization in the energy transition	5.63
5.3 Resource efficiency in the context of the energy transition	2.29
5.4 CO2 technologies	45.09
5.5 Industrial collective research programme cooperation	4.64
5.6 Energy transition and society	15.95
5.7 Materials research	2.05
5.8 Basic research into energy-related use of the subsurface	14.88
5.9 Technology-neutral funding with an international focus	60.00
5.10 Other basic research	11.57
5.11 Accompanying funding for IPCEI battery cell research	3.24

[1] https://www.bmwk.de/Redaktion/EN/Downloads/F/federal-government-report-on-energy-research-2023

As part of the funding format Living Labs for the energy transition, which emerged from the BMWK's first ideas competition in 2019, eleven large-scale Living Lab projects have been implemented in 2022. The projects deal with climate-neutral cities as well as hydrogen technologies and the demonstration of the systemic interaction of technologies in a realistic environment. Around € 100 million per year are available for Living Labs for the energy transition.

Living Labs for the Energy Transition, in the field of “energy-optimised neighbourhoods” include:

- **JenErgieReal -** Energy-optimized real laboratory in the city of Jena by means of real-time scalable energy storage (€ 20.5 million)
- **GWP** - Large-scale heat pumps in district heating networks - installation, operation, monitoring and system integration (€ 21.3 million)
- **DELTA** - Darmstadt energy lab for technologies in application (€ 40.1 million)
- **IW3** - Wilhelmsburg integrated heat transition (€ 22.4 million)

- **TransUrban.NRW** - Transformation of grid-connected, urban heating and cooling supply with intersectoral Power-2-Heat solutions as a contribution to structural change in the coalfields of NRW (€ 15.1 million)
- **SmartQuart** - Smart energy neighbourhoods (€ 19.4 million)

Living Labs for the Energy Transition in the field of "sector coupling and hydrogen technologies" include:

- **H2-Wyhlen** - Development and construction of a test room for regenerative, electricity-based hydrogen production involving the building, transport and industry sectors (€ 14.6 million)
- **North German Living Lab** (NRL) - Energy transition alliance for innovation and effective climate protection (€ 52.3 million)
- **Bad Lauchstädt Energy Park** - Demonstration of sector coupling: wind electrolysis for production, storage and transport of green hydrogen (€ 34 million)
- **H2Stahl** - Hydrogen technologies for the gradual decarbonization of the steel industry (€ 37.1 million)
- **WESTKÜSTE100** - Supply-chain oriented energy transition meets decarbonization of industry (€ 36.7 million)

The findings from the Living Labs in the field of hydrogen are being analysed by the scientific project Trans4Real to support the development of a sustainable hydrogen economy in Germany by the means of knowledge transfer (https://www.energiesystem-forschung.de/forschen/projekte/trans4real).

Innovation plays a central role in many measures of the National Hydrogen Strategy, and the Federal Government has therefore launched its own funding measures for hydrogen research and innovation over the course of 2022 and 2023. These include:

- Basic Research: Three flagship large-scale projects in the field of basic research (€ 700 million provided by the stimulus package) addressing the impulse towards a hydrogen economy and following challenges with a close cooperation between industry and research:
    - **H2GIGA** - Industrialise the production of electrolysers by laying the scientific groundwork for automated mass production (€ 98 million)
    - **H2Mare** - Offshore production of hydrogen from wind power and offshore PtX in integrated facilities (€ 38.8 million)
    - **TransHyDE** - Validation of transport and storage solutions for Green hydrogen (€ 11.6 million)
- Applied research: Dedicated research initiative for applied research on hydrogen technologies.

Public-private engagement in 2022/23

Cooperative projects with partners from research institutions and industry are an important element of public energy RD&D funding in Germany. In 2022, the federal government provided around € 1.49 billion in funding for research on the energy transition. In the process 7,365 ongoing research projects have been supported and 1,661 new projects approved. Within these projects, companies contributed € 390 million for clean energy research. This funding approach ensures, firstly, that the research questions addressed by publicly funded research projects are relevant to industrial partners and, secondly, that the innovation transfer to practical solutions and products needed for the energy transition is already considered at the start of the research project. To accelerate the transfer of innovations, the German Federal Government has established nine energy research networks. Currently more than 3,450 experts from industry, academia and society are organized in these open networks (http://forschungsnetzwerke-energie.de/).

Contribution to Mission Innovation work programme in 2022/23

The Federal Ministry for Economic Affairs and Climate Action and expert groups responsible for technological progress and a rapid and efficient climate-neutral energy transition have met regularly to assess and prioritize the participation in each of the outlined innovation challenges (IC) and Missions at the national level. Within the Clean Hydrogen Mission, Germany is represented through NOW GmbH and together with the EU Commission coordinates the Pillar "Demonstration" working group in order to incorporate the experience gained from the numerous hydrogen projects worldwide. Furthermore, Germany is leading the "Hydrogen Exchange" Program, aiming to enable non-MI countries to initiate their own Hydrogen Valleys. Germany supports the activities of the Green Powered Future Mission, participates in the Net-Zero Industries Mission and has recently joined the Zero-Emission Shipping Mission.

In 2022, the Clean Energy Transition Partnership (CETPartnership) was established to continue the work of the ERA-Networks. The CETPartnership aims to combine the forces of the research community in many countries and regions in Europe to accelerate the energy transition in the sectors of heat and power. Besides the European partners, there are also countries and regions from overseas, e.g. the USA and Israel. The German states of North Rhine-Westphalia and Saxony are also participating as partners from Germany. The German Federal Ministry for Economic Affairs and Climate Action is contributing € 18 million to each of the joint calls for project proposals in 2022 and 2023. 5 further joint calls will follow in the coming years. As a result of the joint call 2022, nearly 50 projects with partners from 32 countries and regions will start by the end of 2023.

The 2023 Joint Call integrates the Green Powered Future Mission (GPFM) under the call module CM2023-02 "Energy system flexibility: renewable generation, storage and system integration" with the aim of addressing key aspects to accelerate the deployment of highly innovative, replicable and scalable solutions for large-scale renewable generation. This includes aspects on flexible operation and reliability, energy storage, system integration and digitalization, as well as energy data management and security. A budget of € 0.5 million has been allocated for this purpose.

International clean energy collaborations in 2022/23

See Annex A, page 151.

Other clean energy innovation activities in 2022/23

- Member of the SET Plan Steering Group and participation in most of the SET Plan Implementation Working Groups (IWG), Lead of the IWGs “PV” and “Energy Efficiency in Buildings”
- Participation in the co-funded partnerships under Horizon Europe Cluster 5 “Clean Energy Transition Partnership” (CETPartnership) and “Driving Urban Transition to a sustainable future Partnership” (DUT-Partnership)
- Participation and leadership of the IPCEI “Important Project of Common European Interest” - Hydrogen Technology (IPCEI Hy2Tech) for the further development of the entire hydrogen value chain and the implementation of hydrogen applications.
- Participation in the European partnership on Batteries.
- Participation in the European partnership Built4People.

India

Major innovation initiatives and programmes in 2022-2023

- In the Union Budget 2023-2024, the Government has allocated INR. 35,000 crores (USD 4.2 billion) for priority capital investment towards energy transition, net zero goals, and energy security. Further steps will be taken up viability gap funding for 4,000 MWh battery energy storage systems and formulation of a detailed framework for pump storage projects with investment of INR. 20,700 crores (USD 2.48 billion) with INR. 8,300 crores (USD 996.24 million) of central support for strengthening interstate transmission and integrating 13 GW of renewable energy from Ladakh.
- The Parliament of India has approved the “Anusandhan National Research Foundation (NRF) Bill, 2023" in August 2023. This landmark legislation is poised to establish the NRF, a vital institution dedicated to fostering Research and Development (R&D) and cultivating a culture of research and innovation within India's universities, colleges, research institutions, and R&D laboratories. Furthermore, it aims to provide a high-level strategic framework for scientific research in accordance with the recommendations outlined in the National Education Policy (NEP) of 2020. This transformative initiative allocated a substantial budget of INR 50,000 crores (USD 6 billion) over a five-year period spanning from 2023 to 2028. The Department of Science and Technology (DST) will serve as the administrative authority responsible for overseeing the NRF. This crucial organization will be governed by a distinguished Governing Board comprising accomplished researchers and professionals from diverse fields of expertise. Moreover, the NRF has the potential to drive the advancement of renewable energy sources and energy-efficient technologies. This substantial investment can expedite the adoption of clean energy solutions, aligning seamlessly with India's sustainability and environmental objectives.
- The National Quantum Mission (NQM) has been approved by the Union Cabinet in April 2023, with an investment of INR 6003.65 crores (USD 721 million), aims to foster Quantum Technology (QT) research and development in India from 2023-24 to 2030-31. The mission seeks to create an innovative ecosystem in QT, ultimately propelling India into a leading position in Quantum Technologies. Quantum technology has significant applications in the clean energy sector, including efficient energy storage, grid optimization, materials discovery, climate modeling, and quantum sensors. The NQM is expected to accelerate India's transition to clean and sustainable energy solutions by harnessing the potential of quantum advancements. India's renewable energy capacity has grown substantially with 172 GW installed capacity as of March 2023. India generated 365.60 Billion Units (BU) of electricity from renewable sources in the year 2022-23 as per Central Electricity Authority. Around 129 GW is either under implementation or tendered, with a target of 500 GW till 2030. Plans to invite bids for 50 GW of renewable energy capacity annually for the next five-year.

KEY INITIATIVES TAKEN BY THE GOVERNMENT OF INDIA (GoI) TO PROMOTE RENEWABLE ENERGY

- Laying of new transmission lines and creating new sub-station capacity under the Green Energy Corridor Scheme for evacuation of renewable power.
- Notification of promoting Renewable Energy through Green Energy Open Access Rules 2022.
- Permitting Foreign Direct Investment (FDI) up to 100 percent under the automatic route.
- Waiver of Inter-State Transmission System (ISTS) charges for inter-state sale of solar and wind power for projects to be commissioned by 30th June 2025.
- Declaration of trajectory for Renewable Purchase Obligation (RPO) up to the year 2029-30.
- Notification of standards for deployment of solar photovoltaic systems/devices.
- Launch of Green Term Ahead Market (GTAM) to facilitate the sale of Renewable Energy Power through exchanges.
- Establishment of Ultra Mega Renewable Energy Parks to provide land and transmission infrastructure for large-scale renewable energy projects.
- Solar power schemes continue to support *Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan* (PM-KUSUM), Solar Rooftop Phase II (RTS), and the 12000 MW CPSU Scheme Phase II.
- National Biogas Programme for the establishment of small and medium-sized biogas plants.

KEY HIGHLIGHTS: HYDROGEN ENERGY

- The Ministry of New and Renewable Energy (MNRE) launched the National Green Hydrogen Mission, with an initial investment of INR 19,744 crores (USD 2.36 billion). This allocation is distributed as: INR 17,490 crores (USD 2.09 billion) for the Strategic Interventions for Green Hydrogen Transition (SIGHT), INR 1,466 crores (USD 175.96 million) for Pilot Projects, INR 400 crores (USD 48.04 million) for Research and Development (R&D), and INR 388 crores (USD 46.60 million) for Mission components.
- The Mission, anticipated to produce significant results by 2030, aims for:
    - Development of a green hydrogen production capacity of at least 5 MMT annually, coupled with a substantial rise in renewable energy capacity, approximately 125 GW.
    - Attracting investments exceeding INR 8 lakh crores (USD 96 billion).
    - Generating more than 600000 jobs.
    - Cumulatively reducing fossil fuel imports by over INR 1 lakh crores (USD 12 billion).
    - Mitigating nearly 50 MMT of annual greenhouse gas emissions.
    - Supporting Green Hydrogen Production.
    - Renewable Energy Availability: Measures include waiving inter-state transmission charges for 25 years, enabling renewable energy supply through Open Access, and implementing the Green Energy Corridor Scheme to ensure cost-effective access to renewable energy for Green Hydrogen production.

- The Ministry of Ports, Shipping and Waterways (MoPSW), GoI has identified and nominated Paradip Port, Deendayal Port & V.O. Chidambaranar Port for developing them as Hydrogen Hubs, capable of handling, storage, and generation of green hydrogen by the year 2030.
- Green Tug Transition Programme (GTTP) - Green Hybrid Tugs', which will be powered by Green Hybrid Propulsion systems, and subsequently adopt non-fossil fuel solutions like (Methanol, Ammonia, and Hydrogen). The initial Green Tugs are likely to start working in all major ports by 2025. At least, 50% of all the Tugs are likely to be converted into Green Tugs by 2030.
- The International Conference for promoting Green Hydrogen initiatives was held in New Delhi in July 2023. The key highlights of the event:
    - The Government of India released the Green Hydrogen R&D roadmap envisions the categorization of projects into three distinct types: grand challenge projects, mission mode projects, and blue sky projects which will span three key verticals: hydrogen production, storage, and transportation, and end-use applications.
    - The Ministry of Petroleum & Natural Gas (MoPNG) has been engaging with PSUs to promote green hydrogen. Their goal is to achieve an annual production capacity of 230 kilo tonnes by 2024-25, and an even more ambitious target of 7 lakh tonnes of green hydrogen per year by 2030.
    - In Gujarat, trials for buses equipped with hydrogen fuel cell technology have been initiated.
    - Various organizations, including academic associations, private universities, the India Energy Storage Alliance (IESA), and the Council of Scientific & Industrial Research (CSIR), are actively engaged in developing specialized courses and programs to facilitate skill development and employment in this field.
    - Additionally, the Ministry of Skill Development & Education (MSDE) is in the process of formulating a policy to provide hands-on training across different aspects of the green hydrogen ecosystem.
- Green Hydrogen Standard in India:
    - The MNRE has set emission thresholds for hydrogen to qualify as 'Green' which encompasses both electrolysis-based and biomass-based hydrogen production methods. According to this a well-to-gate emission, must not exceed 2 kg CO_2 equivalent per kg of H_2 production.
    - The Bureau of Energy Efficiency (BEE), under the Ministry of Power, will serve as the Nodal Authority responsible for accrediting agencies.

KEY HIGHLIGHTS: SOLAR ENERGY

- Total installed capacity of 70.1 GW as of August 2023 i.e., 197% increase over the last 5 years.
- Solar Rooftop Phase II (RTS) Phase-II targets 40 GW of rooftop solar capacity, *Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyaan* (PM-KUSUM) to achieve 10,000 MW capacity through grid-connected solar power plants and solarizes 35 lakhs (3.5 million) agriculture pumps.
- Initiatives to promote domestic solar module manufacturing:
    - Modified Special Incentive Package Scheme (M-SIPS) offers subsidies for capital expenditure, covering components like solar PV cells and modules.

- Tranche-I's success, the Production Linked Incentive (PLI) schemes enabled the creation of 8.737 GW integrated solar PV module manufacturing capacity. With a budget of INR. 24,000 crores (USD 2.88 billion) and a target of 65 GW capacity, the scheme incentivizes solar module manufacturers to manufacture High-Efficiency Solar PV Modules.
- 50 Solar Parks with a total capacity of 37,990 MW across 12 states sanctioned, 11 parks with 8,521 MW capacity are operational, and 7 parks with 3,985 MW capacity are partially completed.

- The "Perovskite Society of India Meet-2023 (PSIM-2030)" held at IIT Roorkee from March 1-3, 2023, served as a catalyst for progress in clean energy by fostering collaboration between academia and industry in perovskite semiconductor-based energy research. This international conference aimed to drive advancements in clean energy technologies.

KEY HIGHLIGHTS: BIOENERGY

- The National Bioenergy Programme, initiated by MNRE: Total budget of INR 1715 crores (USD 205.94 million) is planned in two Phases. Phase I has been set for FY 2021-22 to 2025-26 with a budget outlay of INR. 858 crores (USD 103.06 million), focusing on promoting bioenergy initiatives in various sector.
  - The Waste to Energy Programme (WTE) Programme with a budget of INR 600 crores (USD 72.07 million) aims to support the generation of BioCNG from urban, industrial, and agricultural waste. The MoPNG, through the SATAT initiative, aims to establish 5000 BioCNG plants with a production target of 15 MMT of BioCNG by 2023-24.
  - The GOBARDHAN scheme, overseen by the Department of Drinking Water and Sanitation under the Ministry of Jal Shakti, supports up to INR. 50 lakhs (USD 60000) per district for the establishment of community biogas plants. Finalization of standard for Biogas plant. BioCNG has been included under Priority Sector Lending, and eight Biogas Development and Training Centers have been created.
- Under the Ethanol Blended Petrol (EBP) Programme, India increased ethanol blending in petrol from 1.53% (2013-14) to 10.17% (2022), surpassing the November 2022 target, and advanced its 20% blending goal from 2030 to 2025-26. This achieved savings of over INR 41,500 crores (USD 4.99 Billion), reduced 27 lakh MT of GHG emissions, and provided expedited payments of over INR 40,600 crores (USD 4.88 Billion) to farmers.
- Facilitating multimodal transportation of ethanol and ethanol-blended petrol by railways and pipelines. Through Pradhan Mantri JI-VAN (*Jaiv Indhan- Vatavaran Anukool fasal awashesh Nivaran*) Yojana" Govt is providing financial support to integrated bio-ethanol projects for setting up Second Generation (2G) ethanol projects in the country using lingo-cellulosic biomass and other renewable feedstock. The total financial outlay for the scheme is INR 1969.50 crores (USD 236 Million) for the period 2018-19 to 2023-24.
- Asia's largest Compressed Bio Gas (CBG) plant in Sangrur, Punjab was inaugurated and will create direct employment for 390 individuals and indirect employment for 585 people. The plant will lead to a substantial reduction in stubble burning across 40,000 to 45,000 acres of fields, resulting in an annual cut of 150,000 tons of CO_2 emissions.

- The Ministry of Road Transport and Highways amended rules to allow the usage of Bio-CNG produced from waste in motor vehicles.

KEY HIGHLIGHTS: CARBON CAPTURE, UTILIZATION AND STORAGE (CCUS)

- Four inter-ministerial committees have been constituted by NITI Aayog to study the challenges and finalize recommendations in the area of safety and technical standard development, carbon capture projects, carbon utilization projects, and carbon transportation and storage. Two National Centres of Excellence in Carbon Capture and Utilization (NCoE-CCU and NCCCU) are being established, and are supported by DST, India. These centres aim to promote research and collaboration in Carbon Capture and Utilization (CCU), focusing on the development of carbon capture methods, CO_2 conversion to chemicals, efficient CO_2 capture from power, and biogas plants emissions.
- The GoI is committed to a Net-Zero target by 2070. In the short term (FY 2030), the focus is on reducing carbon emissions in the steel industry, with an emphasis on energy and resource efficiency and renewable energy. In the medium term (2030-2047), the key areas are the utilization of Green Hydrogen and Carbon Capture, Utilization, and Storage (CCUS). In the long term (2047-2070), innovative technologies will play a vital role in transitioning to net-zero emissions.
- At the first Energy Transitions Working Group (ETWG) meeting under the aegis of G20 India presidency at Bengaluru, a report on "Carbon Capture, Utilization, and Storage (CCUS) Technology Gaps and International Collaboration" was unveiled. A 3D model of NTPC's flagship project on Flue Gas CO_2 to Methanol Synthesis was showcased during the event.

KEY HIGHLIGHTS: WIND ENERGY

- To Promote wind energy a trajectory for Wind Renewable Purchase Obligation until 2030 has been established. Certain components for wind electric generators receive custom duty exemptions. Financial incentive to provide interest rate rebate of 0.25% for projects financed by the Indian Renewable Energy Development Agency (IREDA). Currently country boasts a manufacturing capacity of 15 GW.
- The National Institute of Wind Energy in Chennai provides technical support, wind resource assessment, and site identification.
- Total installed capacity is 43.7 GW as of August 2023 to achieve 99.9 GW by 2029-2030.
- The Central Transmission Utility has planned for a 10 GW offshore transmission capacity. The Offshore wind activities are now eligible for trading Carbon Credits.

KEY HIGHLIGHTS: SUSTAINABLE TRANSPORTATION

- Eco-friendly transportation-For promoting the Adoption of Electric Vehicles, as part of Phase-II of the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME India) Scheme, India has extended support to 7,45,713 electric vehicles as of December 7, 2022, through demand incentives totalling approximately INR 3,200 Crores (USD 384 Million). It provides incentives to electric vehicle buyers,

resulting in upfront price reductions, ultimately promoting the widespread adoption of electric and hybrid vehicles across the country.

- To accelerate the adoption of electric vehicles and address associated challenges, the government has taken a series of proactive measures. These include augmenting demand incentives, extending the FAME India scheme until March 2024, and endorsing PLI schemes. India currently boasts a fleet of 16,73,115 hybrid and electric vehicles in operation with 6,586 operational public EV charging stations.

KEY HIGHLIGHTS: ENERGY STORAGE

- The Government of India has made substantial investments in Energy Storage Technologies, coupled with Solar PV Projects. These initiatives include:
  - 1.4 MW Solar PV Project with a 1.4 MWh Battery Energy Storage System in Kavaratti Island, UT of Lakshadweep, supported by an MNRE Grant.
  - 50 MW SPV Project with a 20 MW/50 MWh Battery Energy Storage System at Phyang, Leh, UT of Ladakh, is receiving support through a GoI grant under the PMDP 2015.
  - 100 MW SPV Project with a 40 MW/120 MWh Battery Energy Storage System in Rajnandgaon, State of Chhattisgarh, demonstrates the nation's commitment to advancing solar technology while incorporating efficient energy storage solutions for a more sustainable and resilient energy grid.
- India is committed to reducing its reliance on imported Advanced Chemistry Cells (ACCs) and fostering domestic ACC production through an INR 18,100 Crores (USD 2.1 Billion) PLI Scheme. This initiative will not only strengthen India's position in the energy storage sector but also support the growth of electric vehicle manufacturing.

Public-private engagement in 2022/23

HYDROGEN ENERGY

- Oil India Limited has initiated a pilot plant in Assam, producing 10 kg of green hydrogen per day.
- The Indian Oil Corporation Limited (IOCL) has formalized an agreement with Tata Motors for the development of hydrogen fuel cell technology in India. They also revealed plans to introduce 15 fuel cell-driven buses in Delhi in the upcoming year, with potential expansion to other cities.
- NTPC is also pioneering India's first Green Hydrogen-based PNG blending project. Their ambitious goal is to reach 60 GW of renewable energy capacity by 2032, solidifying their role in Green Hydrogen Technology and Energy Storage, and contributing significantly to India's renewable energy targets.

SOLAR ENERGY

- The Indian Government has allocated 39,600 MW of domestic Solar PV module manufacturing capacity to 11 companies, involving an investment of INR 14,007 Crores (USD 1.6 Billion) under the PLI Scheme for High-Efficiency Solar PV Modules (Tranche-II). Manufacturing capacity will be phased in 7,400 MW by October 2024, 16,800 MW by April 2025, and the remaining 15,400 MW by April 2026. This initiative is expected to attract an investment of INR 93,041 crores (USD 11 Billion).

- Coal Public Sector Undertakings (PSUs) are actively investing in renewable energy infrastructure to mitigate the environmental impact of mining and work towards achieving net-zero carbon emissions. As of March 31, 2022, these PSUs have installed a total of 1649 MW in renewable energy capacity, with 1598 MW from solar power and an additional 51 MW from windmills. This investment underscores their dedication to sustainability and aligns with global efforts to transition to cleaner energy sources, marking a significant step in reducing their carbon footprint.
- Coal India Limited (CIL), a government enterprise, is actively promoting sustainable energy, evident through its installation of 11.5 MW of solar projects and a dedicated budget of INR 853 Crores (USD 102 Million) for solar power in the fiscal year 2022-23. Additionally, CIL is set to establish a significant 1190 MW Solar Power Project in Rajasthan, underscoring its commitment to cleaner and more sustainable energy sources.
- The full operationalization of a 100 MW Floating Solar Power Project at NTPC-Ramagundam, Telangana is a significant achievement in clean energy deployment, raising the total floating solar capacity in the Southern Region to 217 MW. This advanced project is expected to save 1,65,000 tons of coal consumption and reduce 2,10,000 tons of CO_2 emissions annually, making a substantial contribution to sustainability and a cleaner energy future.
- NTPC Renewable Energy Limited (NTPC REL) has secured an 80 MW floating solar project in Madhya Pradesh's Omkareshwar Reservoir, bolstering its renewable energy portfolio.
- The International Solar Alliance (ISA) hosted delegates from thirteen West African countries between February-March 2023, in India. The program focused on promoting solar energy implementation and capacity building. Participants attended classroom sessions, visited solar parks, and interacted with experts in the field. The initiative aimed to strengthen solar ecosystems, trigger policy changes, and build capacity for renewable energy.

BIOENERGY

- The Ministry of Housing and Urban Affairs (MoHUA) in India has joined forces with Engineers India Limited (EIL) to advance waste-to-energy and bio-methanation projects under the Green Growth initiative, with a substantial investment of INR 10,000 Crores (USD 1.2 Billion). The collaboration aims to establish 500 new Waste to Wealth plants, including 200 compressed biogas plants, expanding processing capacity by 15,000 TPD for Bio-Methanation and 10,000 TPD for Waste to Energy, as part of the GOBARdhan scheme.

CARBON CAPTURE, UTILIZATION AND STORAGE (CCUS)

- To promote green steel, the following 2 pilot projects have been undertaken under CCUS:
  - Tata Steel commissioned a 5 tonnes per day (TPD) carbon capture plant at its Jamshedpur Works.
  - Jindal Steel Works (JSW) has established a 100 TPD carbon capture and storage facility at its Dolvi Direct Reduced Iron (DRI) plant, with the captured carbon intended for use in the food and beverages industry.

- Additionally, Saarloha (Kalyani Group), has introduced two green steel brands, KALYANI FeRRESTA, and KALYANI FeRRESTA PLUS, featuring reduced emissions thanks to a 70% scrap utilization and renewable energy in their Electric Arc Furnace production.

SUSTAINABLE TRANSPORTATION

- BS 6 Stage II "Electrified Flex fuel vehicle" developed by Toyota Kirloskar Motor launched. An Electrified Flex Fuel Vehicle combines a Flexi Fuel engine and an electric powertrain, offering increased ethanol use and significantly improved fuel efficiency, akin to Strong Hybrid Electric Vehicles (SHEVs). SHEVs achieve 30-50% higher fuel efficiency by operating in EV mode with the engine shut off for 40-60% of the time.

ENERGY STORAGE

- A Tariff-Based Global Competitive Bidding by SECI Ltd. discovered the lowest bid at INR 10,83,500 (USD 13000)/MW/Month for a 500 MW/1000 MWh standalone Battery Energy Storage Systems (BESS) pilot project. A viability gap funding scheme for 4,000 MWh of BESS has been introduced to reduce the Levelized Cost of Storage.

RENEWABLE ENERGY

- Indian Renewable Energy Development Agency (IREDA): It has partnered with Union Bank of India (UBI) and Bank of Baroda (BoB) for co-lending and loan syndication in tier-2, tier-3 cities, and rural areas.
- NLC India Limited (NLCIL) has made significant strides in renewable energy:
  - NLCIL has achieved a substantial milestone with 1421 MW of installed renewable energy capacity and has ambitious plans to expand it to 6031 MW by 2030. This expansion is supported by a substantial estimated investment of INR 23,403 Crores (USD 2.8 Billion) over eight years, facilitated by government initiatives.
  - NLCIL's strong commitment to sustainability is evident through its emphasis on alternative fuels and Clean Coal Technology, aligning with India's vision for cleaner and more sustainable energy sources while reducing carbon emissions.
  - The company's revenue-sharing Coal Bed Methane project at Bharat Coking Coal Limited highlights its dedication to environmental stewardship and responsible energy practices.
  - NLCIL's strategic acquisition of an 810 MW capacity tender in Rajasthan, in collaboration with RVUNL, will contribute 1.1 GW of green power, generating 50 billion units of clean energy and offsetting 50,000 tonnes of carbon dioxide emissions.

Their overarching goal is to achieve over 6 GW of renewable energy capacity by 2030, actively participating in various solar projects across India to support the government's renewable energy objectives.

Contribution to Mission Innovation work programme in 2022/23

- Joint Mission Innovation (MI-8) Ministerial and the Clean Energy Ministerial (CEM-14) was held in Goa, from July 19 to July 22, 2023. The four-day event was organized by the Department of Science and Technology and Bureau of Energy Efficiency, Ministry of Power. This global gathering boasted a diverse participation of 3000 attendees, including representatives from renowned companies, stakeholders, policymakers, and academicians. The event also attracted 200 international participants from 40 countries and 10 international organizations, fostering international collaboration. The deliberations were spearheaded by eminent dignitaries, with the participation of Ministers representing MI member countries, jointly delineating prospective strategies for advancing clean energy initiatives.
- The CEM-14/MI-8 offered a robust program with 80 side events and 24 technology showcases, with a focus on innovations and emerging technology leads from the lab.
- Major key announcements made during the event were:
  - An investment of USD 10.6 billion for clean energy by the member countries,
  - Launch of the Integrated Biorefineries Mission, and
  - Introduction of the MI Think Tank, “Sunlight to X” and the “CDR Mapping Initiative”.

International Workshops, Conferences, Conclave etc. with participation from MI member countries:

- Organized a side event titled “Spotlight on GPFM: Towards five demos in five continents” in the CEM-14/MI-8 held at Goa during July 19- 22, 2023. The event focused on showcasing GPFM progress and initial outcomes on the Flagship Project FP1 "5 demos in five continents". This side event aimed to explore pathways and disruptive technologies for power system decarbonization, recognizing the paramount importance of international collaboration and supporting joint efforts towards net-zero targets.
- Conducted an international conference on "Perovskite Society of India Meet-2023 (PSIM-2030)" held from March 1-3, 2023, at Department of Physics, IIT Roorkee. The conference provided the platform to interact and stimulate advancements in perovskite semiconductor-based energy research both at the lab and industry levels.
- Organized a side event titled “The transition towards low-carbon affordable heating and cooling solutions - The way ahead” in the CEM-14/MI-8 held in Goa during July 19- 22, 2023. The event focused on exploring pathways and disruptive technologies for sustainable heating and cooling of buildings, identifying synergies with other missions, and fostering international collaboration for potential programs.

Conducted an international conclave on “International Platform on Hydrogen Economy an Industry-Academia Conclave” on 30th September 2022 at the Imperial Hall, The Pride Plaza Hotel Aerocity, New Delhi with MI member countries.

International clean energy collaborations in 2022/23

See Annex A, page 154.

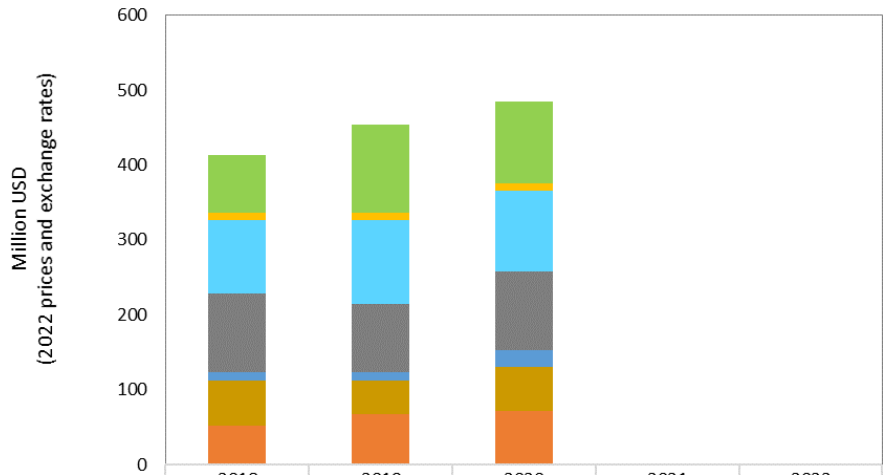
Other clean energy innovation activities in 2022/23

- MNRE hosted a Quad Workshop in December 2022 on Clean Hydrogen Regulations, involving Australia, India, Japan, and the United States. This collaboration aimed to lead in global green hydrogen and green ammonia production, enhancing energy security. The workshop focused on standardizing clean hydrogen regulations for safety and compliance. The Quad Clean Hydrogen Strategic Initiative strives to lower costs across the clean hydrogen value chain, promoting decarbonization and energy supply security.
- From February 2022 to January 2023 MNRE has signed significant agreements. These include a Letter of Intent with Australia, a Memorandum of Understanding (MoU) with Finland, and Joint Declarations of Intent with Germany, all focused on renewable energy and green hydrogen technology. Additionally, a MoU was signed with the United Arab Emirates to promote cooperation in the development and investments in green hydrogen in India.
- In February 2023, a Letter of Intent (LoI) was signed between the Department of Science and Technology (DST) and Fraunhofer Institute for Solar Energy Systems (Fraunhofer ISE) for a long-term collaboration focusing on hydrogen technologies.
- In September 2023, a MoU between MNRE and the Minister of Energy for the Kingdom of Saudi Arabia was signed to boost investments in renewable energy, hydrogen, and sustainable technologies, as well as for developing climate-resilient circular economy practices and harnessing digital transformation, artificial intelligence, and cybersecurity for sustainable energy.

Italy

Public RD&D Data

Italy's public spend on clean energy RD&D since 2018 is as follows:



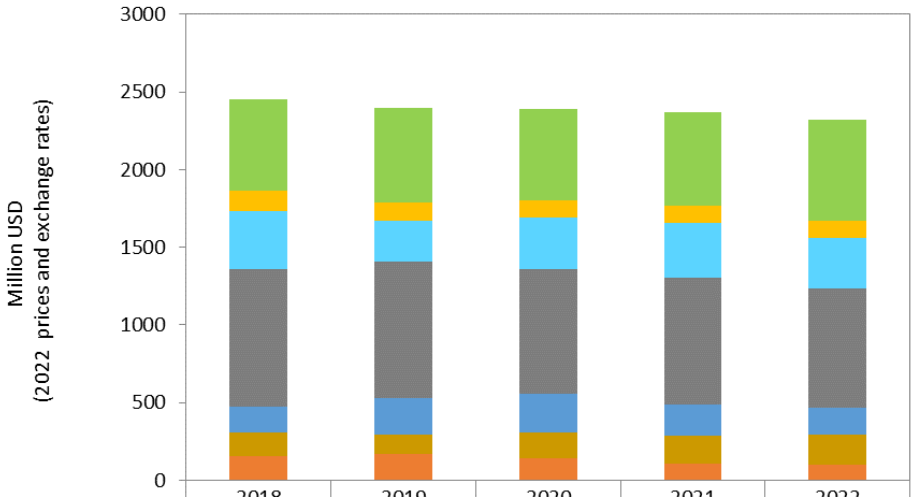
	2018	2019	2020	2021	2022
Energy efficiency	78.1	118.2	109.6	-	-
CCS	9.1	10.0	9.9	-	-
Renewables	98.9	111.5	108.0	-	-
Nuclear	104.2	91.5	105.3	-	-
Hydrogen and fuel cells	11.5	10.7	22.5	-	-
Other power and storage technologies	60.4	45.4	58.0	-	-
Other cross-cutting technologies/research	51.6	66.8	71.8	-	-
Unallocated	-	-	-	-	-
Total Budget	413.7	454.1	485.1	-	-

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Japan

Public RD&D Data

Japan's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	585.7	605.6	593.5	607.6	651.8
CCS	129.6	115.7	108.4	111.1	110.9
Renewables	373.9	269.1	329.3	349.7	321.4
Nuclear	884.4	873.5	805.7	818.1	772.6
Hydrogen and fuel cells	167.4	235.8	249.1	195.1	167.3
Other power and storage technologies	155.7	124.3	167.7	185.7	195.5
Other cross-cutting technologies/research	153.7	171.1	139.3	104.7	102.1
Unallocated	-	-	-	-	-
Total Budget	2,450.5	2,395.1	2,393.0	2,372.0	2,321.7

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Advancement of Hydrogen Technologies and Utilization Project	Grant	JPY 1.26 billion (FY2022)	Hydrogen	FY2014 /2022	With a long-term view toward 2040 and beyond, the goal of this project is to establish new carbon-free energy options such as hydrogen. More specifically, the point of the project is to focus on advanced research and development of technologies in areas such as: high-efficiency/low-cost hydrogen production by using renewable energy, long-distance transportation of hydrogen, long-term hydrogen storage via energy carriers, and large-scale utilization of hydrogen.	https://www.nedo.go.jp/english/activities/activities_ZZJP_100068.html
Development of Technologies to Promote Photovoltaic Power Generation as a Primary Power Source	Grant	JPY 3.14 billion (FY2023)	Solar Power	FY2020 /2024	In this project, NEDO is promoting the development of technologies to address these issues. For example, while the number of suitable sites with favourable conditions for low-cost installation of solar power generation systems, such as ground-based solar farms and residential roofs, is decreasing, modular system technologies are being developed to enable solar power generation in new high-demand settings where conventional solar technologies have not been utilized, such as roofs with weight-bearing limits, exterior building walls, and transportation-related applications such as automobiles.	https://www.nedo.go.jp/english/activities/activities_ZZJP_100174.html
Research and Development of Wind Power Generation Technologies	Grant	JPY 3.57 billion (FY2023)	Wind power	FY2008 /2024	The goal of this project is to overcome Japan's issues related to wind power generation by developing innovative technologies that contribute to further cost reductions and thereby increase wind power introduction and promote enhanced industrial competitiveness. Guidelines on introducing offshore wind power will be prepared in relation to the installation, operation, and maintenance of wind turbines in order to expand offshore wind power. In addition, this project aims to facilitate efforts to develop construction technology that reduces the costs of fixed-bottom offshore wind turbines and therefore steadily and rapidly increase the introduction of offshore wind power in Japan. This project also strives to reduce power generation costs by developing technologies aimed at reducing the downtime as well as the operating and maintenance costs of wind turbines in Japan and by further increasing their energy production.	https://www.nedo.go.jp/english/activities/activities_FF_00383.html
R&D for Innovative Technologies Applied to Geothermal	Grant	JPY 1.2 billion (FY2023)	Heat utilization	FY2021 /2025	This project ultimately aims to promote greater utilization of geothermal power generation, including the development of geothermal resources found in Japanese national parks, as one of Japan's primary sources of renewable power, and realize a maximum geothermal power generation capacity of 1.48	https://www.nedo.go.jp/english/activities/

Exploration and Exploitation					million kW by 2030. To promote greater utilization of geothermal power, NEDO will carry out R&D activities under this project related to surveys targeting resources for supercritical geothermal power generation, which is attracting attention as an innovative next-generation technology.	activities_ZZJP_100198.html
Next-Generation Power Network Stabilization Technology Development for Large-Scale Integration of Renewable Energies	Grant	JPY 1.6 billion (FY2023)	power grid	FY2019 /2023	One goal of this project is to maximize the utilization of existing grid systems by developing prediction and control systems for individual grid systems aimed at the achievement of non-firm connections* at an early stage. Another goal of the project is to develop optimal systems control technology in order to resolve various issues & mdash;including fluctuations in voltage and flow of power distribution systems & mdash;to work toward the establishment of distributed network systems.	https://www.nedo.go.jp/english/activities/activities_ZZJP_100150.html
Research and development of a multi-purpose and multi-terminal hIGH voltage direct current Transmission system (RIGHT Project)	Grant	JPY 1.7 billion (FY2023)	power grid	FY2020 /2025	In this project, we will develop high-voltage direct current (HVDC) transmission technology that enables highly reliable and efficient power transmission by appropriately performing protection control and power flow control by using multi-terminals for direct current transmission lines from wind power generation and other sources. We will also develop control technologies that enable these DC transmission lines to be used for applications such as inter-regional power supply, and compile technical requirements to contribute not only to the widespread introduction of wind power generation, but also to maintaining the regional supply-demand balance, avoiding renewable energy curtailment, and strengthening resilience.	https://www.nedo.go.jp/english/activities/ZZpage_100149.html
Future-generation power network Stabilization Technology development for utilization of Renewable Energy As the Major power source (STREAM Project)	Grant	JPY 3.0 billion (FY2023)	power grid	FY2022 /2026	This STREAM project, based on the results obtained from the NEDO project called "Next-Generation Power Network Stabilization Technology Development for Large-Scale Integration of Renewable Energies", aims to develop technologies to address new challenges like low inertia and short circuit capacity while comprehending the latest technological and policy trends, taking into consideration any possible technological or even institutional risks in the future power grid.	https://www.nedo.go.jp/english/activities/activities_ZZJP_100160.html
Development of Flexible and Distributed Energy Resources Control Technology to Mitigate Congestion in Power Systems (FLEX DER project)	Grant	JPY 1.7 billion (FY2023)	power grid	FY2022 /2026	The FLEX DER project aims to develop technologies for DER flexibility systems, which will serve as the core platform, connecting aggregators and distribution system operators so they can monitor grid congestion as well as the operational status of DERs in the distribution network and control DERs.	https://www.nedo.go.jp/english/activities/activities_ZZJP_100153.html

Development of Material Evaluation Techniques for Advanced and Innovative Batteries (Phase 2)	Grant	JPY 2.149 billion (FY2022)	Storage batteries	FY2018 /2022	The project seeks to promote collaborations between automobile, storage battery, and material manufacturers and universities/public research institutes in order to establish basic technologies for resolving challenging issues common to all-solid-state lithium-ion batteries. At the same time, prototype cells are also being used to develop the technology necessary to evaluate the characteristics of new materials and their suitability for mass production and installation on electric vehicles (EVs). In addition, the project aims to develop safety and durability test evaluation methods while keeping in mind an international standardization process led by Japan. In parallel with the above research and development, this project also involves the consideration of future societal system designs and scenarios to accommodate the large-scale dissemination of EVs.	https://www.nedo.go.jp/english/activities/activities_ZZJP_100146.html
Technology Development for the Utilization and Production of Ammonia as Fuel	Grant	JPY 1.9 billion (FY2023)	Fuel ammonia	FY2021 /2025	With a view toward realizing carbon neutrality in Japan by 2050, this project will focus on the development of technology to utilize ammonia, a compound that does not produce CO2 when combusted, as a fuel for industrial furnaces and thereby promote decarbonization in the heat utilization sector where reduction of CO2 emissions has been difficult to achieve. Specifically, the project will develop an ammonia-oxygen burner for application to industrial furnaces, where heat transfer is mainly conducted using radiant heat, and carry out demonstration testing in a glass-melting furnace to verify technology for enhancing radiant heat transfer and reducing NOx.	https://www.nedo.go.jp/english/activities/activities_ZZJP_100204.html
International Demonstration Project on Japan's Energy Efficiency Technologies	Grant	JPY 6.5 billion (FY2023)	Energy efficiency technologies	FY1993 /	NEDO aims to internationally disseminate Japan’s advanced technologies that can contribute to safety, energy security, economic efficiency and the environment (S+3E) by demonstrating such technologies overseas. Furthermore, international demonstrations to be carried out in energy markets with more advanced energy policies are designed for Japan to gain meaningful results for domestic use.	https://www.nedo.go.jp/english/activities/activities_AT1_00175.html

*The following typology is recommended for consistency across respondents: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.
**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

The Basic Policy for the Realization of GX (Green Transformation)

The Basic Policy was approved by the Cabinet in February 2023. The Ministry of Economy, Trade and Industry (METI) promote the following two initiatives.

1. In order to ensure stable supply of energy, in addition to thorough energy efficiency improvement, we will promote decarbonization initiatives toward GX, such as switching to decarbonized power sources that contribute to improving the self-sufficiency rates of energy, like renewable energy and nuclear power.
2. To achieve GX, we will realize and implement the Pro-Growth Carbon Pricing Concept, which includes bold advance investment support using GX Economy Transition Bonds (will implement initial investment support of 20 trillion yen for 10 years), incentives for GX investment through carbon pricing, and utilization of new financial instruments. https://www.meti.go.jp/english/press/2023/0210_003.html

Green Innovation Fund

The fund, based on the specific goals shared by public and private sectors, is to continuously support companies and other organizations for up to ten years, which show their commitment to challenge such ambitious goals as their business issues ranging from research and development (R&D) to demonstrations to social implementation of the outcomes. METI utilizes the additional 756 billion yen expanded in 2022 and 2023 to add, expand and accelerate project initiatives.

https://green-innovation.nedo.go.jp/en/

The Basic Hydrogen Strategy

The Japanese government revised its hydrogen strategy in 2023 in order to better reflect the evolving circumstances surrounding hydrogen.

The strategy includes the following items as important pillars:

(1) Overall objective

(2) Hydrogen industry strategy (for enhancing the hydrogen industry competitiveness)

(3) Hydrogen safety strategy (for the safe use of hydrogen)

The strategy also sets out the new volume target of about 12 million tons per year (including ammonia) for 2040. It is aimed that the public and private sectors together invest 15 trillion yen in hydrogen/ammonia supply chains with a view to providing a necessary basis for decarbonization.

https://www.meti.go.jp/shingikai/enecho/shoene_shinene/suiso_seisaku/pdf/20230606_5.pdf

Contribution to Mission Innovation work programme in 2022/23

Carbon Dioxide Removal (CDR) Mission

- In September 2022, Japan increased the level of CDR membership status from support to core to contribute more actively to the mission activities.

- Since the launch of the mission at COP26, Japan has been co-leading the LCA/TEA Technical Track and providing dedicated technical expertise to move forward the activities.
- Based on the action plan published in May 2023, Japan is conducting the literature review on LCA methodologies and LCA/TEA inventory data for CDR technologies with an external contractor.
- Japan is also conducting LCA/TEA case study of DAC considering different climate and geological conditions.
- In May 2023, Canada and Japan co-organized the workshop to enhance understanding of LCA for different CDR approaches with existing projects and best practices.
- Japan has played an important leadership role to the BiCRS Technical Track to advance the activities correspond with the BiCRS scope of work and provides coordination among its members.
- Japan has been engaged in the CDR Launchpad sprint and participated as a panellist in the side event of COP27 for its launch in November 2022.
- In January 2023, Japan organized an international webinar to introduce BiCRS strategies and policies in member countries. Various stakeholders such as industry, academia, and research institutes from worldwide participated.
- In July 2023, Japan assigned an expert to the side events related to CDR at CEM14/MI-8 in Goa to enhance and follow up on the dialogue.

Clean hydrogen Mission

- In January 2023, Japan organized an online international workshop on "Hydrogen for Cargo Handling at Ports, focused on hydrogen policy and technology for port application, bringing together participants from various fields.
- In March 2023, Japan organized a hybrid international workshop on "Hydrogen Detection Technologies for Safety" in Tokyo, Japan, focused mainly on heavy-duty applications, the in-person format enhanced building networking between both governments and industries.
- Japan developed a report on "Hydrogen Detection Technologies for Hydrogen Safety: Applications and Technologies" in July 2023 that was released on the MI/CHM website.
- Japan provided input for both the Hydrogen Valleys platform and Transportation Storage Case studies.

Green Powered Future Mission

- In December 2022, Japan participated in the international online workshop hosted by China aimed to promote a high proportion of global renewable energy applications. The experiences and challenges of integrating renewables into the grid in Japan were presented.
- In February 2023, Japan organized an online 2-day workshop on "Novel Photovoltaic: Policy and Technology" to demonstrate the policies, scenarios, and trends of member countries, and to exchange insights and best practices between representatives from the members and PV international experts.
- Japan provided data and information to the mission (e.g. Action Plan 2022-2024, National Pilots Report).
- In July 2023, Japan assigned an expert to the side events related to GPFM at CEM14/MI-8 in Goa to enhance and follow up on the dialogue.

Others

- In July 2023, the EU to Japan and Japan organized a joint hybrid information seminar where their activities under the Clean Hydrogen Mission, CDR mission as well as Green Powered Future mission were introduced and discussed the areas of existing and potential collaboration between the EU and Japan.

MI Governance and Operations

- Japan's involvement in the overall MI activities includes serving as a member of the Steering Committee, a vice chair of Technical Advisory Board (TAG) and providing resources for the virtual Secretariat in TAG operations.

International clean energy collaborations in 2022/23

See Annex A, page 155.

Other clean energy innovation activities in 2022/23

The Ministry of Economy, Trade and Industry (METI) invited ministers from various countries and global experts and leaders from different fields to hold Tokyo GX Week toward achieving GX (green transformation), a process that will mean shifting from the fossil fuel ‐ dependent economic, social, and industrial structures that have prevailed since the Industrial Revolution to ones based predominantly on clean energy, and will lead to reduced emissions and economic growth and development.
More than 13,000 people participated online or in person.

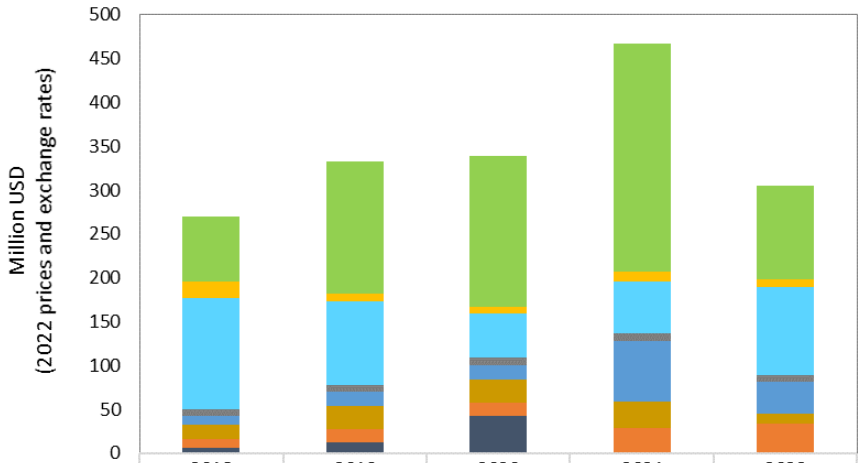
- 4th International Conference on Carbon Recycling (September 26th, 2022)
- 5th Hydrogen Energy Ministerial Meeting (September 26th, 2022)
- Second International Conference on Fuel Ammonia (September 28th, 2022)
- Second Asia CCUS Network Forum (September 30th, 2022)
- Leaders Session of the 4th RD20 Conference (October 6th, 2022)

https://www.meti.go.jp/english/press/2022/1026_003.html

The Netherlands

Public RD&D Data

The Netherland's public spend on clean energy RD&D since 2018 is as follows:



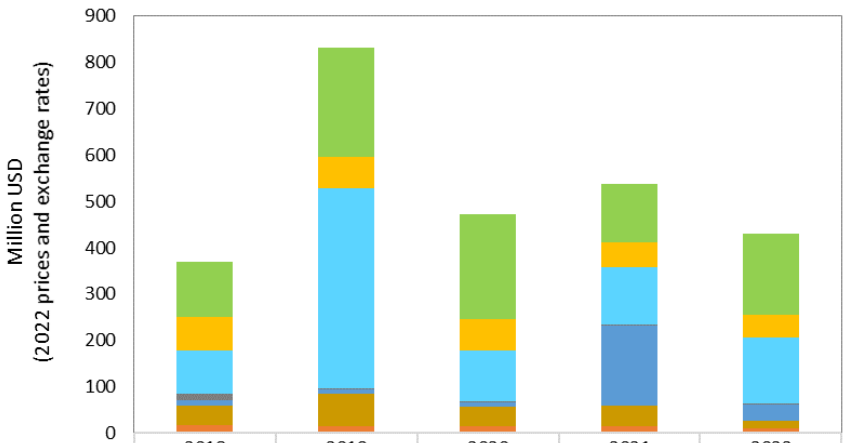
	2018	2019	2020	2021	2022
Energy efficiency	74.2	151.1	171.5	260.3	106.0
CCS	19.7	8.2	7.9	11.2	9.6
Renewables	126.2	94.9	50.7	59.3	100.2
Nuclear	7.8	8.1	8.0	8.6	8.1
Hydrogen and fuel cells	10.2	16.7	17.0	68.7	36.6
Other power and storage technologies	16.1	26.3	26.1	30.3	10.8
Other cross-cutting technologies/research	10.2	14.7	14.5	28.8	33.8
Unallocated	6.0	12.5	43.2	-	-
Total Budget	270.4	332.5	338.9	467.0	304.9

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Norway

Public RD&D Data

Norway's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	119.5	235.7	224.3	124.0	175.4
CCS	72.1	67.8	68.0	55.8	49.1
Renewables	92.3	431.3	110.1	122.8	143.5
Nuclear	15.6	3.1	3.1	1.3	1.0
Hydrogen and fuel cells	11.7	8.9	9.8	172.6	34.6
Other power and storage technologies	41.4	69.9	41.2	45.6	17.0
Other cross-cutting technologies/research	15.7	13.7	13.7	13.7	10.1
Unallocated	1.6	1.3	1.2	1.2	0.3
Total Budget	369.9	831.8	471.4	536.9	431.1

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
New climate-friendly technology	Grants	NOK 731 million (budget for 2023)	Energy, transport and low-emission solutions for the sectors of energy and transport	Ongoing	ENERGIX: Research on renewable energy, energy efficiency, energy savings, sustainable energy systems and energy policy. About 80% of projects in the programme portefolio are headed by or include participation by Norwegian business and industry. FME: Scheme to support research centres for environmentally friendly energy for a duration of five-to-eight years focusing on long-term research of high itnernational calibre to solve specific challenges in the energy sector. Host research institutions provides 25% of the funding and at least 25% is provided by business and other user partners. CLIMIT: National programme for research, development and demonstration of technologies for capture, transport and storage of carbon from fossil-based power produciton and industry.	Energy research - Energifakta Norge

*The following typology is recommended for consistency across respondents: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.
**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

PILOT-E

PILOT-E is a financing offer for the Norwegian business community, established by the Research Council of Norway, Innovation Norway and Enova. It is designed for the private sector and works like a "fast-track" through the stages of research; from idea to market. The aim of the scheme is for completely new products and services in environmentally friendly energy technology to be more rapidly developed and used to contribute to reducing emissions both in Norway and internationally.

In 2022, the sixth round of PILOT-E focused on Flexibility in the power system and fossil-free high temperature heat in Industry. Three projects for flexibility in the power system were allocated funding totaling approximately NOK 45 million.

Flex-E is led byEVINY and was established in 2023 focusing on outstanding research and innovation on electrical consumption within land transport, commercial buildings and maritime transport in an area in a context and collectively make this available as flexible resources into the flexibility market.

Shared resources for industrial growth is led by RINGERIKSKRAFT and was established in 20223dedicated to the research and innovations On Innovative solutions to connect new companies to industry parks with limited grid capacity.

Euroflex is led by AGDER ENERGI and was established In 2023 focusing on new and flexible solutions that can relieve the power grid during the peak hours of consumption.

Full-scale CCS Project "Longship": The Norwegian Government continues the support of the full-scale CCS project Longship with an estimated total national grant contribution of NOK 20,3 billion. The project comprises of carbon capture from Heidelberg Materials' cement factory (previously Norcem) in Brevik in Porsgrunn municipality and Hafslund Oslo Celsio's waste incineration facility in Oslo*. Each facility will capture approximately 400 000 tonnes of CO2 per year. The liquefied CO2 will be transported by ship to a reception terminal in Øygarden municipality, and by pipeline to a well, in which the CO2 will be injected into a storage formation (saline aquifer) 2 600 meters beneath the seabed. Northern Lights, which is a joint venture company owned by Equinor, Shell and Total are developing the CO2 transport and storage solution. The construction is over 80 percent completed. The solution has been designed to cater for a phased development where the first phase, which is part of the Longship funding scheme, has a yearly CO2 storage capacity of approximately 1,5 million tonnes for 25 years. The pipeline from the onshore facility to the reservoir is dimensioned for 5 million tonnes. Since the launch of Longship, Northern Lights have signed two commercial agreements on cross border CO2 transport and storage with Yara and Ørsted respectively.

*In April 2023, Celsio decided to temporarily pause the project due to increased costs of materials and foreign exchange effects. The company is now working to find cost-reducing solutions.

Contribution to Mission Innovation work programme in 2022/23

MI-CDRI

- Norway and Japan have been co-leading the Biomass Carbon Dioxide Removal and Storage (BiCRS) track within Mission Innovation CDR since September 2022 and are working closely together in weekly/bi-weekly meetings.
- The BiCRS (Biomass Carbon Dioxide Removal and Storage) Scope of Work was issued December 2022 and updated in June 2023. Norway initiated the work on the document and have had the editorial responsibility for the BiCRS Scope of Work.
- Norway is responsible for mapping of biomass resources and demo and deployment projects (ref. work package 1 in the BiCRS Scope of work). At the Goa meeting, a first version of a CDR map was launched showing international demo & deployment projects within BiCRS, DAC and Enhanced Mineralization. From the Norwegian side, the Longship demo project has been registered on the map within the BiCRS area. There are also a few Norwegian projects registered within the DAC area.
- Norway is following up and participating in meetings organized by the Life-Cycle-Analysis/Techno-Economic-Analysis (LCA/TEA) track with the aim of international harmonization of methods for LCA/TEA.
- Norway is part of the CDR Lauchpad that was launched at COP27 aiming for increased CDR pilot and -demonstration projects globally. Norway has registered Longship as a CDR demonstration project having biogenic CO2 being stored geologically.
- Norway is participating in all members meetings and workshops of Mission Innovation CDR initiated by the co-leading countries USA, Canada and Saudi Arabia and has given comments to documents on new initiatives within the mission.

MI Clean Hydrogen

In the Clean Hydrogen Mission Norway has reported on activities and prepared basis for collaborative work, as well as supporting the secretariat with relevant input and information in on-going processes.

Zero Emission Shipping Mission.

Norway is participating actively as a Co lead in in the Zero Emission Shipping Mission. The ZESM is divided in three pillars. Norway is together with Denmark leading the Ships-pillar and together with the US leading the Fuels pillar. The third pillar is on Infrastructure.

An important element addressed in the action plan launched in September 2022 is sharing knowledge from demonstration projects, both new-builts and retrofit. In March the final results from the Norwegian led project “Ammonia powered bulk carrier” was launched concluding that it is technically feasible to retrofit an open hatch bulk carrier powered by ammonia. The main barrier is the combination of high retrofit investment costs, lack of availability of competitively priced green ammonia and unclear effects of regulatory frameworks. These results are important strategic inputs both to international industry and authorities.

In June, Norway hosted a four day physical workshop gathering the whole secretariat in ZESM. The workshop was scheduled the same week as the bi-annual Nor Shipping 2023, a leading international maritime event and exhibition that takes place every second year. Results from the pilot study was presented in a panel debate arranged by Norway to share and debate the main findings from the “Ammonia powered bulk carrier”-study.

To address one of the identified barriers, lack of competitively priced green Ammonia, Norway initiated and arranged together with the US a Europe / US workshop on the 19th of April to address the challenge of ammonia availability in US ports. The workshop was a success with close to 30 participants representing different stakeholders, and especially relevant US authorities.

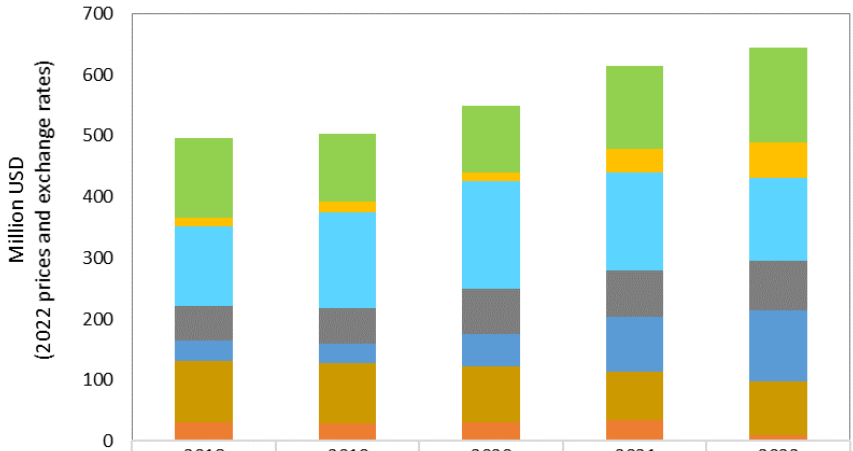
International clean energy collaborations in 2021/22

See annex A, page 156.

Republic of Korea

Public RD&D Data

The Republic or Korea's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	131.1	112.4	109.9	136.9	154.5
CCS	14.0	16.0	13.6	38.3	58.8
Renewables	130.2	157.1	176.7	160.2	136.5
Nuclear	55.8	59.2	74.9	76.7	81.2
Hydrogen and fuel cells	34.3	31.5	52.1	89.8	114.8
Other power and storage technologies	101.2	98.8	92.4	78.9	89.7
Other cross-cutting technologies/research	30.1	28.9	30.3	34.3	8.8
Unallocated	-	-	-	-	-
Total Budget	496.6	503.9	549.9	615.1	644.2

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget	Technology focus	Start/end date	Main activities
Carbon-neutral industry and energy R&D strategy	(l) Other: Energy R&D Strategy	funding milestone in an existing program	Carbon-free power generation, renewable energy, hydrogenation, system advancement, energy storage, and energy high efficiency were selected as key areas for carbon	2021(baseline)/ 2030	Establishing carbon-neutral industry and energy R&D strategy including key technology developing tasks, schedules, and support measures to achieve NDC in 2030 and realize carbon neutrality in 2050
2050 Carbon Neutral Energy Technology Roadmap	(l) Other: Energy R&D Roadmap	funding milestone in an existing program	PV, Wind power, Clean fuel power generation, Fuel cell, Green Hydrogen, Energy Storage, Grid, Sector Coupling, Industrial complex/building energy, Energy Equipment, Resource circulation, CCUS, Oil	2021(baseline)/ 2050	Short-, mid-, long-term technology Acquisition strategy to achieve 2050 carbon neutrality International Cooperation, Human resources development measures

*The following typology is recommended for consistency across respondents: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.
**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programmes

Public-private engagement in 2022/23

- In cooperation with the government, R&D Funding agencies, large enterprises and financial institutions, operating subsidiary fund (100billion KRW, 2022) that invests in carbon-neutral manufacturing technology and energy innovative companies within a technology innovation fund that focuses on supporting R&D activities.
  - The government and R&D funding agencies discover excellent energy companies and link them to investment needs of operators to support investment activities.

- Promoting the private investment ecosystem by establishing a meeting between companies and investors who wish to attract investment
  - Under the auspices of the Korea Institute of Energy Technology Evaluation and Planning, various support programs such as basic education, consulting, Investor Relations consulting and climate· environment consulting, mock training and investment attraction counseling sessions are operated to strengthen the investment attraction capabilities of companies.

Contributions to Mission Innovation work programme in 2022/23

Since 2021, the Korean government is participating in MI 2.0 missions. Among the seven missions, we are participated in Zero-Emission Shipping, Green Powered Future, Clean Hydrogen, Net-zero Industry.

The Korea Institute of Energy Technology Evaluation and Planning, an energy R&D funding agency in Korea, has strengthened networking with MI member countries since 2018 and jointly developed innovative technologies to improve global technology, we supported R&D tasks in smart grids, bio energy, PV(photovoltaics), energy efficiency, resource circulation, and hydrogen. In 2023, we will support R&D projects in Clean Hydrogen, Green Powered Future.

International clean energy collaborations in 2022/23

See Annex A, page 157.

Saudi Arabia

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Technology focus	Main activities
Circular Carbon Economy (CCUS & Hydrogen)	This innovation focus area will concentrate on projects that will deliver cost effective innovative solutions in the areas of carbon capture, utilization and storage & hydrogen production along with the establishment of Carbon & Hydrogen Innovation Centers.	• Align with key stakeholders and mobilize the required enablement resources in energy ecosystem to perform research projects for Carbon Capture, Utilization and Storage • Align with key stakeholders and mobilize the required enablement resources to execute research on blue and green H2 production, transport and utilization at research stage. • Demonstrate Carbon Capture, Utilization and Storage at development stage (e.g. pilot scale) • Demonstrate blue and green H2 production, transport and utilization at development stage (pilot scale). • Demonstrate Carbon Capture, Utilization and Storage in relevant and operational environment at deployment stage. • Demonstrate blue and green H2 production, transport and utilization in relevant and operational environment at deployment stage. • Align with local content to commercialize successfully deployed technologies. • Align with local content to commercialize successfully deployed technologies at commercialization stage.
Energy of the Future	This innovation focus area will concentrate on projects that will deliver cost effective innovative solutions in the areas of energy efficiency, renewables & renewables integration, energy storage and nuclear energy technologies	• Align with key stakeholders and mobilize the required enablement resources in • energy ecosystem to perform research projects of energy efficiency, renewables & renewables integration, energy storage and nuclear energy. • Demonstrate energy efficiency, renewables & renewables integration, energy storage and nuclear energy at development stage (e.g. pilot scale). • Demonstrate energy efficiency, renewables & renewables integration, energy storage and nuclear energy in relevant and operational environment at deployment stage. • Align with local content to commercialize successfully deployed technologies.

Public-private engagement in 2022/23

The Saudi Arabia Ministry of Energy is coordinating and closely monitoring the following projects:

Geothermal Energy Exploration

Some recent reports on geothermal energy show that Saudi Arabia is rich in terms of different geological characteristics and geothermal activity and is qualified to contribute effectively to the domestic energy supply. This geothermal exploration project aims to have a better understanding of the subsurface conditions in Al-Lith

area and assess the possibility of having a geothermal reservoir. This project involves Preliminary and Geoscientific studies (Geological, geophysical, and geochemical studies) in collaboration with TAQA.

Cryogenic Carbon Capture Technology

An internal study showed that an emerging technology that has not yet been commercially developed in global markets, and owned by one of the world's leading companies in the field of carbon management, the American Company Chart, is based on capturing and reusing cryogenic CO2 more efficiently than traditional techniques, and its estimated cost is lower up to $ 34 per ton of carbon dioxide. For this reason, the Ministry, in partnership with King Abdullah University of Science and Technology, the NEOM project and the American Company Chart, has adopted the development of a plan for a pilot plant with a lifespan of up to 5 years in a power plant adjacent to the industrial areas on the West Coast, with the aim of designing and constructing a 30-tons CO2 capture unit and a cryogenic CO2 production.

Direct Air Capture technology development in collaboration with ARAMCO and KAUST

As part of KAUST Circular Carbon Initiative (CCI), the CO2 Capture thrust focuses on the demonstration of direct air capture (DAC) technology encompassing metal-organic-framework (MOF) developed at KAUST and will collaborate with Aramco on the development and upscaling of new adsorbents to process design, cost estimation, environmental analysis and small-scale demonstration.

Membrane-based CO2 capture study in collaboration with ARAMCO

Carbon Dioxide is being emitted as a Tail Gas of Sulfur Recovery Units (SRU). A membrane carbon capture unit is proposed on this stream which contains approximately 22% CO2 by mole (wet basis). A typical carbon capture system design consists of a two-stage membrane process that, based on preliminary calculations, can produce a CO2 product stream of at least 98% purity at a capture rate of approximately 90%. The introduced Membrane Carbon Capturing Technology is currently at TRL 6 where the technology needs to be assessed to determine its feasibility for this particular application before demonstration in a relevant environment.

Contributions to Mission Innovation work programme in 2022/23

Saudi Arabia has joined the mission innovation believing that the mission innovation will act as catalyst to excel the investment in research, development and demonstration to make clean energy affordable, attractive and accessible to all this decade. The kingdom is an active member in three missions, the clean hydrogen mission and the green powered future mission (GPFM), along with co-leading the carbon dioxide removal mission (CDR), the CDR mission will catalyse the advancement in research and development in CDR technologies such as the direct air capture which is promising and important technology for Saudi Arabia.

The Kingdom of Saudi Arabia also contributes 0.5FTE to the MI Secretariat who is currently working as a Communications Officer.

Saudi Arabia has established a global collaboration with a variety of different world-wide countries, from the far East with Japan, Korea and China to the far west with Canada and USA. All the collaborations are directly working to protect the climate while sustaining the global energy security. The collaboration varies from one country to another. On the other hand, many collaboration opportunities are common between all countries. One of the most important collaborations is the circular carbon economy where we can collaborate on infrastructure development projects for carbon circular economy applications (such as CCUS, and DAC), also

to identify areas of cooperation in relation to clean hydrogen technologies in relation to hydrogen transportation and storage, and exchange expertise and experiences to apply best practices in the field of hydrogen projects more over to develop policy, legislation and build awareness of the hydrogen economy. cooperation and exchange of experiences to promote innovation and the use of artificial intelligence in the field of energy.

International clean energy collaborations in 2022/23

See Annex A, page 160.

Other clean energy innovation activities in 2022/23

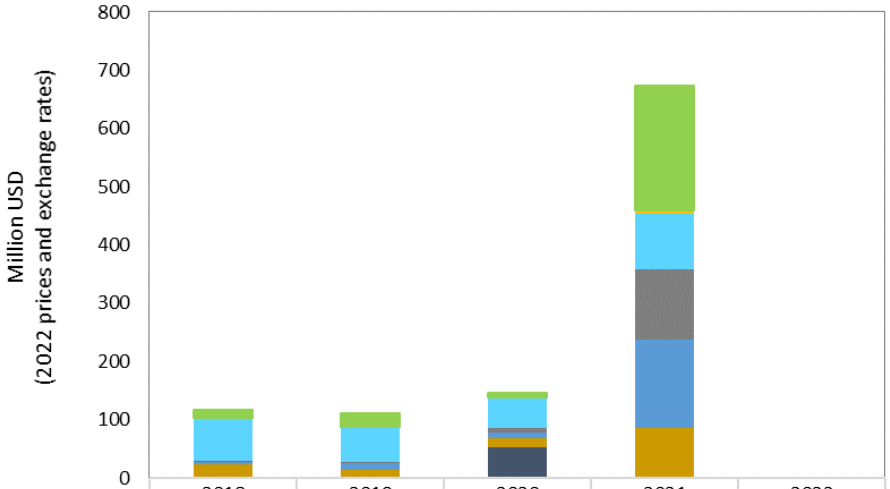
Saudi Arabia aims to achieve net zero emissions by 2060 through the Carbon Circular Economy approach. This is based on the Kingdom's critical role in confronting shared international issues, its belief in the need for collaborative efforts to confront climate change and the necessity of the green transformation to deliver social and economic prosperity to the Kingdom. Saudi Arabia’s ambition to reach net zero emissions aligns with the Kingdom’s economic diversification and development plans and the "Dynamic Baseline" for emissions reduction.

The transition to net zero carbon emissions will be delivered in a manner that preserves the Kingdom's leading role in enhancing the security and stability of global energy markets, particularly considering the maturity and availability of technologies necessary to manage and reduce emissions. For example the Kingdom will plant 450 million trees and rehabilitate 8 million hectares of degraded lands by 2030, reducing 200 million tons of carbon emissions with additional initiatives to be announced in the years to come. The transformation of Riyadh into one of the world’s most sustainable cities is already underway, with an extensive set of sustainability solutions that will be outlined at the Saudi Green Initiative Forum.

Spain

Public RD&D Data

Spain's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	14.5	24.7	7.3	213.7	-
CCS	0.1	0.1	0.1	6.1	-
Renewables	73.9	60.1	52.3	95.5	-
Nuclear	1.1	1.6	8.8	120.9	-
Hydrogen and fuel cells	5.1	11.7	9.6	152.0	-
Other power and storage technologies	20.4	12.6	14.1	85.8	-
Other cross-cutting technologies/research	1.3	0.3	-	-	-
Unallocated	1.1	0.6	53.4	-	-
Total Budget	117.5	111.6	145.6	673.9	-

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

In **Spain**, there are mainly two Ministries that finance R&D&i in clean energy: The Ministry of Science and Innovation (**MICIN**) and the Ministry for the Ecological Transition and the Demographic Challenge (**MITERD or MITECO**) through their financing agencies and attached organizations. Among the latter it is worth highlighting: **CDTI** (MICIN); **AEI** (MICIN); **IDAE** (MITERD). In addition to MICIN and MITERD, other ministries also finance innovation programs related to the decarbonization of their sectors based on the energy transition, such as **MITMA** (Ministry of Transport, Mobility and Urban Agenda) or **MINCOTUR** (Ministry of Industry and Tourism).

The **CDTI** finances R&D&I business projects of all sectors, including energy, which are largely oriented towards clean and renewable energies. Traditionally, CDTI programs follow a bottom-up policy: the CDTI does not set up specific quotas, but rather approves quality projects, regardless of the sector or technology. Along with these programs, there have been some verticalized programs since 2019 in which the CDTI does determine sectors or areas of activity of special interest for which it offers particularly intense support.

The State Research Agency (**AEI)** has as its mission the promotion of scientific and technical research in all areas of knowledge, including energy. Its financing actions include subsidies for R&D and support for public-private collaboration.

The Institute for Energy Diversification and Saving (**IDAE**) has a very relevant role in the management of aid related to the Strategic Project for the Recovery and Economic Transformation of Renewable Energy, Renewable Hydrogen and Storage (PERTE-ERHA), which will mobilize an investment of more than 16.3 billion euros, between contributions from the Recovery, Transformation and Resilience Plan (PRTR) -Funded by the European Union by Next Generation EU- and private funds. In addition, the IDAE manages public aid for the development of programs and projects to promote energy efficiency and deployment of renewable energies in the main energy consuming sectors.

Among the Organizations, Entities and Public Research Centres, in the field of energy and climate, the activities of the Centres for Energy, Environmental and Technological Research (CIEMAT), the State Agency of the Higher Council for Scientific Research (CSIC), stand out. the National Centres for Renewable Energies (CENER), the Iberian Centres for Research on Energy Storage (CIIAE), the National Hydrogen Centres (CNH2) or the Centres for the Control of Renewable Energies (CECRE) of Red Eléctrica de España (REE), in addition to other regional research centres, universities and technological networks, which focus on the execution of R&D&i programs.

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
"TransMisiones" 2023 - R&D&i projects in strategic lines (Financing through the **AEI**)	(b) Grants / Subsidies	60 M€	Green transition, including the energy transition, and the fight against climate change and its consequences.	(Application deadlines : 03/07/2023 - 28/07/2023) Project duration: 1/1/2024 (+ 3 or 4 years)	Industrial research projects, experimental development or a combination of both (Trans-Misiones Program is managed in coordination between CDTI & AEI)	
"TransMisiones" 2022 & 2023- Science and Innovation Missions (Financing through the **CDTI**)	(b) Grant	125 M€ (2022); 70 M€ (2023)	Various technologies. Most of them linked to energy transition, sustainability and clean and renewable energy	Call in second semester of the year. Projects of 3 years	Large industrial development business projects carried out by consortia and aimed to the resolution of major Spanish challenges in areas proposed by the CDTI.	https://www.cdti.es/ayudas/misiones-ciencia-e-innovacion
PID2021 - **Knowledge Generation Projects** (Financing through the AEI)	(b) Grants / (f) Refundable advance	10.5 M€ (for Energy)	Energy: electric / smart grids, H2, PV, solar thermal, bioenergy, energy efficiency, nuclear (mainly fusion), storage, wind. CO2 capture, EERR hybridization and low temperature solar.	1/9/2022 to 31/8/2023 (3 or 4 years)	Generation of quality scientific and technological knowledge.	Proyectos de Generación de Conocimiento 2021 | Agencia Estatal de Investigación (aei.gob.es)
TED2021 – **Ecological and Digital Transitions Projects** (Financing through the AEI)	(b) Grants / Subsidies (charged to Next Generation EU)	22.7 M€ (for Energy)	Decarbonization, energy efficiency, renewable energy, electrification of the economy, development of energy storage. Digital technologies as support for the urban agenda, industry, mobility, etc.	1/12/2022 to 30/11/2024	R&D&i activities in order to increase the competitiveness and international leadership of Spanish science and technology. Strategic projects aimed at the ecological transition and the digital transition	«Proyectos Estratégicos Orientados a la Transición Ecológica y a la Transición Digital» 2021 | Agencia Estatal de Investigación (aei.gob.es)
PDC2021 & PDC2022 - **Proof of Concept Projects 2021 & 2022** (Financing through the AEI)	(b) Grants / Subsidy charged to Next Generation EU	2.9 M€ (for Energy, total in PDC2021 + PDC2022)	Energy: bioenergy, storage, PV, electrical networks, geothermal, hybridization, nuclear, low temperature solar, solar thermal.	PDC2021: 1/12/2021 – 30/11/2023 PDC2022: 1/12/2022 – 30/11/2024	Promote the first stages of precompetitive development and facilitate its practical application. Development, valorization, protection, transfer and exploitation of research results	Proyectos I+D+i «Pruebas de Concepto» 2021 | Agencia Estatal de Investigación (aei.gob.es) Proyectos de «Prueba de Concepto» 2022 | Agencia Estatal de Investigación (aei.gob.es)

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
PLE2021 & PLE2022 - **R&D&i projects in strategic lines, in public-private collaboration 2021 & 2022** (Financing through the AEI)	(b) Grants / Subsidies (charged to Next Generation EU) (f) Loans	18.9M€ (13.2 subsidies & 5.7 M€ loans) (total for Energy in PLE2021 + PLE2022)	Sustainable fuels; capture, storage and recovery of CO2; new generation of batteries; efficient conversion of sunlight to fuels and chemicals; smart building technologies; development and integration of PV applications: agroPV and floating solar; energy storage …	PLE2021: 1/7/2021 – 30/6/2024 PLE2022: 1/7/2022 – 30/6/2025	Research to reduce energy consumption and greenhouse gas emissions in industry	Proyectos de I+D+i en líneas estratégicas, en colaboración público-privada 2021 | Agencia Estatal de Investigación (aei.gob.es) Proyectos de I+D+i en líneas estratégicas 2022 | Agencia Estatal de Investigación (aei.gob.es)
CPP2021 - **Projects in public-private collaboration 2021** (Financing through the AEI)	(b) Grants / Subsidies charged to Next Generation EU (f) Loans	15.4 M€ (9.4 Subsidies & 6 M€ in Loans) (total for Energy	Energy: H2, energy efficiency, wind, PV, electrical networks, solar thermal, storage, marine energy, hydroelectric.	1/4/2022 - 31/3/2025	Innovative experimental development in collaboration and with results close to the market.	Proyectos en colaboración público-privada 2021 | Agencia Estatal de Investigación (aei.gob.es)
PTR2022 - **Aids to Technological and Innovation Platforms 2022** (Financing through the AEI)	(b) Grants / Subsidy (c) Operational funding	1.5 M€ (for Energy)	Energy: H2 and fuel cells, wind, CO2, electrical networks, PV, biomass for the bio economy, energy efficiency, geothermal, concentrated solar thermal, low temperature solar thermal, energy storage.	1/1/2023 – 31/12/2024	Teamwork forums, led by the industry, that integrate all the agents of the Science-Technology-Innovation system (companies, technology Centress, public research organizations, universities, R&D Centress, associations, foundations, etc..) that contribute to defining the short, medium and long-term vision of the sector and establishing a strategic route in R&D&I.	Ayudas a Plataformas Tecnológicas y de Innovación 2022 | Agencia Estatal de Investigación (aei.gob.es)
Royal Decree 568/2022 - **General framework of the regulatory test bed for the promotion of R&I in the Electricity Sector**	(l) Other: regulatory sandbox	0 M€ (funding may be obtained via the TED/1359/2022 from CDTI)	Electricity sector	12/07/2022	Establishment of the general framework of the regulatory test bed for the promotion of research and innovation in the electricity sector	BOE-A-2022-11511 Real Decreto 568/2022, de 11 de julio, por el que se establece el marco general del banco de pruebas regulatorio para el fomento de la investigación y la innovación en el sector eléctrico.

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Order TED/567/2023 - **Access to the regulatory test bed to promote research and innovation in the electricity sector**	(l) Other: regulatory sandbox	0 M€ (funding may be obtained via the TED/1359/2022 from CDTI)	Electricity sector	6/06/2023	Access to the regulatory test bed for the promotion of research and innovation in the electricity sector Access of innovative pilot projects to the regulatory sandbox of the electricity sector, with the final objective of achieving a regulatory innovation.	BOE-A-2023-13525 Orden TED/567/2023, de 31 de mayo, por la que se convoca el acceso al banco de pruebas regulatorio para el fomento de la investigación y la innovación en el sector eléctrico, previsto en el Real Decreto 568/2022, de 11 de julio.
RD 477/2021- **Direct granting to the autonomous communities and the cities of Ceuta and Melilla of aid for the implementation of various Incentive Programmes,** (within the framework of the PRTR) (Financing through the IDAE)	(e) Investment (b) aid	1500 M€	Self-consumption and energy storage with renewable energy sources, as well as the implementation of renewable thermal systems in the residential sector	30/6/21 – 31/12/2023	**Incentive Programme 1:** Implementation of self-consumption installations, with renewable energy sources, in the services sector, with or without storage; **Incentive Programme 2:** Implementation of self-consumption installations, with renewable energy sources, in other productive sectors of the economy, with or without storage. Incentive Programme 3: Incorporation of storage in self-consumption installations, with renewable energy sources, already existing in the services sector and other productive sectors; **Incentive Programme 4:** Implementation of self-consumption installations, with renewable energy sources, in the residential sector, public administrations and the third sector, with or without storage; **Incentive Programme 5:** Incorporation of storage in self-consumption installations, with renewable energy sources, already existing in the residential sector, public administrations and the third sector; **Incentive Programme 6:** Implementation of thermal renewable energy installations in the residential sector.	https://www.boe.es/buscar/doc.php?id=BOE-A-2021-10824 https://www.idae.es/ayudas-y-financiacion/para-energias-renovables-en-autoconsumo-almacenamiento-y-termicas-sector/ampliaciones-de-presupuesto-real-decreto-4772021-de-29-de-junio#:~:text=El%20presupuesto%20inicial%20del%20RD,1.480.187.915%2C35%20%E2%82%AC.
Order TED/1447/2021 - **Innovative energy storage R&D projects** (within the framework of the PRTR Plan, financed	(e) Investment (b) aid	50 M€	Innovative energy storage. Technology neutral; any technology will be eligible, as long as it is at the required level of technological maturity.	(submission period) 08/03/2022 – 10/05/2022	Energy storage R&D projects that have a pre-commercial technology maturity level, measured as TRL, between level 6 and 8, and that, once the project is completed, reach TRL 9. The projects must be scalable, and therefore have a minimum power of 1 MW or a capacity	https://www.boe.es/diario_boe/txt.php?id=BOE-A-2021-21344

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
by the NextGenerationEU) (Financing through the IDAE)					of 1 MWh. Storage systems must be connected to the grid for operation after project completion.	
Order TED/1071/2022 - **Circular Repowering Programs** Implementation of various incentive programmes (Framework of PRTR Plan, financed by the NextGenerationEU) (Financing through the IDAE)	(e) Investment (b) aid	222.5 M€	Wind farms, mini-Hydroelectric plants of up to 10 MW and in innovative wind turbine blade recycling facilities.	(submission period) 17/01/2023 – 10/03/2023	**Programme 1:** Repowering of wind farms. For the purposes of these regulatory bases, the name of these facilities will be "generation facility". Programme 1 actions may include the addition of hybrid storage. **Programme 2:** Technological and environmental renovation of mini-hydroelectric plants of up to 10 MW. The name of these facilities for the purposes of these regulatory bases will be "generation facility". Programme 2 actions may include the addition of hybrid storage. **Programme 3**: Innovative wind turbine blade recycling facilities. The name of these facilities for the purposes of these regulatory bases shall be "recycling facility".	https://www.boe.es/buscar/doc.php?id=BOE-A-2022-18449
Order TED/1177/2022 - **Innovative hybrid energy storage projects** (Framework of PRTR Plan, financed by the NextGenerationEU) (Financing through the IDAE)	(e) Investment (b) aid	150 M€	Hybrid energy storage with electrical energy generation facilities from renewable energy sources .	(submission period) 18/01/2023 – 21/003/2023	Energy storage projects hybridised with electricity generation facilities from renewable energy sources located in the national territory, with the exception of hydrogen storage projects. Principle of technological neutrality, all energy storage projects that enable the large-scale commercial deployment of energy storage, without being large-scale commercial deployment of energy storage	https://www.boe.es/diario_boe/txt.php?id=BOE-A-2022-20160
Order TED/807/2023 - **Innovative energy storage projects** (Implementation of two aid programmes)	(e) Investment (b) aid	150 M€ standalone storage 30 M€ thermal storage	Innovative energy storage projects (Electrical, thermal, mechanical, electrochemical, electrochemical)	(submission period) 18/09/2023 – 31/10/2023	**Aid line 1:** independent or "stand-alone" electrical storage projects, throughout the national territory, connected to the electricity transmission or distribution networks. **Aid line 2:** projects for thermal storage using sensible, latent or thermochemical heat, provided that the storage is directly connected to a renewable energy production facility. The stored energy	https://www.boe.es/buscar/doc.php?id=BOE-A-2023-16708

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
(Framework of PRTR Plan, financed by the NextGenerationEU) (Financing through the IDAE)					shall be converted into thermal energy for final use.	
Order TED/807/2023 - **Innovative energy storage projects** (Framework of PRTR Plan, financed by the NextGenerationEU) (Financing through the IDAE)	(e) Investment (b) aid	100M€	Pumped hydro projects (Mechanical)	(submission period) 20/09/2023 – 03/11/2023	Energy storage projects using reversible pumped hydro storage (reversible hydroelectric power plants), throughout the national territory connected to the electricity transmission or distribution networks, and which involve adding power and storage capacity to the Spanish energy system, Eligible projects may be either a new reversible hydroelectric plant or the extension of an existing one	https://www.boe.es/buscar/doc.php?id=BOE-A-2023-16708
PERTE ERHA – Strategic Project for the Recovery and Economic Transformation of Renewable Energy, Renewable Hydrogen and Storage (Framework of PRTR Plan, financed by the NextGenerationEU) (Financing through the MITERD)	(f) Loans, (b) grants or both	3 550 M€ (Of public funds to mobilize a total investment. of 16 300 M€)	Renewable Energy, Renewable Hydrogen, Storage	Approved: 14/12/2021-the bulk of the aid lines and actions will be available between 2022 and 2023, and the beneficiary projects will be executed until 2026	25 transformative measures aimed at the development of technology, industrial capabilities, new business models and their implementation in the country's productive fabric	https://planderecuperacion.gob.es/como-acceder-a-los-fondos/pertes/perte-de-energias-renovables-hidrogeno-renovable-y-almacenamient
H2 PIONEROS Program - Incentive program for pioneering and unique renewable hydrogen projects	(b) Grants	1rst call (2022): 150 M€	Renewable H2	submission period: **1rst Call:** 7/3/2022 - 6/5/2022	**1rst call -** Pioneering and unique renewable hydrogen projects on: the installation of electrolysers and auxiliary systems,	1st Call: Programa H2 Pioneros. Ayudas para proyectos pioneros y singulares de hidrógeno renovable | Idae; 2nd Call:

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
1rst Call: 2022 **2nd Call: 2023** (within PERTE - ERHA In the framework of PRTR Plan, financed by the NextGenerationEU) (Financing through the IDAE)		2nd call (2023): 150 M€		**2nd Call:** 1/6/2023 - 31/7/2023 (projects completion: 36 months)	the renewable installations (in the case of dedicated installations) necessary for the production of renewable hydrogen, the facilities and equipment for compression, transportation and storage that are part of the logistics infrastructure necessary to deliver the production of renewable hydrogen from the location of the electrolyser to the consumers foreseen in the project. **2nd call** Pioneering renewable hydrogen projects, with commercial viability, for local production and consumption in sectors that are difficult to decarbonize, such as industry or heavy transportation. The actions to be financed must have a minimum installed electrolysis power of 0.5 MW and a maximum of 50 MW (compared to the 20 MW of the first call), with the minimum investment per project being €1,000,000.	https://sede.idae.gob.es/lang/modulo/?refbol=tramites-servicios&refsec=programa-h2-pioneros&refsec=programa-h2-pioneros&idarticulo=146985
Order TED/1359/2022 - **New business models for the energy transition** (Within PERTE-ERHA. Framework of PRTR Plan, financed by the NextGenerationEU) (Financing through the IDAE)	(b) Grants	156 M€	All energy sectors	(submission period:) 12/06/2023-01/08/2023	The projects must be framed in one of the three different lines of aid: Innovation in energy transition; Decarbonization of the energy sector and improvement of the integration of renewable energies; Startups for the energy transition	Convocatoria de ayudas para proyectos de Nuevos Modelos de Negocio en la Transición energética
PERTE of Industrial Decarbonization **(Strategic Project for the Recovery and Economic Transformation –**	(f) Loans, (b) grants or both	3 100 M€ (of public subventions: to mobilize a total investment of 11 800 M€)	Decarbonization of energy sources with the electrification of processes and the incorporation of hydrogen; Reducing natural resource use Carbon capture	2023 to 2026 (to carry out the planned actions)	Main objectives: 1. Decarbonization of production processes, allowing the viability of industries in the medium and long term. 2. Improvement of energy efficiency, through the incorporation of the best available technologies in industries and implementation of energy management systems.	https://planderecuperacion.gob.es/como-acceder-a-los-fondos/pertes/perte-de-descarbonizacion-industrial Descriptive Memory: Industrial decarbonization PERTE

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Industrial Decarbonization) (Within framework of PRTR Plan, financed by the NextGenerationEU) (component 12)					3. Improve the competitiveness of the manufacturing sector. 4. Promote energy security in Spain. 5. Promote the use of renewable energies. 6. Promote the improvement of the environment by supporting the use of by-products and the recovery of waste to integrate them into other processes and thus reduce the environmental impact of products throughout their life cycle. 7. Creation of high added value employment.	
Royal Decree 251/2023 - **Direct granting of subsidies to the company ArcelorMittal España S.A. for the execution of the DRI Circular Hydrogen project** (within PERTE of industrial decarbonization in the framework of the PRTR (component 12)	(b) grants/ Subsidy,	450 M€	Replace the use of fossil fuels, such as coal and natural gas, with hydrogen of renewable origin from electrolysers for the manufacture of steel in furnaces	4/4/2023 - The planned actions will be carried out between 2023 and 2026, although the projects could end later.	Foster the development of the industrial hydrogen value chain and achieve decarbonization objectives. Direct granting of a subsidy to ArcelorMittal España, SA, for the execution of the "DRI circular hydrogen" project within the framework of the "IPCEI of hydrogen" in the IPCEI Hy2Use theme, aimed at the decarbonization of the industry through the use of clean hydrogen	Real Decreto 251/2023, de 4 de abril, por el que se regula la concesión directa de subvenciones a la empresa ArcelorMittal España S.A. para la ejecución del proyecto Hidrógeno circular DRI, en el marco del Plan de Recuperación, Transformación y Resiliencia.
PERTE for the Naval Industry **(Strategic Project for the Recovery and Economic Transformation on Naval Industry)** (Within the PRTR (component 12, «Industrial Policy Spain 2030»)	(f) Loans, (b) grants or both	310 M€ (of public funds to mobilize a total of 1 460 M€ with 1150 M€ of private investment)	Iintegration and transformation actions of the industrial value chain of the naval sector Research and innovation processes, technology transfer and cooperation between companies, with special emphasis on the circular economy. Energy efficiency and demonstration projects in large companies and SMEs and support measures.		Design or development of processes, organization, adaptation of construction infrastructure, equipment, components, systems or prototypes for the use of marine renewable energy, including parks for the generation of marine renewable energy or for the generation of renewable hydrogen at sea. Design or development of ships and advanced naval propulsion systems that use, to varying degrees, fuels from renewable sources and that represent a significant improvement from an environmental point of view.	https://www.boe.es/diario_boe/txt.php?id=BOE-A-2022-12898 https://planderecuperacion.gob.es/como-acceder-a-los-fondos/pertes/perte-para-la-industria-naval

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
					Design of a collaborative industrial model that allows the development of parks for the generation of marine renewable energy. Automation, sensorization, communication, robotization and artificial intelligence of processes. Design or development of unmanned systems. Advanced manufacturing and Industry 4.0 technologies such as 3D printing, digital twins, IoT, blockchain and virtual, augmented and mixed reality technologies, among others Development of circular economy solutions. Reduction of environmental impact in aspects such as ecodesign, reuse, waste reduction and pollution reduction. Improvement of energy efficiency in processes or products.	
Order ICT/739/2022 & Order ICT/149/2023 **Call 2023 of the PERTE for the Naval Industry** (Strategic Project for the Recovery and Economic Transformation for the Naval Industry) (Within the PRTR (component 12, «Industrial Policy Spain 2030»)	(f) Loans, (b) grants or both	190 M€ (120 M€ in subsidies and 70 M€ in loans) (extendable by 40 M€)	Integration and transformation actions of the industrial value chain of the naval sector Research and innovation processes, technology transfer and cooperation between companies, with special emphasis on the circular economy. Energy efficiency and demonstration projects in large companies and SMEs and support measures.	21/12/2022 – 30/6/2025, (maximum project duration: 30 months)	Lines of action: 1. Line of research, development and innovation. Industrial research projects, experimental development, innovation projects in terms of organization and processes, and feasibility studies 2. Line of innovation in sustainability and energy efficiency: a) Innovative investments aimed at protecting the environment. b) Innovative investments in energy saving or energy efficiency measures. 3. Line of regional investment aid	Order ICT/1306/2022, of December 21 (BOE 12/29/2022), which modifies Order ICT/739/2022, of July 28, which establishes the regulatory bases and carries out the call through advance processing corresponding to the year 2023. **Modification and correction of errors in Order ICT/1306/2022:** Order ICT/149/2023, of February 19 (BOE 02/22/2023), which modifies and corrects errors in Order ICT/1306/2022, of December 21, which modifies the Order ICT/739/2022, of July 28, which establishes the regulatory bases, and the call is made through

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
						advance processing corresponding to the year 2023.
PERTE VEC- Strategic Project for the Recovery and Economic Transformation for the development of Electric and Connected Vehicles (Framework of PRTR Plan, financed by the NextGenerationEU) (Financing through the MITERD & MITMA)	(f) Loans, (b) grants or both	4300 M€ (contribution from the public sector to mobilize a total investment of more than 24 000 M€)	electrification of mobility	in the period 2021-2023	Comprehensive initiative on the industrial value chain of electric and connected vehicles. Measures to boost the electric and connected vehicle value chain to guarantee the manufacturing of the VEC (new VEC manufacturing lines and/or adaptation of existing ones incorporating digitalization and new technologies. National manufacturing of lithium batteries, the electrical power system, the power train. Manufacturing of other essential and highly technological components of the VEC, etc. .). Facilitating measures to create new mobility.	https://planderecuperacion.gob.es/como-acceder-a-los-fondos/pertes/perte-del-vehiculo-electrico-y-conectado
Granting aid to projects to promote the **Industrial Value Chain of the Electric and Connected Vehicle** Regulatory Bases: Order ICT/359/2022 & Order ICT/736/2023 **Call 2022:** Order ICT/209/2022 **Call 2023:** Order ICT/736/2023 (within the PERTE VEC - Strategic Project for Economic Recovery and Transformation in the Electric and Connected Vehicle sector)	(f) Loans, (b) grants or both	**Call 2022:** 1 550 M€ (Grants)+ 1 425 M€ (Loans) **Call 2023** (Section A : Electric Vehicle batteries): 550 M€ (grants) + 287 M€ (loans) (Section B: The rest of the industrial value chain of the electric	Electric Vehicles Batteries, Components, parts and accessories for vehicles and certain auxiliary infrastructure systems necessary for EV deployment	**Call 2022:** April 2022 – 30 Jun 2025 **Call 2023:** (submission period) 16/8/2023-15/9/2023. (project duration 30 months) - Until Sept. 2025	**Call 2022:** Comprehensive actions of the electric and connected vehicle industrial chain. In the line of R&D&i: **a)** Industrial research projects; **b)** experimental development projects; **c)** innovation projects in organizational matters; **d** innovation projects regarding processes; **e)** feasibility studies prior to industrial research. In the line of innovation in sustainability and energy efficiency: a) Innovative investments aimed at protecting the environment, b) innovative investments aimed at energy saving or energy efficiency measures. In the line of training aid: projects that are linked to the Comprehensive training plan in management skills, digitalization and generation of innovative ecosystems in the electric and connected vehicle value chain **Call 2023** **(Section A**: Production of electric vehicle batteries, their essential components and the production or recovery of necessary fundamental raw materials. Aid for investment	**Regulatory bases** (Apr 2022): Order ICT/426/2022, of May 13 (BOE 05/14/2022), which modifies Order ICT/209/2022, of March 17, by which its call for 2022 is made, and is modified Order ICT/1466/2021, of December 23, which establishes the regulatory bases **Call 2022:** Order ICT/209/2022, of March 17 (BOE 03/18/2022) by which the call corresponding to the year 2022 is made and the Order ICT/1466/2021, of December 23, by which establish the regulatory bases **Call 2023 (Section A):** Order ICT/736/2023, of July 5, which establishes the regulatory bases and the call for aid for electric vehicle

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
(Funds charged to the PRTR - Next Generation EU, Component 17) (Financing through MITERD and MITMA)		and connected vehicle): 344.4 M€ (Grants) + 215.2 M€ (loans)			plans in the industrial chain of the electric and connected vehicle, innovative in the value chain of the electric and connected vehicle. **section B:** The rest of the industrial value chain of the electric and connected vehicle, its systems, subsystems and components, and certain auxiliary infrastructure systems necessary for its deployment, such as: Manufacture of textile fabrics, electronic components , printed circuits and other electrical material and equipment; Production of precious metals and other non-ferrous metals; Manufacture of electric motors, generators and transformers, etc…	battery production projects for the year 2023. **(Section B):** Order by which the call for granting aid is made projects to promote the electric vehicle value chain and connected (VEC). (Section B)
Order TED/1444/2021 – **Aids to the Innovative Value Chain of Renewable Hydrogen** Four Incentive Programs (within PERTE - ERHA In the framework of PRTR Plan, financed by the NextGenerationEU) (Financing through the IDAE)	(b) Grants	Program 1: 30 M€ Program 2: 80 M€ Program 3: 100 M€ Program 4: 66.6 M€	Renewable H2	(submission period) Programs 1, 2 & 3 : 8/4/2022 - 7/6/2022 Program 4: 8/9/2023 to 7/11/2023 (projects completion: 36 months)	**Incentive Program 1**: capabilities, technological advances and implementation of testing and/or manufacturing lines" included in the incentive programs for the innovative value chain and knowledge of renewable hydrogen. **Incentive Program 2:** design, demonstration and validation of hydrogen-powered mobility. Innovation projects with the aim of promoting prototypes and advancing the maturity of the designs of new vehicles powered by renewable hydrogen as well as the different equipment that is integrated into said vehicles. **Incentive Program 3:** Large electrolysis demonstrators, innovative renewable hydrogen production project. **Subprogram 3 a)** for the development and manufacture of a large electrolyser, a first prototype that includes elements of progress with respect to the current state of the art. **Subprogram 3 b)** for real and effective integration of a large electrolyser in an industrial operating context, **Incentive Program 4**: Challenges of basic-fundamental research, innovative pilots and training in key enabling technologies within the value chain	Incentive Program 1: https://www.idae.es/ayudas-y-financiacion/programas-de-ayuda-la-cadena-de-valor-innovadora-del-hidrogeno-renovable-en Incentive Program 2: https://www.idae.es/sites/default/files/documentos/ayudas_y_financiacion/H2_Cadena-de-valor_PRTR/Resolucion%20SEE%20convocatoria%20H2%20cadena%20de%20valor%20P2%20(1).pdf Incentive Program 3: https://www.infosubvenciones.es/bdnstrans/GE/es/convocatoria/611288# Incentive Program 4: https://sede.idae.gob.es/lang/extras/tramites-servicios/2023/CADENA_DE_VALOR_H2/20230713_Resolucion_convocatoria_P4_retos_investigacion_ba.pdf

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Royal Decree 4/2023 - **IPCEI (Important Project of Common European Interest) - Hy2Tech** (Component 9 - Framework of PRTR Plan, financed by the NextGenerationEU) (Financing through the IDAE)	(b) Grants	74 M€	Renewable H2	(submission period) 1/2/2023 to 1/3/2023	Development of innovative technologies to produce renewable and low-carbon hydrogen through electrolysis, pyrogasification or other processes; as well as the promotion of the use of hydrogen in fuel cells for mobile or stationary applications; and/or to the storage, transportation, distribution and final application of hydrogen in industry and transportation. Direct granting of subsidies to Spanish projects for their participation in the IPCEI-Hy2Tech (common project formed between 15 EU Member States to promote the advancement of technology in the creation of a European hydrogen value chain).	https://www.idae.es/ayudas-y-financiacion/programa-piice-hy2tech
Complementary Plan for Renewable Energy and Hydrogen (R&D&I financing coordination plan between 10 state public organizations: MICIN, CSIC and 8 Regional Governments) (Funds charged to the PRTR - Next Generation EU, Component 17)	(b) Grants / Subsidy	92 M€	Renewable Hydrogen and Renewable Biofuel	29/7/20221 + 6 years	**LA-1:** Low-temperature generation of green hydrogen from renewable energy; **LA-2:** Low-temperature generation of green hydrogen from off-shore wind power; **LA-3**: High-temperature generation of hydrogen from renewable energy using residual heaters; **LA-4**: Hydrogen and biomethane generation from biomass; **LA-5:** Generation of biofuels from hydrogen and CO2; **LA-6:** Development of systems for pressurised storage and supply of green hydrogen; **LA-7:** Uses of hydrogen in heavy transport, aviation and maritime sectors; **LA-8:** Uses of hydrogen in the industrial combustion sector; **LA-9:** Uses of hydrogen in the industrial and domestic sectors using fuel batteries; **LA-10:** Uses of hydrogen in the industrial sector to reduce CO2 emissions and as a chemical agent;; **LA-11**: Technical and economic studies and market launch of utility models. Dissemination, education and training activities. **LA-12:** General project coordination; **LA-13**: Commissioning of the National Energy Storage Research Centre.	https://www.ciencia.gob.es/InfoGeneralPortal/documento/4508c426-797e-4f75-88e9-e58eb5d74dbf

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Aeronautical Technological Program, (PTA) **Calls PTA 2022 & PTA2023** (Component 9 - Framework of PRTR Plan, financed by the NextGenerationEU) (Financing through the CDTI)	(b) Grant	80 M€ (PTA 2022); 41.7 M€ (PTA 2023).	Technologies focused on reducing emissions: zero-emission aircraft (PTA includes other aeronautical technologies not linked to energy) Development of technologies focused on the challenge of achieving solutions in the medium-long term that provide a considerable or total reduction in polluting emissions from air traffic.	**PTA 2022 call:** 1/1/2023 – 30/6/2025 **PTA 2023 call:** X-30/6/2025 max (Maximum duration of projects: 3 years)	R&D aerospace business projects aimed at achieving low and zero emissions and responding to the new challenges of the sector such as climate change, global security and digital transition The R&D lines include: 1.1 New propulsion systems. 1.2 Comprehensive optimization of the generation, distribution and storage of non-propulsive energy. 1.3 Technologies that promote the incorporation of systems that allow a more electric aircraft. 1.4 Innovative developments in aero structures. 1.5 Development of new aerodynamic calculation and optimization tools. 1.6 New advanced materials. 1.7 Research of new technologies and demonstrators of on-board systems for the use of hydrogen in aircraft.	https://www.cdti.es/ayudas/programa-tecnologico-aeronautico-pta 2022 call 2023 call
ACTIVA Financing - Grants for the Connected Industry 4.0 initiative	(f) Loans, (b) grants	140 M€ (2022 call): + 30 M€ (2023 call)	Digital transformation of the industry	**2022 call:** 24 month duration **2023 call:** 24 month duration	Grants for research and development projects, as well as innovation projects in terms of organisation and processes that contribute to the digital transformation of industrial Thematic priorities: 1. Platforms for interconnecting the company's value chain; 2. Solutions for advanced data processing; 3. Artificial intelligence solutions; 4. Industrial simulation projects; 5. Additive Design and Manufacturing 6. Augmented reality, virtual reality, and computer vision projects; 7. Collaborative and cognitive robotics; 8. Sensors.	2022 Call 2023 Call

*The following typology is recommended for consistency across respondents: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.
**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

- The recent update (June 2023) of the National Energy and Climate Plan (NECP/PNIEC) has increased the ambition in climate and energy objectives for 2030 (32% reduction in GHG emissions compared to 1990; a weight of renewables of 48% of final energy consumption, reaching 81 % of electricity; an improvement in energy efficiency up to 44% and increase from 4 to 11 GW of electrolysis power to be installed) and is aligned with the increase in European and national technological autonomy in clean energy.
- During this year, Spain has continued to implement Strategic Projects for Economic Recovery and Transformation, PERTE, (using European aid packages such as Next Generation EU and RePowerEU), with strong traction in technological innovation. In particular, the PERTE-ERHA for Renewable Energy, Hydrogen and Storage (which will mobilize an investment of around 16.3 billion euros to maximizing economic, industrial, labour, innovation and involvement opportunities for citizens and SMEs) includes specific aid programs to promote innovation in these sectors and is helping to accelerate the energy transition projected in the NECP /PNIEC.
- Hydrogen valleys have been identified as suitable public-private ecosystems to promote the development and deployment of hydrogen technologies. Current initiatives in Spain include: 7 Hydrogen Valleys; 4 H2 corridors (either national or transnational) and 2 Clusters; with more than 120 projects ,that cover the entire value chain of this energy vector, in different phases of development and projected investments exceeding 21,000 million €

Contribution to Mission Innovation work programme in 2022/23

Spain's formal adhesion to Mission Innovation took place during the 7th Ministerial meeting in September 2022, initially joining the missions on Clean Hydrogen (CHM) and Green Powered Future (GPFM) and, shortly after, in the Urban Transitions Mission (UTM).

This first year of membership in MI has served to verify the alignment of sectoral developments and national innovation programs with the 2022-2024 priorities identified in the Action Plans of the three missions in which Spain participates and to strengthen collaboration and coordination between national agents (public and private) that incentivize innovation in technologies for energy transition (such as MICIN, MITERD, MITMA or the National Energy Technology Platforms, PTEs).

GPFM:

- In GPFM the Spanish representatives, in collaboration with the national technological platforms in the energy field, have identified more than 20 projects (on-going or planned) fully aligned with the innovation priorities identified by the mission that have been included in the deliverable "Flagship Project 1: 5 Demos in Five Continents NATIONAL PILOTS REPORT" and, together with Italy, have been leading Task Force II for the identification and monitoring of pilot projects in the European area

CHM:

The commitment assumed by Spain´s national representatives in this initial year of participation in CHM has focused on supporting Pillar 2 of the Action Plan in its two sprints:

- In Sprint 1 the H2V platform already incorporates 5 Spanish hydrogen valleys, but additional hydrogen valleys have already been identified in Spain, with the aim of incorporating them into the platform in the 2023-2024 horizons.
- In Sprint 2 (Support for the Hydrogen Exchange of non-MI countries to develop Hydrogen Valleys) 5 workshops have been scheduled that range from the definition of roadmaps, to the development of skills or procedures of financing, aimed at representatives of the public administration in decision-making in Latin America, with representatives from Spain as speakers.

UTM:

- Seven Spanish cities (out of a total of 112 in Europe) have been selected by the EC to be part of the European Mission for Smart and Climate Neutral Cities: Madrid, Barcelona, Valencia, Sevilla, Zaragoza, Valladolid, Vitoria-Gasteiz.
- In March 2023, Spain launched the “citiES 2030” platform, as part of the NetZeroCities project, to complement and expand to more Spanish municipalities the work of the European Mission on Climate Neutral and Smart Cities coordinated by the European Commission within the framework of the Horizon Europe program. The main beneficiaries of the platform will be the City Councils of Spanish cities with more than 50,000 inhabitants or provincial capitals that have the desire to achieve climate neutrality in whole or in part by 2030.

International clean energy collaborations in 2022/23

See Annex A, page 165.

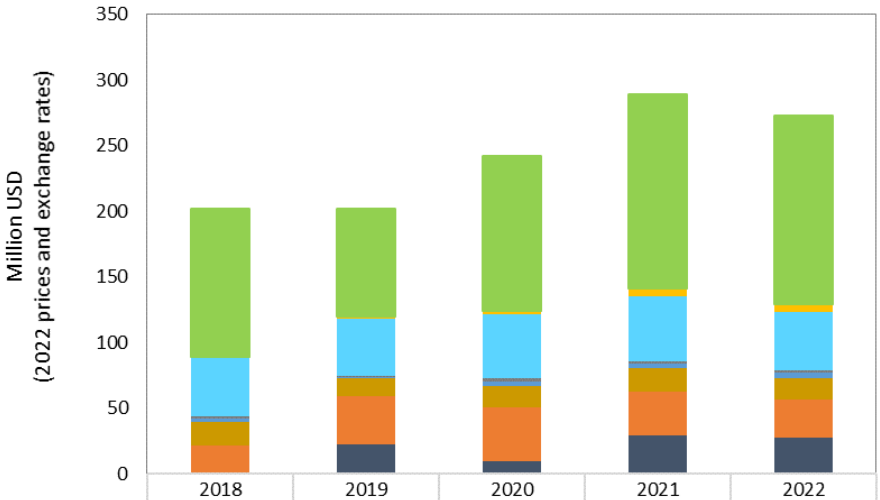
Other clean energy innovation activities in 2022/23

- During 2022 the CDTI approved 188 R&D and innovation business operations in the area of renewable and clean energies with a total budget of 151.3 M€ and a CDTI support of 106 M€ (credits and grants), a sharp increase compared to previous years.
- As of December 2022, Innvierte Coinversión had homologated 9 investment investors in energy and environment, in 2021 began the joint investments and as of December 2022, the total investment made by Innvierte Coinversión in energy and environment was 8.8 million euros in a portfolio of 6 companies. (Innvierte Coinversión ia a Public-private venture capital programme for technology-based companies that covers several areas and among them, energy and environment).
- The joint CDTI and AEI "Trans-missions" program to support R&D&I for renewable and clean energy projects financed, in 2022, 110 R&D business operations with a total investment of 82.7 M€ and CDTI support of 56.1 M€, which represents more than half of the CDTI's support in the matter.
- In January 2023, the Alliance for the use of hydrogen in aviation (AH2A) was founded, which incorporates the Ministry of Transport, Mobility and Urban Agenda (MITMA), the Spanish association of petroleum products operators, the Association of Airlines, the National Hydrogen Centres, the Iberian Association of Natural Gas, Hydrogen and Renewable Gas for Mobility, the Spanish Hydrogen Technology Platform, the Spanish Association of Defence, Security, Aeronautics and Space Technologies and the Spanish Aerospace Platform
- Within the Urban Transition Mission, the Spanish National Platform (citiES 2030) has organized in the last 12 months weekly meetings with the cities included in the platform, a monthly newsletter, 5 webinars, a 1-day workshop focused on building retrofitting to increase energy efficiency, and a 2.5-days in person event with 150 people from the public, private, and social sectors. There is more information available at: https://cities2030.es

Sweden

Public RD&D Data

Sweden's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	113.0	81.9	117.8	148.0	143.7
CCS	0.0	1.8	2.9	6.2	5.7
Renewables	44.9	43.1	48.5	49.1	44.4
Nuclear	1.9	1.0	2.6	1.6	2.0
Hydrogen and fuel cells	2.0	0.9	3.0	3.6	4.1
Other power and storage technologies	18.3	13.5	16.4	17.8	16.1
Other cross-cutting technologies/research	21.4	37.3	41.1	34.1	29.1
Unallocated	-	21.9	9.3	28.6	27.5
Total Budget	201.6	201.4	241.6	289.1	272.6

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget	Technology focus	Start/end date	Main activities	Link
Energy R&I Programme	(b) Grants, (d) Inducement prizes; (h) Start-up and innovation prices etc.	1 450 million SEK for 2022	Energy	Started in the 1970's; currently open-ended	Research, applied research, development, pilot- and demonstration projects, commercialisation and product development.	Innovations, R & D (energimyndigheten.se)
Industrial Leap Programme	(b) Grants	909 million SEK for 2022	GHG emissions from industry, and CCS technology	2018 - 2040	Pilot studies, research, demonstration, and investments to decrease greenhouse gas emissions from industry, to achieve net-zero emissions and strategic industry projects contributing to climate mitigation.	The Industrial Leap (energimyndigheten.se)
Credit Guarantees for Green Investments	(f) Loans, debt financing and loan guarantees;	The scope of the guarantee scheme is 50 000 million SEK for 2022	Industry	2021	Mandate for the National Debt Office to issue state credit guarantees to promote large industrial investments in Sweden that contribute to reaching the goals of the Swedish environmental objectives system and climate policy framework.	Credit guarantees for green investments - Riksgälden.se (riksgalden.se)
Almi Invest GreenTech Fund	(e) Equity investments (e.g., in start-ups);	Total of 65 million euros under management	Any technology that can reduce GHG emissions	2016 - 2023	Start-ups that significantly reduce greenhouse gas emissions	Almi Invest GreenTech Fund - investing for net zero - almi invest
Governmental innovation partnership programmes	Coordination and collaboration	Companies, universities, civil society, and public sector jointly set priorities to meet societal challenges.	The objective is to identify innovative solutions to major challenges facing society and to contribute to Sweden's competitiveness.	2019 - 2022	Climate neutral industry; Skills supply and lifelong learning; Digital transformation of industry; and Health and life sciences. One of the programmes in particular is energy related: Climate neutral industry	The Government's innovation partnership programmes - Government.se

Climate Competence and Skills Enhancement	(a) Education and training	100 million SEK for 2022	Climate	2022 – 2024	Initiatives for education and training in areas of relevance for industry to meet climate challenge	Kompetenslyft för klimatet - Regeringen.se (only in Swedish)
Support for upgrading biogas to biomethane	Production support	500 million SEK for 2022	Upgrading of biogas to biomethane; liquefaction of biomethane	2022 – 2040; evaluation milestone 2024	0,30 SEK/kWh for upgrading; 0,15 SEK/kWh for liquefaction	Stöd för er som producerar biogas som uppgraderas till biometan (energimyndigheten.se) (only in Swedish)
Bio-CCS	Reverse auction	10 million SEK for 2022	Bio-CCS	Auctions from 2023. Planned for 2022 but delayed due to state aid review; payments 2026 – 2040	400 million SEK per annum 2026 – 2040 for supporting contract winners for Bio-CCS	Statligt stöd för bio-CCS (energimyndigheten.se) (only in Swedish)
IPCEI	(b) Grants	575 million SEK and 238 million SEK 2022	Swedish actors' participation in IPCEI projects on batteries	2022 - 2027	Industrial collaborative projects	The pandemic requires a new industrial strategy - Government.se Uppdrag att stödja uppbyggnaden av ett center för elektromobilitet (only in Swedish) Uppdrag att stödja utveckling av battericeller och utbyggnad av ett elektrifieringscampus för batteriforskning i Västerås (only in Swedish)

*The following typology is recommended for consistency across respondents: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.
**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

Activities in the Energy Research and Innovation Programme include a large number of research, development, pilot, and demonstration projects with Public-Private funding. The following examples can be mentioned:

The Swedish Energy Agency together with the Swedish Innovation Agency and the Research Council for Sustainable Development launched a call for the next generation of Innovation Programmes. The aim is to establish actor-driven, long-term programmes that will accelerate a sustainable transition for global competitiveness and societal benefits. The programmes should empower a system innovation towards ambitious transition goals, so-called missions. The call targeted actors jointly want to mobilize their efforts towards these objectives. The call generated 23 applications from which around 5 programmes will be chosen and are expected to start in the beginning of 2024.

The Strategic Innovation program Viable Cities among other activities develop different instruments like Climate City Contracts, Climate Investment Plans, Climate City Challenge, and Systems demonstrations.

Contributions to Mission Innovation work programme in 2022/23

Sweden participates actively in the activities of the Net-Zero Compatible Innovations Initiative (NCI)/Avoided emissions framework. A partnership between the NIC and the UNFCCC has been established with the aim of developing the UNFCCC Global Innovation Hub (UGIH). The UGIH was launched at COP26 in Glasgow. NCI also launched the report 21st Century Climate Innovation Assessments.

Sweden is a Supporting member of the Net-Zero Industries mission.

Sweden is engaged in the Urban Transitions Mission**.**

Sweden is also engaged in the Innovation Community on Affordable Heating and Cooling through IEA HPT, SETplan Geothermal IWG och EU Clean Energy Transition Partnership CETP TRI 4/Geothermica.

Sweden, together with Austria, is coordinating the public funders dialogue and the corresponding work with the MICall series in the innovation platform of MI (collaborate). As part of this work, Sweden and Austria are currently focusing on connecting funders from the Mission Innovation countries together with the two large European funding networks: the CETPartnership and the DUTPartnership under Horizon Europe in order to jointly launch calls in the MICall series.

In the MICall23 there´s a specific call topic collaboration between the MI Green Powered Future Mission and the CETPartnership, and the MICall24 is being prepared with an ambition to connect several more of the MI Missions as well as engaging more new public funders on the global level. For this purpose, the Swedish Energy Agency is working on establishing a strategic collaboration model with the MI for CETPartnership and DUTPartnership non-funding partners/third country funders to participate in the Joint Call scoping process. The Swedish Energy Agency is also working on establishing a simplified procedure for CETPartnership and DUTPartnership non-funding partner/ third country funders participation in CETPartnership and DUTPartnership Joint Calls. It will include the development of a “Dummies guide for funders” on MICalls.

In the MICall22 and MICall23 (call topics hosted by CETPartnership and DUTPartnership), there was participation from more than thirty funding agencies from Europe, Canada, Israel, India, USA and Tunisia.

Sweden is making a voluntary contribution in 2023 supporting the MI Secretariat.

International clean energy collaborations in 2022/23

Sweden participates in the EU activities on energy R&I. This includes proactive work for the Horizon Europe partnerships Driving Urban Transition and Clean Energy Transition, as well as for the European Mission Climate-Neutral and Smart Cities. Two of the seven projects to be awarded funding in the first call of the EU Innovation Fund were from Swedish companies: Beccs Stockholm: Bio Energy Carbon Capture and Storage by Stockholm Exergi and HYBRIT Demonstration: Swedish large-scale steel value chain demonstration of Hydrogen Breakthrough Iron-making Technology. Swedish actors also participate in the EU Strategic Energy Technology Plan and its different implementation groups, as well as in European Important Projects of Common European Interest (IPCEI) in the areas of Batteries and Hydrogen.

In addition to the EU collaboration, Sweden participates in the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the Clean Energy Ministerial (CEM), and the International Solar Alliance (ISA). Sweden takes part in the Management Board of the Leadership Group for Industry Transition (LeadIt).

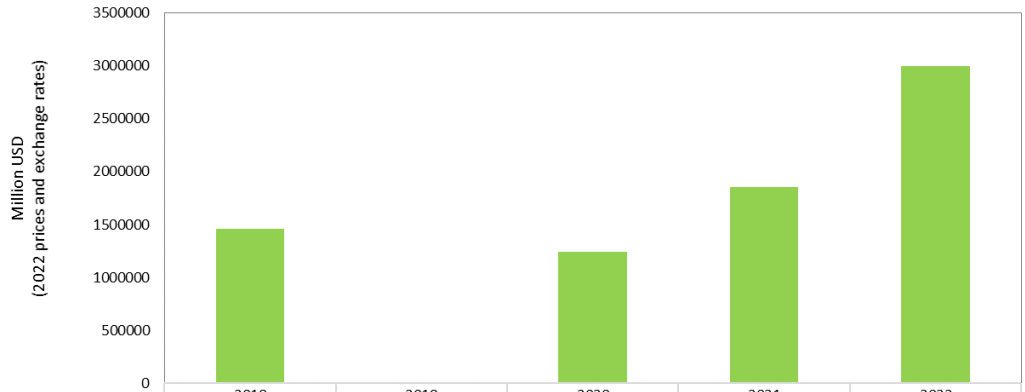
Apart from multilateral collaborations, Sweden has bilateral collaboration agreements with a number of countries outside of the European Union.

Further information on Sweden’s international clean energy collaborations can be found in Annex A, page 172.

United Arab Emirates

Public RD&D Data

United Arab Emirates' public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	1,456,949.2	2,933.6	1,240,110.0	1,851,160.9	2,996,786.9
CCS	-	-	-	-	-
Renewables	-	-	-	-	-
Nuclear	-	-	-	-	-
Hydrogen and fuel cells	-	-	-	-	-
Other power and storage technologies	-	-	-	-	-
Other cross-cutting technologies/research	-	-	-	-	-
Unallocated	-	-	-	-	-
Total Budget	1,456,949.2	2,933.6	6,002.7	3,085,268.2	2,996,786.9

Note: the data above only encompasses spending from the Ministry of Energy and Infrastructure, which does not capture country-level expenditures.
The data for the United Arab Emirates presented in this graph has been directly provided by the UAE to the Mission Innovation Secretariat.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
UAE Energy Strategy 2050	National Strategy		First unified energy strategy based on supply and demand	2017-2050	The UAE's updated Energy Strategy 2050 focuses on advancing renewable and nuclear energy adoption, improving energy efficiency, fostering energy technology research and innovation, bolstering local clean energy capacity, and attracting investments in the clean energy sector. With a goal to triple the contribution of renewable energy, the strategy also includes substantial investments of AED 150 to AED 200 billion by 2030 to meet the growing energy demand resulting from the country's rapidly expanding economy.	https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/strategies-plans-and-visions/environment-and-energy/uae-energy-strategy-2050
The UAE National DSM program	National Program		establishing of an advanced database to support decision-making to develop most recent used technologies to reduce demand in: Built environment, Transport, Industry, Agriculture	2021-2050	The programme includes three main pillars: Energy, water and consumption rationalisation. It sets ambitious targets for energy and water savings by 2050 by achieving the target of 40% reduction in energy and 50% reduction in water over business as usual by 2050. . This program aligns with the UAE Energy Strategy 2050 and the UAE Water Security Strategy 2036, as well as local initiatives within each emirate. The National DSM Program 2050 focuses on four key pillars with substantial potential for impact.	https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/strategies-plans-and-visions/environment-and-energy/national-water-and-energy-demand-management-programme
National Hydrogen Strategy	National Strategy		support low-carbon local industries, contribute to achieving climate neutrality and enhance the UAE's position as one of the largest producers of hydrogen by 2031.		The primary goal of the National Hydrogen Strategy is to bolster environmentally friendly local industries, actively contribute to the pursuit of climate neutrality, and further solidify the UAE's standing as a major hydrogen producer by 2031. This strategy places emphasis on ten key facilitators and delineates the critical measures that the UAE plans to implement in order to expedite the expansion of the hydrogen economy and curtail emissions in sectors with high emission intensity. The UAE aims to achieve these objectives through activities like building robust supply chains, setting up hydrogen hubs, and establishing a specialized national research and development center focused on hydrogen technologies.	

Dubai Clean Energy Strategy	Local Strategy		infrastructure, legislation, funding, building capacities and skills, and environment friendly energy mix.	2015-2050	The Dubai Clean Energy Strategy is geared towards generating 75% of the emirate's energy needs from clean sources by 2050, while also positioning Dubai as a global hub for clean energy and the green economy. Infrastructure initiatives include the impressive Mohammed Bin Rashid Al Maktoum Solar Park, set to be the world's largest solar energy generator with a capacity of 5,000 MW by 2030. The legislation pillar focuses on a legislative framework to support clean energy policies. The funding pillar involves the Dubai Green Fund, a substantial AED 100 billion resource offering affordable loans for clean energy investors. The fourth pillar aims to enhance human resources through global training programs, collaborating with international organizations and institutes. Lastly, the fifth pillar centers on an eco-friendly energy mix, with plans to increase clean energy sources to 75% by 2050, thereby positioning Dubai as the city with the world's lowest carbon footprint.	https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/strategies-plans-and-visions/environment-and-energy/dubai-clean-energy-strategy
RAK Energy Efficiency and Renewable Energy Strategy 2040	Local Strategy		Energy Efficiency, Renewables and Demand Side Management	2018 - 2040	The Ras Al Khaimah Energy Efficiency and Renewables Strategy 2040 (EE&R Strategy) outlines the long-term plan for Ras Al Khaimah's energy efficiency and renewable energy initiatives. This comprehensive strategy encompasses nine distinct programs, including green building regulations, energy management, efficient appliances, and solar programs. The primary goals are to achieve a minimum of 30% electricity consumption savings, a 20% reduction in water consumption, and a 20% contribution from renewable energy sources in the energy supply mix compared to business-as-usual scenarios. These targets are consistent with the RAK Vision 2030 objectives, aiming for 10% electricity savings and 5% of electricity demand to be met through solar power by 2030.	https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/strategies-plans-and-visions/environment-and-energy/ras-al-khaimah-energy-efficiency-and-renewable-energy-strategy-2040
Abu Dhabi Demand Side Management and Energy Rationalization Strategy 2030	Local Strategy		Energy Efficiency, Renewables and Demand Side Management	2030	The strategy aims to balance supply and demand in the energy sector to secure significant economic and environmental gains, ensure the stability of the energy demand ecosystem. The strategy focuses on cost-effective solutions to enhance energy security, reduce the energy supply and demand gap, and mitigate climate change impacts while promoting sustainable economic development.	

*The following typology is recommended for consistency across respondents: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.
**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

Private sector engagement is one strategic approach and priorities to speed local efficiency initiatives and policies' adoption. The Ministry of Energy and Infrastructure try to establish a long-term strategic partnership with private sector and hold many workshops with them, that aims to utilize advanced technology and energy sustainability through digital technologies, and to adopt the latter as a major part of the ministry’s technical solutions and enhance its efforts to drive sustainable development and digital transformation in line with the UAE government directives.

The Ministry of Energy and Infrastructure Collaborate with Shell in order to develop the UAE energy sketch and forecast the energy future fir the country under different scenarios. Also, both GHD & Franhoufer work with the Ministry of Energy and Infrastructure in developing the UAE hydrogen strategy.

The transportation sector is one of the most important sectors that produce carbon dioxide emissions. Therefore, the Ministry of Energy and Infrastructure has worked to develop green mobility programs with strategic partners from the private sector especially electric cars manufacturer with the aim of facilitating the spread of Hybrids/EVs among community.

The Ministry of Energy and Infrastructure has been also sought in establishing partnerships with the private sector(ESCO) to develop building retrofit program and introducing advance smart building technolog. This will achieve the targets of the buildings sector of the UAE National DSM Program, especially in the buildings retrofit program which is saving of 298 TWH.

Also, R&D initiative was conducting in collaboration with universities and privet sectors to to ensure a continuous improvement of the UAE National DSM Program.

Contributions to Mission Innovation work programme in 2022/23

UAE has an active role in the international energy communities and organizations, it always participate in the Affordable Heating and Cooling in buildings IC7 where it supports innovation on low carbon affordable heating and cooling of buildings.

Clean Energy Ministerial (CEM’s) Energy Management Leadership Awards: are designed to highlight the clear, environmental, energy, and business benefits achieved by diverse types of organizations that invest in energy efficiency and to showcase leading organizations ISO 50001 energy management success.
Ministry of Energy & Infrastructure is collaborating with the Clean Energy Ministerial to offer the UAE National Energy Management Award [local branch of the global award] since 2017, Over these years, many entities in the country have participated and presented their successful experience. The award aims to praise and encourage efforts in applying energy management standards in the UAE and support in achieving the UAE’s National Demand Reduction Target of 40% by 2050.

The UAE is deeply involved in international climate initiatives, investing over USD 50 billion in renewable energy projects across 70 countries and planning to invest another USD 50 billion in the next decade.

The UAE's energy sector is also ramping up its commitment to renewable energy investments. For instance, since 2006, the Abu Dhabi Future Energy Company (Masdar) has emerged as one of the world's leading developers of renewable energy ventures, with a presence in over 40 countries. Masdar currently manages a portfolio of

renewable energy projects with a combined capacity exceeding 20 GW, either operational or in various stages of development, with total capital requirements estimated at USD 30 billion, including secured or pledged investments. The company has set an ambitious goal of expanding its renewable portfolio to 100 GW by 2030, a commitment backed by investments exceeding USD 60 billion. By 2030, Masdar's renewable energy initiatives are anticipated to mitigate CO2 equivalent emissions by approximately 95 million tonnes annually on a global scale.

International clean energy collaborations in 2022/23

See Annex A, page 173.

Other clean energy innovation activities in 2022/23

UAE Wind Program: The UAE Wind Program is a 103.5-megawatt clean energy project designed to seamlessly incorporate cost-effective, large-scale wind power into the UAE's electricity grid. This initiative serves the purpose of diversifying the country's energy sources and accelerating the shift towards cleaner, more sustainable energy. It strongly underscores the UAE's dedication to decarbonization and its ambitious goal of achieving net zero emissions by 2050. The project is projected to annually provide energy for over 23,000 UAE households and reduce carbon dioxide emissions by 120,000 tonnes.

National Climate Adaptation Action Plan: The National Climate Adaptation Plan is a comprehensive strategy with three key components aimed at assessing climate trends and their impacts on critical sectors like food, ecosystems, business, etc. The plan further focuses on addressing urgent concerns, such as increased demand for water and electricity while engaging all sectors on utilizing existing knowledge and resources, embedding adaptation into policy frameworks, fostering awareness about the importance of adaptation, promoting resilience measures, and continuously monitoring progress and effectiveness.

Solar Energy Project for Government Buildings: The Ministry of Energy and Infrastructure is expanding the use of solar energy in government buildings to reduce operational costs and carbon emissions. Mini solar power stations have been added to the rooftops of eligible government buildings, generating an initial 4 megawatts for schools, hospitals, and mosques.

Retrofit government buildings: A project to reduce energy and water consumption in government buildings (energy and water retrofit) by rehabilitating the buildings that consume the most energy and water through the shared savings mechanism and the partnership method between the public and private sectors. Phase 1 was implemented as a pilot project for 10 buildings to reduce energy by 0 %and water consumption by 25%. Phase two will cover 422 government buildings to reduce a minimum of 20% in energy and water consumption compared to the average consumption of the last three years.

Policy Regulating Local Energy Market: The policy provides guidelines for the contractual framework among energy stakeholders and various contracting mechanisms. It aims to consolidate business operations, financing, and partnerships between the public and private sectors. Short-term objectives include reducing water use by 23%, cutting operational costs by 20% in federal buildings, contributing 5% to clean energy, enhancing building sustainability by 5-10%, and raising awareness about energy and water conservation and behavioural change. In the long term, the policy is projected to decrease energy demand in the building sector by 51% by 2050.

The Ministry of Energy and Infrastructure are working on developing the "EV Charger's Roadmap" at national level with cooperation with all partners around the country (federal and local level) to build a national network of EV chargers to support the owners of EV. The project will facilitate the movement of electric cars

between the UAE and connect all highways and local roads by this national network. The project also will include the development of a digital platform with electric charging stations on highway roads in UAE and government buildings controlled through the federal road control center of the Ministry.

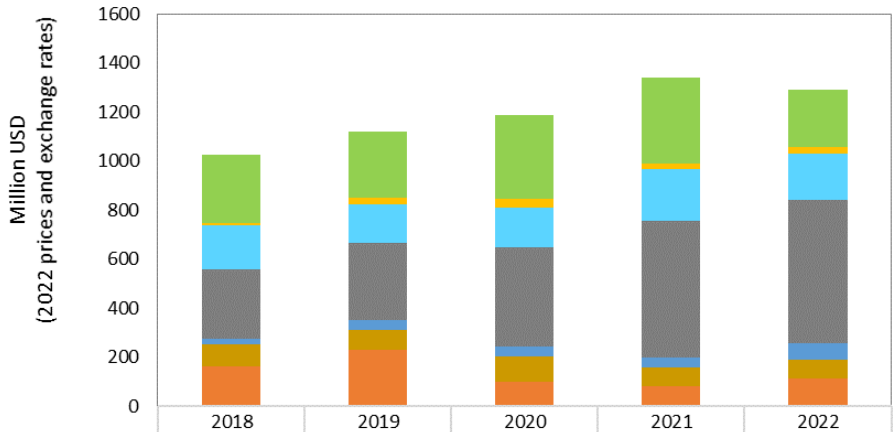
In 2018, the Ministry of Energy and Infrastructure conducted a survey to study the level of awareness and behaviour of the Emirati community. An analysis process for the survey findings were done to understand unique behavioural mechanisms and help develop tools to encourage actions. 17 programs were introduced for all segments. Implementing these initiatives will bring out one strong message to the public in energy and water conservation.

In 2021, the Ministry of Energy and Infrastructure launched the National Energy Conservation campaign with new aspects and tools to meet the needs of the society which will be as one of the DSM enablers in targeted sectors: buildings- transport- manufacturing- agriculture. The national campaign target to make a significant behavioural change on energy and water consumption.

United Kingdom

Public RD&D Data

The United Kingdom's public spend on clean energy RD&D since 2018 is as follows:



	2018	2019	2020	2021	2022
Energy efficiency	279.8	269.1	339.3	350.3	232.7
CCS	9.4	24.8	39.3	22.7	28.5
Renewables	177.6	157.4	159.6	211.4	187.0
Nuclear	282.4	316.1	402.7	555.8	583.5
Hydrogen and fuel cells	25.1	41.9	41.0	40.8	68.3
Other power and storage technologies	86.4	78.1	104.4	76.6	75.4
Other cross-cutting technologies/research	161.6	230.2	100.5	74.7	109.8
Unallocated	3.3	2.1	0.2	6.4	4.9
Total Budget	1,025.7	1,119.7	1,187.0	1,338.8	1,290.1

Note: The data presented in this graph is available from the IEA Energy RD&D Database.

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
UK Net Zero Research and Innovation Framework	Funding	£4.2bn (£1.3 billion for net zero innovation)	System integration and flexibility; renewables; nuclear; bioenergy; industry and low-carbon hydrogen supply; carbon capture, utilisation and storage and greenhouse gas removal; heat and buildings; transport; natural resources, waste and F-gases	2022 - 2025	The Net Zero Research and Innovation Delivery Plan sets out the current government portfolio of research and innovation programmes to deliver the UK's net zero target.	https://www.gov.uk/government/publications/uk-net-zero-research-and-innovation-framework-delivery-plan-2022-to-2025
Net Zero Innovation Portfolio and Advanced Nuclear Fund (part of above Framework)	Grants and Procurement	£1.3bn (of above)	Advanced nuclear; Disruptive technologies; homes and buildings; GGR; advanced CCUS; Hydrogen; Industry; bioenergy; future offshore wind; energy storage and flexibility	2022 - 2025	The Net Zero Innovation Portfolio provides funding for low carbon technologies and systems, to help enable the UK to end its contribution to climate change.	https://www.gov.uk/government/collections/net-zero-innovation-portfolio

*The following typology is recommended for consistency across respondents: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.
**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

- UK Net Zero Research and Innovation Framework includes multiple government-led programmes across many sectors of the economy that are delivering the UK's Net Zero target. Many of these involve partnerships with the private sector. More detail can be found online, including at https://www.gov.uk/government/publications/uk-net-zero-research-and-innovation-framework-delivery-plan-2022-to-2025. A few example highlights are set out below.
- Breakthrough Energy Catalyst partnership: On Oct 19 2021 the UK Prime Minister and Bill Gates announced a strategic partnership between the Breakthrough Energy's Catalyst program and the UK Government, to accelerate the deployment of the next generation of green technologies, and achieve net zero by 2050. The Breakthrough Energy Catalyst will seek to match up to £200m of government funding for the demonstration of high-impact decarbonisation technologies; green hydrogen; long term energy storage; sustainable aviation fuels; and direct air capture of greenhouse gases.
- Advanced Nuclear: The £210 million Small Modular Reactor programme (also known as Low-Cost Nuclear Challenge) is funding the development of the Rolls Royce UK SMR design and progressing it through the extensive regulatory assessment. Building on a first phase that developed a concept design, the second phase, supported with £258 million private sector funding, will further develop the concept reactor design to allow it to pass through the UK Regulators' generic design assessment (GDA) process. That phase is expected to conclude by early 2025.
- UKSHORE: The Department for Transport's £206 million UK Shipping Office for Reducing Emissions (UK SHORE) programme was announced in March 2022 and focuses on accelerating the technology necessary to decarbonise our domestic maritime sector. UK SHORE interventions address maritime decarbonisation challenges over the full range of technology-readiness levels (TRL) and are being rolled out between 2022 and 2025. Since July 2022, the UK SHORE programme has awarded £72 million funding to 50 projects through the second and third rounds of the Clean Maritime Demonstration Competition (CMDC) and launched a £34 million fourth round. Other funding awards include £80 million to ten projects through the Zero Emission Vessels and Infrastructure (ZEVI) competition, targeting close-to-commercial technologies, and £7.4 million, co-funded with the Engineering and Physical Sciences Research Council (EPSRC), to a consortium of UK universities to establish a Clean Maritime Research Hub. UK SHORE funded projects are leveraging private investment through match funding.
- Clean Growth Fund: In March 2022, the Clean Growth Fund - a commercially run venture capital fund, which aims to speed up the deployment of innovative clean technologies that reduce greenhouse gas emissions, by making direct investments in companies seeking to commercialise promising technologies - announced the final fund size of £101 million, with seven private sector investors backing the Fund, alongside £20m from UK Government. The Fund's focus is on commercial returns and UK based innovations that demonstrate clear reductions in greenhouse gases. The Fund's current portfolio of investments is available from the Clean Growth Fund website.

Contributions to Mission Innovation work programme in 2022/23

The UK is an active member of Mission Innovation.

1) **MI Governance:** The UK is a member of the MI Steering Committee and the Technical Advisory Group;
2) **The UK hosts the MI Secretariat core team**: providing 2.5 FTE including the Head of the MI Secretariat;
3) **Missions and Platform initiatives:** The UK participates in 6 out of 7 of the MI Missions, and in the Heating and Cooling Innovation Community.

Technical Advisory Group (member)
The UK provides support to Mission Innovation in the form of our Technical Advisory Group member, Professor Peter Bruce. Prof. Bruce is Wolfson Professor of Materials at the University of Oxford; founder and Chief Scientist of the Faraday Institution, the UK centre for research on electrochemical energy storage; and is the Physical Secretary and Vice President of the Royal Society. He provides expert advice to Mission Innovation as part of his role in the advisory group, supporting this independent review and advisory function which helps MI governments maximise their impact.

Green Powered Future Mission (co-lead)
The UK is a co-lead of the **Green Powered Future Mission** which aims to enable the integration of up to 100% variable renewable energy into energy systems around the world. The UK actively participate in the Governance of the Mission, providing strategic direction and support to the evidence collection and knowledge-sharing activities of the Mission over the past year. This includes in-person participation in a technical workshop in Jiangsu, China, and the development of a progress report to be published at the end of the year. The UK is leading on Pillar 3: Data and Digitalisation for System Integration and will soon be committing additional resource by recruiting a full-time member of staff to continue its leadership of the Mission in 2024-25.

Clean Hydrogen Mission (co-lead)
The UK is a co-lead of the Clean Hydrogen Mission (CHM), which aims to increase the cost-competitiveness of clean hydrogen by reducing end-to-end costs to a tipping point of 2 USD/kg by 2030. As a co-lead of the CHM, the UK has shaped the strategic direction of the Mission through its input into the Mission's Action Plan 2022-24. To deliver against the Action Plan, the UK has used its leadership of the CHM R&I Production Working Group to deliver several workshops to share knowledge and best practice on innovations enabling the scale up of electrolytic or 'green' hydrogen production, particularly on electrochemical materials for electrolysis. The UK will also be committing additional resource by recruiting a full-time member of staff to continue its leadership of R&I Production Group activity in 2024.

Zero-Emission Shipping Mission (ZESM) (core member)
The UK continues to play a leading role in the Zero Emission Shipping Mission's work on green shipping corridors via the Clydebank Declaration, launched at COP26 in Glasgow. In 2022-2023, the UK convened Clydebank signatories and ZESM members for webinars on the development of green shipping corridors and announced the £1.5 million International Green Corridor Fund which will fund feasibility studies examining Green Corridor routes. The UK was also a key contributor to the launch of the ZESM's Green Shipping Corridor Hub. The UK remains a core member of the ZESM and is active on its secretariat, its executive committee, and its Port and Fuel Infrastructure pillar. It continues to provide significant in-kind support to the ZESM's strategic

planning and visibility, attending CEM-MI in Pittsburgh in September 2022, as well as a ZESM workshop in Copenhagen in October 2022, and ZESM meetings and events related to Nor-Shipping in Oslo in June 2023.

Net-Zero Industries Mission (core Member)
The UK is a core member of the Net Zero Industries Mission, which is co-led by Austria and Australia. The UK has supported the development of the recently published Action Plan for the Mission and has progressed vital deliverables under the Action Plan such as strengthening international knowledge networks through an international workshop on industrial cluster decarbonisation in collaboration with the Industrial Decarbonisation Research and Innovation Centre (IDRIC). The UK continues to work with other countries to accelerate the industry transition through regular member meetings, and strategic dialogues on issues such as technology innovation to and from emerging economies held at MI-8.

Carbon Dioxide Removal Mission (support member)
The UK is a supporting member of the **Carbon Dioxide Removals (CDR) mission** which is led by Canada, US and the Kingdom of Saudi Arabia, with a goal to achieve a net reduction of 100 million tonnes of CO2 per year by 2030. The UK has actively collaborated on the BiCRS pillar, Biomass with Carbon Removal and Storage, including presenting at two knowledge exchange webinars during 2023 and contributing UK projects to the global CDR mapping exercise. Additionally, we are supporting the Lifecycle Analysis (LCA) technical track, providing expert participation in workshops between member countries through the year.

Integrated Biorefineries Mission (support member)
The UK is a support member of the Integrated Biorefineries Mission, represented by UK Research and Innovation (UKRI). The UK has contributed to the Mission including through the organisation of an international webinar, supported by the Netherlands and attended by more than 50 delegates. The UK, with Sofinnova Partners, undertook part of a recent study across the Mission's stakeholders investigating how investors might react to supporting biorefineries via interviews with potential investors. The UK has plans to convene future webinars as well as a study trip to Canada to identify further collaboration opportunities relevant to the Mission.

Innovation Community on Heating and Cooling of Buildings (co-lead)
The UK is a co-lead of the **Innovation Community on the Heating and Cooling of Buildings** with the aim of convening the global research and innovation community, facilitating research collaborations and accelerating private investment across the international heating and cooling space. Over the past year, the innovation community has launched an online wiki platform to provide a repository with live library/database/information on state-of-the-art innovation topics. We have also supported the development of the Global Cooling Pledge to be announced at COP28. We have also supported the development of innovation on mitigation of extreme heat though the extreme heat working group of the cool coalition.

International clean energy collaborations in 2022/23

See Annex A, page 175.

Other clean energy innovation activities in 2022/23

- The UK is actively involved in clean energy innovation collaboration with numerous bilateral partners. This includes:
    - Saudi Arabia: Space Solar Ltd. was awarded grant funding from our Space Based Solar Power innovation programme (via Satellite Applications Catapult) to develop a first iteration of a

concept design based on the CASSIOPeiA architecture. NEOM, a new smart city currently being built in Saudi Arabia, is providing the match funding required for this grant.

- Australia: The current Clean Technology Partnership (CTP) is the central focus of the UK's bilateral relationship with Australia on clean energy innovation and one of the UK's biggest bilateral agreements tackling climate change. It focuses on both countries' shared goal to make low-emissions technologies scalable and commercially viable in order to rapidly accelerate global emissions reductions, enable clean growth and reach net zero emissions. The CTP has led to increased collaboration between the UK and Australia clean energy industries; for example, resulting in the Industrial Decarbonisation Global Expert Mission to Australia in February 2022, which identified the hydrogen and carbon capture utilisation and storage industries as key collaboration areas.

- The **Clean Energy Ministerial (CEM)** brings together a community of the world's largest and leading countries, companies and international experts to accelerate clean energy transitions. The UK has been a member of the CEM since its founding in 2009 and sits on the CEM Steering Committee. The UK also leads 4 workstreams under the CEM: CCUS, Industrial Deep Decarbonisation Initiative (IDDI), the Super-Efficient Equipment and Deployment (SEAD) Initiative, and Nuclear Innovation. We also participate in initiatives on gender equality, electric vehicles, hydrogen and biofuels.

- At the COP26 World Leaders Summit, world leaders from 45 countries, representing over 70% of global GDP, launched the **Breakthrough Agenda** – a commitment to work together to accelerate the innovation and deployment of clean technology in key emitting sectors, ensuring they are affordable and accessible for all. The UK co-leads 5 out of 7 Breakthroughs: on Road Transport, Steel, Hydrogen, Power and Agriculture. Two new Breakthroughs will be launched at COP28: Buildings Breakthrough (co-led by France and Canada) and the Cement and Concrete Breakthrough (co-lead by Canada and UAE). The Breakthrough Agenda is a collaborative political process informed by an annual independent expert report by the International Energy Agency (IEA), International Renewable Energy Agency (IRENA) and UN High Level Climate Action Champions. The latest Breakthrough Agenda Report was launched on 14 September.

- The UK has continued to lead the **Green Grids Initiative** **(GGI)**, which was launched in partnership with India's One Sun One World One Grid at COP26 and is a leading initiative under the Glasgow Power Breakthrough. The GGI brings together an organised ecosystem of global political, technical, and financial resources to provide a conduit for investment and assistance for flagship projects that will have a transformational impact on grids globally. The GGI has pioneered new approaches to unlock financial and technical support for major infrastructure projects, such as the ZiZaBoNa (Zimbabwe-Zambia-Botswana-Namibia) interconnector, as well as innovative platforms for capacity building, such as the Electricity Transition Playbook to be launched at COP28, working with the Climate Compatible Growth (CCG). The GGI is also working with international finance institutions to improve methodologies for assessing grid projects to increase access to climate finance.

Other relevant publications:

Net Zero Research and Innovation Framework Delivery Plan
Details UK public sector investment and activity towards delivery of the research and innovation challenges and needs identified in the related Net Zero Research and Innovation Framework document published in 2021. The new Delivery Plan provides a record of what the UK Government either is, or will be investing in over the course of the current UK Government Spending Review (SR) period, 2022-25. Link: https://www.gov.uk/government/publications/uk-net-zero-research-and-innovation-framework-delivery-plan-

2022-to-2025. Link to the Framework document here: Link: https://www.gov.uk/government/publications/net-zero-research-and-innovation-framework).

UK Green Finance Strategy
Sets out our pathway for the UK to become the world's first Net Zero Aligned Financial Centre – equipping the market with the information and tools necessary to meet this goal. Sets out the investment opportunities and relevant Government support to make sectors investable. Link: https://www.gov.uk/government/publications/green-finance-strategy

UK Net Zero Innovation Portfolio
This report sets out progress made by the UK's Net Zero Innovation Portfolio (NZIP) and the Advanced Nuclear Fund (ANF) from 2021 to 2022. Link: Net Zero Innovation Portfolio and the Advanced Nuclear Fund: progress report 2021 to 2022

United States

Major innovation initiatives and programmes in 2022-2023

Table 1: New programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Grid Resilience and Innovation Partnership Program	Grants, Financing Assistance	$5.5 Billion in Grants $5 Billion in Financing Assistance	Grid Innovation	FY22-FY24	Grid Resilience Utility and Industry Grants support activities that will modernize the electric grid to reduce impacts due to extreme weather and natural disasters. Smart Grid Grants increase the flexibility, efficiency, and reliability of the electric power system, with particular focus on increasing capacity of the transmission system, preventing faults that may lead to wildfires or other system disturbances, integrating renewable energy at the transmission and distribution levels, and facilitating the integration of increasing electrified vehicles, buildings, and other grid-edge devices. Grid Innovation Program provides financial assistance to one or multiple states, Tribes, local governments, and public utility commissions to collaborate with electric sector owners and operators to deploy projects that use innovative approaches to transmission, storage, and distribution infrastructure to enhance grid resilience and reliability.	Grid Resilience and Innovation Partnerships (GRIP) Program | Department of Energy
Regional Clean Hydrogen Hubs	Grants, Financial Assistance	$8 Billion	Hydrogen		The Regional Clean Hydrogen Hubs (H2Hubs) will kickstart a national network of clean hydrogen producers, consumers, and connective infrastructure while supporting the production, storage, delivery, and end-use of clean hydrogen. the H2Hubs will accelerate the commercial-scale deployment of clean hydrogen helping to generate clean, dispatchable power, create a new form of energy storage, and decarbonize heavy industry and transportation.	Regional Clean Hydrogen Hubs | Department of Energy
Regional Direct Air Capture Hubs	Grants, Financial Assistance	$3.5 Billion	Direct Air Capture		The DAC Hubs will help accelerate the demonstration and deployment of direct air capture technologies, supporting efforts to create good-paying jobs, reduce pollution, and reinforce America's global competitiveness in clean energy technologies.	Regional Direct Air Capture Hubs | Department of Energy
Carbon Capture Demonstrations	Grants, Financial Assistance	$2.5 Billion	Carbon Capture		This program will help accelerate the demonstration and deployment of carbon management technologies, supporting efforts to create good-paying manufacturing jobs, reduce pollution to deliver healthier communities, and reinforce America's global competitiveness in the clean energy technologies of the future.	Carbon Capture Demonstration Projects Program | Department of Energy

Carbon Capture Large-Scale Pilots	Grants, Financial Assistance	$937 Million	Carbon Capture		The Carbon Capture Large-Scale Pilots will establish a carbon capture technology program for the development of transformational technologies that will significantly improve the efficiency, effectiveness, costs, emissions reductions, and environmental performance of coal and natural gas use, including in manufacturing and industrial facilities.	Carbon Capture Large-Scale Pilot Programs | Department of Energy
Industrial Demonstrations Program	Grants, Financial Assistance	$6 Billion	Industrial		The Industrial Demonstrations Program (IDP) will accelerate decarbonization projects in energy-intensive industries and provide American manufacturers a competitive advantage in the race to lead the world in low- and net-zero carbon manufacturing. This program will be a central driver in helping solidify a "first-mover" advantage for U.S. industry, bolstering its competitiveness globally for decades into the future.	Industrial Demonstrations Program | Department of Energy
Energy Improvements in Rural/Remote Areas	Grants, Financial Assistance	$1 Billion	Various		This program will improve the resilience, reliability, and affordability of energy systems in communities across the country with 10,000 or fewer people. ERA aims to fund community-driven energy projects that demonstrate new energy systems, deliver measureable benefits to customers and build clean energy knowledge and capacity throughout the rural United States.	Energy Improvement in Rural or Remote Areas | Department of Energy
Clean Energy Demonstration Program on Current and Former Mine Land	Grants, Financial Assistance	$500 Million	Solar, microgrids, geothermal, direct air capture, fossil-fueled electricity generation with carbon capture, utilization, and sequestration, energy storage, and advanced nuclear technologies.		The Clean Energy Demonstration Program on Current and Former Mine Land (CEML) will demonstrate the technical and economic viability of deploying clean energy on current (operating) and former (abandoned or inactive) mine land. These projects are expected to be replicable, providing knowledge and experience that catalyze the next generation of clean energy on mine land projects.	Clean Energy Demonstration Program on Current and Former Mine Land | Department of Energy
Energy Earthshots Initiative	Financial Assistance (e.g. Grants), Prizes	*DOE Energy Earthshots align and leverage existing R&D funding to focus on cost and performance targets	Until September 2023, seven Energy Earthshots focused on: (1) Hydrogen Production; (2) Long Duration Energy Storage; (3) Carbon Dioxide Removal; (4) Floating Offshore Wind; (5) Enhanced Geothermal Systems; (6) Industrial Heat; (7) Clean Fuels and Products	2021 - 2035		Energy Earthshots Initiative | Department of Energy

TItle 17 Clean Energy Financing	Loans, debt financing and loan guarantees	$72.2 Billion in Remaining Loan Authority	Innovative Energy: projects that deploy New or Significantly Improved Technology. Innovative Supply Chain: projects that employ a New or Significantly Improved Technology in the manufacturing process for a qualifying clean energy technology or for projects that manufacture a New or Significantly Improved Technology. State Energy Financing Institutions: projects that support deployment of qualifying clean energy technology and receive meaningful financial support or credit enhancements from an entity within a state agency or financing authority.	Available until loan authority is exhausted	Under the Title 17 Clean Energy Financing Program, DOE's Loan Programs Office (LPO) provides access to debt capital for projects in the United States that support clean energy deployment and energy infrastructure reinvestment to reduce greenhouse gas emissions and air pollution. Title 17 was created by the Energy Policy Act of 2005 and has since been amended, most recently by the Infrastructure Investment and Jobs Act in 2021 and the Inflation Reduction Act in 2022. The legislation expanded the scope of Title 17 to include certain state-supported projects and projects that reinvest in legacy energy infrastructure, and it leverages additional loan authority and funding available for projects involving innovative energy technologies. The Title 17 Clean Energy Financing Program is central to LPO's mission to serve as a "Bridge to Bankability" for clean energy projects that are critical to achieving the decarbonization of the energy sector and enhancing the domestic clean energy supply chain. Repeat deployments that prove market adoption enable 'bankability,' unlocking commercial debt markets. The Title 17 program can support technologies at each deployment milestone—first-of-a-kind deployments that solve applied engineering challenges; follow-on deployments that establish engineering, procurement, and construction excellence and lower total project costs; substantial scaling of deployment and manufacturing capacity to drive advancement along the learning curve; and education of commercial debt markets to enable broadly available debt financing.	https://www.energy.gov/lpo/title-17-clean-energy-financing
Advanced Technology Vehicles Manufacturing Loan Program	Loans, debt financing and loan guarantees	Approximately $50 billion in loan authority	Manufacturing facilities for light-, medium- and heavy-duty vehicles, locomotives, maritime vessels, aviation, and hyperloop – and related qualifying vehicle components.	Available until loan authority is exhausted	The Advanced Technology Vehicles Manufacturing (ATVM) Loan Program provides acces to debt capital to build new facilities or reequip, modernize, or expand existing facilities in the United States; and/or for engineering integration related to the manufacturing of eligible vehicles or components. Eligible vehicles must meet certain fuel economy requirements, or low or zero exhaust emissions of greenhouse gases	https://www.energy.gov/lpo/advanced-transportation-financing
Title 17 Clean Energy Financing – Energy Infrastructure Reinvestment (EIR)	Loans, debt financing and loan guarantees	The Inflation Reduction Act (IRA) appropriates $5 billion, to carry out EIR, with a	The following is a set of project types that could be eligible for Energy Infrastructure Reinvestment financing, subject to LPO review. These examples are neither exhaustive nor limiting:	2022 through September 30, 2026	The Energy Infrastructure Reinvestment (EIR) Loan Program can provide access to debt capital for projects retool, repower, repurpose, or replace Energy Infrastructure (facilities used for electric generation or transmission, or facilities used for fossil fuel-related production, processing, and delivery) that has ceased operations; or enable operating Energy Infrastructure to avoid, reduce, utilize, or sequester air pollutants or emissions of greenhouse gases. EIR projects are not required to employ innovative technology.	https://www.energy.gov/lpo/eir

		total cap on loans of up to $250 billion. LPO estimates that the credit subsidy appropriated by IRA can support $60 billion in loans.	Retired power plant (or other qualifying energy infrastructure) retooled, repowered, repurposed or replaced with: Renewable energy and/or storage, Distributed energy (e.g., virtual power plant), Transmission interconnection to off-site clean energy, New manufacturing facilities for clean energy products or services, Nuclear energy, Fossil or biomass generation with carbon capture and sequestration, Reconductoring transmission lines and upgrading voltage, Retrofitting of fossil-fuel power plant with carbon capture and sequestration, Repurposing oil and gas pipelines (e.g., for H2, CO2), Upgrading or retrofitting refineries (e.g., for biofuels or hydrogen), Upgrading or uprating existing generation facilities (with emissions control technologies for projects involving fossil generation), Energy infrastructure repurposing for decarbonization			

Carbon Dioxide Transportation Infrastructure Finance and innovation (CIFIA) program	Loans, debt financing and loan guarantees ; Grants	IIJA authorized and appropriated up to $2.1 billion CIFIA. This appropriation would support an estimated $20 billion in CIFIA loans.	Large-capacity common carrier CO2 transportation infrastructure project that transports CO2 captured from anthropogenic sources and/or ambient air by pipeline, shipping, rail, or other methods for storage and/or use	CIFIA's $2.1 billion will be appropriated to DOE in annual increments between 2022 and 2026.	The Loan Programs Office (LPO), in partnership with DOE's Office of Fossil Energy and Carbon Management (FECM), offers access to capital for large-capacity, common-carrier carbon dioxide (CO2) transport projects (e.g., pipelines, rail, shipping, and other transport methods) under the Carbon Dioxide Transportation Infrastructure Finance and Innovation Act (CIFIA), as incorporated into and enacted under the Bipartisan Infrastructure Law of 2021.	https://www.energy.gov/lpo/cifia

*The following typology is recommended for consistency across respondents: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) Start-up and innovation prizes; (i) Business accelerators / incubators; (j) Public procurement; (k) Access to public energy research and testing infrastructure; (l) Other: please specify.
**This can relate to new initiatives/programmes, or to milestones within an existing initiative/programme.

Public-private engagement in 2022/23

In 2023, the US Department of Energy, through the **Innovation Network for Fusion Energy** (INFUSE) program, provided $2.3 million towards projects that will pair private industry with DOE's National Laboratories.

The US Department of Energy's Loan Programs Office (LPO) offers several loan programs to help deploy innovative projects at commercial scale, including energy technologies and supply chains, manufacturing facilities for advanced technology vehicles, reinvestment in energy infrastructure, and large-capacity, common-carrier carbon dioxide (CO2) transport projects. By statute, LPO can provide financing for up to 80 percent of total projects costs. This requires borrowers to invest equity into the project, which is typically more than the 20 percent of the statutory minimum. Since July 2022 LPO has announced nearly $20 billion in closed loans and conditional commitments to deploy innovative clean energy technologies and manufacturing facilities.

Contributions to Mission Innovation work programme in 2022/23

- MI Steering Committee: Principal Deputy Assistant Secretary of International Affairs Julie Cerqueira serves as chair of the MI Steering Committee providing strategic input to elevate the coalition and advance its goals. One of her priorities as MISC chair has been to raise MI's profile globally, diversify its membership, and increase its impact. She has worked closely with the MI Secretariat to begin implementing these objectives over the last year. The United States is also represented on the Steering Committee.

The United States co-leads the following MI efforts (we also support the Net Zero Industries Mission):

- Zero Emission Shipping Mission: Conducted a green shipping corridor pre-feasibility study between the U.S. and the Republic of Korea. Results will be discussed at COP28. Led the creation and subsequent upkeep to date of the Green Shipping Corridors Hub where stakeholders can view mapping and status of announced green shipping corridors, access a resource library, and take part in the green shipping corridor online matchmaker.

- CDR Mission: Led the development of and published an Innovation Roadmap, which presents an overview of the current status, innovation needs, and research efforts in MI CDR member countries for CDR approaches. Launched a data sharing platform for members by leveraging the EDX platform from the National Energy Technology Laboratory. Facilitated collaborations and engagements with CDR stakeholder groups including the EU Zero Emissions Platform, IEA GHG R&D Programme, Bellona, CO2RE, and RMI. Launched first sprint project called CDR Launchpad, which encourages information sharing on large scale demonstration and pilot projects. Contributed expertise to technical tracks on BiCRS, mapping, and lifecycle assessment, including expert presentations at workshops and webinars. Provided mission leadership serving as Mission Director.

- Clean Hydrogen Mission: Stimulated research, development and innovation to reduce cost. Took steps to integrate production, storage, distribution and end-use applications in hydrogen valleys. Prepared the ground for the scale-up of the hydrogen economy by building a coalition of partners to provide a clear and coherent enabling environment. As part of our domestic contribution to delivering 100 hydrogen valleys by 2030, the United States announced $8BN for regional hydrogen hubs.

- MI Finance Dialogue: As Mission Innovation members launch new clean energy demonstration projects, financing to de-risk and scale-up these emerging technologies is critical. To bring together expert voices

on this topic with interested MI member governments – Mission Innovation and the United States Department of Energy hosted an MI Financing Masterclass - the first MI Think Tank event. During the event, guest speakers from the Australian Government, U.S. Department of Energy, First Movers Coalition, Energy Transitions Commission, ArcelorMittal, Volvo Group, and HINT.CO GmbH shared their perspectives. MI will continue to explore opportunities to support knowledge exchange on financing emerging clean energy technologies, recognizing its cross-cutting importance to the work of MI and its members. The Financing Masterclass had two parts - presentations from expert speakers and an open discussion period where speakers took questions from attending MI member representatives.

International clean energy collaborations in 2022/23

See Annex A, page 194.

Other clean energy innovation activities in 2022/23

- In 2023, the US launched the Net Zero World Initiative's Climate Smart Women Energy Leader's (CS-WEL) program, which aims to empower women in partner countries by expanding their skills and resources to tackle climate change and promote a global clean energy transition. For the first phase of the initiative, CS-WEL brought together eight female energy leaders from partner countries for intensive training for at DOE National Labs which included topics such as clean energy analysis tools and data, advanced technology performance testing and validation, innovation and entrepreneurship, policy and deployment best practices, and finance mobilization. In addition, the participants had the opportunity to network and engage in leadership training.

- The Energy Earthshots, an initiative launched in 2021, are an all-hands-on-deck call for innovation, collaboration, and acceleration of our clean energy economy by tackling the toughest remaining barriers to quickly deploy emerging clean energy technologies at scale. From June 2022 - September 2023, DOE announced four new Energy Earthshots: (1) Floating Offshore Wind Shot - announced September 15, 2022, with the goal of driving down costs to $45 per megawatt-hour by 2035; (2) Enhanced Geothermal Shot - announced September 8, 2022, i to dramatically reduce the cost of enhanced geothermal systems by 90%, to $45 per megawatt hour by 2035; (3) Industrial Heat Shot – announced September 21, 2022, to develop cost-competitive industrial heat decarbonization technologies with at least 85% lower greenhouse gas emissions by 2035; and Clean Fuels & Products Shot—announced May 24, 2023, decarbonizing the fuel and chemical industry through alternative sources of carbon to advance cost-effective technologies with a minimum of 85% lower GHG emissions by 2035. Through the Energy Earthshot initiative, DOE brings together Department wide efforts, aligning and leveraging existing funding and enhancing collaboration along the RDD& D continuum, across the Department from Science to Applied Energy Offices, ARPA-E, and Infrastructure offices focused on demonstration and deployment. Energy Earthshots have annual summits to convene stakeholders and engage the whole of the R&D community around these cost and performance targets. Six Energy Earthshots held summits from June 2022 - September 2023: Hydrogen Shot held an annual summit (it's second overall) in June 2023; Carbon Negative Shot had an inaugural summit July 2022; Long Duration Energy Storage Shot held an annual summit (second overall) July 2023; Enhanced Geothermal Shot Inaugural Summit was held May 2023; Floating Offshore Wind Inaugural Summit was held February 2023, and Industrial Heat Summit Inaugural Summit was held in September 2023.

- International Energy Agency (IEA): The United States actively supports IEA activities focused on clean energy innovation. Beyond contributing to IEA Secretariat work on clean energy technologies, DOE serves as a Vice Chair of the IEA's Committee on Energy Research and Technology, which oversees a network of 39 autonomous Technology Collaboration Programmes (TCPs). IEA members launch TCPs through a legal

framework, or contracting arrangement, enables lasting partnerships. Some are nearly 50 years old. DOE also holds leadership positions in two CERT working parties, including chairing the Renewable Energy Working Party. Working parties oversee TCP activities within their respective scope. DOE programs participate, bottom-up, in roughly 30 of these TCPs, collaborating on issues and technologies ranging from user-centered energy systems to efficient energy-use technologies to smart grids to bioenergy to elements of future of energy systems, as well as crosscutting issues like energy technology systems analysis and opportunities to improve gender diversity in the energy sector.

- National Labs: DOE has 17 national laboratories that host thousands of visitors each year to conduct trainings, use their world class facilities – oftentimes at no cost, and share the breadth and depth of U.S. technology innovation.

Annex A: International Clean Energy Collaborations

(tables in Alphabetical order of MI Countries)

AUSTRALIA

Other countries involved	**Name of collaboration**	**Objective of activities or outcomes**	**Sectors involved** (PP /PR)*	**Type of collaboration** (research, development, and/or demonstration)	**Start Date** (Year)	**End Date** (Year)	**Funding amount**	**Additional information** (link)
Germany	German-Australia Hydrogen Innovation and Technology Incubator (HyGATE)	To reduce the cost of renewable hydrogen production and support technology innovation in the industry.	PP	Research, development and demonstration	2023		AUS$50 million + €50 million for 4 projects in 2023.	Growing Australia's hydrogen supply chain with Germany | Ministers (dcceew.gov.au)
Netherlands	Australia-Netherlands MoU on green hydrogen	To promote clean energy supply chains between Australia and the Netherlands on green hydrogen	PP	Research	30 Jan 2023	TBC		Australia and the Netherlands ink deal to advance cooperation on hydrogen | Ministers (dcceew.gov.au)
Indonesia	Australia-Indonesia Energy Dialogue	To identify scope for cooperation between Australia and Indonesia. Australia has hosted both a CCUS and Hydrogen study tour under this partnership arrangement to further policy and regulatory knowledge between the two countries.	PP	Capacity Building, Policy Development	2022	TBC	$1.6M	https://minister.dcceew.gov.au/bowen/media-releases/partnering-indonesia-climate-and-energy

Singapore	Australia-Singapore Initiative on Low Emissions Technologies for Maritime and Port Operations (ASLET)	Accelerate the deployment of low emissions fuels and technologies like clean hydrogen to reduce emissions in maritime and port operations.	PR	RD&D	2022	2026	AUS$10M towards $30M total	https://www.dcceew.gov.au/climate-change/international-commitments/international-partnerships#singapore
Singapore	Australia-Singapore Memorandum of Understanding on Low Emissions Solutions	Exchange on policy, regulatory and technical matters. Australia organised policy workshops with Singapore, ROK and Japan under the existing partnerships agreements. The objective of the workshops was to discuss the challenges in moving CO2 between countries.	PP	Policy Development	2023		N/A	www.dcceew.gov.au/about/news/australia-and-singapore-to-work-together-to-accelerate-low-emissions-technologies
Republic of Korea	Australia – ROK Low and Zero Emissions Technology Partnership Agreement	Exchange on policy, regulatory and technical matters. Australia organised policy workshops with Singapore, ROK and Japan under the existing partnerships agreements. The	PP	Policy development	2023		NIl	https://www.dcceew.gov.au/about/news/new-low-emissions-technology-partnership-with-the-republic-of-korea

		objective of the workshops was to discuss the challenges in moving CO2 between countries.						
Japan	Australia – Japan Partnership on Decarbonisation through Technology	Exchange on policy, regulatory and technical matters. Australia organised policy workshops with Singapore, ROK and Japan under the existing partnerships agreements. The objective of the workshops was to discuss the challenges in moving CO2 between countries.			2023		NIl	Japan-Australia partnership on decarbonisation through technology | Ministers for the Department of Industry, Science and Resources
G7 members + Chile, Argentina, Austria, Colombia, EC, Denmark, Indonesia, Kenya, South Korea, Luxembourg, The Netherlands, Norway, Singapore, Switzerland, Uruguay, Vanuatu, Ukraine, Egypt, Morocco	Climate Club	The decarbonisation of hard-to-abate industrial sectors, under 3 pillars: 1. Advancing ambitious and transparent mitigation policies; 2. Transforming industries; and 3. Boosting international cooperation and partnerships	PP	Research and demonstration	2023	TBC	-	

Australia, Belgium, Colombia, Denmark, Germany, Ireland, Japan, Netherlands, Norway, Portugal, Spain, Saint Lucia, the UK and the US	Global Offshore Wind Alliance	To achieve a total global offshore wind capacity of a minimum of 380 GW by 2030, with 35 GW on average each year across the 2020s and a minimum of 70 GW each year from 2030	PP	Research	2022			GOWA (irena.org)
IEA members	Technology Collaboration Programs (TCP), including: • Hydrogen TCP • Photovoltaic Power Systems • Solar Heating and Cooling • SolarPACES	Depends on the TCP	PP/PR	Research and demonstration	ongoing	-	Varies across TCPs	Technology collaboration - About - IEA
India	India-Australia Green Hydrogen Taskforce	Increase the trade, commercial and research opportunities between India and Australia through the manufacture and deployment of green hydrogen.	PP	Capacity Building, policy development	2023	2024	NIL	India-Australia Green Hydrogen Taskforce - DCCEEW
India	India-Australia Solar Taskforce	Identify and advise both governments on opportunities in solar to increase the trade, commercial and research opportunities between India and Australia, and provide expert	PP	Capacity Building, policy development	2023	2023	NIL	Press Statement New Delhi, India | Prime Minister of Australia (pm.gov.au)

		advice on potential joint initiatives to accelerate the manufacture and deployment of solar technology.						
Canada, Egypt, the EU, Japan, Saudia Arabia, the UAE, the US, Norway and Denmark	Carbon Management Challenge 2023	Aims to accelerate carbon capture, removal, use, and storage technologies.	PR	Demonstration	2023	2023	-	

AUSTRIA

Other countries involved	**Name of collaboration**	**Objective of activities or outcomes**	**Sectors involved** (PP /PR)*	**Type of collaboration** (research, development, and/or demonstration)	**Start Date** (Year)	**End Date** (Year)	**Funding amount**	**Additional information** (link)
EC, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Latvia, Lithuania, The Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Slovakia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.	Driving Urban Transitions Partnership – Call 2023	Support transnational research and/or innovation projects addressing urban challenges to help cities in their transition towards a more sustainable economy and functioning. Topics with Austrian engagement; "Plus-energy districts", "Mobility in the 15-minute city" and "Circular economy"	PR	rom research to innovation and implementation	1 September 2023	Funding decision July 2024	€6.6M	https://www.ffg.at/ausschreibungen/dut2023 https://dutpartnership.eu/funding-opportunities/dut_call_2023/
26 EU Member States and 5 Associated Countries ; MI – funding partners from outside of Europe are US, Canada, India and Morocco	Clean Energy Transition Partnership, Joint Call 2023	The CETPartnership aims to empower the clean energy transition and contribute to the EU's goal of becoming the first climate-neutral continent by 2050, by pooling national and regional RDTI funding for a broad variety of technologies and system solutions required to make the transition.	PR	Research & development	20 September 2023	Funding decisions July 2024	€4.7M in total €2M (Integrated industrial energy systems) €0.4M (Direct current (DC) technologies for power grids) €1.5M (Hydrogen and renewable fuels)	Joint Call 2023 | CETPartnership
TCPs are concluded between	Research Cooperation IEA	Since Austria joined the International	PR	Research and development services	19 May 2023	Funding decision:	€3.3M	Forschungskooperation Internationale

interested **IEA member** countries and **partner countries**	Call 2023	Energy Agency (IEA), Austria has been actively involved in the IEA Technology Collaboration Programmes (TCPs). These are an important complement to national energy research. The focus of the call is to ensure Austrian participation in the research activities of the IEA and to enable the dissemination of the results obtained and the networking activities.				October 2023		Energieagentur (IEA) – Ausschreibung 2023 | FFG

CANADA

Other countries involved	Name of collaboration	Objective of activities or outcomes	Sectors involved (PP /PR)*	Type of collaboration (research, development, and/or demonstration)	Start Date (Year)	End Date (Year)	Funding amount	Additional information (link)
United States	Natural Resources Canada – US Department of Energy Memorandum of Understanding and MOU Action Plan	The MOU and associated Action Plan, is a key milestone in meeting the commitments set out in the Roadmap for a Renewed US-Canada Partnership. It increases bilateral cooperation on sustainable and equitable energy transitions, clean energy innovation, connectivity and low carbon transportation, including in clean electricity, clean fuels, energy efficiency, critical minerals, nuclear energy, and CCUS.	PP	Policy discussions leading to potential RD&D collaborations.	2021	2026	N/A	https://www.nrcan.gc.ca/energy/resources/international-energy-cooperation/memorandum-understanding/23749
Germany	Canada-Germany Energy Partnership	Canada and Germany to foster energy transformation through exchanges on policy, best practices and technologies as well as through cooperative activities and projects focused on: energy policy, planning and regulations; resilient electricity systems that can integrate high levels of renewables; energy efficiency; sector coupling and low-carbon fuels; and, innovation and applied research. Launched in 2021, the implementation of this Partnership continued in with the endorsement of the 2023-24 Partnership Action Plan.	PP	Policy discussions leading to potential RD&D collaborations	2021	Ongoing	N/A	https://www.nrcan.gc.ca/energy/resources/international-energy-cooperation/memorandum-understanding-between-the-department-natural-resources-canada-and-the-fede/23423
Germany	German Canadian Materials Acceleration Centre	GCMAC is focused on bringing together Canadian and German research communities to align approaches, promote common methodologies & set standards, and train researchers of the future in accelerated materials discovery techniques through workshops, webinars, events, researcher and knowledge exchange and joint R&D projects.	PP	R&D collaboration	2021	2026	€6M	https://gcmac.de/
Japan	Canada-Japan Energy Policy Dialogue	Collaboration between Canada and Japan focuses on the following key areas: oil and gas, CCUS/carbon recycling, hydrogen, atomic energy, and critical minerals. Working together, this relationship aims to advance technical cooperation and build on existing partnerships to deepen knowledge exchange and develop sustainable industries.	PP	Policy discussions leading to potential RD&D collaborations.	2020	Ongoing	N/A	N/A

European Union	Canada-EU High Level Energy Dialogue	Established in 2007, the dialogue is updated regularly to reflect the latest opportunities for collaboration on shared priorities (e.g. hydrogen).	PP	Policy discussions leading to potential RD&D collaborations	2022 (updated)	Ongoing	N/A	N/A
IEA Member Countries	International Energy Agency (IEA) Committee on Energy Research and Technology (CERT), Working Parties, and Technology Collaboration Programmes (TCPs)	The CERT co-ordinates and promotes the development, demonstration and deployment of technologies to meet challenges in the energy sector. Canada currently chairs the CERT committee, participates in its four working parties and 22 of the IEA's 38 Technology Collaboration Programmes (TCPs), including the International Smart Grid Action Network (ISGAN) and the Greenhouse Gas R&D Programme, (IEAGHG), and others.	PR (TCPs can include private sector)	RD&D	CERT was created in 1975.	Ongoing	Canada provided $588,500 (CAD) in 2020-2021 to IEA grants such as TCP membership fees.	https://www.iea.org/about/structure

CHILE

Other countries involved	**Name of collaboration**	**Objective of activities or outcomes**	**Sectors involved** (PP /PR)*	**Type of collaboration** (research, development, and/or demonstration)	**Start Date** (Year)	**End Date** (Year)	**Funding amount**	**Additional information** (link)
USA	Net Zero World Initiative	- Develop rigorous, country-driven net zero pathways and technical and investment plans, at the energy-system-wide level as well for the power, transportation, and other sectors at national or subnational level, - Enable transformative decarbonization actions, including deep technical and analytic support for key levers, such as technology cooperation, policy solutions, procurements, investment mobilization, and workforce development, and - Accelerate investment mobilization by translating technical pathways into detailed investment plans and engaging with public and private sector partners to support robust project pipelines.	PP	Research, development, and demonstration	2022	-		
Denmark (Mærsk Mc-Kinney Møller Cetner for Zero Carbon Shipping)	Pre-feasibility study and mapping of green corridor potential for the decarbonization of Chilean maritime transport	The objective is to promote the formation of consortiums among various actors operating in the value chain of the corridors, who have the potential to materialize these green corridors in the country.	PR	Research	2022	2023		
Germany	Energy Partnership	Promoting sustainable energy transition	PP	Research, development, and demonstration	2019	-		https://www.energypartnership.cl/es/home/acerca-de-la-alianza-energetica/

CHINA

Other countries involved	**Name of collaboration**	**Objective of activities or outcomes**	**Sectors involved** (PP /PR)*	**Type of collaboration** (research, development, and/or demonstration)	**Start Date** (Year)	**End Date** (Year)	**Funding amount**	**Additional information** (link)
Italy, Singapore, France	The "Green Powered Future" Mission Cooperation Project	Green power technology	PR	Research, development and demonstration	2023	2026	25 million RMB	https://service.most.gov.cn/u/cms/static/202211/%E2%80%9C%E6%94%BF%E5%BA%9C%E9%97%B4%E5%9B%BD%E9%99%85%E7%A7%91%E6%8A%80%E5%88%9B%E6%96%B0%E5%90%88%E4%BD%9C%E2%80%9D%E9%87%8D%E7%82%B9%E4%B8%93%E9%A1%B92023%E5%B9%B4%E5%BA%A6%E7%AC%AC%E4%B8%80%E6%89%B9%E9%A1%B9%E7%9B%AE%E7%94%B3%E6%8A%A5%E6%8C%87%E5%8D%97_20221109121612.pdf
European Union	China-EU Research and Innovation Flagship Cooperation Project	Data and model development and pathway simulation of global climate governance and carbon neutrality	PR	Research, development and demonstration	2023	2026	30 million RMB	
The United Kingdom, Greece, Italy, Spain, Portugal	China-Europe National Joint Laboratory Cooperation Project	Environment and energy	PP	Research and development	2022	2025	Unpublished	
Germany	China-Germany Intergovernmental Science and Technology Cooperation Project	Hydrogen and fuel cell vehicle	PR	Research, development and demonstration	2023	2026	20 million RMB	
Italy	China-Italy Intergovernmental Science and Technology Cooperation Project	Green energy	PP	Research and development	2023	2026	Unpublished	
Russia	China-Russia Intergovernmental Science and Technology Cooperation Project	Low-carbon technology	PP	Research and development	2023	2025	Unpublished	
Korea	China-Korea Intergovernmental Energy Technology Joint Research Project	Clean thermoelectric technology and renewable energy	PR	Research, development and demonstration	2023	2026	15 million RMB	
Spain	China-Spain Intergovernmental Science and Technology Cooperation Project	Clean technology	PR	Research, development and demonstration	2023	2026	Unpublished	
Belgium	China-Belgium (Wallonia) Intergovernmental Science	Environment and green technology	PR	Research, development and demonstration	2022	2025	Unpublished	

	and Technology Cooperation Project							
Poland	China-Poland Intergovernmental Scientific and Technological Innovation Cooperation Project	Energy science and technology	PP	Research and development	2023	2025	Unpublished	
Finland	China-Finland Intergovernmental Science and Technology Cooperation Project	Intelligent green energy	PR	Research, development and demonstration	2023	2026	Unpublished	

DENMARK

Other countries involved	Name of collaboration	Objective of activities or outcomes	Sectors involved (PP = public – public or PR = public-private)	Start Date (Year)	Funding amount	Additional information (e.g. link to website)
China, Mexico, South Africa, Vietnam, Ukraine, Indonesia, India, Ethiopia, Turkey, Egypt, United Kingdom, Germany, USA, South Korea, the Netherlands, Poland, Kenya, France, Japan	Government to government cooperation	The Danish Energy Agency cooperates with several governments in order to contribute to their reduction of carbon emissions and to assist in their energy transition to become a low-carbon economy.	PP	2013 (Vietnam)	Newest agreement for Danish Energy Partnership Programme collaboration with Vietnam from 2021-2025 with grant of USD 10 million.	https://ens.dk/en/our-responsibilities/global-cooperation/country-cooperation
Members of commission: Oman, Norway, Italy, Senegal, Chile, Colombia, Mexico, Canada, Guyana, Spain, Indonesia, Belgium	Chairmanship for the IEA Global Commission on People-Centred Clean Energy Transitions	The commission will focus on the social and economic impact on individuals and communities in the energy transition as well as on affordability and fairness.	PP	2021 (Chairmanship) Denmark has been a member of the IEA since 1974.		https://www.iea.org/news/new-global-commission-headed-by-danish-prime-minister-will-focus-on-putting-people-at-the-heart-of-energy-transitions
Costa Rica, France, Greenland, Ireland, Sweden, Wales and Quebec. Associate members: California, New Zealand, Portugal.	Beyond Oil and Gas Alliance	Aims to Raise global climate ambitions and align oil and gas production with the Paris Agreement goal of "well below 2ºC, pursing efforts for 1.5ºC". To ensure that this topic is placed firmly on the international energy and climate agenda, and normalize the need for an equitable global managed phase-out of oil and gas production to meet the objectives of the Paris Agreement as well as climate neutrality commitments.	PP	2021		https://beyondoilandgasalliance.com/
Denmark, Norway, Sweden, Finland, Iceland, Faroe Islands, UK	Climate Investment Coalition	The Climate Investment Coalition (CIC) is public-private partnership mobilising financial commitments towards investments in clean energy and climate solutions now and towards 2030. The CIC was established in 2019 by the Government of Denmark, Insurance &	PR	2019	2021: commitment of US$130 billion from Nordic and UK pension funds to be invested in clean energy and climate solutions by 2030.	https://www.climateinvestmentcoalition.org/about

		Pension Denmark, the Institutional Investors Group on Climate Change (IIGCC) and World Climate Foundation				
	The Danish Government's Climate Partnerships (the most recent, number 14: Defence)	The Danish government has formed 14 climate partnerships. The partnerships are tasked with presenting a proposal on how their individual sector can contribute to CO2e reductions in a just way, supporting Danish competitiveness, exports, jobs, welfare and prosperity. This has resulted in more than 400 recommendations.	PR	2022 (Defence)		https://climatepartnerships2030.com/

EUROPEAN COMMISSION

Other countries involved	**Name of collaboration**	**Objective of activities or outcomes**	**Sectors involved** (PP /PR)*	**Type of collaboration** (research, development, and/or demonstration)	**Start Date** (Year)	**End Date** (Year)	**Funding amount**	**Additional information** (link)
Morocco	REFFECT Africa	The EU-funded REFFECT AFRICA project will develop innovative, reliable and adapted sustainable energy solutions based on the valorisation of biomass wastes from agriculture and the food industry through biomass gasification. Full-scale demonstrators will be built in Morocco, Ghana and South Africa to consider both urbanised and rural contexts on the continent. The project will propose solutions for on-grid and off-grid communities, such as the generation of renewable energy, its transmission and the use of storage systems.	PR	Demonstration	2021	2026	EUR 8.1 million	
Morocco	SESA	Implemented in nine African countries, the EU-funded SESA project will develop and test solutions to accelerate the green transition and energy access in Africa. It will explore innovative technologies and services in urban and rural contexts and support their uptake, deepening technical, financial and policy aspects. Specifically, SESA will co-develop innovations with local partners. The first phase will start in Kenya, where solutions include using water hyacinths from Lake Victoria to produce biogas. In the second phase, SESA will test energy solutions in Ghana, Malawi, Morocco and South Africa. The findings, included in a scalable toolbox for advanced implementation and management strategies, will facilitate the applicability and replicability of the technologies.	PR	Demonstration	2021	2025	EUR 10.2 million	
India		The call 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' will be co-funded by India and possibly the other members of the MI Integrated Biorefineries Mission.		Development	2024 budget		EUR 7 million	Funding & tenders (europa.eu)
India, Brazil, Canada		The Horizon Europe ICARUS project has just started in support of MI Sustainable Biofuels / Integrated Biorefineries Mission / Innovation for International Sustainable Aviation Fuel Collaborative Module. The project involves 5 MI countries.		Research	2023	2026	EUR 3.2 million	
Various	CETP Partnership with Power Mission	The joint call module with CETPartnerhip: "Innovative solutions for system flexibility: renewables production, storage and system integration" opened in Sept 2023. Projects with partners outside Europe are expected to foster the CETPartnership approach worldwide, also contributing to link		Research	2023			

		the GPFM Internet-based platform to the CETPartnership knowledge community.						
Spain, Italy, others								

FRANCE

Other countries involved	**Name of collaboration**	**Objective of activities or outcomes**	**Sectors involved** (PP = public – public or PR = public-private)	**Type of collaboration** (research, development, and/or demonstration)	**Start Date** (Year)	**End Date** (Year)	**Funding amount**	**Additional information** (e.g. link to website)
EU, Iceland, Switzerland, Turkey, Norway, USA	ERANet Geothermica	Combination of 17 geothermal energy research and innovation programme owners and managers from 14 countries and their regions.	Public – private	Demonstration and technology development projects to accelerate geothermal energy deployment	2021	Call Close on **31 Januar y 2022**		http://www.geothermica.eu/joint-call-2021/
EU	CETP	The co-funded partnership on Clean Energy Transition (CETP) aims at addressing the challenge of a climate-neutral economy through R&I in clean energy technologies thus accelerating the clean energy transition. The CETP is embedded in and contributes to a wider national, European and global policy context and implementation instruments and contributes to their overarching goals.	public-private	transformative research, development and innovation programme	The *CETPartship Joint Call for 2022* has been launched in september 2022.	2027		https://www.horizon-europe.gouv.fr/le-partenariat-clean-energy-transition-30809
EU, Israel, Brazil, Canada, Turkey, Taiwan, South Africa, South Korea	M ERA. Net	Materials sciences and Batteries: Modeling for materials engineering and processing, Innovative surfaces, coatings and interfaces, High performance composites, Functional materials, New strategies for advanced material-based technologies in health applications, Materials for Additive Manufacturing Fuel cells	Public – private	Research TRL 2 -4	The M-ERA.NET Joint Call for 2023 has been launched in March 2023.		25 M€	https://m-era.net/joint-calls/joint-call-2022
EU, Turkey, Canada, South Africa	Eramin 3	Raw Materials for Batteries: Supply of raw materials from exploration and mining (also for batteries, namely Li), Design, Processing, Production and Remanufacturing, Recycling and Re-use of End-of-life products (as well batteries), Cross-cutting topic	Public – private	Research and development	2021 Call for 2023 was launched in December 2022.		19,5 M€	https://www.era-min.eu/joint-call/era-min-joint-call-2021
EU	BATT4EU	BATT4EU is a Co-programmed Partnership established under Horizon Europe (The next Framework Programme for Research and Innovation of the European Union)	Public – private	transformative research, development and innovation programme	2022			https://www.horizon-europe.gouv.fr/le-partenariat-sur-les-batteries-batt4eu-30827

EU	Clean H2	The Clean Hydrogen Partnership will accelerate the development and deployment of the European value chain for clean hydrogen technologies, contributing to sustainable, decarbonised and fully integrated energy systems. Together with the Hydrogen Alliance, it will contribute to the achievement of the Union's objectives put forward in the EU hydrogen strategy for a climate-neutral Europe. It will focus on technology R&I for producing, distributing and storing clean hydrogen as well as solutions for hard to abate sectors, such as energy intensive industries and heavy-duty transport.	Public – private	transformative research, development and innovation programme	2022	2022	300 M€	https://hydrogeneurope.eu/clean-h2-partnership/
EU	European Clean Hydrogen Alliance	The European Clean Hydrogen Alliance support the creation of a European hydrogen industry and the deployment of clean hydrogen for Europe's green transition.	Public – private	transformative research, development and innovation programme	2022		Up to 3,2 G€ thanks to the IPCEI program (French participation)	the first projects have been selected https://single-market-economy.ec.europa.eu/industry/strategy/hydrogen/ipceis-hydrogen_en
Canada, Denmark, France, Germany, Greece, India, Italy, The Netherlands, Norway, the Nordic Region, Romania, Spain, Switzerland, Turkey, UK, USA	ACT – Accelerating CCS technologies	ACT is an international initiative to facilitate RD&D and innovation within CO2 capture, transport, utilization and storage (CCUS).	Public-private	transformative research, development and innovation programme	2016	Ongoing		Calls ACT (act-ccs.eu)
EU + associated	Horizon Europe,	This cluster aims to fight climate change by better understanding its causes, evolution,	Public-private	Research, development and demonstration	2021	2027		https://ec.europa.eu/info/res

countries	Cluster 5 on Climate, Energy and Mobility	risks, impacts and opportunities, and by making the energy and transport sectors more climate and environment-friendly, more efficient and competitive, smarter, safer and more resilient.						earch-andinnovation/ fun ding/fundingopportunities/ f undingprogrammesand-opencalls/ horizoneurope/ cluster -5-climateenergy-andmobility_ en
IEA member countries	IEA research cooperation call 2023	France contributes to the IEA technology programmes. France is represented in most of the TCPs.	Public-private	R&D services	2022			https://www.iea.org/programmes/technology-collaboration-programme
EU, Israel, Turkey, UK	Solar Eranet	Solar Eranet aims at the development of solar energy solutions for the energy transition, boosting the R&D initiatives in that field.	Public-private	transformative research, development and innovation programme	2021	2025		https://www.solar-era.net/

GERMANY

Other countries involved	Name of collaboration	Objective of activities or outcomes	Sectors involved (PP /PR)*	Type of collaboration (research, development, and/or demonstration)	Start Date (Year)	End Date (Year)	Funding amount	Additional information (link)
Global	Energy and climate partnerships and energy dialogues.	The aim is to build reliable partnerships for expanding renewable energies and integrating them into the system, increasing energy efficiency, integrating joint climate instruments such as carbon pricing, and managing the environmental and social dimensions of this transition. Collaboration is also increasingly focused on energy security.	Public- Private	Demonstration	2022	Ongoing		https://www.bmwk.de/Redaktion/EN/Textsammlungen/Energy/international-energy-policy.html
EU	The Clean Energy Transition Partnership (CETPartnership)	The co-funded Clean Energy Transition Partnership (CETP) aims to address the challenge of a carbon-neutral neutral economy and develop clean energy technology solutions to accelerate the transition to clean energy.	Public- Public (co-founded partnership between EC and MS/AC under Horizon Europe - Cluster 5: Climate, Energy and Mobility)	Research, development	2022	2027	Federal government: € 18 million State NRW: € 1 million State Saxony: € 3 million	https://www.energieforschung.de/antragsteller/foerderangebote/foerderaufruf/cetp-joint-call-2022 https://cetpartnership.eu/about
EU	European Partnership on Clean Hydrogen	The aim is to accelerate the development and deployment of the European value chain for clean hydrogen technologies. The partnership will contribute to a sustainable, decarbonized and fully integrated energy system, thus advancing the implementation of the EU Hydrogen Strategy.	Public – Private	Research and innovation activities	2022	2027	€ 2 billion	https://www.clean-hydrogen.europa.eu/index_en
EU	European Partnership Driving Urban Transitions to a Sustainable Future (DUT)	The aim is to create an environment for science-policy cooperation and mobilization of cities, urban districts, companies, social actors and research institutions.	Public – Private	Research, development	2022	Ongoing		https://jpi-urbaneurope.eu/driving-urban-transitions-to-a-sustainable-future-dut/
EU	IPCEI Hydrogen: Important Project of	Within the framework of the IPCEI Hydrogen, integrated projects along the entire the entire hydrogen value chain,	Public – Private	Research, development	2022	Ongoing	Up to € 10 billion	https://commission.europa.eu/projects/hydro

	Common European Interest	from the production of green hydrogen and the necessary infrastructure to its use in industry and for mobility.						gen-projects-within-framework-ipceis_en
The Netherlands	Electrochemical Materials and Processes for Green Hydrogen and Green Chemistry (ECCM)	The aim is to cover the entire innovation chain of green hydrogen and green chemistry, from basic research to industrial application involving end users. The funding call covers five areas: Electrolysis (including hydrogen storage and power-to-X technologies), electro-synthesis, materials and catalysis, development and manufacturing processes for electrolysis systems, and system design and integration.	Public – Private	Research, development	2022	ongoing	Up to € 2 million	https://www.energieforschung.de/foerderaufruf-eccm
Australia	Research alliance HYGATE (German-Australian Hydrogen Innovation and Technology Incubator)	This initiative aims to develop and to improve hydrogen technologies and to test them under real-life conditions before bringing them to scale. HyGATE thus addresses the most important challenges in building a global hydrogen economy.	Public – Private	Research, development	2023	ongoing	€ 50 million	https://www.bmwk.de/Redaktion/EN/Pressemitteilungen/2021/06/20210613-declaration-of-intent-signed-to-establish-german-australian-hydrogen-alliance.html
Namibia	Research and development collaboration with Namibia. First pilot project “Daures Green Hydrogen Village”	Support of the national Hydrogen strategy, pilot projects and student grants.	Public – Private	Research, development	2022	Ongoing		https://daures.green/
Namibia	Oshivela	Pilot project Green H_2 production for iron ore reduction. The aim of the Oshivela project is to demonstrate a climate-neutral iron production technology on a first industrial scale.	Public – Private	Research, development, and demonstration	2022	2024	€ 13.8 million	https://hyiron.com/oshivela https://www.enargus.de/search/?q=oshivela

South Africa	HyShift	Green hydrogen production for a market ramp-up of sustainable power-to-liquid (PtL) fuels for CO2-neutral aviation	Public – Private	Research, development, and demonstration	2022	2024	€ 15 million	https://www.hyshift.org https://www.enargus.de/search/?q=Hyshift
South Africa	CARE-0-SENE	The goal is to accelerate the knowledge-based development of FT catalysts for the highly efficient and sustainable production of SAF in relevant quantities necessary for the transformation of the aviation sector.	Public – Private	Research, development, and demonstration	2022	2025	€ 29.9 million	https://www.hyshift.org https://www.enargus.de/search/?q=Hyshift
Saudi Arabia	Element One (NEOM)	Development and Production of green Hydrogen (20 MW water electrolysis module) / Ammonia based on solar and wind-power.	Public – Private	Research, development, and demonstration	2021	2024	€ 1.5 million	https://www.bmwk.de/Redaktion/DE/Pressemitteilungen/2020/12/20201216-altmaier-uebergibt-foerderbescheid-fuer-internationales-projekt-fuer-gruenen-wasserstoff.html
Canada, India, Norway, United States	ACT fourth Call.	Advancing CCUS Technology. The aim is to facilitate the deployment of CCUS in the energy and industrial sectors	Public – Private	Research and development	2022	2026	€ 3 million	http://www.act-ccs.eu/calls
Spain, Turkey, Switzerland and Israel	CSP ERA-NET Additional Call 2021 (*)	Strategic targets (based on priorities identified in the (SET) Plan: Short-term: > 40% cost reduction; Longer-term: develop the next generation of CSP/STE technology	Public – Private	Research and development	2021	2025	€ 3 million	https://csp-eranet.eu/calls/additional

(*) In addition, Germany also participates in the European ERA-Net activities: Geothermica, SOLAR-ERA.NET and ERA-NET SES.

INDIA

Other countries involved	**Name of Collaboration**	**Objective of activities or outcomes**	**Sectors involved** (PP /PR)*	**Type of collaboration** (research, development, and/or demonstration)	**Start Date** (Year)	**End Date** (Year)	**Funding amount**
Denmark	Indo-Danish programme of Cooperation in the field of Green Hydrogen	Development of 100 L volume ZDHYDRO model for hydrogen production from sewage sludge targeting circular economy	PP	Demonstration	2023	2026	INR 1,07,06,702 (USD 128,604)
		Development of a full-scale pilot plant for the production of Green Fuels and enabling future green hydrogen will be established in India	PR	Demonstration	2023	2026	INR 95,47,385 (USD 114,678)
		A pilot scale U-reactor demonstration plant of 20 kg/hr feed capacity in India	PP	Demonstration	2023	2026	INR 1,11,87,446 (USD 134378)
		Development of a power electronic converter for the electrolyzer stack	PP	Demonstration	2023	2026	INR 1,66, 15,172 (USD 199573)
Denmark, Netherlands, Poland, Greece, United Kingdom, Spain	India-EU Joint Call On Integrated Local Energy Systems	Smartly integrating a large amount of renewable energy in local energy systems	PP	Research, development, and demonstration	2021	2024	INR 24,80,91,233 (USD 2.97 million)

JAPAN

Other countries involved	**Name of collaboration**	**Objective of activities or outcomes**	**Sectors involved** (PP /PR)*	**Type of collaboration** (research, development, and/or demonstration)	**Start Date** (Year)	**End Date** (Year)	**Funding amount**	**Additional information** (link)
Denmark	International Collaborative Research for Standard Ground Erosion Tests Against Blade Erosion	The purpose of this project is to standardize ground test facilities to establish a prediction method for the erosion characteristics of wind turbine blades via international joint research with Technical University of Denmark. By conducting erosion tests using common standard blades with three kinds of test equipment (a pulse jet type, a whirling arm type, and a rubber ball type), the relationship between erosion initiation and number of impacts will be explained through measurements and theoretical calculations, and a basis for the standardization of testing methods will be established.	PR	R&D	2022	2025 (scheduled)	max JPY50M	https://www.nedo.go.jp/english/activities/activities_ZZJP_100173.html
UK	International Collaborative Research for Electrochemical Ammonia Synthesis Under Ambient Conditions	This project aims to realize the electrochemical synthesis of ammonia from nitrogen and water at room temperature via international joint research with Imperial College London (ICL) in the UK. Based on unique electrolyte design and operando reaction analysis of Osaka University (OU), a highly efficient conversion reaction of nitrogen-ammonia will be realized.	PR	R&D	2022	2025 (scheduled)	max JPY50M	https://www.nedo.go.jp/english/activities/activities_ZZJP_100173.html

NORWAY

Other countries involved	Name of collaboration	Objective of activities or outcomes	Sectors involved (PP /PR)*	Type of collaboration (research, development, and/or demonstration)	Start Date (Year)	End Date (Year)	Funding amount	Additional information (link)
Denmark, France, Germany, Greece, India, Italy, The Netherlands, Norway, the Nordic Region, Romania, Spain, Switzerland, Turkey, UK and the USA	ACT – Accelerating CCS tech-nologies	ACT is an international initiative to facilitate RD&D and innovation within CO_2 capture, transport, utilization and storage (CCUS).	Public-private	RD&D	2016	2026	Approx. EUR 14 mill. For the 4th Call in September 2022.	Calls — ACT (act-ccs.eu)
EU member states + 17 associated countries (mainly Europe)	Horizon Europe	Horizon Europe is the EU's key funding programme for research and innovation.	Public-private	RD&D	2021	Ongoing (2027)	95,5 billion Euro	Horizon Europe | European Commission (europa.eu)
31 member countries + 11 associated countries	IEA	The IEA works with governments and industry to shape a secure and sustainable energy future for all.	Public-public	R&D				
30 countries, European Member States and Associated Countries	CETP	The Clean Energy Transition Partnership is a multilateral and strategic partnership of national and regional RDI programs.	Public-private	RD&D	2022	Ongoing (2027)	210 mill Euro (two calls 2022 and 2023	Home | CETPartnership
27 European countries	DUT	Driving Urban Transitions to a Sustainable Future is the new programme of JPI Urban Europe starting in 2022	Public-private	RD&D	2022	Ongoing		Driving Urban Transitions - Sustainable future for cities | JPI Urban Europe (jpi-urbaneurope.eu)
Norway, Sweden, Finland, Denmark, Iceland, (Faroe Islands, Åland and Greenland)	Nordic Energy Research	Nordic Energy Research is the platform for co-operative energy research and policy development under the auspices of the Nordic Council of Ministers.	Public-public	R&D	1975	Ongoing		Nordic Energy Research
United States + 25 other countries	CCS/TCM (Test Centre Mongstad)	Norway collaborates on CCUS with the US and several other nations through organizations such as CSLF TG, CEMCCUS) and MI CCUS&CDR. In addition, the US (DOE) and Norway (OED) operates under a MoU with special focus on promoting cooperation on CCUS	Public-private	RD&D		Ongoing		Carbon Sequestration Leadership Forum (CSLF) - Climate Initiatives Platform

REPUBLIC OF KOREA

Other countries involved	Name of collaboration	Objective of activities or outcomes	Sectors involved (PP = public – public or PR = public-private)	Type of collaboration (research, development, and/or demonstration)	Start Date (Year)	End Date (Year)	Funding amount	Additional information (e.g. link to website)
USA	ROK-US Energy Policy Dialogue	Share information, carry out joint R&D project, etc.	PP	research, development	2011	not decided	approx.* 840million KRW/year, project	
Canada	·(KETEP) Memorandum of Understanding between the Korea Institute of Energy Technology Evaluation and Planning and the Innovation and Energy Technology Sector of the Department of Natural Resources of Canada on Cooperation in Clean Energy Technologies	Cooperating in below areas · CCUS · Renewable Energy · Distributed Power Generation, including Smart Grid and Storage Technologies · Combined heat and power generation · Next Generation Transportation · IOT application in energy technologies · Natural resources (shale gas, oil)	PP	research, development	2014	not decided	approx.* 780million KRW/year, project	
Spain	·(KETEP) Memorandum of Understanding on Industrial Technology Cooperation in the field of Energy between KETEP and CDTI	Cooperating in below areas · Nuclear power · Sustainable energy and Energy Efficiency · Distributed Energy and Energy Efficiency · Distributed Power Generation including Smart Grid · Micro Grid and ESS	PP	research, development	2017	not decided	approx.* 360million KRW/year, project	
Germany	(MOTIE) The German-Korean Energy Partnership	·The expansion and system integration of renewable energies ·Increasing energy efficiency ·energy systems of the future ·Green hydrogen	PP	research, development	2019	not decided	-	
Czech Republic	·(KETEP) Memorandum of Understanding on Information Exchange between the Korea Institute of Energy Technology Evaluation and Planning and the	Cooperating in below areas · Nuclear Power and Safety · Renewable Energy · Energy Efficiency	PP	research, development	2021	not decided	approx.* 440million KRW/year, project	

	Technology Agency of the Czech Republic	· Distributed Power Generation, including Smart Grid, Micro Grid and ESS · Electricity Transmission and Distribution						
Norway	·(KETEP) Money Follows Cooperation Agreement between the Korea Institute of Energy Technology Evaluation and Planning (KETEP) and the Research Council of Norway (RCN)	Cooperating in below areas · Renewable Energy, · Energy Efficiency · Smart grid · ESS	PP	research, development	2019	not decided	approx.* 520million KRW/year, project	
China	·(MOTIE) Memo of the Ministry of Trade, Industry and Energy (MOTIE) of the Republic of Korea and the Ministry of Science and Technology (MOST)of the People's Republic of China on the Joint Program for R&D and Energy Technologies		PP	research, development	2018~	not decided	approx.* 450million KRW/year, project	
India	·(KETEP) Memorandum of Understanding between Korean Institute of Energy Technology Evaluation and Planning and Global Innovation & Technology Alliance	Cooperating in below areas · Renewable Energy · Energy Efficiency · Smart Grid	PP	research, development	2018	not decided	approx.* 380million KRW/ year, project	
Thailand	·(KETEP) Memorandum of Understanding between Korea Institute of Energy Technology Evaluation and Planning and the Thailand Research Fund Kingdom of Thailand	Cooperating in below areas · New and Renewable Energy · Smart grid · Energy efficiency	PP	research, development	2018	not decided	approx.* 780million KRW/ year, project	
Singapore	·(MOTIE) Memorandum of Understanding between the Ministry of Trade, Industry and Energy of the Republic of Korea and the Ministry of Trade and Industry of the Republic of Singapore on Cooperation in the filed of Smart Grids	·(KETEP) Cooperating in below areas · Smart Grids including Distributed Power Generation, Micro-grids, ESS, and AMI · Energy Security, IOT applications in energy technologies	PP	research, development	2019	not decided	approx.* 500million KRW/ year, 1project	

	·(KETEP) Memorandum of Understanding Between the Korea Institute of Energy Technology Evaluation and Planning of the Republic of Korea and the Energy Market Authority of Singapore on Joint Research and Development Projects	· Solar energy including offshore floating PV and building integrated PV						
Australia	·(MOTIE) Australia-Republic of Korea Low and Zero Emissions Technology Partnership ·(KETEP) Corporate Concept between The Korea Institute of Energy Technology Evaluation and Planning of the Republic of Korea And The Australian Department of Industry, Science, Energy and Resources	Cooperating in below areas · Clean hydrogen	PP	research, development	2021	not decided	approx.* 620million KRW/ year, 1project	
UK	(KETEP) Memoranduum of Understanding Between Korea Instituute of Energy Technology and Planning and Innoavate UK on Cooperation in Energyy Technologies	Cooperating in below areas · Clean Hydrogen · Renewable Energy · Energy Efficiency · Energy Storage System · Nuclear Power Generation including Smart Grid and Micro Grid	PP	research development	2022	not decided	approx..* 150million KRW/year, project	
Poland	(KETEP) Memorandum of Understanding between the Korea Institute of Energy Technology Evaluation and Planning and the National Centre for Research and Development on Energy R&D Cooperation	Cooperating in below areas ·Renewable Energy ·Hydrogen and Fuel Cell ·Nuclear Power and Safety Energy Systems ·Energy Efficiency · Distributed Power Generation and Smart Grid Technologies	PP	research development	2022	not decided	approx.* 250million KRW/year, project	
IEA	TCP (Technology Collaboration Program)	·Doing IEA task professional activities	-	networking	depends on IEA TCP program	depends on IEA TCP program,	approx.* 1billion KRW/year, project	

SAUDI ARABIA

Other countries involved	**Name of collaboration**	**Objectives of activities or outcomes**	**Sectors involved** (PP = public-public or PR = public-private)	**Type of collaboration** (research, development, and/or demonstration)
Australia	- Circular Carbon Economy (CDR & H2)	- Infrastructure for CCUS & DAC - Hydrogen applications transportation best practices - Hydrogen economy policies	PP	Research development
Brazil	- Circular Carbon Economy (CDR & H2) - Artificial Intelligence (GPFM)	- Infrastructure for CCUS & DAC - Hydrogen applications transportation best practices - Hydrogen economy policies - AI in Energy	PP	Research development
Canada	- Circular Carbon Economy (CDR & H2) - Artificial Intelligence (GPFM) - Climate change and the role of the circular carbon economy at the international level (CDR & H2)	- Infrastructure & development for CCUS & DAC - Hydrogen applications & transportation best practices - Hydrogen economy policies - AI in Energy - Localization for innovation & development.	PP	Research development
Chile	- Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM)	- Cooperation in the development of all different technologies in the energy mix. - Best Practices in CCE - AI in Energy - Capacity building related to Energy	PP	Research development
China	- Circular Carbon Economy (CDR & H2) - Artificial Intelligence (GPFM) - Climate change and the role of the circular carbon economy at the international level (CDR & H2)	- Infrastructure & development for CCUS & DAC - Hydrogen applications & transportation best practices - Hydrogen economy policies - Low cost & carbon hydrogen production - Establishment of joint CCUS projects. - Utilising renewable to produce clean hydrogen. - AI in Energy - Localization for innovation & development.	PP	Research development demonstration

Denmark	- Circular Carbon Economy (CDR & H2)	- Hydrogen applications & transportation best practices - Partnership with companies and research institutes to develop cost- effective technologies to reduce greenhouse gas emissions.	PP PR	Research development
Finland	- Circular Carbon Economy (CDR & H2)	- Hydrogen applications & transportation best practices - Partnership with companies and research institutes to develop cost- effective technologies to reduce greenhouse gas emissions.	PP PR	Research development
France	- Circular Carbon Economy (CDR & H2) - Artificial Intelligence (GPFM) - - Climate change and the role of the circular carbon economy at the international level (CDR & H2)	- Air Liquid partnership for clean hydrogen. - Infrastructure & development for CCUS & DAC - Hydrogen applications & transportation best practices - Collaboration in Circular carbon economy. - Cooperation in the international initiatives - Green finance. - Environmental Technology Verification AI in Energy	PP PR	
Germany	- Circular Carbon Economy. (CDR & H2) - Artificial Intelligence. (GPFM) - Climate change and the role of the circular carbon economy at the international level. (CDR & H2) - Innovation and development. (CDR)	- Localization of hydrogen reactors and engines. - Hydrogen standards. - Hydrogen applications & transportation best practices - Infrastructure & development for CCUS & DAC - Utilising circular carbon economy to be tool for emissions management. - Localization for innovation & development. - AI in Energy.	PP PR	Research development demonstration

IBM	- Circular Carbon Economy. (CDR & H2) - Artificial Intelligence. (GPFM)	- Energy Blockchain - IoT - Forecasting and planning for renewables generation. - Assets management. - Improving electrical systems infrastructure. - Establish research centres. - Hydrogen applications & transportation best practices - Infrastructure & development for CCUS & DAC - AI in Energy. - Support to achieve the goals of the Saudi green initiative & Middle East Initiative.	PR	Research development demonstration
India	- Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM)	- Policy development, legislation and building awareness for the hydrogen economy during the G20 - Infrastructure & development for CCUS & DAC - Hydrogen applications & transportation best practices - Hydrogen economy policies - Low cost & carbon hydrogen production - Attracting competencies and business specialized in AI. - AI in Energy	PP PR	Research development
Italy	- Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM)	- Infrastructure & development for CCUS & DAC - Hydrogen applications & transportation best practices - Hydrogen economy policies - Collaboration with FBK-ICT. - Benefit form Italian National strategy.	PP	Research development
Japan	- Circular Carbon Economy (CDR & H2) - Hydrogen - Artificial Intelligence. (GPFM)	- Policy development, legislation and building awareness for the hydrogen economy during the G20 - Infrastructure & development for CCUS & DAC - Hydrogen applications & transportation best practices - Hydrogen economy policies	PP PR	Research development demonstration
		- Low cost & carbon hydrogen production - Blue ammonia collaboration - Collaboration with Grid & Idemitsu companies - Collaborate with MitoyoAI Development		

Korea	- Circular Carbon Economy. (CDR & H2) - Artificial Intelligence. (GPFM) - Climate change and the role of the circular carbon economy at the international level. (CDR & H2) - Innovation and development. (CDR)	- Hydrogen standards. - Hydrogen applications & transportation best practices - Infrastructure & development for CCUS & DAC - Utilising circular carbon economy to be tool for emissions management. - Localization for innovation & development. - AI in Energy. - Support to achieve the goals of the Saudi green initiative & Middle East Initiative. - Collaboration in the CEM/MI, GMI & CSLF initiatives. - Collaboration with Samsung & KAIST.	PP PR	Research development demonstration
Morocco	- Circular Carbon Economy (CDR & H2)	- Hydrogen applications & transportation best practices	PP	Research development
Norway	- Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM) -	- Hydrogen applications & transportation best practices - Partnership with companies and research institutes to develop cost- effective technologies to reduce greenhouse gas emissions. - AI in Energy. - - Collaborate with NorwAI & the national strategy.	PP PR	Research development
Oman	- Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM) -	- Hydrogen standards. - Hydrogen applications & transportation best practices - Infrastructure & development for CCUS & DAC - Utilising circular carbon economy to be tool for emissions management. - AI in Energy. - Cooperation with universities and companies.	PP PR	Research development
Sudan	- Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM) -	- Utilising circular carbon economy to be the tool to manage the energy mix - AI in Energy. - Joint ventures, joint ventures, in the field of energy. - Capacity building related to Energy	PP	Research development demonstration

UK	- Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM)	- Infrastructure & development for CCUS & DAC - Hydrogen applications & transportation best practices - Hydrogen economy policies - Low cost & carbon hydrogen production - AI in Energy	PP	Research development
USA	- Establishment of Clean Energy (CDR, Hydrogen & GPFM). - Areas of Clean Energy (GPFM). - Projects for Clean Energy (CDR, Hydrogen & GPFM)	- Collaboration to examine the innovation, development, financing, and deployment of clean energy infrastructure. - Infrastructure & development for CCUS & DAC - Hydrogen applications & transportation best practices - Hydrogen economy policies - Enhancing Participants' energy sustainability and energy transition ambitions; and helping to facilitate progress of the Circular Carbon Economy ("CCE"). - Collaboration in enhancing power systems. - Improving the economics of clean electricity generation technologies and energy storage systems. - Providing access to clean cooking solutions. - Improving and accelerating life cycle emissions reductions of fuels. - AI in Energy. - Energy cyber security solutions - Best Practises in GHG emissions. - Knowledge exchanges between national laboratories, research centers, academic institutions, and training programs - Bi-directional clean technology trade missions - project development in other areas of the energy sector	PP PR	Research development demonstration

SPAIN

Other countries involved	Name of collaboration	Objective of activities or outcomes	Sectors involved (PP /PR)*	Type of collaboration (research, development, and/or demonstration)	Start Date (Year)	End Date (Year)	Funding amount	Additional information (link)
Austria, India, Tunisia, Belgium, Canada, Switzerland, Cyprus, Czech Republic, Germany, Denmark, Estonia, Greece, **Spain**, Finland, France, Croatia, Hungary, Ireland, Israel, Iceland, Italy, Lithuania, Latvia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Sweden, Turkey, United Kingdom, United States (Seven Spanish public organizations are members of CETParnership)	**CET Partnership** (Clean Energy Transition Partnership) (Co-funded European Partnership)	CET Partnership enables national and regional RTDI programme owners and managers from 33 countries to align their priorities, pool national budgets and implement annual joint calls The CET Partnership aims to empower the clean energy transition and contribute to the EU's goal of becoming the first climate-neutral continent by 2050, by pooling national and regional RDTI funding for a broad variety of technologies and system solutions required to make the transition The CETPartnership consortium organizes dynamic learning activities, extracts strategic knowledge (through the CETP Knowledge Community) and maximises the impact (the CETP Impact Network) to accelerate the up scaling, replication and market diffusion of innovative solutions, as well as foster the up-take of cost-effective clean energy technologies. The CETPartnership has 7 Transition Initiatives (TRIs) focusing on the RDI Challenges described in the Strategic Research and Innovation Agenda (SRIA) The **CETPartnership builds on** 15 years of transnational cooperation in 9 energy relevant **ERA-Nets**	PP	Research and development	2022 (first year of funded call under the CET Partnership)	Stat + 3 years (typical project duration under CET Partnership)	140 M€ (Total expected funding of the 2022 Joint Call, coming from national/regional budgets and EC contribution	Clean Energy Transition Partnership (cetpartnership.eu)
Austria, Belgium, Croatia, Czech Republic, Denmark,	**SES ERA-NET** (European Research Area	ERA-Net Smart Energy Systems provide a sustainable and service-oriented joint programming platform to finance	PP	Research, Development & Demonstration	2022	2026 …	12 M€ (Spain)	https://www.eranet-

Finland, France, Germany, Hungary, Ireland, India, Israel, Italy, Latvia, Morocco, The Netherlands, Norway, Poland, Portugal, Romania, Scotland, Slovenia, Spain, Sweden, Switzerland, Turkey (Spain participates through CDTI)	Network on Smart Energy Systems).	transnational RDD projects, developing technologies and solutions in thematic areas like smart power grids, regional and local energy systems, heating and cooling networks, digital energy and smart services, etc. ERA-Net Smart Energy Systems provides a substantial contribution to turn the implementation plan of the European Strategic Energy Technology Plan (SET-Plan) Action 4 „Increase the resilience and security of the energy system" into action. Main outcomes: 2 joint calls: 2022, 2023		(RDD)				smartenergysystems.eu/
Switzerland; Austria, Belgium, Cyprus; France, Germany; Greece; Israel; Italy; Netherlands; Spain; Sweden, Turkey	**SOLAR-ERA.NET Cofund 2**	SOLAR-ERA.NET is a European network of national and regional funding organisations and RTD and innovation programmes in the field of solar electricity generation, i.e. photovoltaics (PV) and concentrating solar power (CSP) / solar thermal electricity (STE). It was established within a FP7 ERA-NET project and continues its activities in the Cofund ERA-NET scheme. SOLAR-ERA.NET shall contribute to reaching the objectives of the Strategic European Technology (SET-) Plan by launching Joint calls for supporting transnational projects. SOLAR-ERA.NET is supported by the European Commission within the EU Framework Programme for Research and Innovation HORIZON 2020 (Cofund ERA-NET Action, N° 691664 and N° 786483). **SOLAR-ERA.NET Cofund 2** will contribute to substantial cost reductions of solar power technologies, to support the economic development of the European solar power sector and to reinforce Europe's strong position in solar power technologies.	PP	research	2018	2023	17.8 M€	https://www.solar-era.net/

		Reducing technology cost, lowering the environmental impact of power production and advancing manufacturing technologies, applications and energy system integration are essential to increasing the deployment of solar power technologies as crucial element of the Low Carbon Energy strategy set out in the Energy Package.						
Germany; Greece; Italy; Israel; Spain; Switzerland; Portugal	**CSP ERA-NET**	CSP ERANET aims to coordinate the efforts of Member States, Associated Countries and Regions towards achieving CSP SET Plan objectives, by pooling their financial resources to implement joint calls for R&I proposals, resulting on strategic projects with substantial volumes of investment, which cannot be allocated by individual countries or by the European Commission on their own.	PP	research	2019	2024	12 M€	https://csp-eranet.eu/
Austria; Belgium; Bulgaria; Cyprus; Denmark; Estonia; Finland; France; Germany; Italy; Greece; Hungary; Iceland; Latvia; Lithuania; Netherlands; Norway; Poland; Portugal; Romania; Slovakia; Slovenia; Spain; Sweden; Turkey; Switzerland; United Kingdom	**DUT - Driving Urban Transitions**	DUT aims at developing and implementing a transformative research and innovation (R&I) programme to strengthen urban transitions towards climate-neutral, inclusive and sustainable urban areas. In order to support cities along their specific strategies, the Partnership focuses on three critical urban sectors, **energy**, mobility and circular economy, and their interrelations. Three Transition Pathways (TPs) – **Positive Energy Districts** (PED), the 15-minute City (15minC) and Circular Urban Economies (CUE) – will be addressed with a long-term perspective.	PP	research	2022	2028	158.6 M€	https://dutpartnership.eu/
Austria, Belgium, Bulgaria , Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece,	**European Energy Research Alliance (EERA)**	Objectives: To expand and optimize EU energy research capabilities. Today it brings together more than 250 organizations from 30 countries. EERA coordinates its activities through 18 Joint Programmes that provide world-leading	PP	Research and development	2018		38 M€ (payment of the fees)	https://www.eera-set.eu/

Hungary, Iceland Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden, Switzerland, Turkey, United Kingdom,.		scientific expertise on three pillars: low-carbon technologies, materials, and systems' topics. Spain is member of EERA Exco, leads 3 Joint Programmes (Concentrated Solar Power, Nuclear Materialsans Digitalization for Energy) and participates in AMPEA, Bioenergy, Clean Energy Transition for Sustainable Society (e3s), Energy Storage, Fuel Cells and Hydrogen, Photovoltaic Solar, Energy Smart Cities, Smart Grids, Wind Energy, Energy System Integration, Carbon Capture and Storage and Energy Efficiency in Industrial Processes						
Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Lithuania, Luxembourg, Mexico, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, The Netherlands, Türkye, United Kingdom, United States,	**IEA TCPs (Technology Collaboration Programmes)**	The Technology Collaboration Programmes function within a framework created by the IEA and supports the work of independent, international groups of experts that enable governments and industries from around the world to lead Programmes and projects on a wide range of energy technologies and related issues: Concentrated Solar Power (SolarPaces TCP), Solar Heating and Cooling (SHC TCP, Geothermal TCP, Hydrogen TCP; Ocean Energy Systems (OES TCP), PV Systems Programme (PVPS TCP), Wind TCP, Heat Pumping Technologies (HPT TCP), Smart Grids (ISGAN TCP), Energy in Buildings and Communities (EBC TCP), Energy Technology Systems Analysis (ETSAP TCP) .The experts in these collaborations work to advance the research, development and commercialization of energy technologies. The scope and strategy of each collaboration is in keeping with the IEA Shared Goals of energy security, environmental protection and	PR	Research, development and commercialization				https://www.iea.org/energy-system

		economic growth, as well as engagement worldwide.						
Australia, Belgium, Canada, China, Denmark, France, Germany, Greece, Israel, Italy, Japan, Korea, Norway, Spain, Sweden, United Kingdom, United States	**IEA Hydrogen TCP–Task40**: "Energy Storage and conversion based on hydrogen"	Develop reversible or regenerative hydrogen storage materials (solid or liquid) fulfilling the technical targets for mobile and stationary applications Develop the fundamental and engineering understanding of hydrogen storage materials and systems that have the capacity of fulfilling Target I Develop materials and systems for energy storage and conversion based on hydrogen, including hydrogen storage for use in stationary, mobile and portable applications, electrochemical storage, and solar thermal heat storage	PP	Research and development	2019	2024		https://www.ieahydrogen.org/task/task-40-energy-storage-and-conversion-based-on-hydrogen-2/
Australia, Austria, Canada, Denmark, France, Germany, Italy, New Zealand, Norway, Portugal, Spain, United Kingdom	**IEA Hydrogen TCP** **Task41:** "Analysis and modelling of Hydrogen Technologies"	**IEA Hydrogen TCP:** Accelerate hydrogen implementation and widespread utilization to optimize environmental protection, improve energy security and promote economic development internationally. Position the Hydrogen TCP as a premier global resource for expertise in hydrogen. **Task 41:** An updated and updatable long-lasting; database on hydrogen technologies; • An improved appreciation of hydrogen; energy modelling; • Support of decision-making; • Closer collaboration between the; Hydrogen TCP and the ETSAP analysis; community	PP	Research and development	2020	2024		https://www.ieahydrogen.org/task/task-41-data-and-modelling-sub-task-c-cooperation-with-etsap/
Australia, Austria, China, Denmark, European Commission, France, Germany, Italy, Norway, Portugal, Spain, United Kingdom, United States	**IEA Hydrogen TCP Task42:** Underground Hydrogen Storage (UHS)"	Focus on R&D&D challenges to establish. The technical & socio-economic viability of UHS as a preparation for responsible demonstration and upscaling. Storage options in porous reservoirs, salt caverns, and lined-rock caverns. Technical feasibility of fast-cyclic and high-performance injection and production, as well as optimal management of dense clusters of them. The technical viability of H2 storage in porous reservoirs is relatively	PP	Research and development	2022	2024		https://www.ieahydrogen.org/task/task-42-underground-hydrogen-storage/

		less established, and as such, it is still under more fundamental scientific and technological investigations.						
1st wave, Hy2Tech: Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Italy, the Netherlands, Poland, Portugal, Slovakia and Spain **2nd wave, Hy2Use:** 13 MSs + NO Austria, Belgium, Denmark, Finland, France, Greece, Italy, Netherlands, Norway, Poland, Portugal, Slovakia, Spain and Sweden.	**IPCEI Hydrogen** (Important Project of Common European Interest on Hydrogen)	Aimed at innovation as well as demonstration and deployment of hydrogen technology. Consists of 4 combined clusters of projects from more than half of the European Union member states and from Norway. The projects take place in the complete value chain of hydrogen: production, import, transportation as well as end use. Currently 2 clusters of projects ("waves") have been notified by the EC under State Aid rules: Hy2Tech and Hy2Use. These 2 waves consist of almost 80 projects, which are large in size individually: project budgets range from several M€s to several 100s of M€s per project. Spain: 4 projects on Hy2Tech, and 7 on Hy2Use. Funds devoted to Hy2Tech already awarded.	PP and PR	Research, development and demonstration	2022	2026	**1st wave (Hy2Tech):** 5 400 M€, Spain: 245 M€ (total investment with 74 M€ of public support) **2nd wave (Hy2Use):** 5 200 M€	IPCEIs on hydrogen (europa.eu) 1st wave: State Aid (europa.eu) 2nd wave: State Aid (europa.eu) Spain: IPCEIs on hydrogen (europa.eu) IPCEI Hydrogen (ipcei-hydrogen.eu) 1st wave: Hy2Tech · IPCEI Hydrogen (ipcei-hydrogen.eu) 2nd wave: Hy2Use · IPCEI Hydrogen (ipcei-hydrogen.eu)
EU Member States and 4 associated countries: Norway, Iceland, Turkey and Switzerland	**EU- Strategic Energy Technology Plan (SET Plan)** .	The European Strategic Energy Technology Plan (SET Plan) is a key stepping-stone to boost the transition towards a climate-neutral energy system through the development of low-carbon technologies in a fast and cost-competitive way.						https://energy.ec.europa.eu/topics/research-and-technology/strategic-energy-technology-plan_en

		Spain participates in the 14 Implementation working groups that address the entire innovation chain, from research to market incorporation, and address both financing and regulatory frameworks, and chairs the one dedicated to Concentrated Solar Power Technologies (CSP)..						

SWEDEN

Other countries involved	**Name of collaboration**	**Objective of activities or outcomes**	**Sectors involved** (PP = public – public or PR = public-private)	**Type of collaboration** (research, development, and/or demo)	**Start Date** (Year)	**End Date** (Year)	**Funding amount**	**Additional information** (e.g. link to website)
The Nordic Countries	Nordic energy Research	co-operative energy research and policy development for a sustainable energy system	PP, PR	Research, development, demonstration etc.	1985; as a Nordic Institution from 1999	Open-ended	36 MNOK contributions from the Nordic countries in 2022	Nordic Energy Research

UNITED ARAB EMIRATES

Other countries involved	**Name of collaboration**	**Objective of activities or outcomes**	**Sectors involved** (PP /PR)*	**Type of collaboration** (research, development, and/or demonstration)	**Start Date** (Year)	**End Date** (Year)	**Funding amount**	**Additional information** (link)
US	Partnership for Accelerating Clean Energy (PACE)	The UAE and the US have forged a new partnership to combat climate change, promote clean energy technology, and enhance their collaborative efforts. In November 2022, they initiated the Partnership for Accelerating Clean Energy (PACE), aiming to mobilize USD 100 billion to establish 100 GW of clean energy by 2035. This venture signifies the joint determination of two significant energy contributors to undergo a rapid and robust energy shift.	PP	demonstration	2022	2035	USD 100 billion	
UK	Bilateral Memoranda of Understanding (MOUs)	The governments of the UK and UAE have inked a Memorandum of Understanding (MoU). This agreement is designed to enhance the exchange of technical know-how, guidance, capabilities, and proficiency. It will also foster increased collaboration in energy and climate sectors and is anticipated to spur job growth and investment in the UK. This strengthens the solid economic ties formed between the two countries from their 2018 MoU regarding Energy Cooperation. The updated MoU broadens the areas of bilateral partnership to include emerging energy sources like the low carbon super fuel, hydrogen. This is highlighted by ADNOC, UAE's premier energy firm, acquiring a 25% share in BP's blue hydrogen project, H2Teesside, in the previous year.	PP	research, development	2018			
Germany	Emirati-German Energy Alliance	UAE and Germany chose to enhance their thriving cooperation in the energy domain by forming the Emirati-German Energy Partnership. Acknowledging the vital interplay between climate and energy also discussing the role of hydrogen. Collaborative goals are set during bilateral steering committee sessions. The mutual undertakings materialize through working groups that actively involve the corporate sector. This revamped partnership promotes the sharing of expertise, organizes educational trips, hosts delegation visits, and conducts bilateral seminars.	PP	research, development				

Japan	pledged to collaborate on technology and climate change	pledged to collaborate on technology and climate change aims to ensure energy provisions and advance eco-friendly technology and hydrogen. The alliance encompasses an initiative to enhance energy security and establishes a structure for the UAE to partner with Japan in areas such as semiconductor and battery tech investments.	PP	research, development				
• Finland • Holland • Russia • Lindy gas • India	Bilateral Memoranda of Understanding (MOUs)	Cooperation in the field of hydrogen	PP	research, development,				
• Chile • Kazakhstan • Portugal • Russia • Israeli • Türkiye • Uzbekistan • Bahrain • Girqistan • Indonesia	Bilateral Memoranda of Understanding (MOUs)	Cooperation in the field of Energy	PP	research, development,				

UNITED KINGDOM

Other countries involved	**Name of collaboration**	**Objective of activities or outcomes**	**Sectors involved**	**Type of collaboration** (research, development, and/or demonstration)	**Start Date** (Year)	**End Date** (Year)	**Funding amount**	**Additional information** (link)
Australia, Austria, Azerbaijan, Belgium, Cabo Verde, Cambodia, Canada, Chile, China, Denmark, Egypt, EU, Finland, France, Germany, Guinea-Bissau, Holy See, India, Ireland, Israel, Italy, Japan, Kenya, Latvia, Lithuania, Luxembourg, Malta, Mauritania, Morocco, Namibia, Netherlands, New Zealand, Nigeria, North Macedonia, Norway, Panama, Portugal, Republic of Korea, Senegal, Serbia, Slovakia, Slovenia, Spain, Sweden, Turkey, UAE, USA	Breakthrough Agenda	A cross-cutting initiative bringing countries together to accelerate the innovation and deployment of clean technology in key emitting sectors, ensuring they are affordable and accessible for all.	Road Transport, Steel, Hydrogen, Power, Agriculture, Buildings and Cement	Innovation & deployment	2021	Ongoing		https://www.iea.org/reports/breakthrough-agenda-report-2023
Australia, Austria, Azerbaijan, Belgium, Cabo Verde, Cambodia, Canada, Chile, China, Denmark, Egypt, EU, Finland, France, Germany, Guinea-Bissau, Holy See, india, Ireland, Israel, Italy, Japan, Kenya, Latvia, Lithuania, Luxembourg, Malta, Mauritania, Morocco, Namibia, Netherlands, New Zealand, Nigeria, North Macedonia, Norway, Panama, Portugal, Republic of Korea, Senegal, Serbia, Slovakia,	Breakthrough Agenda	A cross-cutting initiative bringing countries together to accelerate the innovation and deployment of clean technology in key emitting sectors, ensuring they are affordable and accessible for all.	Road Transport, Steel, Hydrogen, Power, Agriculture, Buildings and Cement	Innovation & deployment	2021	Ongoing		https://www.iea.org/reports/breakthrough-agenda-report-2023

Slovenia, Spain, Sweden, Turkiye, UAE, USA								
driv	The Cool Coalition	Work together to on access to sustainable cooling through advocacy, action and knowledge exchange.	PP/PR	R,D & D	2019	ongoing	Adhoc/ in-kind	https://coolcoalition.org/
UNEP, UAE, US, Netherlands, France, Panama, Japan, Denmark	Global Cooling Pledge development working group	Development of the GCP commitments to be launched at COP28	PP/ PR	D&D	2023	2030	In-kind	https://www.cop28.com/en/energy-and-industry/global-cooling-pledge#:~:text=Cooling%3A%20Announcement%20of%20the%20Global%20Cooling%20Pledge&text=This%20voluntary%20Pledge%20intends%20to,cooling%20for%20the%20most%20vulnerable.
UNEP, India, EC, US, UTM	Urban Heat Adaption Working Group	A number of initiatives linked to adaption to extreme heat including the Beating the Heat Handbook, The Heat Action Platform and localised studies in urban areas	PP/ PR	D&D	2021	2025	In-kind	https://coolcoalition.org/about/what-we-do/
UNEP, India, EC, US, UTM, SEforALL	Nature Based Solutions for Cooling	A competition to develop/ demonstrate nature based solutions in urban areas	PP/ PR	D&D	2022	2025	£5m with £1.5m support from JEF.	https://coolcoalition.org/about/what-we-do/
Peru, India	GEMdev: Grounded Energy Modelling for equitable urban planning development in the global South	Research project developing energy planning tools for global South.	PP	Research	2019	2023		https://gemdev.net/en_GB/

Japan	JAEA & NNL Memorandum of Co-operation	Develop a HTGR reactor design and coated particle fuel technology	PP & PR	R&D	2023	2025	£31m	Japan Atomic Energy Agency (JAEA) and National Nuclear Laboratory (NNL) signed a renewed collaboration agreement.
France, Germany, Netherlands, Denmark, Norway, Austria, Finland, Iceland, Canada, Japan, Australia, Italy, Spain, Sweden, Switzerland	World Bank Energy Sector Management Assistance Program (ESMAP)	ESMAP is a partnership between the World Bank and 24 partners to help low and middle-income countries reduce poverty and boost growth through sustainable energy solutions. ESMAP's analytical and advisory services are fully integrated within the World Bank's country financing and policy dialogue in the energy sector. Through the World Bank Group (WBG), ESMAP works to accelerate the energy transition required to achieve Sustainable Development Goal 7 (SDG7) to ensure access to affordable, reliable, sustainable and modern energy for all.	PP	Research	1983	Ongoing	£162m committed between the FCDO and DESNZ since 2014 (of which £129m were paid up to March 2023)	https://www.esmap.org/ FCDO's current main unpreferenced contribution to ESMAP is from https://tea.carbontrust.com/ There are also preferenced contributions on specific issues such as from Modern Energy Cooking Services (MECS) https://mecs.org.uk/ DESNZ also makes contributions to ESMAP which are coordinated by managed separately
UK, Denmark, Germany, Iceland, USA, Switzerland, Italy, Austria are current funding members, but given SEforALL's UN Mandate on SDG7, all nations are linked.	Sustainable Energy for All (SE4ALL)	SEforALL is an international organization that works in partnership with the United Nations and leaders in government, the private sector, financial institutions, civil society and philanthropies to drive faster action towards the achievement of Sustainable Development Goal 7 (SDG7) – access to affordable, reliable,	PR	Research and Development	2011	Ongoing	Current funding around £500k through the FCDO Transforming Energy Access platform) (other funding	Sustainable Energy for All (SE4All) https://www.seforall.org/ FCDO's current main contribution to SEforALL is from https://tea.carbontrust.com/ Which includes specific support to the https://www.seforall.org/partners/mini-grids-partnership/

		sustainable and modern energy for all by 2030 – in line with the Paris Agreement on climate.					has been provided previously, and is being considered looking forward)	
USA, Sweden, Germany (GIZ, EnDev), World Bank, IKEA Foundation, Rockefeller Foundation/GEAPP Co-chaired by the UK and IKEA Foundation	Efficiency for Access (E4A)	Efficiency for Access is a global coalition working to promote affordable, high-performing, and inclusive appliances that enable access to clean energy for the world's poorest people. It is a catalyst for change, accelerating the growth of off and weak-grid appliance markets to boost incomes, reduce carbon emissions, improve quality of life, and support sustainable development.	PR	Research and Development	2017	Ongoing	£23 million (via the LEIA programme, including £5m through the FCDO Transforming Energy Access platform)	Efficiency for Access With our contribution coming from the LEIA programme https://efficiencyforaccess.org/leia
USA, Germany, France, EU, plus a range of development banks and investment fund managers. Co-chaired by the UK, World Bank and African Development Bank.	Mini-Grid Funders Group	The Mini-Grid Funders Group (MGF) was first established in 2017, and now consists of around 30 sector funders and financiers co-ordinating efforts and sharing lessons. These funders represent a total committed investment of around $1.8bn into mini-grids globally, of which $1.4bn is in Africa.	PR	Research and Development	2017	Ongoing	Direct funding for secretariat services only (from Carbon Trust through the FCDO Transforming Energy Access platform)	Mini-Grid Funders Group FCDO's support is via the secretariat provided via https://tea.carbontrust.com/

USA, Canada, Korea, Austria, Belgium, Germany, China, South Africa, Morocco, India, Spain, Denmark. Led by the World Bank ESMAP	The Energy Storage Partnership	To enable the rapid uptake of Variable Renewable Energy (VRE) in developing countries, the World Bank Group convened the Energy Storage Partnership (ESP), a global initiative involving national laboratories, research institutions, development agencies, and philanthropies. The ESP aims to foster international technological cooperation and training to develop and adapt to new energy storage solutions tailored to the needs and conditions of developing countries.	PR	Research and Development	2018	Ongoing	No specific cash contribution, but wider funding to ESMAP and to participating UK institutions (Faraday Institution, Innovate UK, Loughborough University /LCEDN)	ESMAP Energy Storage Partnership
UK, Papua New Guinea, Soloman Islands, Vanuatu, Fiji, and other Pacific Community (SPC) Island members who will all benefit from the partnership. Led by the Pacific Community (SPC) through the Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE)	Clean Energy Partnership between the UK and the Pacific community (SPC)	Research and innovation Clean Energy Partnership between the UK and the Pacific community (SPC) – via the FCDO Transforming Energy Access (TEA) platform - which will gather data and evidence, build capacity, and seed innovative clean energy projects in the region with an initial focus on high energy deficit islands (including Papua New Guinea, Solomon Islands and Vanuatu) and areas where there is significant opportunity for diesel generator displacement including Fiji.	PR	Research and Development	2023	Ongoing	£1m from the FCDO Transforming Energy Access (TEA) platform	Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE) | SPC Geoscience, Energy and Maritime Division

Austria, Australia, Belgium, Canada, China, Denmark, the European Commission, Finland, France, Germany, Greece, Israel, Italy, Japan, Korea, Lithuania, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, & United Kingdom.	IEA Hydrogen TCP	MISSION: Accelerate hydrogen implementation and widespread utilization to optimise environmental protection, improve energy security and promote economic development internationally. Position the IEA Hydrogen TCP as a premier global resource for expertise in hydrogen. "In 2022 no tasks closed as complete. The following tasks were extended: Task 40: Energy Storage and conversion based on hydrogen Three new tasks commenced: Task 43: Safety and RCS of Large Scale Hydrogen Energy Applications Task 42: Underground Hydrogen Storage Task 44: Hydrogen from Nuclear Energy Five new tasks were under development: Renewable Hydrogen Production Offshore Hydrogen Production Natural Hydrogen Hydrogen Certification International Hydrogen Supply Chains	Both Public and Private. PP & PR	The strategy is to facilitate, coordinate and maintain innovative research, development and demonstrationactivities as a hub for international cooperation and knowledge exchange.	1977	Continuing	Tasks are self funding meaning a total spend is not known by member countries.	https://www.ieahydrogen.org/

Open to IEA members	IEA District Heating and Cooling (DHC) TCP	Collaborative research on various aspects of DHC	Both Public and Private. PP & PR	RD&D		Continuing		https://www.iea-dhc.org/home
Open to IEA members	IEA Heat Pumping Technologies (HPT)	Collaborative research on various aspects of HPT	Both Public and Private. PP & PR	RD&D		Continuing		https://heatpumpingtechnologies.org/
Open to IEA members	IEA User-Centred Energy Systems (Users) [previously Demand-Side Management (DSM)] TCP	Collaborative research on various aspects of DSM	Both Public and Private. PP & PR	RD&D		Continuing		https://userstcp.org/
Open to IEA members	IEA Geothermal TCP	Collaborative research on various aspects of geothermal	Both Public and Private. PP & PR	RD&D		Continuing		https://iea-gia.org/
Open to IEA members	IEA Solar Heating and Cooling (SHC) TCP	Collaborative research on various aspects of SHC	Both Public and Private. PP & PR	RD&D		Continuing		https://www.iea-shc.org/
Austria, Belgium, Canada, China, Czech Republic, Denmark, Finland, France, Germany, Israel, Italy, Japan, South-Korea, Netherlands, Norway, Slovenia, Sweden, Switzerland, Turkey, United Kingdom, USA.	IEA Energy Conservation through Energy Storage (ECES) TCP	Mission: to facilitate integral research, development, implementation and integration of energy-storage technologies to optimise the energy efficiency of all kinds of energy system and to enable the increasing use of renewable energy instead of fossil fuels. The priorities in the strategic plan are: system integration; electrical storage, and;	Both Public and Private. PP & PR	RD&D		Continuing	Tasks are self funding meaning a total spend is not known by member countries.	https://iea-es.org/

		thermal storage. The 2022 annual report can be found here: https://iea-es.org/publications/annual-report-2022/ There are ten Tasks in operation: Task 32: Open Sesame − Open-Source Energy Storage Models Task 35: Flexible sector Coupling by the implementation of Energy Storage Task 37: Smart Design and Control of Energy Storage Systems Task 38: Ground Source de-icing for Infrastructure Task 39: Large TES for District heating Task 40: Compact Thermal Energy Storage (joint Task with SHC TCP) Task 41: Economics of Energy Storage Task 42, new: System flexibility from Medium-Duration Energy Storage. This is led by the UK. Task 43, new: Standardized use of building mass as storage for renewables and grid flexibility						

Open to IEA members Current Membership: Australia, Austria, Belgium, Brazil, Canada, China, Czech Republic, Denmark, France, Finland, Germany, Ireland, Italy, Japan, Norway, New Zealand, Netherlands, Portugal, Singapore, Sweden, Switzerland, Spain, South Korea, Turkey, US, UK	IEA Energy in Buildings and Communities (EBC) TCP	Mission: To support the acceleration of the transformation of the built environment towards more energy efficient and sustainable buildings and communities, by the development and dissemination of knowledge, technologies and processes and other solutions through international collaborative research and open innovation. The following projects are in the working phase: Annex 81 Data-Driven Smart Buildings – UK has a leading role in this Annex Annex 82 Energy Flexible Buildings Towards Resilient Low Carbon Energy Systems Annex 83 Positive Energy Districts Annex 84 Demand Management of Buildings in Thermal Networks Annex 85 Indirect Evaporative Cooling Annex 86 Energy Efficient Indoor Air Quality Management in Residential Buildings Annex 87 Energy and Indoor Environmental Quality Performance of Personalised Environmental Control Systems	Both Public and Private. PP & PR	RD&D	1977	Continuing	Tasks are self funding meaning a total spend is not known by member countries.	https://www.iea-ebc.org/

		The following projects are in the preparation phase: Annex 88 Evaluation and Demonstration of Actual Energy Efficiency of Heat Pump Systems in Buildings Annex 89: Implementing Net Zero Emissions Buildings The following projects are in development: Project Concept: Open BIM for Energy Efficient Buildings – International meeting to be organised Project Concept: Building Energy Codes Future Activities						
Australia, Austria, Belgium, Brazil, Canada, China, Croatia, Denmark, Commission of the European Union, Finland, France, Germany, India, Ireland, Italy, Japan, the Republic of Korea, the Netherlands, New Zealand, Norway, South Africa, Sweden, Switzerland, UK, USA	IEA Bioenergy TCP	Collaborative research on various aspects of Bioenergy	Both Public and Private. PP & PR	RD&D Collaboration. The TCP work programme is available at https://www.ieabioenergy.com/our-work-tasks/	1978	Continuing	US $ 50,700	https://www.ieabioenergy.com/
Open to IEA members	International Smart Grid Action Network (ISGAN) TCP	Collaborative research on various aspects of ISGAN	Both Public and Private. PP & PR	RD&D		Continuing		https://www.iea-isgan.org/
driv	The Cool Coalition	Work together to on access to sustainable cooling	PP/PR	R,D & D	2019	ongoing	Adhoc/ in-kind	https://coolcoalition.org/

		through advocacy, action and knowledge exchange.						
UNEP, UAE, US, Netherlands, France, Panama, Japan, Denmark	Global Cooling Pledge development working group	Development of the GCP commitments to be launched at COP28	PP/ PR	D&D	2023	2030	In-kind	https://www.cop28.com/en/energy-and-industry/global-cooling-pledge#:~:text=Cooling%3A%20Announcement%20of%20the%20Global%20Cooling%20Pledge&text=This%20voluntary%20Pledge%20intends%20to,cooling%20for%20the%20most%20vulnerable.
UNEP, India, EC, US, UTM	Urban Heat Adaption Working Group	A number of initiatives linked to adaption to extreme heat including the Beating the Heat Handbook, The Heat Action Platform and localised studies in urban areas	PP/ PR	D&D	2021	2025	In-kind	https://coolcoalition.org/about/what-we-do/
UNEP, India, EC, US, UTM, SEforALL	Nature Based Solutions for Cooling	A competition to develop/ demonstrate nature based solutions in urban areas	PP/ PR	D&D	2022	2025	£5m with £1.5m support from JEF.	https://coolcoalition.org/about/what-we-do/
Peru, India	GEMdev: Grounded Energy Modelling for equitable urban planning development in the global South	Research project developing energy planning tools for global South.	PP	Research	2019	2023		https://gemdev.net/en_GB/
Japan	JAEA & NNL Memorandum of Co-operation	Develop a HTGR reactor design and coated particle fuel technology	PP & PR	R&D	2023	2025	£31m	Japan Atomic Energy Agency (JAEA) and National Nuclear Laboratory (NNL) signed a renewed collaboration agreement.

France, Germany, Netherlands, Denmark, Norway, Austria, Finland, Iceland, Canada, Japan, Australia, Italy, Spain, Sweden, Switzerland	World Bank Energy Sector Management Assistance Program (ESMAP)	ESMAP is a partnership between the World Bank and 24 partners to help low and middle-income countries reduce poverty and boost growth through sustainable energy solutions. ESMAP's analytical and advisory services are fully integrated within the World Bank's country financing and policy dialogue in the energy sector. Through the World Bank Group (WBG), ESMAP works to accelerate the energy transition required to achieve Sustainable Development Goal 7 (SDG7) to ensure access to affordable, reliable, sustainable and modern energy for all.	PP	Research	1983	Ongoing	£162m committed between the FCDO and DESNZ since 2014 (of which £129m were paid up to March 2023)	https://www.esmap.org/ FCDO's current main unpreferenced contribution to ESMAP is from https://tea.carbontrust.com/ There are also preferenced contributions on specific issues such as from Modern Energy Cooking Services (MECS) https://mecs.org.uk/ DESNZ also makes contributions to ESMAP which are coordinated by managed separately
UK, Denmark, Germany, Iceland, USA, Switzerland, Italy, Austria are current funding members, but given SEforALL's UN Mandate on SDG7, all nations are linked.	Sustainable Energy for All (SE4ALL)	SEforALL is an international organization that works in partnership with the United Nations and leaders in government, the private sector, financial institutions, civil society and philanthropies to drive faster action towards the achievement of Sustainable Development Goal 7 (SDG7) – access to affordable, reliable, sustainable and modern energy for all by 2030 – in line with the Paris Agreement on climate.	PR	Research and Development	2011	Ongoing	Current funding around £500k through the FCDO Transforming Energy Access platform) (other funding has been provided previously , and is being considere	Sustainable Energy for All (SE4All) https://www.seforall.org/ FCDO's current main contribution to SEforALL is from https://tea.carbontrust.com/ Which includes specific support to the https://www.seforall.org/partners/mini-grids-partnership/

							d looking forward)	
USA, Sweden, Germany (GIZ, EnDev), World Bank, IKEA Foundation, Rockefeller Foundation/GEAPP Co-chaired by the UK and IKEA Foundation	Efficiency for Access (E4A)	Efficiency for Access is a global coalition working to promote affordable, high-performing, and inclusive appliances that enable access to clean energy for the world's poorest people. It is a catalyst for change, accelerating the growth of off and weak-grid appliance markets to boost incomes, reduce carbon emissions, improve quality of life, and support sustainable development.	PR	Research and Development	2017	Ongoing	£23 million (via the LEIA programme, including £5m through the FCDO Transforming Energy Access platform)	Efficiency for Access With our contribution coming from the LEIA programme https://efficiencyforaccess.org/leia
USA, Germany, France, EU, plus a range of development banks and investment fund managers. Co-chaired by the UK, World Bank and African Development Bank.	Mini-Grid Funders Group	The Mini-Grid Funders Group (MGF) was first established in 2017, and now consists of around 30 sector funders and financiers co-ordinating efforts and sharing lessons. These funders represent a total committed investment of around $1.8bn into mini-grids globally, of which $1.4bn is in Africa.	PR	Research and Development	2017	Ongoing	Direct funding for secretariat services only (from Carbon Trust through the FCDO Transforming Energy Access platform)	Mini-Grid Funders Group FCDO's support is via the secretariat provided via https://tea.carbontrust.com/

USA, Canada, Korea, Austria, Belgium, Germany, China, South Africa, Morocco, India, Spain, Denmark. Led by the World Bank ESMAP	The Energy Storage Partnership	To enable the rapid uptake of Variable Renewable Energy (VRE) in developing countries, the World Bank Group convened the Energy Storage Partnership (ESP), a global initiative involving national laboratories, research institutions, development agencies, and philanthropies. The ESP aims to foster international technological cooperation and training to develop and adapt to new energy storage solutions tailored to the needs and conditions of developing countries.	PR	Research and Development	2018	Ongoing	No specific cash contribution, but wider funding to ESMAP and to participating UK institutions (Faraday Institution, Innovate UK, Loughborough University /LCEDN)	ESMAP Energy Storage Partnership
UK, Papua New Guinea, Soloman Islands, Vanuatu, Fiji, and other Pacific Community (SPC) Island members who will all benefit from the partnership. Led by the Pacific Community (SPC) through the Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE)	Clean Energy Partnership between the UK and the Pacific community (SPC)	Research and innovation Clean Energy Partnership between the UK and the Pacific community (SPC) – via the FCDO Transforming Energy Access (TEA) platform - which will gather data and evidence, build capacity, and seed innovative clean energy projects in the region with an initial focus on high energy deficit islands (including Papua New Guinea, Solomon Islands and Vanuatu) and areas where there is significant opportunity for diesel generator displacement including Fiji.	PR	Research and Development	2023	Ongoing	£1m from the FCDO Transforming Energy Access (TEA) platform	Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE) | SPC Geoscience, Energy and Maritime Division

Austria, Australia, Belgium, Canada, China, Denmark, the European Commission, Finland, France, Germany, Greece, Israel, Italy, Japan, Korea, Lithuania, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, & United Kingdom.	IEA Hydrogen TCP	MISSION: Accelerate hydrogen implementation and widespread utilization to optimise environmental protection, improve energy security and promote economic development internationally. Position the IEA Hydrogen TCP as a premier global resource for expertise in hydrogen. "In 2022 no tasks closed as complete. The following tasks were extended: Task 40: Energy Storage and conversion based on hydrogen Three new tasks commenced: Task 43: Safety and RCS of Large Scale Hydrogen Energy Applications Task 42: Underground Hydrogen Storage Task 44: Hydrogen from Nuclear Energy Five new tasks were under development: Renewable Hydrogen Production Offshore Hydrogen Production Natural Hydrogen Hydrogen Certification International Hydrogen Supply Chains	Both Public and Private. PP & PR	The strategy is to facilitate, coordinate and maintain innovative research, development and demonstrationactivities as a hub for international cooperation and knowledge exchange.	1977	Continuing	Tasks are self funding meaning a total spend is not known by member countries.	https://www.ieahydrogen.org/
Open to IEA members	IEA District Heating and Cooling (DHC) TCP	Collaborative research on various aspects of DHC	Both Public and Private. PP & PR	RD&D		Continuing		https://www.iea-dhc.org/home

Open to IEA members	IEA Heat Pumping Technologies (HPT)	Collaborative research on various aspects of HPT	Both Public and Private. PP & PR	RD&D		Continuing		https://heatpumpingtechnologies.org/
Open to IEA members	IEA User-Centred Energy Systems (Users) [previously Demand-Side Management (DSM)] TCP	Collaborative research on various aspects of DSM	Both Public and Private. PP & PR	RD&D		Continuing		https://userstcp.org/
Open to IEA members	IEA Geothermal TCP	Collaborative research on various aspects of geothermal	Both Public and Private. PP & PR	RD&D		Continuing		https://iea-gia.org/
Open to IEA members	IEA Solar Heating and Cooling (SHC) TCP	Collaborative research on various aspects of SHC	Both Public and Private. PP & PR	RD&D		Continuing		https://www.iea-shc.org/
Austria, Belgium, Canada, China, Czech Republic, Denmark, Finland, France, Germany, Israel, Italy, Japan, South-Korea, Netherlands, Norway, Slovenia, Sweden, Switzerland, Turkey, United Kingdom, USA.	IEA Energy Conservation through Energy Storage (ECES) TCP	Mission: to facilitate integral research, development, implementation and integration of energy-storage technologies to optimise the energy efficiency of all kinds of energy system and to enable the increasing use of renewable energy instead of fossil fuels. The priorities in the strategic plan are: system integration; electrical storage, and; thermal storage. The 2022 annual report can be found here: https://iea-es.org/publications/annual-report-2022/ There are ten Tasks in	Both Public and Private. PP & PR	RD&D		Continuing	Tasks are self funding meaning a total spend is not known by member countries.	https://iea-es.org/

		operation: Task 32: Open Sesame − Open-Source Energy Storage Models Task 35: Flexible sector Coupling by the implementation of Energy Storage Task 37: Smart Design and Control of Energy Storage Systems Task 38: Ground Source de-icing for Infrastructure Task 39: Large TES for District heating Task 40: Compact Thermal Energy Storage (joint Task with SHC TCP) Task 41: Economics of Energy Storage Task 42, new: System flexibility from Medium-Duration Energy Storage. This is led by the UK. Task 43, new: Standardized use of building mass as storage for renewables and grid flexibility						

Open to IEA members Current Membership: Australia, Austria, Belgium, Brazil, Canada, China, Czech Republic, Denmark, France, Finland, Germany, Ireland, Italy, Japan, Norway, New Zealand, Netherlands, Portugal, Singapore, Sweden, Switzerland, Spain, South Korea, Turkey, US, UK	IEA Energy in Buildings and Communities (EBC) TCP	Mission: To support the acceleration of the transformation of the built environment towards more energy efficient and sustainable buildings and communities, by the development and dissemination of knowledge, technologies and processes and other solutions through international collaborative research and open innovation. The following projects are in the working phase: Annex 81 Data-Driven Smart Buildings – UK has a leading role in this Annex Annex 82 Energy Flexible Buildings Towards Resilient Low Carbon Energy Systems Annex 83 Positive Energy Districts Annex 84 Demand Management of Buildings in Thermal Networks Annex 85 Indirect Evaporative Cooling Annex 86 Energy Efficient Indoor Air Quality Management in Residential Buildings Annex 87 Energy and Indoor Environmental Quality Performance of Personalised Environmental Control Systems	Both Public and Private. PP & PR	RD&D	1977	Continuing	Tasks are self funding meaning a total spend is not known by member countries.	https://www.iea-ebc.org/

		The following projects are in the preparation phase: Annex 88 Evaluation and Demonstration of Actual Energy Efficiency of Heat Pump Systems in Buildings Annex 89: Implementing Net Zero Emissions Buildings The following projects are in development: Project Concept: Open BIM for Energy Efficient Buildings – International meeting to be organised Project Concept: Building Energy Codes Future Activities						
Australia, Austria, Belgium, Brazil, Canada, China, Croatia, Denmark, Commission of the European Union, Finland, France, Germany, India, Ireland, Italy, Japan, the Republic of Korea, the Netherlands, New Zealand, Norway, South Africa, Sweden, Switzerland, UK, USA	IEA Bioenergy TCP	Collaborative research on various aspects of Bioenergy	Both Public and Private. PP & PR	RD&D Collaboration. The TCP work programme is available at https://www.ieabioenergy.com/our-work-tasks/	1978	Continuing	US $ 50,700	https://www.ieabioenergy.com/
Open to IEA members	International Smart Grid Action Network (ISGAN) TCP	Collaborative research on various aspects of ISGAN	Both Public and Private. PP & PR	RD&D		Continuing		https://www.iea-isgan.org/

UNITED STATES

Other countries involved	**Name of collaboration**	**Objective of activities or outcomes**	**Sectors involved** (PP /PR)*	**Type of collaboration** (RD&D)	**Start Date** (Year)	**End Date** (Year)	**Funding amount**	**Additional information** (link)
Australia	Australia-US Net Zero Technology Acceleration Partnership	A bilateral partnership to accelerate the development and deployment of zero emissions technology, and cooperate on critical minerals supply chains to reduce greenhouse gas emissions while supercharging economic growth.	Long-duration Battery Storage and Grid Modernization	Research and Development	2023	NA	TBD	https://www.energy.gov/media/276507

CEM and MI Members	Global Clean Energy Action Forum (GCEAF)	The U.S. hosted the CEM and MI joint ministerials. GCEAF brought together a business forum, ministerial meetings, over 200 side events and nine roundtables to bring together the global innovation and deployment communities in an effort to accelerate clean energy transitions.	Cross-cutting PP & PR	Research, Development, and Demonstration PP & PR	2022	2022	N/A	Chair's Summary: Global Clean Energy Action Forum 2022 | Department of Energy https://www.energy.gov/sites/default/files/2022-09/USG%20GCEAF%20FACTSHEET_final_1.pdf
Argentina, Chile, Egypt, Indonesia, Nigeria, Singapore, Thailand, Ukraine	Net Zero World	A whole-of-government program utilizing ten of DOE's national laboratories to provide demand-driven technical assistance. The program supports emerging economies to develop net zero pathways, conduct energy planning activities, implement policies and attract project investment to deliver on their clean energy goals.	Buildings, Industry, Transportation, Power and Energy Storage, CCUS, Agriculture, Energy Systems, and Nuclear; Primarily public-public, but also included public-private partnerships	Research and Development PP	2021	Ongoing	$21.485M	https://www.nrel.gov/international/net-zero-world.html
Brazil	U.S-Brazil Energy Forum	Government-to-government bilateral partnership that aims to strengthen clean energy cooperation between both nations	Nuclear, carbon management, grid modernization, clean hydrogen, off-shore wind, sustainable fuels, distributed energy	Demonstration, Deployment PP	2022	On-going	$500,000	

Brazil	US-Brazil Clean Energy Industry Dialogue - CEID	The CEID is a public-private bilateral energy cooperation with the goal of advancing the adoption of clean energy technologies in the U.S. and Brazil. The CEID promotes trade and investment and informs and government to government cooperation agenda between the U.S. and Brazil.	carbon and methane management; clean hydrogen; sustainable fuels; grid modernization and storage; and offshore wind.	Demonstration, Deployment PR	2023	Ongoing	None	
ROK	LPO-KSURE MOU	On September 14, 2023 LPO and KSURE signed a MOU to explore opportunities for co-financing, better sharing of best practices, and increased opportunities for the U.S. and ROK private sector to invest in clean energy and manufacturing projects in the United States at scale. In November 2023, LPO visited Seoul to formalize this partnership with KSURE and discuss potential opportunities for cofinancing.	Prioritizes clean energy projects including electric vehicles, bioenergy, critical minerals including rare metals, and renewable technologies	PR	2023			
EU	US-EU TTC	Publication of joint Transatlantic Technical Recommendations for Government Funded Implementation of Elective Vehicle Charging Infrastructure; publication of joint Transatlantic Technical Recommendations for Public Demonstrations of Vehicle-Grid Integration; two associated stakeholder workshops.	Primarily public-public between DOE's Argonne National Laboratory (ANL) and the EC's Joint Research Centre (JRC). ANL and the JRC have worked to incorporate private sector stakeholder feedback in this engagement through multiple workshops.	Research, development, and demonstration of electric vehicle charging and electric vehicle-grid integration PP & PR	2021 (builds on 10 yrs of ANL/JRC work)	2023 (ANL/JRC work will continue)	Research is funded by DOE's Vehicle Technologies Office and the EC's DG MOVE.	TTC4_WG2_Joint-Recommendations-EV-Charging-Infrastructure_vFINAL-2.pdf (energy.gov) U.S.-EU Trade and Technology Council: Factsheet for the Joint Report on Electro-mobility and Interoperability with Smart Grids | Department of Energy U.S.-EU Trade and Technology Council: Work on Electro-Mobility and Interoperability with Smart Grids | Department of Energy
India	US-India SCEP	As part of the bilateral US-India Strategic Clean Energy Partnership (SCEP), the sides advance clean energy R&D through: 1) Partnership to Advance Clean Energy- Research (PACE-R), and 2) Renewable Energy Technology Action Platform (RETAP)	1)PP / PR - Smart grids and energy storage collaboration includes a consortium of technical and research institutes	1) R&D with pilots of developed smart grid and advanced ES technologies	1) 2017 2) 2023	1) 2023 2) 2029	1) $7.5M committed each by US and India and matched by collaborative consortium for a total $30M	1) PACE-R Smart Grids and Energy Storage Consortium called UI-ASSIST, UI-ASSIST | Home (uiassist.org) 2) RETAP Announcement: pib.gov.in/PressReleaseIframePage.aspx?PRID=1953550

			and industry funded by a gov-to-gov program 2) PP / PR – RETAP is a gov-to-gov collaboration on RE technologies (H2, long duration energy storage, offshore wind, geothermal), some phases will include public-private engagement	2) will include R&D and pilots and testing		(initial 5-year plan)	2) TBD	
Israel	Israel-U.S. Binational Industrial Research and Development Foundation (BIRD)	This program facilitates collaboration between U.S. and Israeli universities and the private sector to conduct R&D on clean energy technologies. Numerous technologies have become commercialized, and since its inception, the program has mobilized roughly $1BN in investments	Numerous	R&D PR	1977	On-going	$6M annually	BIRD Energy - BIRD Foundation

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