



SEPTEMBER 2022

Member Insights 2021-2022



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Introduction

The Mission Innovation Member Insights Report 2021-22 presents information on clean energy research, development and demonstration (RD&D) activities covering the period June 2021 to September 2022. 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. Taken together 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 2021¹.

The Member Insights Report contains a section on each MI Member Country who either responded to the MI Member Survey 2022 or where they have provided public sector RD&D data. The core elements covered in each country section are:

- **Clean energy innovation activities:** MI Members have provided a summary of RD&D funding and programmes announced or implemented in the previous year. This complements the forward-looking priorities and plans to be found in the National Innovation Pathways Report
- **Public RD&D data:** New for this year, 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 Database². 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 2016 so that trends over time can be seen. Readers should note that this information may be different to figures presented previously in the annual MI Country Highlights reports which tracked spending against the baseline for commitments in MI 1.0, and is not directly comparable. The Public RD&D spend for

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/reports/energy-technology-rdd-budgets-overview/public-energy-rdd-in-iea-countries>

INTRODUCTION

each member is included here as it helps us track the commitment made by MI members to sustain and, where possible, enhance RD&D investments in the MI2.0 member statement³.

- **Public-private collaborations:** Members have provided a summary of major programmes or initiatives that leverage private sector expertise and funding tackle their priority clean energy innovation challenges.
- **Involvement in Mission Innovation:** Members have described how they have contributed to and met their commitments as members of MI since June 2021, including through the Missions and other initiatives, and possible outcomes of such collaborations.
- **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 tables are collated together in Annex A.
- **Other Clean Energy Innovation Activities (optional):** Members have provided 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 information publicly available via reporting to the IEA. We will update this report as members return their responses.

³ <http://mission-innovation.net/about-mi/overview/2021-joint-launch-statement/>

Australia

Major innovation initiatives and programmes in 2021-2022

In November 2021 the Australian Government announced investments of \$1.7 billion in government funding for low emissions technology. This included an investment of \$565 million for international partnerships to progress collaboration on low and zero emission technology. The Australian Renewable Energy Agency (ARENA) also announced their 'Solar 30 30 30' initiative to help drive down the cost of solar technology. Solar 30 30 30 aims to achieve 30% module efficiency at 30 cents per installed watt by 2030.

In December 2021 the Australian Government announced it was committing almost AUD\$900 million of new funding over ten years to support emissions reduction. This included:

- \$500m to the Clean Energy Finance Corporation (CEFC) Low Emissions Technology Commercialisation Fund
- \$180m to expand the Future Fuels Fund, to accelerate the uptake of new vehicle technologies
- \$150m for two additional hydrogen hubs, bringing the Government's total commitment to \$464 m to fund seven (7) hubs
- \$33m for the Australian Renewable Energy Agency (ARENA) to support development and deployment of sustainable aviation and marine biofuels
- \$10m on analysis and modelling to ensure the electricity grid is ready for increased EV uptake and avoid unnecessary investment in distribution networks.

In May 2022, the Australian Government committed to a new package of policies and investment in clean energy innovation. These will be delivered in the July 2022 to June 2023 period and will be reported in the next annual survey.

AUSTRALIA

Table 1: New programmes and activities relevant to energy innovation

Name	Type*	Budget	Technology focus	Start/end date	Main activities	Link
Solar 30 30	(l) Other	AUD \$40m	Ultra low cost solar	2021	Aims to achieve 30% module efficiency at 30 cents per installed watt by 2030.	https://arena.gov.au/blog/fresh-funding-strives-for-more-efficient-and-affordable-solar/
Clean Hydrogen Industrial Hubs program	(b) Grants	AUD \$464 million	Clean hydrogen	2021	The Clean Hydrogen Industrial Hubs program will enable the rollout of hydrogen hubs across seven priority regional sites	https://www.industry.gov.au/news/funding-available-for-clean-hydrogen-industrial-hubs
Low Emissions Technology International partnerships	(b) Grants	AUD \$565 million	Solar, clean hydrogen, green steel	2021	To support new international partnerships that make low emissions technologies cheaper and drive investment	https://www.minister.industry.gov.au/ministers/taylor/media-releases/australia-enters-sixth-bilateral-low-emissions-technology-partnership

AUSTRALIA

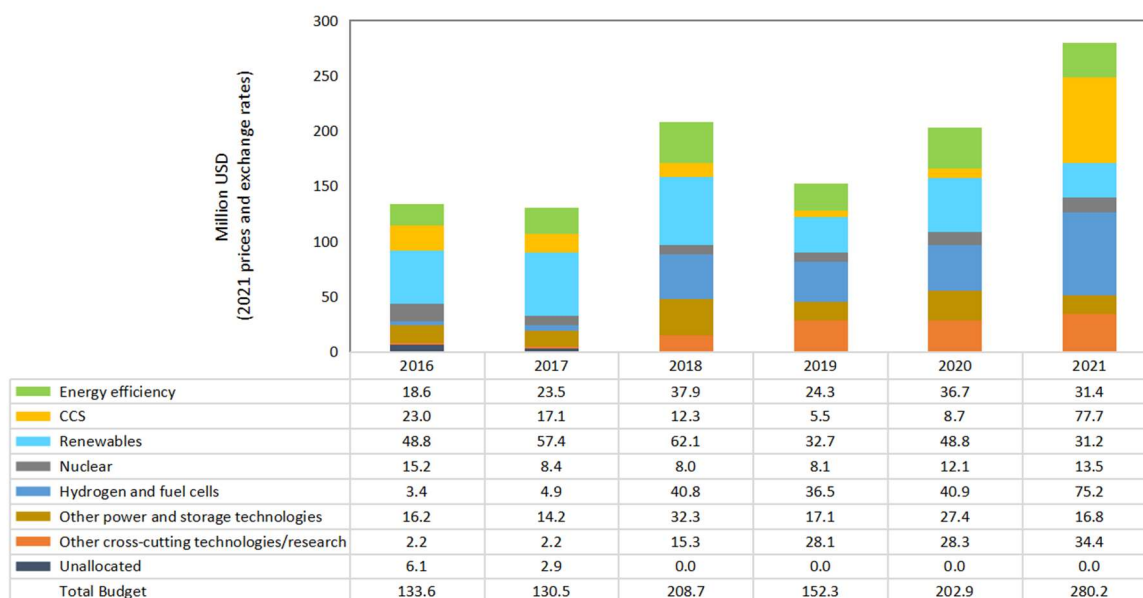
Powering Australia	(I) Other	>AUD \$23b	Whole of Economy	2022-	<p>This is Australia's plan to increase renewable energy and reduce emissions. A number of programs will be rolled out under PA. Upgrading Australia's electricity grid; investing in solar banks and community batteries; reducing federal public sector emissions to net zero by 2030; improving the 'Safeguard Mechanism'; setting up a National Reconstruction Fund to support renewables manufacturing and deployment of low emissions technologies; introducing an EV discount; developing a national EV strategy</p>	<p>https://keystone-alp.s3-ap-southeast-2.amazonaws.com/prod/61a9693a3f3c53001f975017-PoweringAustralia.pdf https://www.alp.org.au/policies/powering-australia (link to Labor page, the above is a direct link to the pdf)</p>
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* 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.

AUSTRALIA

Public RD&D Data

Australia's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

AUSTRALIA

Public-private engagement in 2021/22

Based on interim data⁴, 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.

Major contributions to Mission Innovation collaborative initiatives in 2021/22

Mission Innovation Steering Committee

Jo Evans, Deputy Secretary of the Australian Government Department of Climate Change, Energy, the Environment and Water joined the MI Steering Committee in April 2022 to provide high-level strategic guidance to MI.

Net Zero Industries Mission

Australia co-leads the Net Zero Industry Mission (NZIM) with Austria. Australia announced its co-lead of the NZIM at the soft launch in November 2021 at COP26. In June 2022 Australia's Heavy Industry Low-Carbon Transition Cooperative Research Centre (HILT CRC) formally commenced leadership of Australia's technical engagement in the NZIM. A discussion paper for public consultation was released in May 2022.

Clean Hydrogen Mission

Australia co-leads the Clean Hydrogen Mission with Chile, European Union, United Kingdom, and United States. Australia's engagement is led by the CSIRO, leading the Storage and Distribution working group under Pillar 1 - R&I. In November 2021 the Clean Hydrogen Mission released a discussion paper for public consultation. Feedback on the Discussion Paper will

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.

AUSTRALIA

feed into a final version of the paper and Clean Hydrogen Mission Action Plan, to be released in 2022.

Green Powered Futures Mission

In November 2021, at COP26 Australia joined as a core member of the Green Powered Futures Mission (GPFM), and contributed to the development of the GPFM Joint Roadmap of Global Innovation Priorities, released in November 2021. Australia's engagement is led through the CSIRO.

Carbon Dioxide Removal Mission

Australia is in the Mission Core Group for the Carbon Dioxide Removal (CDR) Mission. The CDR Mission was announced at COP26 in November 2021. The CSIRO leads Australia's engagement in the CDR Mission, and have contributed time and resources to support Mission co-leads and core members.

Innovation Platform

The Australian Affordable Heating and Cooling Innovation Hub (i-Hub) project explored the potential for digitalization to support delivery of flexible demand services from buildings. The i-Hub investigated various innovations that could make digitalization more scalable. This included developing a real-time data management platform to address interoperability barriers, and to support possible future institutional arrangements for data sharing.

Australia continues to lead the MI Affordable Heating and Cooling 'Predictive Maintenance and Optimization' priority area under the auspices of the International Energy Agency 'Energy in Buildings and Communities' Annex81 'Data-Driven Smart Buildings'. The Annex is a collaboration of 19 countries and over 50 organisations.

International clean energy collaborations in 2021/22

See annex A on page 115.

Other clean energy innovation activities in 2021/22

Clean Energy Ministerial

Australia contributes to a number of initiatives of the Clean Energy Ministerial, including The Clean Energy Solutions Center (co-lead with the United States), The International Smart Grid Action Network, and Energy Management Working Group, the CCUS Initiative, SEAD, C3E and the Clean H2 Initiative.

AUSTRALIA

G-PST Consortium

The G-PST is an international group of electricity system operators collaborating with leading international researchers to accelerate the transition to low emissions, low-cost, secure and reliable power systems. The G-PST represents a major global commitment to implementing technologies and approaches to permanently reduce emissions trajectories, while simultaneously improving grid reliability, resilience, and security. The Australian Energy Market Operator (AEMO) is a founding member of the G-PST and, with CSIRO, leads the Australian research delegation contributing to the Consortium.

Sydney Energy Forum

In July 2022 Australia held the Sydney Energy Forum. The forum was co-hosted by the Australian Government and International Energy Agency, with support from the Business Council of Australia. The focus of the forum was on exploring the challenges and opportunities associated with the development of diverse, competitive and resilient clean energy supply chains in the Indo-Pacific region.

Austria

Major innovation initiatives and programmes in 2021/22

A detailed analysis of the national Energy RD&D expenditures of Austria in 2021, was conducted following the standards set by the IEA Guide to Reporting Energy RD&D Budget and OECD (Frascati Manual).

It showed that in 2021, about 1,200 projects and activities for publicly funded energy-related research, development and first-of-a-kind demonstration amounted to 224.1 million euros. A year-on-year comparison shows a substantial increase in public energy research expenditures of 68.9 million euros or 44.4% for the year 2021 and thus an all-time high.

A summary of the outcomes in English can be downloaded through this [link](#).

AUSTRIA

Table 1: Programmes and initiatives relevant to energy innovation

Name	Type*	Budget*	Technology focus	Start/end date	Main activities	Link
Zero Emission Mobility 2022	Grants	€8M.	Zero-Emission: Vehicles, Infrastructure, Logistics & Mobility Solutions	1 June 2022 – 14 October 2022	This funding programme promotes market-oriented research into zero-emission technologies to increase efficiency in the transport system.	https://www.klimafonds.gv.at/wp-content/uploads/sites/16/Guide-for-Proposers-Zero-Emission-Mobility-2022.pdf
Resilient cities: Lighthouse projects 2040	Grants	€7M	Resilient Cities	24 May 2022 – 13 Oct. 2022	<p>Within the framework of this call for proposals, demonstration projects can be submitted on the following three priority topics as well as further R&D services:</p> <ul style="list-style-type: none"> • Urban transformation through climate change adaptation of public space, • Resilient settlement development in existing neighbourhoods, • Social innovation & participation as a driver of sustainable urban development. 	https://www.klimafonds.gv.at/call/leuchttuerme-fuer-resiliente-staedte-2040-ausschreibung-2022/
Pioneer City - Partnership for Climate Neutral Cities 2030	Grants	€12M	Climate neutral Cities		The pioneer cities build capacity, transform their administrative processes and structures, implement this reorientation towards climate neutrality in an exemplary neighbourhood, and provide an innovative learning environment in one or more exemplary neighbourhoods with their developed solution modules.	Pionierstadt – Partnerschaft für klimaneutrale Städte 2030 FFG

AUSTRIA

Transformation of the Economy	Investment Costs for Demonstration Projects	€35M	Energy Intensive Industry	1 st Call: 11 July – 21 Oct 2022;	Object of funding are transformative projects for the conversion to renewable energies for the permanent reduction of greenhouse gas emissions in energy-intensive industry.	Transformation der Wirtschaft, 1. Ausschreibung - Klima- und Energiefonds - Klima- und Energiefonds (klimafonds.gv.at)
Energy Research, 8 th Call	Grants	€8M.	materials science issues with high application potential in the energy sector	22 nd Dec 21– 4 th May 22	The aim is to expand technological competencies, strengthen Austria as a location for innovation in clean energy technologies and improve export opportunities. Funding is provided for: oriented basic research, exploratory studies & Cooperative R&D projects	Energieforschung - 8. Ausschreibung FFG
City of the Future, 9 th Call	Grants	€8M.	Climate neutral cities, neighbourhoods & buildings	6 th Oct 2021 – 27 th Jan 2022	The 9 th call for proposals is based on the guiding principle "Climate Neutral City - Becoming an Innovation Leader with RTI". Ideas and solutions are sought that enable the transformation to an energy-efficient and climate-friendly city.	Stadt der Zukunft - 9. Ausschreibung FFG
Important Projects of Common European Interest (IPCEI) Hydrogen	(I) other**	Total budget €125M	<ul style="list-style-type: none"> Technology for the Creation of a European Hydrogen Value Chain Decarbonisation through the Use of H2 in Industrial Applications 	20 th June 2021	<ul style="list-style-type: none"> Renewable hydrogen especially for industrial applications Integrated projects with focus on industrial application/use of hydrogen Projects with focus on technology development and FID (production, transport, storage, application, energy service) 	h2 (bmk.gv.at)
Important Projects of	See above		<ul style="list-style-type: none"> short- or medium-term 	Summer 2022:	On May 20, 2022, Austria, together with Spain, Belgium, Luxembourg, Poland and	IPCEI: Aufruf zur Interessensbekundung zum

AUSTRIA

Common European Interest (IPCEI) Photovoltaics			industrialization of the next PV technology generation, • integrated PV solutions, • system integration solutions • circular photovoltaics		Lithuania, presented the initiative with which these countries want to promote PV technologies as an “Important Project of Common European Interest”. By the summer, further member states are to join the initiative and the focus areas will be defined more concretely.	Thema Photovoltaic (Phase 1) FFG
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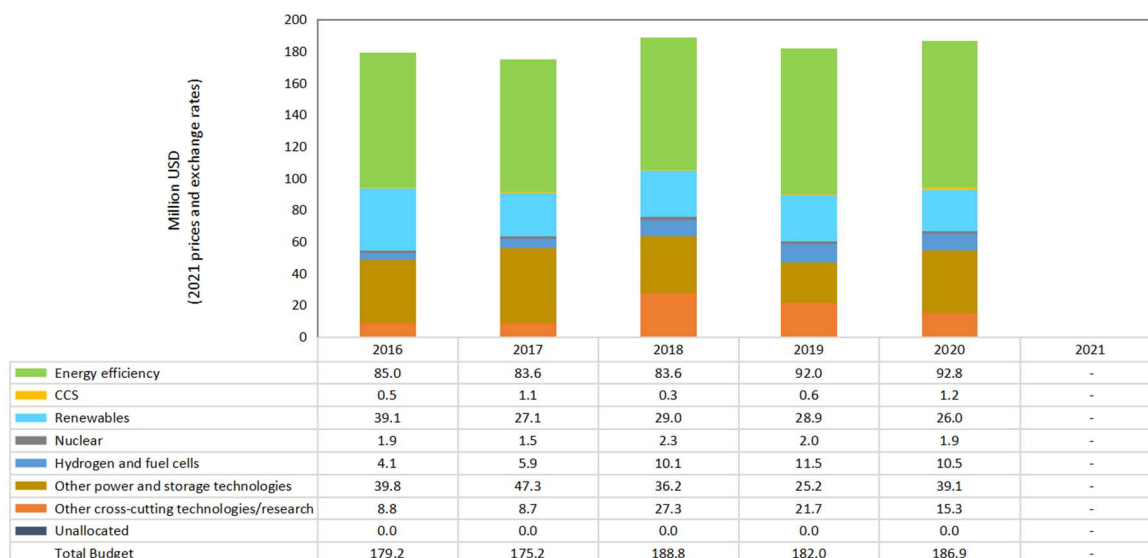
* Type categories: (a) Education and training; (b) Grants; (c) Operational funding for institutions (e.g. national labs, universities); (d) Inducement prizes; (e) Equity investments (e.g. in start-ups); (f) Loans, debt financing and loan guarantees; (g) Tax credits and exemptions (e.g. for R&D); (h) 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.

** IPCEI is a State aid regulation of the European Union. It allows exemptions to current state aid law for clearly defined, cooperative projects of European interest. If approved by the EC, Member States are entitled to the distribution of state aid.

AUSTRIA

Public RD&D Data

Austria's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

AUSTRIA

Public-private engagement in 2021/22

The engagement of the private sector in clean energy innovation and research policies and projects has a long tradition in Austria. For more than ten years, the Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology as well as the Climate and Energy Fund of the Austrian Federal Government focused on collaborations between industry and the research community in their programmes. This led to a significant private sector contribution to programmes such as the Flagship Regions Energy where more than doubling of public money by the private sector is expected. More information on the 3 Flagship regions can be found here: » [Vorzeigeregionen – Vorzeigeregion \(vorzeigeregion-energie.at\)](https://www.vorzeigeregionen.at/).

Major contributions to Mission Innovation collaborative initiatives in 2021/22

Net- Zero Industries Mission: Co-Lead

In Spring 2021, Austria has actively taken over the pre-scoping of the Net Zero Industries Mission and has, with the support of the UK, organized 2 pre-scoping workshops that laid the foundation for the mission (identification of tipping points and mission goals). Shortly before COP27, Australia agreed to Co-Lead the Mission, which had a “soft launch” at COP26. 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, Austria has secured resources to fill several positions within the Mission Governance (Mission Director, Mission Secretariat & PR, Technical Analysts and Support)

Clean Hydrogen Mission: Core Member

Provision of national expert to contribute to the Mission activities.

Green Powered Future Mission: Mission Support Group (Tier 2 Member)

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))

AUSTRIA

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 2021/22

See Annex A on page 118.

Other clean energy innovation activities in 2021/22

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, 160.000 tickets have been sold and public transport has significantly increased. Customers that extend their tickets between July and December 2022 get a 13th month for free.

Link: [Das Warten hat ein Ende: Klimaticket Now geht an den Start – BMK INFOTHEK](#)

Austrian Climate Council

The first Climate Council of Austrian Citizens presented the result of its work on Monday, 4 July 2022. In a 97-page report with a total of 93 recommendations for federal and state policy. In this report, the Climate Council has formulated the path to climate neutrality by 2040. The recommended measures concern the areas of energy, food & land use, mobility, housing as well as production and consumption, but also general, political recommendations such as a basic right to climate protection.

Link: [Klimarat präsentiert die Ergebnisse seiner Arbeit \(bmk.gv.at\)](#)

AUSTRIA

Important Projects of Common European Interest (IPCEI) Photovoltaic (27.06.2022)

On May 20, 2022, Austria, together with Spain, Belgium, Luxembourg, Poland and Lithuania, presented the initiative with which these countries want to promote PV technologies as an "Important Project of Common European Interest" (IPCEI). By the summer, further member states are to join the initiative and the focus areas will be defined more concretely. The current plan is to start official negotiations and the next steps in the IPCEI process as early as autumn 2022.

From June 27 to August 19, 2022 the Federal Ministry for Climate Action is calling on domestic companies and research institutions to submit innovative project ideas from the photovoltaic (PV) sector. Individual or consortium projects related to the short- or medium-term industrialization of the next PV technology generation, integrated PV solutions, system integration solutions or circular photovoltaics are sought.

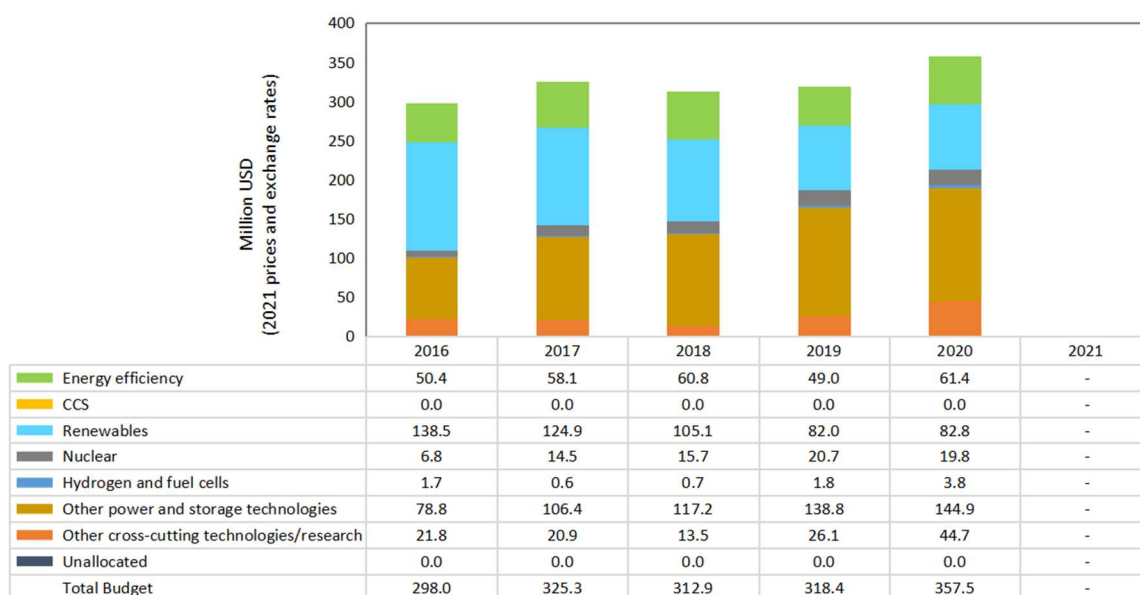
Press release: [Klimaschutzministerium sucht innovative Projektideen für EU-weite Photovoltaik-Initiative | BM für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie, 27.06.2022 \(ots.at\)](#)

BRAZIL

Brazil

Public RD&D Data

Brazil's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Canada

Major innovation initiatives and programmes in 2021/22

In 2021-22, the Government of Canada continued to award funding through its existing clean technology programs, while also launching new programs and initiatives in support of clean energy research, development and demonstration in priority areas. Highlights of Canada's new funding programs launched in 2021-22 include:

- Funded various energy research, development and demonstration (RD&D) projects under the Clean Growth Program, the Program of Energy Research and Development, the Energy Innovation Program (EIP), and the Green Infrastructure suite of programs.
- Launched new funding calls, including a \$53M EIP call on [Clean Fuels and Industrial Fuel Switching](#), a \$319M EIP call on [Carbon Capture, Utilization and Storage](#), and the \$10M [Oil Spill Response Challenge](#).
- Launched the [Critical Minerals RD&D program](#) 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 material inputs for use in batteries and permanent magnets.
- The [Strategic Innovation Fund Net-Zero Accelerator](#), which was initially announced through Canada's Enhanced Climate Plan in December 2020, received additional funding (now providing a total of \$8 billion) in support of projects, including some at the demonstration stage, that will enable Canada to reduce its domestic greenhouse gas emissions through industrial transformation.

Grand Prize winners were announced under the six Impact Canada Initiative Clean Tech Challenges: the Women in Cleantech Challenge, the [Charging the Future Challenge](#), The [Sky's the Limit Challenge](#), the [Canada-UK Power Forward Challenge](#), the [Crush It! Challenge](#), and the [Indigenous Off-Diesel Initiative](#).

CANADA

Name	Type *	Budget	Technology focus	Start/end date	Main activities	Link
Energy Innovation Program – Clean Fuels and Industrial Fuel Switching Stream	B	\$53M total	Lower carbon fuels and feedstocks (i.e. electricity, hydrogen, biomass, biofuels, and gaseous fuels).	2022-2027 (5 years)	As part of the Government's efforts to accelerate the development of technologies that can decarbonize industry, this call for proposals under the Energy Innovation Program will target industrial fuel switching and production of clean fuels for use in hard-to-abate sectors, focusing specifically on three technology areas. The three focus areas are: 1) Industrial Fuel Switching, 2) Clean Fuels Production, and 3) Hydrogen Codes and Standards	https://www.nrcan.gc.ca/science-and-data/funding-partnerships/funding-opportunities/funding-grants-incentives/energy-innovation-program/energy-innovation-program-clean-fuels-and-industrial-fuel-switching/23956

CANADA

Energy Innovation Program – Carbon Capture, Utilization, and Storage (CCUS) Stream	B	\$319M total	CCUS	2021-2028 (7 years)	<p>Announced in Budget 2021, the government is investing \$319M over 7 years for RD&D to advance the commercial viability of CCUS technology. The first call under this stream (selected projects announced April 2022) supported Front-End Engineering and Design (FEED) studies for CCUS projects that have the potential to significantly mitigate emissions. The second call (launched July 2022) aims to support earlier-stage RD&D across Capture, Storage/Sequestration, and Utilization focus areas. The Capture focus area launched in July 2022, with the other two to follow in the coming months.</p> <p>In addition, the federal laboratories are currently participating in a CCUS federal R&D program. In its second year, funding over 80 projects in federal labs, the program is providing \$100M over the 7 years for CCUS R&D activities to advance commercialization of CCUS technology.</p>	https://www.nrcan.gc.ca/our-natural-resources/energy-sources-distribution/carbon-capture-utilization-and-storage/4275
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CANADA

Energy Innovation Program (EIP) – ongoing funding	B	\$24M/year	Clean Energy Innovations	Ongoing	<p>The EIP advances clean energy technologies that will help Canada meet its climate change targets, while supporting the transition to a low-carbon economy. It funds research, development and demonstration projects, and other related scientific activities. Individual targeted calls and specific collaboration and investments programs under EIP will support Clean Energy Innovation across four Missions: 1) Improving efficiency and processes to reduce emissions from energy end-use; 2) Accelerating electrification and maximize benefits of low-emitting heat and power; 3) Developing cleaner hydrocarbon and renewable fuels pathways; and 4) Maintaining safe and resilient energy systems to protect Canadians in the changing energy landscape.</p>	https://www.nrcan.gc.ca/science-and-data/funding-partnerships/funding-opportunities/funding-grants-incentives/energy-innovation-program/18876
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CANADA

Emissions Reduction Fund (offshore RD&D stream)	B	\$33M total	Decarbonizing the offshore oil and gas industry	2022-2024	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 gas industry.	https://www.nrcan.gc.ca/science-and-data/funding-partnerships/funding-opportunities/current-funding-opportunities/emissions-reduction-fund/new-offshore-emissions-reduction-fund-helps-economy-and-environment/23091
Green Infrastructure Program – Electric Vehicle Infrastructure Demonstration	B	\$76M total	Electric vehicle infrastructure	2016-2022	The EVID program aims to accelerate the market entry of next generation clean energy infrastructure, by supporting demonstration projects of innovative EV charging and hydrogen refuelling technologies, in order to lead to an increased uptake of zero-emission vehicles (ZEVs).	https://www.nrcan.gc.ca/climate-change/adapting-impacts-and-reducing-emissions/green-infrastructure-programs/electric-vehicle-infrastructure-demonstrations-evid/20467

CANADA

Green Infrastructure Program – Energy Efficient Buildings RD&D	B	\$48.4M total	Energy efficient buildings	2018-2026	<p>\$48.4 million to support the development and implementation of building codes for existing buildings and new net-zero energy-ready buildings through RD&D initiatives that:</p> <ul style="list-style-type: none"> - Accelerate development and adoption of technologies, design and construction. - Provide more cost-effective solutions. - Validate locally with real-world demonstrations. - Build confidence for adoption of updated codes. 	https://www.nrcan.gc.ca/netzerobuildings
Green Infrastructure Program – Smart Grids (demonstration stream)	B	\$35M total for demonstration stream	Smart grids	2018-2023	The demonstration stream of the Smart Grid Program promotes 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.	https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/smart-grids/19793

CANADA

Clean Energy for Rural and Remote Communities	B	\$136M total for demonstrations	Renewable energy, storage, efficiency, and smart grid projects	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
Clean Growth Program	B, K	\$155M total	Focus on three sectors: energy, mining, and forestry	2017-2022 (5 years)	The first-of-its-kind Clean Growth Program (CGP) provided \$155 million to co-fund 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.	https://www.nrcan.gc.ca/climate-change/canadas-green-future/clean-growth-programs/20254

CANADA

Impact Canada Initiative – Clean Technology Challenges	A, B, D, H, K	\$75M total	Six technology areas of focus: comminution (mining), batteries, grid flexibility, sustainable aviation fuel, off-diesel transition, women clean tech entrepreneurs	2017-2022 (5 years)	Impact Canada accelerates the adoption of outcomes-based approaches to deliver meaningful results to Canadians. Natural Resources Canada received \$75M over four years to launch six Cleantech Challenges under Impact Canada. These Challenges addressed persistent barriers in cleantech development and adoption by setting ambitious but achievable goals to identify and develop breakthrough solutions. The program sunset in March 2022 and all final prizes have been awarded.	https://impact.canada.ca/challenges/projects
Oil Spill Response Challenge	B	\$10M total	Oil spills in aquatic environments	2022-2024 (3 years)	This new Impact Canada Challenge, launched in March 2022, seeks to advance innovative and rapidly deployable oil spill response solutions to effectively improve response time and/or increase recovery of oil spilt in diverse Canadian aquatic environments when compared against conventional technology.	https://impact.canada.ca/en/challenges/oil-spill-response

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Federal Internal Energy R&D	C	\$46.6M / year	Energy efficiency, electrification, renewables, cleaner hydrocarbons, energy system resilience	Ongoing	The Office of Energy Research and Development at Natural Resources Canada funds world-class energy research at its Canmet research centres and other federal research facilities through the Energy Innovation Program and the Program of Energy Research and Development.	https://www.nrcan.gc.ca/science-and-data/funding-partnerships/funding-opportunities/funding-grants-incentives/program-energy-research-development/4993
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	<p>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:</p> <ul style="list-style-type: none"> - 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/

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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	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/iam/clean-technology-firms
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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
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National Research Council of Canada (NRC)	B, K	Variable	Energy storage and generation; bioenergy and low carbon fuels; materials for clean fuels; clean transportation; smart buildings	Ongoing	<p>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. Through the EME, NRC's Advanced Clean Energy program accelerates the development of clean renewable fuels and energy storage materials and devices that will facilitate the transition to low- and zero-carbon fuel and the electrification of our energy supply, across all sectors.</p> <p>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.</p>	https://nrc.canada.ca/en
Critical Minerals RD&D Program	B	\$10.95M total	Mining technologies, inputs for Zero-Emissions Vehicle value chains	2022-2024	<p>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 material inputs for use in batteries and permanent magnets.</p>	https://www.nrcan.gc.ca/mining-materials/resources/specialized-mining-services/critical-minerals-research-development-and-demonstration-program/24288

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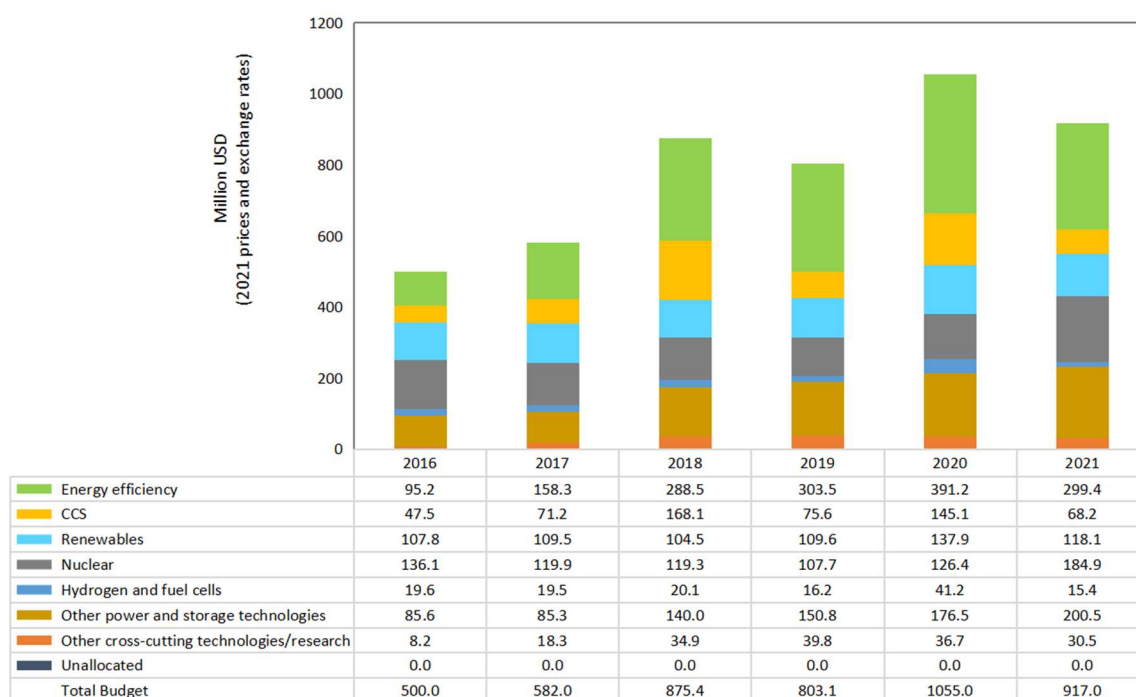
Strategic Innovation Fund – Net Zero Accelerator	B	\$8B total	Cross sectoral. Initial focus on industrial decarbonization and energy storage.	2021-2028 (7 years)	The Net Zero Accelerator (NZA) initiative supports Canada's net zero goals to help transform the economy for clean and long term growth. This 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
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* 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.

CANADA

Public RD&D Data

Canada's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Public-private engagement in 2021/22

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. In October 2021, NRCan hosted an Accelerator Session for the [ten companies in the BESC cohort, providing them with](#) an opportunity to pitch to an audience of investors and other partners about their company and technology development since the beginning of the program. This event had the aim of promoting cohort companies, and to helping them attract additional investment and partners.

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Between accelerator events, the cohort has remained engaged, sharing challenges and offering peer-to-peer guidance in support of company growth. To complement this support, the program initiated a series of BESC Expert Sessions, introducing subject matter experts and experienced professionals to mentor cohort companies on identified issues of interest. To date, sessions have focused on fundraising and company valuation (in partnership with the Canadian Venture Capital Association), human resources best practices for high-growth companies, project financing considerations, and taking companies public.

Major contributions to Mission Innovation collaborative initiatives in 2021/22

Carbon Dioxide Removal Mission

- 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. This has included delivering stakeholder engagement sessions; chairing member meetings and working with members one-on-one to identify their priorities; leading the Mission's lifecycle assessment technical track; developing the Mission's Action Plan and coordinating input from members; and collaborating with co-leads to develop sprint project proposals.

Clean Hydrogen Mission

- 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 approach. In 2022, Canada has joined working groups that advance clean hydrogen priorities for the department, provided input to the Mission's Action Plan, and is working with Mission leads to develop collaborative actions.

Green-Powered Future Mission

- Canada has played an active role as a member of the Power Mission, contributing technical expertise and advice to Mission activities, and contributing to Mission flagship projects. NRCan also serves as the official liaison between the Mission and

CANADA

the International Smart Grid Action Network (ISGAN), strengthening connections across the innovation to deployment continuum.

Integrated Biorefineries Mission

- Since the Integrated Biorefineries Mission was launched in April 2022, Canada has played a leading role in compiling information from Mission members on their national policies, research priorities, funding programs, projects, and other relevant information. This mapping exercise played a crucial role in informing the Biorefineries Mission's Innovation Roadmap, which Canada helped to develop.

Net-Zero Industries Mission

- Canada will officially join the Net-Zero Industries Mission at the Global Clean Energy Action Forum in September 2022. In the lead-up to the event, Canada has participated in Mission activities and provided input into the development of the Mission's Innovation Roadmap and Action Plan.

MI Innovation Platform – Collaborate Module Initiatives

- Canada co-leads the Materials for Energy Initiative (M4E) to accelerate the development and deployment of advanced materials for clean energy technologies. Since 2021, Canada supported the launch of the German-Canadian Materials Acceleration Centre, and further supported the promotion and uptake of self-driving materials laboratories.
- Canada participates as a member of the Innovation Community on Affordable Heating and Cooling of Buildings.

MI Governance and Operations

- In addition to contributions to specific MI activities, Canada plays a leading role in MI's governance and operations, serving as Chair and a member of the MI Steering Committee and resourcing the virtual MI Secretariat.

International clean energy collaborations in 2021/22

See Annex A, page 123.

Other clean energy innovation activities in 2021/22

The Office of Energy Research and Development (OERD) at Natural Resources Canada leads 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 of low-emitting heat and power;
- Develop cleaner fuels pathways; and
- Maintain safe and resilient energy systems to protect Canadians in the changing energy landscape.

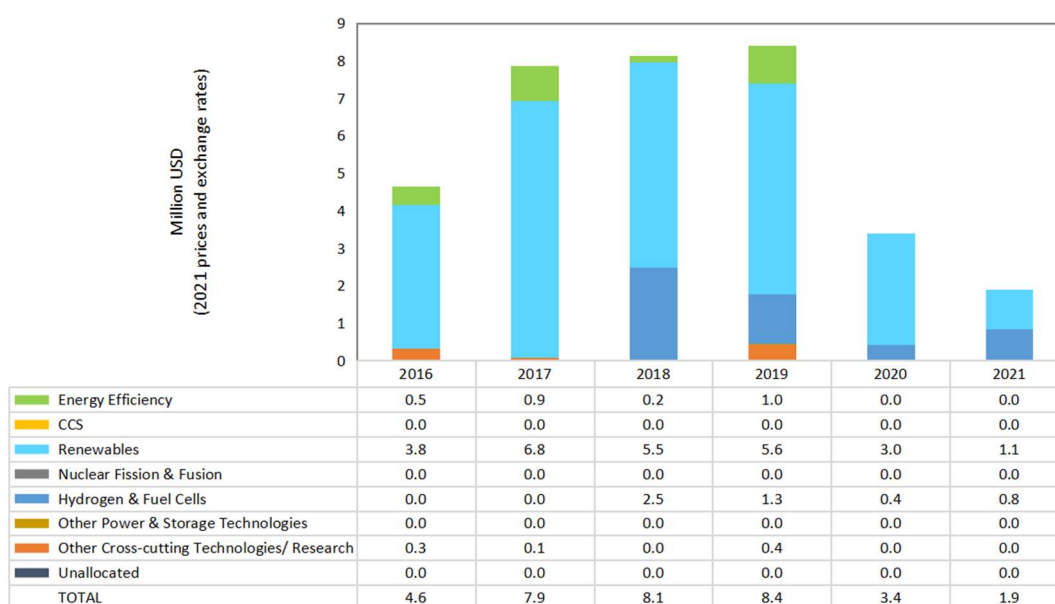
In January 2022, the International Energy Agency (IEA) released an In-Depth Review of Canada's energy policies that highlighted Natural Resources Canada's energy innovation activities as supporting global best practices, and further recommended increased federal investment in energy RD&D to build on this success and accelerate innovation.

CHILE

Chile

Public RD&D Data

Chile's public spend on clean energy RD&D since 2016 is as follows:



The data in this graph was provided to Mission Innovation directly by Chile. The data has been reviewed by the IEA.

DENMARK

Denmark

Major innovation initiatives and programmes in 2021/22

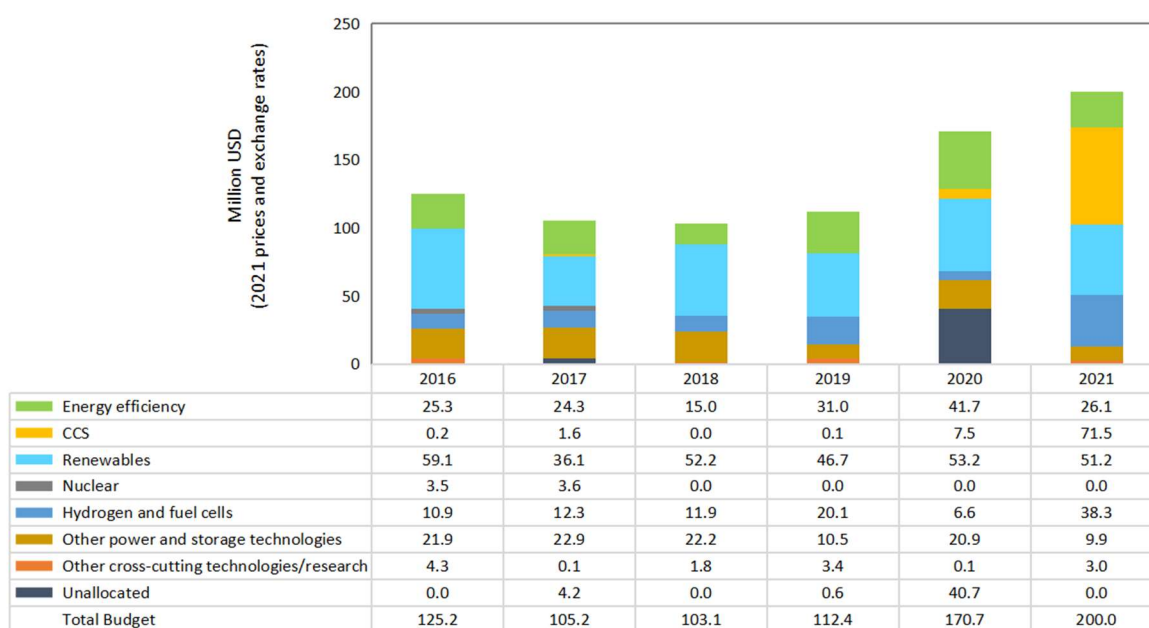
Name	Type*	Budget	Technology focus	Start/end date	Main activities	Link
Danish Climate Agreement for Energy and Industry 2020	Green transformation of industry and the energy sector	16,5 billion DKK (2022 amount)	CCUS fund	2024	Carbon capture and Power-to-X	https://kefm.dk/Media/C/B/faktaark-klimaafale%20(English%20august%2014).pdf
Green Partial Agreement in regards to 22 in the Finance Act (Technology neutral fund)	Investments in the continued green transition of Denmark	2,5 billion DKK (2022 amount)	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.	18,2 billion DKK (2022 amount)	CCS	2026	Capture and storage of fossil and biogenic sources	https://fm.dk/media/26070/aftale-om-groen-skattereform-for-industri-mv-a.pdf

* 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.

DENMARK

Public RD&D Data

Denmark's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Public-private engagement in 2021/22

On November 13, 2019, the Danish Prime Minister Mette Frederiksen presented the Danish government's 13 "climate partnerships" at a meeting in Marienborg, the Prime Minister's residence. The 13 partnerships represent all branches of Danish business. The Danish business community has a central role in the green transition and with the climate partnerships, the government wants to work closely with the business community on solving the climate challenges. The climate partnerships put forward their recommendations and plans on the 16th of March. Some of the key recommendations are reflected in the Danish Climate Agreement for Energy and Industry 2020, e.g. on PtX.

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The Danish government published in September 2020 a strategy for green research with four missions that will drive innovation and research in energy technology. Find the report [here](#).

In June 2021 the Danish Minister for Industry, Business and Financial Affairs [Mr. Simon Kollerup] together with the US Secretary of Energy and the Norwegian Minister of Climate and Environment launched the Zero-Emission Shipping Mission under Mission Innovation. The Shipping Mission is a public-private partnership that will demonstrate commercially-viable zero-emission vessels by 2030, making vessels that operate on zero-emission fuels the natural choice for ship owners when they renew their fleet.

Major contributions to Mission Innovation collaborative initiatives in 2021/22

Leading national experts from Danish Universities have participated in four Mission Innovation challenges: #1 Smart Grid, #3 Carbon Capture Utilization and Storage, #4 Biofuels and #6 Material.

Among other things, Denmark has played a central role in advancing the smart grid challenge, e.g. by contributing to the IC 1 Smart Grids Innovation Challenge Country Report 2019 and by co-hosting a total of four events on Flexibility in the energy system, Smart grid solution sprints, Next generation city action and MI energy hack. More information at <https://mission-innovation.dk/>

Moreover, Denmark has played a role in establishing collaborations and securing European funding under H2020 for the BIG-MAP: Battery Interface Genome – Materials Acceleration Platform. The BIG-MAP Platform is a large (20 M€) collaborative research project, which builds upon the fundamental ideas and concepts developed under Mission Innovation Challenge 6 (Clean Energy Materials).

At the 4th MI Ministerial meeting at Vancouver in May 2019, DTU Professor Tejs Vegge, an expert in computer-based methods for developing novel energy materials, was appointed as Denmark's Innovation Champion. Tejs Vegge's field of research focuses on ways to develop new materials for energy storage much faster, which is a key innovation challenge for developing sustainable energy systems based on fluctuating renewable

DENMARK

energy sources such as wind. The Innovation Fund Denmark supported the Mission Innovation activities, e.g. the MI Champions initiative.

International clean energy collaborations in 2021/22

See Annex A page 129.

European Commission

Major innovation initiatives and programmes in 2021/22

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 will double 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 electrolyzers, 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 billion 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 will be **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.

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

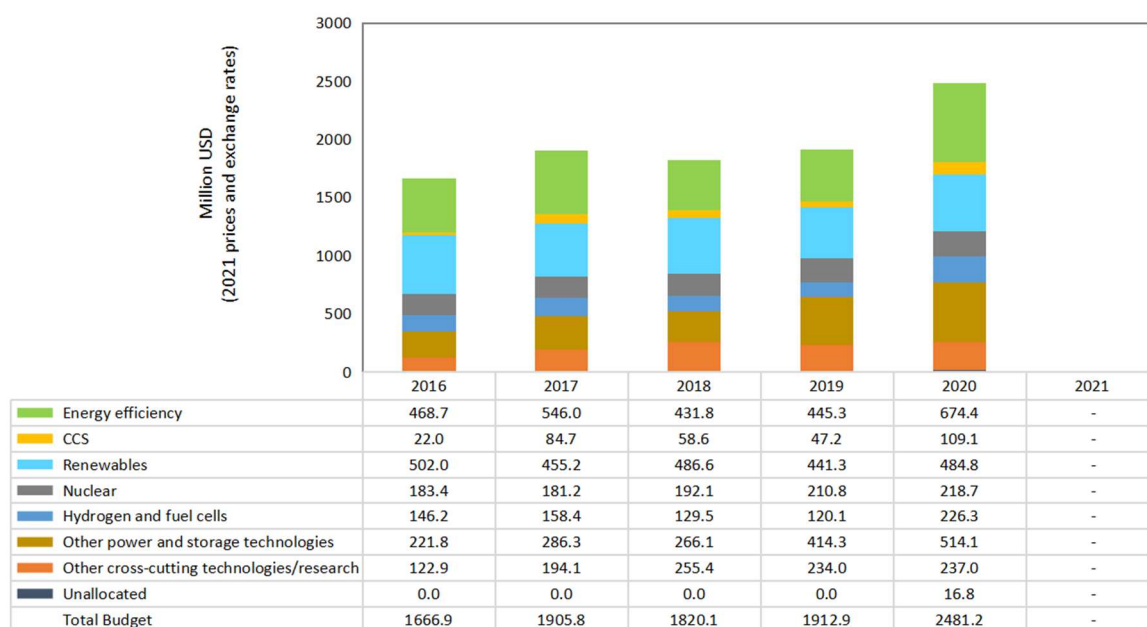
contributes significantly to the approach of REPowerEU, bridging the crucial intersection between TRL 7 and 9. Breakthrough Energy issued a first Request for Proposals (RFP) in early January 2022, and the first projects will be selected in 2022 already.

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).

Public RD&D Data

The European Commission's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Public-private engagement in 2021/22

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.

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 bn

Partners' commitments: At least EUR 1 bn

The focus of Clean Hydrogen JU's research and innovation activities will primarily be 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 develop disruptive new aircraft technologies to support the European Green Deal and climate neutrality by 2050. These technologies will deliver net greenhouse gas (GHG) reductions of no less than 30%, compared to 2020 state-of-the-art.

- **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

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.

- **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

Partner 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.

- **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.

Major contributions to Mission Innovation collaborative initiatives in 2021/22

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 will launch a Global Knowledge Exchange Centre for cities and climate in early 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 will contribute to the MICall22 with international calls for urban R&I with over EUR 60 million in funding.

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.

International clean energy collaborations in 2021/22

Please see Annex A, page 132.

Other clean energy innovation activities in 2021/22

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' to be 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

Finland

Major innovation initiatives and programmes in 2021/22

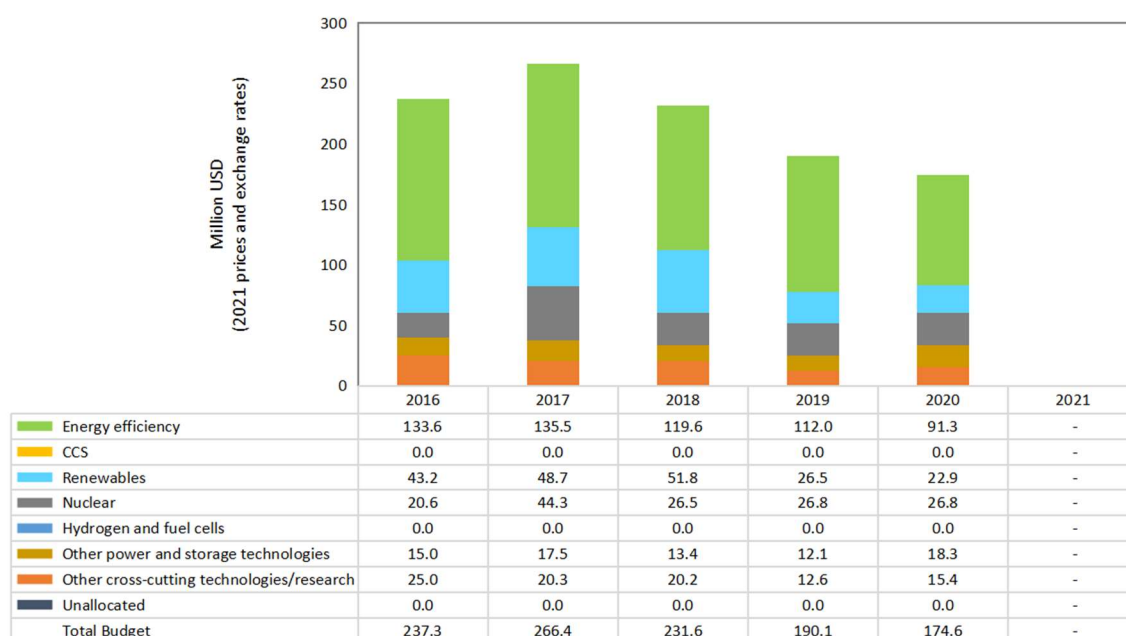
Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Sustainable growth programme for Finland	Grants	1 000 000 000 (approx.)	R&D and investments in green transition	5/2021 - 6/2026	Green RDI funding and demonstration project funding for clean energy and circular economy	https://vm.fi/en/sustainable-growth-programme-for-finland
Zero Carbon Future mission	Business accelerator		energy, traffic, and mobility	7/2021-->	Help companies renew and accelerate their journey to the international markets by creating climate neutral business cases	

* 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.

FINLAND

Public RD&D Data

Finland's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Public-private engagement in 2021/22

The Finnish Climate Fund started its operations in December 2020. The Finnish Climate Fund is a Finnish state-owned special-assignment company. Its operations focus on combating climate change, boosting low-carbon industry and promoting digitalisation.

In 2021, the focus of the company's operations was on launching investment activities and making investment decisions, recruiting and inducting personnel, as well as developing the company and its administration. The Climate Fund made seven investment decisions totalling €45.5 million. A total of €9.6 million in funding has been paid out to these investments by the end of Q2/2022.

For more information www.ilmastorahasto.fi

Major contributions to Mission Innovation collaborative initiatives in 2021/22

Finland is a member of Hydrogen Mission and Net Zero Industries Mission. Finland is actively developing hydrogen valleys and promoting clean energy transition of industries by e.g. investing hundreds of millions of euros during the coming years in these sectors.

FRANCE

France

Major innovation initiatives and programmes in 2021/22

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 renewable 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	<ul style="list-style-type: none"> - CO2 capture and storage ; - energy efficiency ; - use biomass, waste as a substitute for the most emissive fossil fuels and biosourced 	february 2022	Mining-metallurgy, cement, chemicals - improving energy efficiency ;	https://www.gouvernement.fr/decarbonation-de-l-industrie

FRANCE

			products as resources; - material efficiency and the circular economy			
France 2030 – Nuclear	Education and training, Grants, refundable advance	€ 1 bn	small modular reactors, radioactive waste management : recyclage multiple	february 2022	<p>Develop new reactor technologies: SMR reactor and innovative nuclear reactors.</p> <p>Management of fuel and decommissioning waste :</p> <ul style="list-style-type: none"> • 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,	€ 3,7 bn of which	All technologies involved in	September 2020	development of decarbonised hydrogen	https://www.gouvernement.fr/hydrogene-decarbone

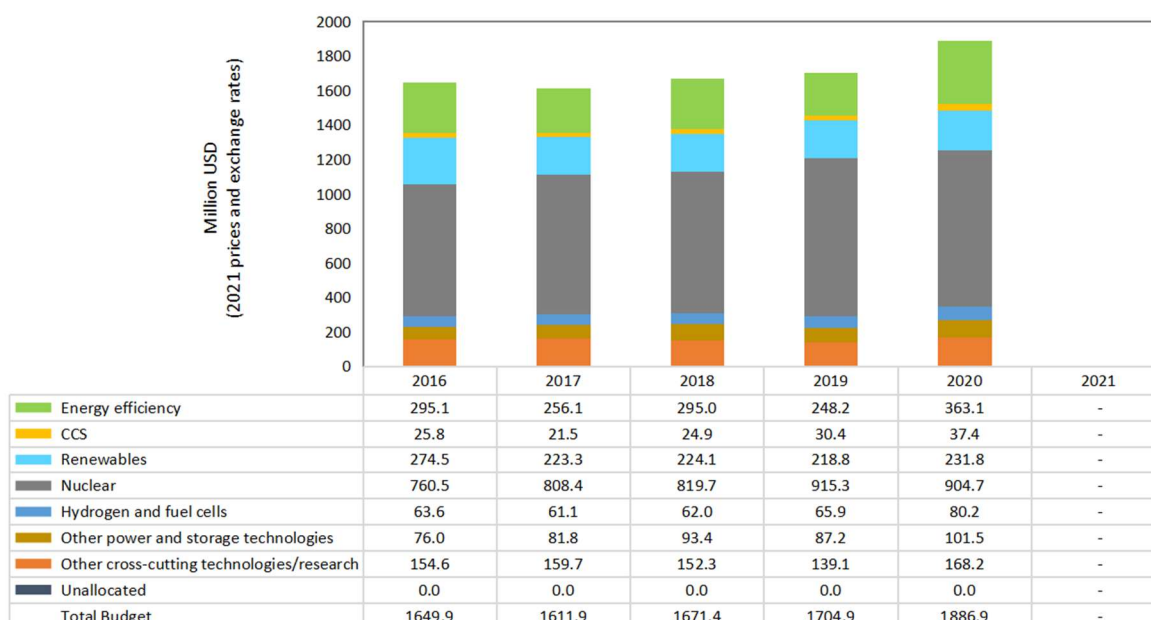
FRANCE

	Grants, refundable advance	€ 3.2 bn IPCEI	the production of H2		for industry, heavy mobility	
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FRANCE

Public RD&D Data

France's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Public-private engagement in 2021/22

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 ground-breaking projects, particularly in the field of new energy technologies.

The France 2030 plan sets several objectives, including

FRANCE

- Promote the emergence of a French offer of small modular reactors (SMR) by 2035 and support breakthrough innovation in the sector (€1 bn) ;
- Become the leader in green hydrogen (€3 bn) and renewable energies (€1 bn) by 2030 ;
- Support the development of decarbonised processes to achieve our commitment to reduce greenhouse gas emissions in this sector by 35 % between 2015 and 2030.

For the period from June 2021 to June 2022, numerous calls for proposals have been launched, the first projects have arrived and some are already being financed.

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 €400M.

Major contributions to Mission Innovation collaborative initiatives in 2021/22

The period June 2021 - June 2022 was devoted to redefine the French investment programme, which resulted in the announcement by the President of the Republic of the France 2030 plan in October 2021. This plan notably makes it possible to support

FRANCE

innovation in the field of energy along the entire development continuum (Low TRL to High TRL) as well as the industrialisation of breakthrough projects.

During the period, France participated in **the Zero-emission shipping mission** :

France participated in the workshops organised by Mission Innovation in preparation for the action plan, a version of which was communicated to members at the beginning of August. The Ministry of the Sea invited representatives of the French maritime sector, via the French Maritime Cluster, to participate in these workshops. 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.

In addition, a national roadmap on the decarbonisation of maritime transport is being drawn up and should be published by the end of the year. The work already carried out by Mission Innovation, in particular the action plan, could feed into this roadmap.

Some of IM's ambitions are included in the France 2030 investment plan.

Due to lack of human resources, France is not currently a member of the "**Clean Hydrogen**" and "**Net Zero Industry**" missions. French strategy on hydrogen and the decarbonisation of industry in the France 2030 plan is largely in line with the objectives of these missions, and France is currently assessing the interest of a more active participation to this missions.

During this period, France kept abreast of the other missions, and in particular participated in exchange meetings on the "Integrated biorefineries" and "carbon dioxide removal" missions.

International clean energy collaborations in 2021/22

See Annex A page 134.

Other clean energy innovation activities in 2021/22

In 2020, French public spending on energy research and development (R&D) reached €1.52 bn, which is an 11% increased compared to 2019 in constant euros. 50% of public

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funding is spent on the nuclear industry. New technology in the energy sector saw a strong increase in 2020 (+32%) and now represents 41% of spending. France allocates the highest share of its GDP to public R&D in the energy sector among the G7 countries, with nuclear power being the most significant, but is also well placed in marine energy, energy efficiency in transport and hydrogen production.

We would like also to report as part of the work on multi-annual energy planning, the update of the National Energy Research Strategy adopted in December 2016 was launched in June 2022.

Germany

Major innovation initiatives and programmes in 2021/22

As innovation plays a central role in many measures of the National Hydrogen Strategy, the Federal Government launched dedicated funding measures for hydrogen research and innovation over the course of 2021 and 2022. These include:

- Four large-scale Living Labs for the Energy Transition (700 million euros in funding) which will address the real-live implementation of hydrogen technologies in industry, transport and buildings
- Three Large-scale flagship projects in the field of basic research (700 million euros provided by the stimulus package) addressing the following challenges with a close cooperation between industry and research:
 - H2GIGA: Industrialise the production of electrolyzers by laying the scientific groundwork for automated mass production
 - H2Mare: Offshore production of hydrogen from wind power and offshore PtX in integrated facilities
 - TransHyDE: Validation of transport solutions for Green hydrogen
- Dedicated research initiative for applied research on hydrogen technologies.

Six large scale Living Labs for the Energy Transition were started. These address climate neutral cities as well as hydrogen technologies and demonstrate the systemic interaction of technologies close to application a real-world environment. Around 100 million Euros per year are available for Living Labs for the Energy Transition.

A new phase of the Carbon2Chem projects (78 million euro in funding) was launched. The Carbon2Chem project will expand the large-scale recycling of emissions from steel production.

Furthermore, many smaller projects and initiatives were launched addressing various areas of clean energy such as geothermal systems, battery storage, smart meters, resource efficiency, digital technologies, societal aspects of the energy transition, CO₂-technologies, system integration and more. In addition, Germany responded effectively

GERMANY

to the challenges the COVID-19 pandemic caused for energy research, by providing additional funding and simplifying administrative procedures.

The yearly Federal Government Report on Energy Research provides an overview of clean energy innovation funding in Germany and is available in English. [2]

[2]<https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/bundesbericht-energieforschung-2022.html>, English version will be available in autumn

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Table 1: New programmes and activities relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
7 th Energy Research Programme	(b) Grants	1.311 billion € in 2021, 1.216 billion € in 2020, 1.148 billion € in 2019	<p>Energy RD&D in all areas also collected by IEA RD&D report, but excluding conventional mobility technologies (i.e. combustion engines)</p> <p>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.</p>	October 2018 / still under implementation	<p>Activities reported in annual report: https://www.bmwk.de/Redaktion/EN/Publikationen/Energie/federal-government-report-on-energy-research-2019.html (2019);</p> <p>https://www.bmwk.de/Redaktion/EN/Publikationen/Energie/federal-government-report-on-energy-research-2020.html (2020);</p> <p>https://www.bmwk.de/Redaktion/EN/Publikationen/Energie/federal-government-report-on-energy-research-2021.html (2021);</p> <p>https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/bundesbericht-energieforschung-2022.html (2022), English version will be available in autumn</p>	<p>https://www.bmwk.de/Redaktion/EN/Publikationen/Energie/7th-energy-research-programme-of-the-federal-government.html</p> <p>Living Laboratories: https://www.energieforschung.de/spotlights/reallabore</p>

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* 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.

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Overview of project funding for relevant energy research topics in the 7th Energy Research Program in 2021 [1]

Funding topic / Technology areas	Cash outflow in € million (2021)
1. Strategic funding formats: Living labs of the energy transition and hydrogen lead projects	
1.1 Living labs of the energy transition	18.29
1.2 Hydrogen lead projects	48.64
2. Energy transition in the consumption sectors	
2.1 Energy transition in buildings and neighbourhoods	98.57
2.2 Energy transition in industry, commerce, retail and services	73.49
2.3 Energy transition in transport	40.85
3. Power generation	
3.1 Photovoltaics	88.39
3.2 Wind energy	82.87
3.3 Bioenergy	63.72
3.4 Thermal power plants	29.77
3.5 Geothermal energy	22.71
3.6 Hydropower and ocean energy	0.93
4. System integration: grids, storage, sector coupling	
4.1 Electricity grids	69.75
4.2 Energy storage	25.47
4.3 Sector coupling and Hydrogen technologies	106.47
5. Cross-system research topics	
5.1 Energy system analysis	19.74
5.2 Digitization in the energy transition	5.06
5.3 Resource efficiency in the context of the energy transition	0.07
5.4 CO2 technologies	32.87
5.5 Program cooperation in joint industrial research	5.71
5.6 Energy transition and society	12.28
5.7 Materials research	3.96
5.8 Fundamental research energy-related use of the subsoil	3.55
5.9 Open technology funding with International Focus	24.46
5.10 Other fundamental research	15.70

[1] <https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/bundesbericht-energieforschung-2022.html>

Six of the ten Living Lab projects selected within BMWK's first ideas competition in 2019 have started in 2021. [1]

In the field of sector coupling and hydrogen technologies:

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- **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 euros)
- **North German Living Lab** (NRL) - Energy Transition Alliance for innovation and effective climate protection (52.3 million euros)
- **EnergieparkBL** - Demonstration of sector coupling: wind electrolysis for production, storage and transport of green hydrogen (34 million euros)
- **H2Stahl** - Hydrogen technologies for the gradual decarbonization of the steel industry (37.1 million euros)

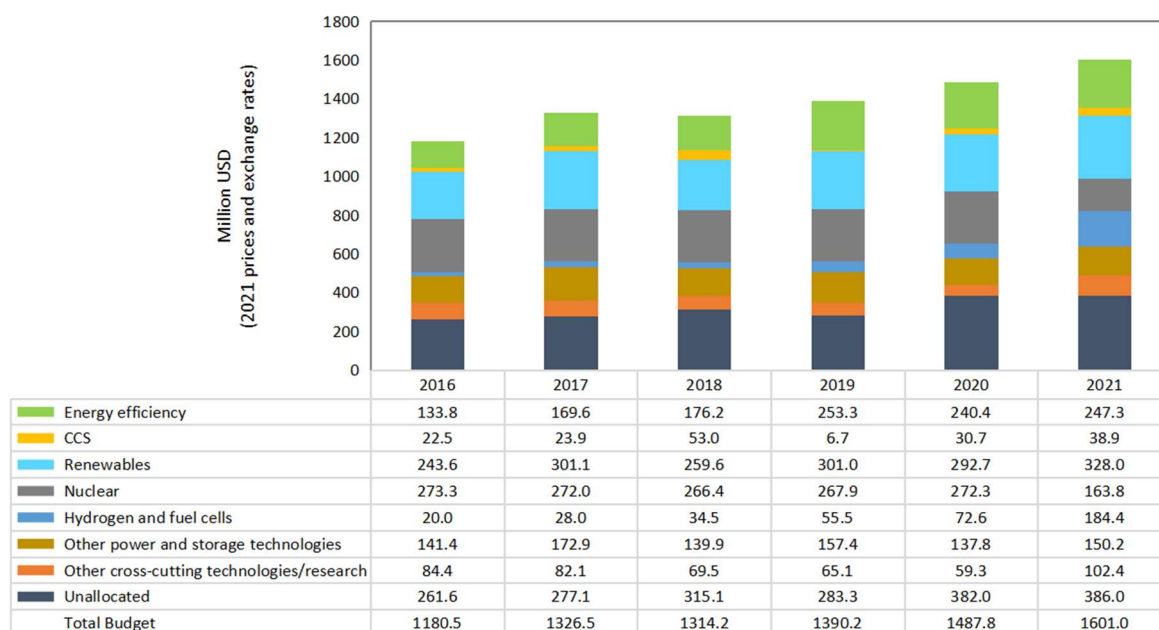
In the field Energy-Optimized Neighbourhoods:

- **GWP** - Large-Scale Heat Pumps in District Heating Networks - Installation, Operation, Monitoring and System Integration (21.3 million euros)
- **DELTA** - Darmstadt Energy Lab for Technologies in Application (40.1 million euros)

GERMANY

Public RD&D Data

Germany's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Public-private engagement in 2021/22

Cooperative projects with partners from research institutions and industry are an important element of public energy RD&D funding in Germany. Within such projects, companies contributed 744 million Euros for clean energy research in 2021. This funding approach ensures firstly that the research questions addressed by publicly funded research projects are relevant to industrial partners and secondly, 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 initiated ten Energy Research Networks. Currently more than 4000 experts from industry, academia and society are organized in these open networks.

Major contributions to Mission Innovation collaborative initiatives in 2021/22

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 discuss and assess the applicability and participation in each of the initially outlined eight innovation challenges (IC) at the national level. The participation and degree of collaboration within the context of the various missions, as well as work with co-lead countries, has been both prioritized and determined. At the technical level, Mission Innovation has been integrated into already established structures (e.g. IEA) to support it by existing measures (e.g. energy research program, bilateral research cooperations based on the Berlin model) and, in particular, to generate added value for existing and planned measures of national energy research policy.

Within the Clean Hydrogen Mission, Germany is represented through NOW GmbH and coordinates the "Hydrogen Valley" working group in order to incorporate the experience gained from the numerous hydrogen projects. Germany supports the activities of the Green Powered Future Mission as a Tier 2 member, participates in the Carbon Dioxide Removal Mission at the technical level and plans the participation in the Net-Zero Industries Mission.

There was significant engagement and support through Public Funder Dialogues, meetings and workshops in which the Technical Advisory Group was involved. In particular, key actions for Carbon Dioxide Removal and Green Power Future Missions have been identified and prioritized as preparation for the 7th Mission Innovation Ministerial.

International clean energy collaborations in 2021/22

See Annex A, page 138.

Other clean energy innovation activities in 2021/22

- Member of the SET Plan Steering Group and participation in most of the SET Plan
 - Participation in the newly founded co-funded partnerships under Horizon Europe Cluster 5: International collaboration in R&I through the upcoming calls of this new partnerships
 - "Clean Energy Transition Partnership" (CETPartnership) and
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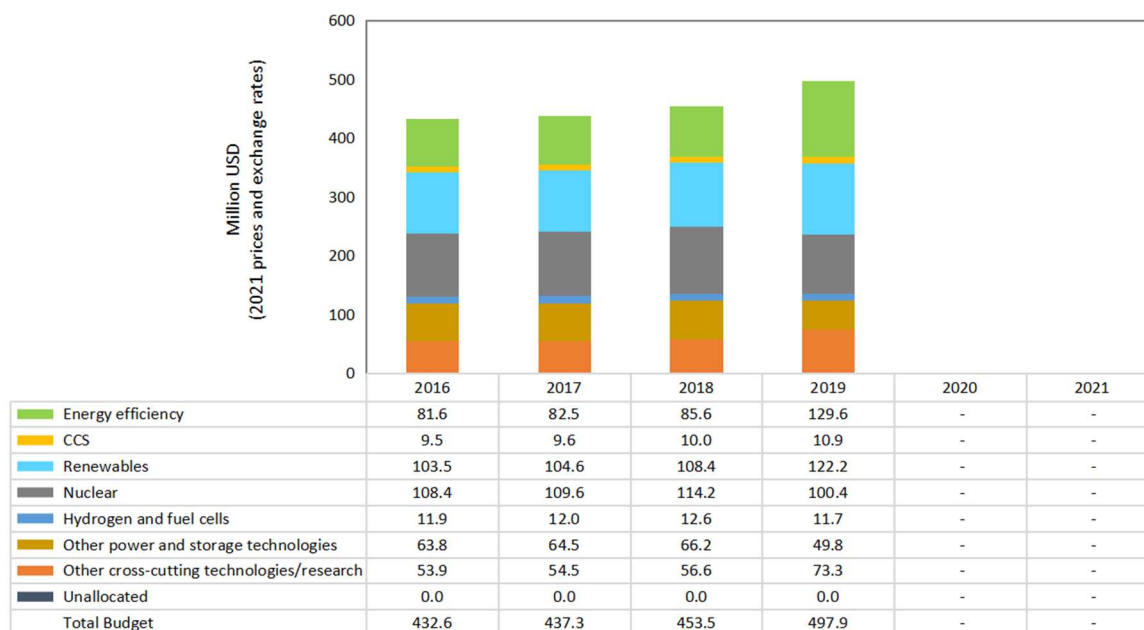
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- “Driving Urban Transition to a sustainable future Partnership” (DUT)
- Participation and leadership of the IPCEI “Important Project of Common European Interest” – Hydrogen Technology (IPCEI Hy2Tech) for the further development of the entire hydrogen value chain and the implementation of hydrogen applications.

Italy

Public RD&D Data

Italy's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

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Japan

Major innovation initiatives and programmes in 2021/22

Table 1: New programmes and activities relevant to energy innovation

Name	Type*	Budget	Technology focus	Start/end date	Main activities	Link
<p>Moonshot Research and Development Program</p> <p>< Goal 4 “Realization of sustainable resource circulation to recover the global environment by 2050” ></p>	Grant	25.68 bill yen (FY2020/FY 2024)	Carbon dioxide removal technologies	2022/2029	<p>The Goal 4 aims to solve the problem of global warming (the Cool Earth) and to solve the problem of environmental pollution (the Clean Earth) through realizing sustainable resource circulation and aims to deploy commercial plants or products utilizing circulation technology globally by 2050. Under the goal, we continued to work on the 13 projects selected for 2020.</p> <p>A new call for projects was issued, limited to CO2 capture and absorption technologies that artificially accelerate natural processes.</p>	https://www.nedo.go.jp/english/news/ZZCA_100007.html
Development of Technologies for Realizing a Hydrogen Society	Grant	FY2021: 7.31 bil yen	Hydrogen	2014/2025	Development and demonstration of power-to-gas technology to produce hydrogen, aiming to commercialize water electrolysis technology and to	https://www.nedo.go.jp/english/activities/activities_ZZJP_100096.html

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					build a model of a hydrogen society in Fukushima and other regions.	
Research and Development Initiative for Scientific Innovation of New Generation Batteries 3	Grant	FY2021: 2.5 bil yen	Batteries	2021 /2025	This project will perform research and development of fluoride and zinc-anode batteries, which completely differ from conventional lithium-ion batteries, use inexpensive materials with no resource risks, and provide both high energy density and excellent safety. The project aims to maintain or improve the competitiveness of the automobile and battery industries through commercializing these batteries for EVs and PHEVs in the early stage. We will work in collaboration with industry, academia, and government to research and develop a common technological platform that covers from materials development through battery design and prototyping to characterization and analysis. Additionally, NEDO will manage the virtuous cycle of the wisdom of the players within the project, with the aim of creating technological breakthroughs that will lead to practical application of innovative automotive batteries.	https://www.nedo.go.jp/english/activities/activities_ZZJP_100193.html
Research and Development of Advanced Aircraft Systems for Practical Application	Grant	FY2021: 1.90 bil yen FY2020: 1.35 bil yen	Low-carbon aviation	2015/2023	This project is intended to develop lightweight, low-cost, and safe systems for next generation aircraft that can enter service after 2030. Thus, Japanese system manufacturers will enhance their	https://www.nedo.go.jp/english/activities/activities_ZZJP_100104.html

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					competence as system integrators to become Tier 1 manufacturers, and contribute to the further development of the Japanese aircraft industry.	
Development of Environmental Technology for the Steelmaking Process	Grant	FY2021: 4.5 bil yen FY2020: 4.2 bil yen	Low carbon steelmaking	2017/2022	To achieve reduced CO2 emissions on a global scale, it is necessary to develop innovative steel manufacturing technologies. 1. Development of hydrogen reduction and other technologies (phase II - step 1) (COURSE 50) 2. Development of ferrocoke-utilization process technologies	https://www.nedo.go.jp/english/activities/activities_ZZJP_100050.html
Development of Manufacturing Processes for Chemicals with High Energy Efficiency	Grant	FY2021: 2.28 bil yen	Photosynthesis, zero-emission industry	2014/2021	(1) An energy-saving manufacturing process that uses solar energy to produce critical chemicals such as plastic materials from carbon dioxide and water (2) An energy-saving manufacturing process that directly synthesizes organosilicon materials aiming to manufacture highly functional organosilicon materials such as next-generation LED encapsulants (3) An energy-saving manufacturing process for the production of functional chemicals and significantly reduces waste emissions	(1) https://www.nedo.go.jp/english/activities/activities_EV_00296.html (2) https://www.nedo.go.jp/english/activities/activities_EV_00295.html (3) https://www.nedo.go.jp/english/activities/activities_ZZJP_100152.html
Program to Develop and Promote the	Grant	FY2021: 7.55 bil yen	Energy efficiency	2021/2035	This project aims to realize sustainable energy conservation compatible with economic growth, and provide seamless	https://www.nedo.go.jp/english/activities/activities_ZZJP_100197.html

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Commercialization of Energy Conservation Technologies to Realize a Decarbonized Society		FY2020: 7.35 bil yen			support for technology development up to the commercialization stage, focusing on key technologies in the industrial, consumer (household and business), and transportation sectors as set forth in Japan's Energy Conservation Technology Strategy, as well as technologies expected to have high energy conservation effects by 2040.	
Feasibility Study Program on Energy and New Environmental Technology/Feasibility Study Program on New Technology for Creating New Industries/ Uncharted Territory Challenge 2050	Grant	FY2021: 4.5 bil yen FY2020: 3.95 bil yen	General (innovation)	2014/2023	The goal of this project is to use a framework of industry-academia collaboration to conduct advanced research on innovative technology and systems to be implemented in society by 2050 for fields that include energy conservation, new energy, CO2 reduction, and other energy/environmental fields as well as industrial technology fields connected to the creation of new industries. The basic aim is to discover innovative potential technology to pave the way for future national projects.	https://www.nedo.go.jp/english/activities/activities_ZZJP_100100.html
Research, Development and Demonstration of CCUS Technology	Grant	FY2021: 6.53bil yen FY2020: 6.20bil yen	CCUS	2018/2026	To realize the goal of achieving carbon neutrality by 2050, announced in the Strategic Energy Plan approved by the Japanese Cabinet in October 2021, NEDO has been carrying out activities in this project related to the research, development, and demonstration of carbon capture, utilization, and storage (CCUS) technologies. These activities	https://www.nedo.go.jp/english/activities/activities_ZZJP_100141.html

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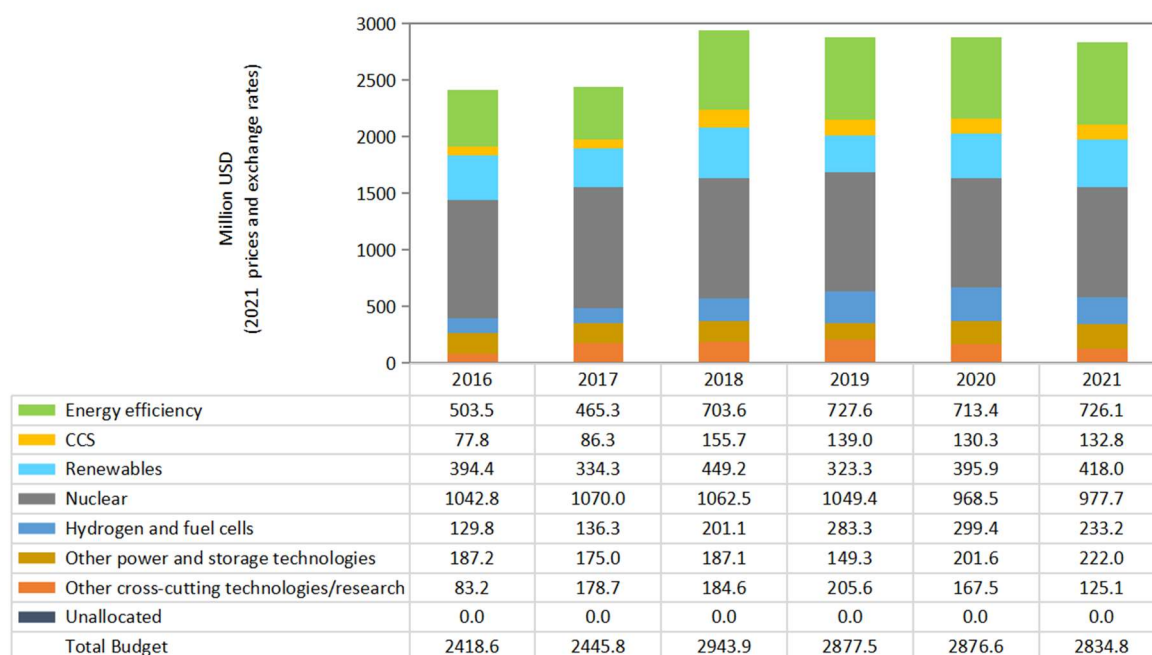
					<p>include the development of monitoring technologies for the safe storage of CO₂ through large-scale demonstration testing and the conduct of surveys on related technologies.</p> <p>In addition, based on Japan's Long-term Strategy under the Paris Agreement, NEDO will conduct demonstration testing for transporting captured CO₂ to storage and utilization facilities, aiming for the near-term commercialization of CCUS technologies by integrating processes related to CO₂ separation, capture, transportation, storage, and utilization.</p>	
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* 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.

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Public RD&D Data

Japan's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Public-private engagement in 2021/22

Green Innovation Fund Projects

Overview

The Ministry of Economy, Trade and Industry (METI) developed a Green Innovation Fund at the level of 2 trillion yen as part of the New Energy and Industrial Technology Development Organization (NEDO). The plan, based on the specific goals shared by public and private sectors, is to continuously support companies and other organizations for the coming 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.

JAPAN

Priority fields

14 priority fields for which implementation plans have been formulated within the Green Growth Strategy.

Energy related industries

1. Offshore wind power Solar and geothermal industries (Next-generation renewable energy)
2. Hydrogen and fuel ammonia industry
3. Next-generation heat energy industry
4. Nuclear industry

Transport/manufacturing industries

5. Automobile and battery industries
6. Semiconductor and information and communication industries
7. Shipping industry
8. Logistics, people flow, and civil engineering infrastructure industries
9. Food, agriculture, forestry, and fisheries
10. Aircraft industry
11. Carbon Recycling and materials industry

Home/Office related Industries

12. Housing and building industry and next-generation power management industry
13. Resource circulation-related industries
14. Lifestyle-related industries

<https://green-innovation.nedo.go.jp/en/about/>

Major contributions to Mission Innovation collaborative initiatives in 2021/22**Carbon Dioxide Removal (CDR) Mission**

- Together with Canada, Japan co-leads LCA Technical Track to support CDR mission's three technological tracks (DAC, BiCARS and Enhanced Mineralization). Japan assigned CDR experts to the mission's workshops and meetings to explore the possibilities of CDR technologies.
- Japan organized an online workshop "*CDR Mission Workshop: Life Cycle Assessment of CDR Technologies – How Life Cycle Assessment (LCA) approach helps Carbon Dioxide Removal (CDR) deployment – Technology and Business perspectives*" in March 2022

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to share the latest knowledge on CDR technologies and to address challenges in terms of LCA. Among 80 participants from the world joined the workshop.

- Japan helped the preparation of CDR roadmap, by providing the latest ICEF* roadmap, and also by exchanging information via expert discussions at workshops. (* Innovation for Cool Earth Forum (ICEF))

Clean hydrogen Mission

- Japan assigned experts to the mission's workshops and meetings for knowledge sharing.
- Japan provided data and information to the mission (e.g. policy survey).

Green Powered Future Mission

- Japan assigned experts to the mission's workshops and meetings for knowledge sharing.
- Japan provided data and information to the mission (e.g. policy survey).

MI Secretariat

- Japan provides 0.5FTE to the MI Secretariat through a dedicated officer supporting the Technical Advisory Group.

Technical Advisory Group

- Japan has provided an expert to the Technical Advisory Group who is also the Deputy Chair.

International clean energy collaborations in 2021/22

See Annex A page 141.

Other clean energy innovation activities in 2021/22

The Ministry of Economy, Trade and Industry (METI) hosted Tokyo Beyond-Zero Week, which is composed of the following eight conferences, from October 4 to 8, 2021. Toward the establishment and public implementation of innovative technologies toward a successful "Beyond Zero" initiative (i.e., not only global carbon neutrality, but also retroactively reducing CO₂ through the stock base approach), these conferences were held to present individual challenges that member countries should address and to provide approaches and

JAPAN

methods to overcome these societal challenges. A total of approximately 17,000 people registered online as participating viewers for these conferences.

- First Asia Green Growth Partnership Ministerial Meeting: October 4th 2021
- Third International Conference on Carbon Recycling: October 4th 2021
- Fourth Hydrogen Energy Ministerial Meeting: October 4th 2021
- 10th LNG Producer–Consumer Conference: October 5th 2021
- Third Task Force on Climate-related Financial Disclosures (TCFD) Summit: October 5th 2021
- First International Conference on Fuel Ammonia: October 6th 2021
- Eighth Innovation for Cool Earth Forum (ICEF): October 6th and 7th 2021
- Third Research and Development 20 for Clean Energy Technologies (RD20) (Leader’s Session): October 8th 2021.

https://www.meti.go.jp/english/press/2021/1013_003.html

The Netherlands

Major innovation initiatives and programmes in 2021/22

With the Dutch Climate Agreement from 2019, the Netherlands is targeting CO2 reduction on sectoral levels for the Electricity sector, Industry, Mobility, The built environment and Agriculture & land-use. The knowledge and innovation challenges for these sectoral missions have been translated into the mission oriented knowledge and innovation agenda (IKIA), which contains 13 mission oriented innovation programs (MMIP's). Through sectoral Mission-oriented Innovation teams (MI-teams) – composed of end-users, private actors, knowledge institutes and government agencies – all Dutch innovation efforts concerning Climate and Energy across all TRL-levels are guided towards the MMIP's and the missions of the Climate Agreement, creating focus on those innovations and technologies with which we can achieve the biggest impact.

The declaration of intent on knowledge and innovation (KIC) of 2020 between public and private parties gave insight in and commitment of foreseen financial means for RD&D. In the years between 2020–2023, the financial means for climate and energy will be almost €1 billion per year. About €320m public funding for RDD and €590m private funding.

We are in the midst of recalibrating the 13 MMIPs of the IKIA of the Dutch Climate Agreement in order to incorporate the ambitions of the coalition agreement and the European Fit For 55 package (in line with the European Fit-For-55 package, the Netherlands increased its 2030 CO2 reduction target from 49% to 55% compared to 1990). The Top Consortia for Knowledge and Innovation (TKIs) in which governments, knowledge institutes and Dutch organizations come together, play an important role in the recalibration of the MMIPs. Together these parties decide on the RD&D priorities of the coming years and formulate the MMIPs that will guide the involved actors to deliver the innovations needed to meet the our climate targets.

In 2021, a proposal on hydrogen for the Dutch 'Growth Fund' has been awarded funding. The project 'Green Power of the Dutch Economy', will receive €338 million for an ecosystem based on green hydrogen. As part of this, a grant scheme was launched in June 2022 focused on demonstration projects for hydrogen and green chemistry (called 'DEI+ Hydrogen and Green Chemistry') with a budget of €30 million.

Besides the hydrogen proposal, several other 'Growth Fund' proposal that relate to climate and energy have been awarded funding: 'New Heat Now! (aims to accelerate the construction of sustainable collective heat systems by means of innovation – will receive

THE NETHERLANDS

max €200 million), 'Zero Emission Services' (aims to make inland shipping more sustainable, such as through electric batteries in containers and accessible charging infrastructure – will receive max €100 million) and 'Future Proof Living Environments' (aims to promote innovation to increase the productivity in the construction sector – will receive max €100 million).

In 2020, the Netherlands launched the first MOOI-call; a mission oriented subsidy scheme of the Topsector Energy to facilitate integral integrated concepts to advance on the set missions for 2030 in the IKIA. The MOOI subsidy runs for two years. Therefore it was not planned to make new budget available in 2021. However, because of the success of this call, the budget was increased with €13.8 million in 2021. This year, we launched a new MOOI-call, with a total budget of €81.4 million

€154.6 million was made available for the Energy Innovation Demonstration grant scheme (DEI+). This subsidy focuses on demonstration projects for innovative energy technologies.

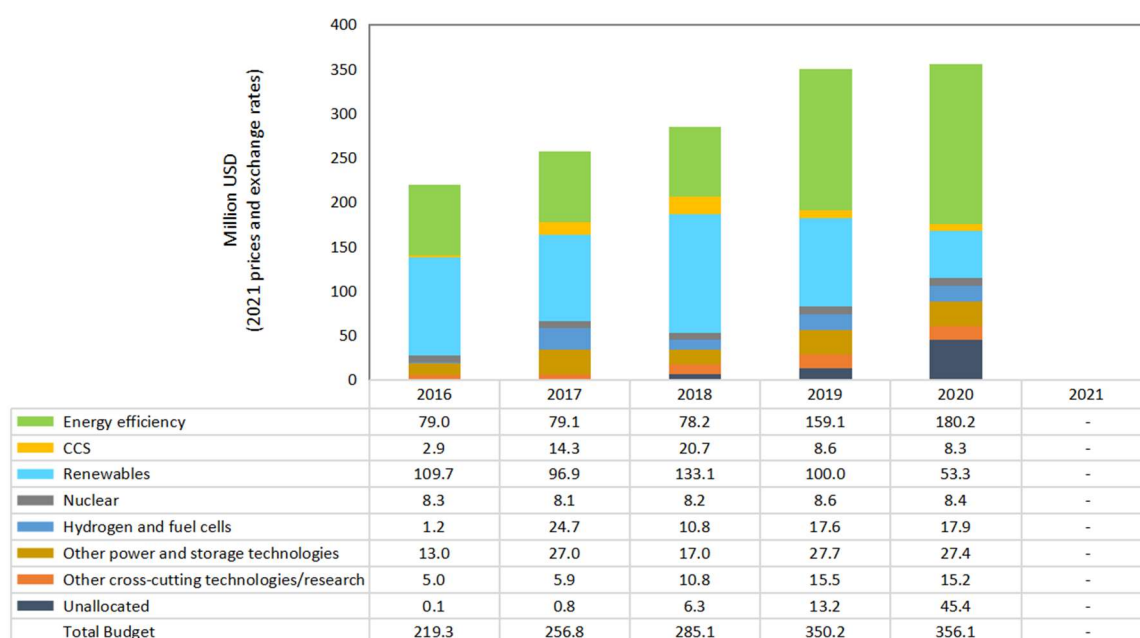
Moreover, TNO (the Netherlands Organisation for applied scientific research) determined the priorities of her research programs in interaction with the Mission-Innovation Teams of the IKIA. In 2021, a total amount of roughly €64m was spent on climate and energy projects.

Furthermore, in 2021, the Dutch Research Council (NWO) committed €24m to climate and energy research. We launched calls around, amongst others, the following topics: Ecology & offshore wind; Ecology & offshore PV; Innovations for wind and solar energy: cost reduction and circular design.

THE NETHERLANDS

Public RD&D Data

The Netherlands' public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Public-private engagement in 2021/22

The Netherlands supports public-private collaboration through various policies and initiatives:

- General policies, such as the [public-private allowance](#), which facilitates private contributions for public-private partnerships for research and innovation within the Top Sectors.
- Energy-innovation policies, requiring a private contribution (in-cash or in-kind). For example the Renewable Energy Scheme (HER) (on average 50%), the DEI+ (on average 75%), the MOOI (on average 40%). In 2021, the Dutch government has invested €181 million euros in energy innovation through various subsidy schemes, with €298 million euros in private contributions. This means that on average, 62% of the investments are private contributions.

THE NETHERLANDS

- Private actors are part of the Mission Teams, prioritizing innovation efforts within the Mission Oriented Innovation Programs (MMIPs). By involving the private sector and the demand-side of innovation in aligning our energy innovation investments (from fundamental research to demonstration/implementation), policies, regulations, market conditions and international efforts we aim to create focus and mass in clean energy investments. This provides a more predictable and focussed framework for investors to invest in low-carbon innovations.
- A dedicated investment agency – [Invest-NL](#) – aims to invest in innovative, low-carbon technologies with a higher risk profile. This venture capital should trigger new investments from the private sector to bring innovative technologies onto the market.
- The [Dutch National Growth Fund](#) was created to enhance the structural growth of the Dutch economy. This investment fund will invest €20 billion between 2021 and 2025 in large-scale investment projects and programs with a minimum subsidy amount of €30 million per proposal. Each proposal requires a private contribution of at least 50%. Subsidy will be made available in three rounds. In April it was announced that €4.5 billion of the €6.3 billion that the government is making available in the second round is earmarked for projects relevant to the agreements in the Climate Agreement. Hundreds of millions will go, for example, to hydrogen, heat networks and a future-proof living environment. This money will be doubled with private money.
- In the Knowledge and Innovation Covenant (KIC) both public and private actors specify their intended contribution to the Dutch mission oriented Topsector policy. This amounts to roughly €355m public funds and €590m private funds per year (2020-2023) on climate and energy innovation.

Major contributions to Mission Innovation collaborative initiatives in 2021/22

Integrated Biorefineries Mission

The Netherlands is co-lead of the Mission on Integrated Biorefineries. Kees Kwant from the Dutch Enterprise Agency is the Mission Director. Kees is applying 30+ years of experience in bioenergy and the biobased economy to lead the Mission. After the official launch during the Annual Gathering in New Delhi last April, the team with representatives from India, Canada, Brazil and the United Kingdom started developing an Innovation Roadmap. The aim of the roadmap is to guide the Mission's progress towards its goal to develop and

THE NETHERLANDS

demonstrate innovative solutions to accelerate the commercialization of integrated biorefineries with a target of replacing 10% of fossil-based with low-carbon sustainable bio-based fuels, chemicals and materials by 2030.

To support the development of the Innovation Roadmap, participating members conducted an exhaustive analysis of existing domestic policies programs and projects to identify gaps in program and policy support for integrated biorefining. This analysis was also supplemented with domestic consultation workshops, where participating members held national stakeholder workshops to hear from domestic stakeholders about current challenges and how the Mission could support the domestic value chain. Together with Canada, the Netherlands took a leading role in writing the Innovation Roadmap.

Clean Hydrogen Mission

As part of Sprint 5 of the Clean Hydrogen Mission, the Netherlands is working on a project to connect Dutch hydrogen valley knowledge to future hydrogen valleys in less developed countries. In creating a worldwide hydrogen economy, it will be crucial to introduce and implement hydrogen technology also in currently less industrially developed countries. This will enable a truly global new hydrogen economy from an early stage. For this project, a report will be delivered that elaborates on best practices for setting up hydrogen valleys, addressing questions such as how to make sure that entire value chain contributes to sustainable local development.

International clean energy collaborations in 2021/22

See annex A, page 145.

Norway

Major innovation initiatives and programmes in 2021/22

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 was launched; projects that can contribute towards increased flexibility in the power system and emission-free high-temperature heating in the industry were invited to apply.

In 2021, the fifth round of PILOT-E focused on emission-free maritime transport, hydrogen and the energy system. Three projects for emission-free maritime transport and hydrogen and three projects developing the energy system were allocated funding totalling approximately NOK 65 million.

Three new centres for energy research were established in 2021 and 2022 on hydrogen and offshore wind. The centres complement ten national centres on environmentally friendly energy and are given funding for a period of up to eight years for a total of about 420 million NOK:

Northwind is led by SINTEF and was established in 2021 focusing on outstanding research and innovation to reduce the cost of wind energy, facilitating its sustainable development, create jobs and grow exports.

HYDROGENi is led by SINTEF and was established in 2022 dedicated to the research and innovations within hydrogen and ammonia needed to meet the 2030 and 2050 goals of the Norwegian hydrogen roadmap.

HyValue is led by NORCE and was established in 2022 focusing on developing knowledge, methodology and innovative solutions for hydrogen energy carriers.

Table 1: Programmes and initiatives relevant to energy innovation:

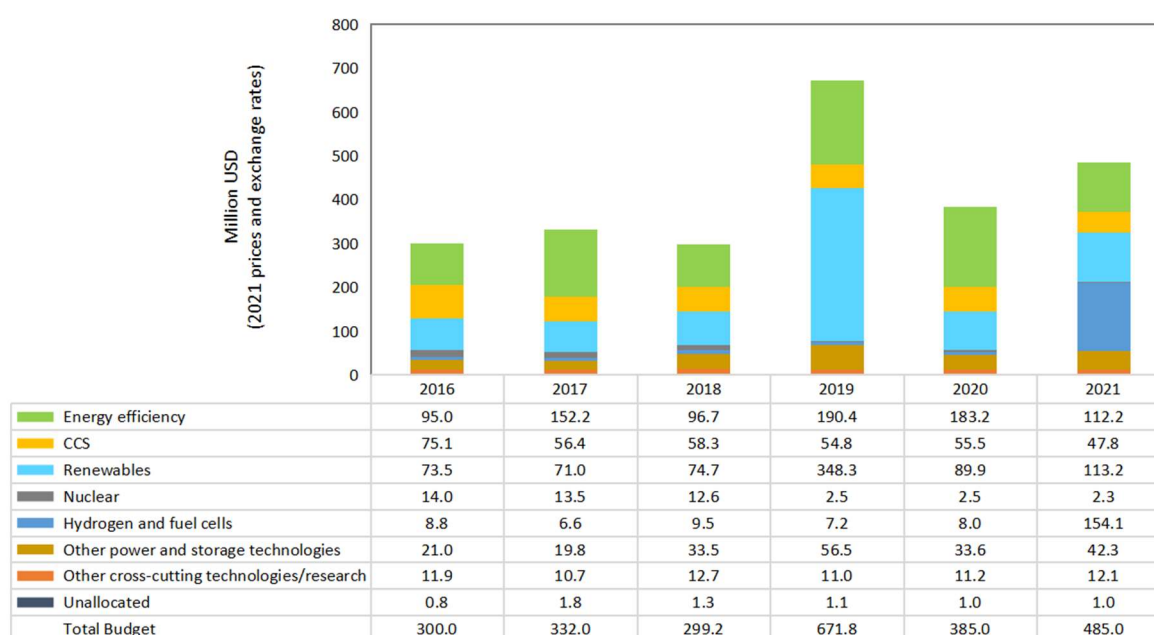
NORWAY

Name	Type*	Budget** (In thousands of USD)	Technology focus	Start/end date	Main activities	Link
Hydrogen: Infrastructure and market development	Grants	USD 27 500 (2021-2022)	Development of infrastructure and hubs for hydrogen	2021 - ongoing	Demonstration and introduction of technologies.	

* 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.

Public RD&D Data

Norway's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Public-private engagement in 2021/22

Full-scale CCS Project “Longship”: In 2021, the Norwegian Government granted a total of NOK 16,8 billion to the Longship project. Longship comprises of carbon capture from Norcem’s cement factory in Brevik in Porsgrunn municipality and Hafslund Oslo Celsio’s waste incineration facility in Oslo. Each facility will capture approximately 400 000 tons of CO₂ per year. The CO₂ will be transported by ship to a reception terminal in Øygarden municipality, and by pipeline to a well, in which CO₂ will be injected into a storage formation (saline aquifer) 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 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 tons for 25 years.

Grants for maritime hydrogen hubs and industry projects: Five production plants for renewable hydrogen and seven pioneering hydrogen and ammonia-powered vessels were granted NOK 1,12 billion (approx. USD 110 million) by Enova in June 2022. The projects will contribute to technology development and hubs for clean hydrogen.

Three industry projects were granted a total of 1.6 billion NOK by Enova, Innovation Norway and Gassnova December 2021. The projects will contribute to technology development enabling the production and utilisation of clean hydrogen in industry.

Major contributions to Mission Innovation collaborative initiatives in 2021/22

Norway contributes to the work of Zero-Emission Shipping Mission (co-lead), Clean Hydrogen Mission (core coalition member) and Carbon Dioxide Removal Mission (core mission member).

Norway is participating actively as a Co lead in in the Zero Emission Shipping Mission. Together with Denmark we are leading the Ships-pillar on the ships, and together with the rest of the team, developed hey comprehensive Innovation gap analysis leading up to an Action plan which will be published in September. The pilot project with the Norwegian ship owner “Grieg star” will retrofit an existing ship into a Trans-Atlantic Bulk Carrier on Green Ammonia.

NORWAY

In the Clean Hydrogen Mission, our participation has mostly been reporting on Norwegian activities and preparing the basis for the collaborative work starting up now.

In the CDR mission, Norway (represented by Gassnova) is participating actively in the preparation of the Road Map and Action Plan.

On 28 June 2022, Norway held a workshop on Carbon Dioxide Removal (CDR) in Bergen hosted by The Research Council of Norway. The workshop included a presentation of MI CDR, as well as presentations from technology providers, regulators, researchers and policymakers in the field.

International clean energy collaborations in 2021/22

See annex A page 148.

Republic of Korea

Major innovation initiatives and programmes in 2021/22

Carbon-neutral industry and energy R&D strategy: In October 2021, Korea confirmed its GHG emissions target for 2030 at a 40% reduction from the 2018 amount. To achieve its NDC, Korea announced major areas for carbon neutrality R&D. In particular, it identified core technologies in 17 major areas of industry/energy carbon neutrality R&D, categorized them into technologies to achieve NDC in 2030 and technologies to achieve carbon neutrality in 2050, and presented a development timeline for each stage.

2050 Carbon Neutral Energy Technology Roadmap: Established 2050 Carbon Neutral Energy Technology Roadmap on Dec. 2021. Roadmap presented the development schedule and securing of 197 key technologies in 13 areas (clean fuel power generation, fuel cell, solar power, power system, sector coupling, energy storage, green hydrogen, industrial buildings, resource circulation, CCUS, energy facilities, oil refining).

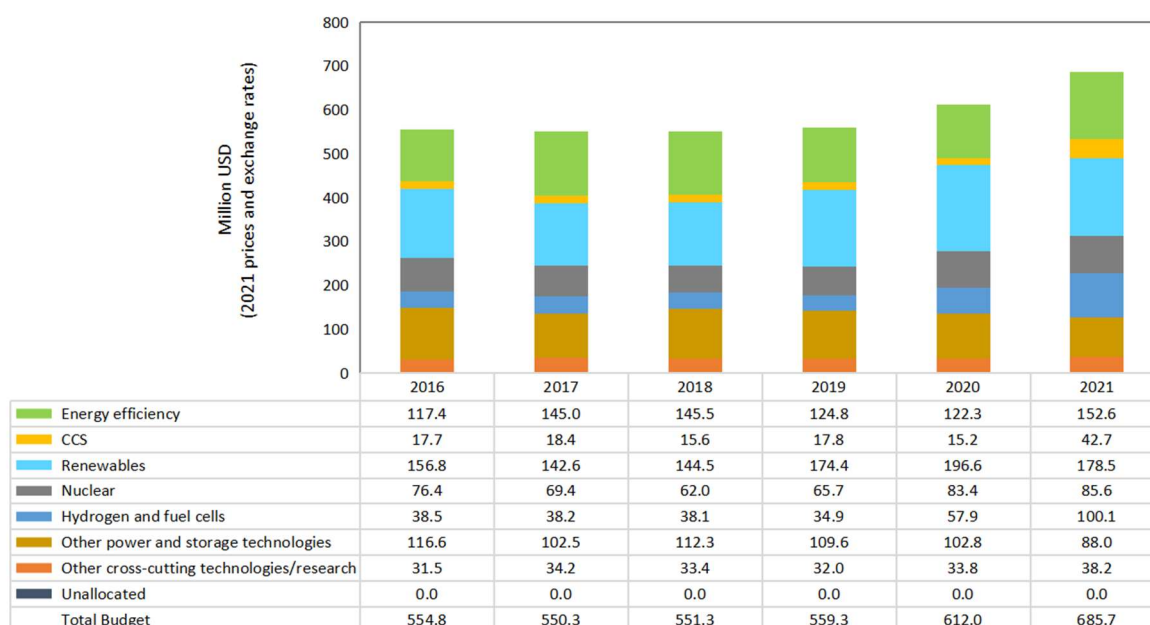
REPUBLIC OF KOREA

Name	Type*	Budget	Technology focus	Start/end date	Main activities
Carbon-neutral industry and energy R&D strategy	(I) 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	(I) 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

REPUBLIC OF KOREA

Public RD&D Data

The Republic of Korea's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Public-private engagement in 2021/22

Public-private engagement activities include:

- Manage feeder funds (KRW 80 billion, 2021-) investing in downstream and upstream R&D of ESS/secondary cell in the Technology Innovation Fund (master fund, KRW 280 billion in 2021, sourcing funding from private banks), in which the government, R&D specialized institutions, large corporations, and financial institutions cooperate to make focused investments in the R&D activities of SMEs/middle-standing companies
 - Government/R&D specialized institutions develop outstanding energy companies and connect them to the investment demand of asset management companies to support their investment activities.
- Reinvigorate the private investment ecosystem by arranging meetings between companies seeking investment and investors.

REPUBLIC OF KOREA

- Under the auspices of the Korea Institute of Energy Technology Evaluation and Planning, various support programs such as basic education, consulting, mock training, and investment attraction counselling sessions are operated to strengthen the investment attraction capabilities of companies

Major contributions to Mission Innovation collaborative initiatives in 2021/22

The Korean Government is participating in the Clean Hydrogen Mission, Green Powered Future Mission, and Zero-Emission Shipping Mission. Moreover, KETEP, which is Korea's dedicated energy R&D institute, has reinforced networking and supported R&D initiatives in the smart grid, CCUS, bio, solar, energy efficiency, resource, and hydrogen areas to enhance global technological competitiveness through the joint development of innovative technology with MI member states since 2018.

International clean energy collaborations in 2021/22

See Annex A page 151.

Saudi Arabia

Major innovation initiatives and programmes in 2021/22

Table 1: 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.	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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

SAUDI ARABIA

		nuclear energy in relevant and operational environment at deployment stage. • Align with local content to commercialize successfully deployed technologies.
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Public RD&D Data

None currently available.

Public-private engagement in 2021/22

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.

Major contributions to Mission Innovation collaborative initiatives in 2021/22

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

SAUDI ARABIA

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 2021/22

See Annex A page 157.

Other clean energy innovation activities in 2021/22

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.

SWEDEN

Sweden

Major innovation initiatives and programmes in 2021/22

Table 1: 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 prizes 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 that is implemented by	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)

SWEDEN

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	400 million SEK per annum 2026 – 2040 for supporting contract winners for Bio-CCS	Statligt stöd för bio-CCS (energimyndigheten.se)

SWEDEN

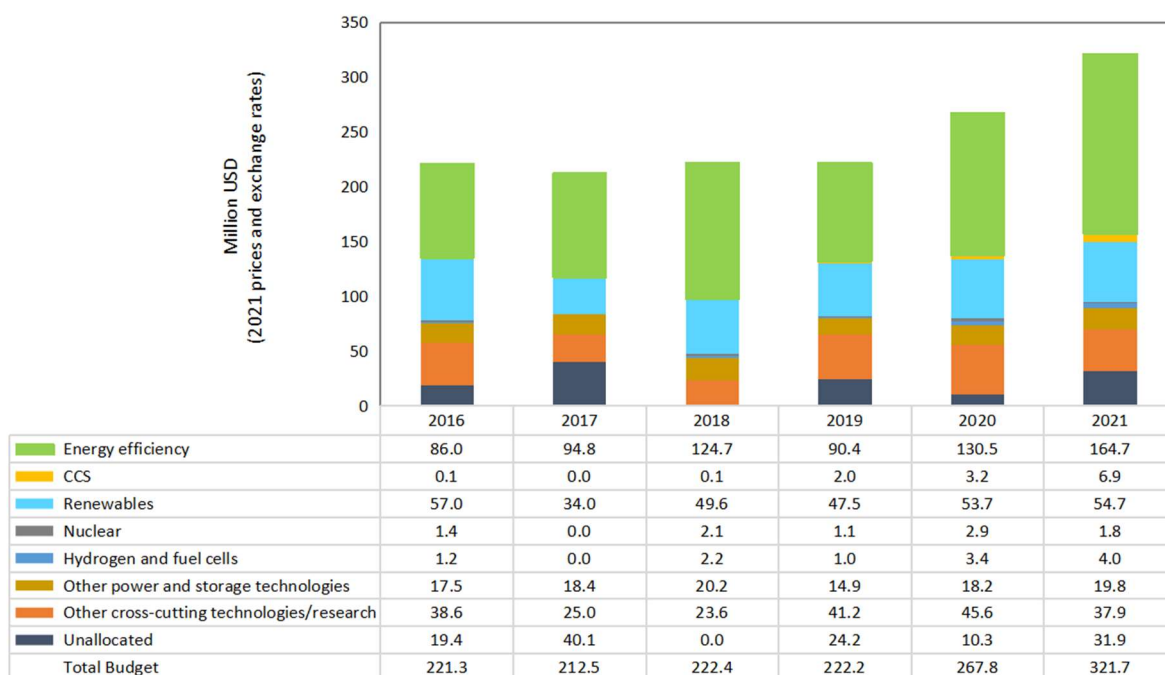
				2022 but delayed due to state aid review; payments 2026 – 2040		(only in Swedish)
IPCEI	(b) Grants	575 million SEK and 238 million SEK 2022	Swedish actors' participation in IPCEI projects on batteries	2022 – 2027	Industrial collaborative projects	The pandemic requires a new industrial strategy – Government.se 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 used: (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

SWEDEN

Public RD&D Data

Sweden's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Public-private engagement in 2021/22

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:

- Eleven new Centres of Competence have been initiated in the energy area. A Centre of Competence is an organization where universities, institutes, industry, and society collaborate on excellent needs-driven research to provide solutions that are central for a sustainable energy system. The financing is provided by the Energy Agency, the University and Industry partners. The initiative is a part of the Energy R&I Programme of the Swedish Energy Agency.

SWEDEN

- Vinnova, the Swedish Energy Agency and Formas fund seventeen strategic innovation programs. Through collaboration in areas that are strategically important for Sweden, conditions are created for sustainable solutions to global societal challenges and increased international competitiveness. Within the programs, companies, academia, and organizations together develop the sustainable products and services of the future. The programmes are formulated bottom up by industry and representatives of society. A number of these programmes are energy related.
- The efforts to promote commercialization and product development has been partly reorganized in programme form. The programme is to promote new and innovative products and services in the energy area that can contribute to the transition to a sustainable energy system. It will run for six years from 2021 with a budget of 381 million SEK. The initiative is a part of the Energy R&I Programme of the Swedish Energy Agency.
- The support for pilot- and demonstration projects has also been partly reorganized in programme form. The goal of the Pilot and demonstration programme is to bring innovations that contribute to a sustainable energy system from research to market. The Programme will run to 2026 and has a budget of 381,5 million SEK. The initiative is a part of the Energy R&I Programme of the Swedish Energy Agency.

Major contributions to Mission Innovation collaborative initiatives in 2021/22

Sweden participates actively in the MICall programme; a public/private collaboration on Joint Programming

The MICall 19 focused on energy storage solutions. MICall 20 focused on digital transformation of the energy system. In connection with the launch of MI 2.0, a new collaborative forum called Public funders dialogue was initiated. It is led by the Swedish Energy Agency and the Austrian Federal Ministry for Transport, Innovation and Technology. The upcoming MICall 21 is hosted by the JPI Urban Europe and is focusing on the role of cities.

Sweden participates actively in the activities of the Net-Zero Compatible Innovations Initiative (NICI)/Avoided emissions framework. A partnership between the NIC and the UNFCCC has been established with the aim of developing the UNFCCC Global Innovation

SWEDEN

Hub (UGIH). The UGIH was launched at COP26 in Glasgow. NCI also launched the report 21st Century Climate Innovation Assessments.

Sweden has sent a voluntary contribution in 2021 to the IEA for work supporting the MI Secretariat. A voluntary contribution during 2022 is under consideration.

During 2021, Sweden and India arranged a call for proposals on smart grids. This was done in collaboration between the Swedish Energy Agency and Indian Department of Science and Technology (DST). Two Swedish/Indian collaborative projects were granted support. They will start work in the beginning of 2022 and plans to run for two years.

The Swedish Energy Agency has collaborated with the UK (Foreign, Commonwealth and Development Office, as well as the Department of Business, Energy, and Industrial Strategy, BEIS) and Austria (Federal Ministry for Energy, Climate, and Innovation) established a thematic networking and knowledge exchange platform on smart grids. More than 200 participants from more than 25 countries participated in the activities.

A joint action on electrification of the transport sector has been initiated in collaboration between the Swedish Energy Agency, the Innovation Norge, and the UK Department for Business, Energy and Industrial Strategy. The activity was called UK-Nordic EV-Hub and focused on increasing the knowledge on market specific challenges and solutions in the Nordic countries and the UK

International clean energy collaborations in 2021/22

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.

SWEDEN

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 five countries outside of the European Union.

Further information on Sweden's international clean energy collaborations can be found in annex A, page 164.

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United Kingdom

Major innovation initiatives and programmes in 2021/22

Table 1: Programmes and initiatives relevant to energy innovation

Name	Type*	Budget**	Technology focus	Start/end date	Main activities	Link
Clean Maritime Demonstration Competition	(b)	£23m government match funding	Electric, hydrogen, ammonia, battery, energy bunkering, fuel cell, hybrid	March 2021 – March 2022	To support the design and development of clean maritime technologies through 55 feasibility studies and technology trials across the UK.	https://apply-for-innovation-funding.service.gov.uk/competition/888/overview
Scale-up of the FCDO Transforming Energy Access (TEA) platform	Various, including: (b) Grants (c) Operational funding for institutions (e.g. national labs, universities) (e) Equity investments	New funding: £126.4 million scale-up between 2021/22 and 2025/26	Various, including: 1. Energy Efficiency 3. Renewable Energy Sources 5. Hydrogen 6. Other Power and storage technologies	2016/17 to 2025/26	Transforming Energy Access (TEA) 2016–2026 (£225 million budget) is the flagship FCDO research and innovation platform supporting early-stage testing and scale-up of innovative technologies and business models that accelerate access to affordable, clean, and modern energy in developing countries in Sub-Saharan Africa, South Asia, and the Indo-Pacific.	UK Gov Press Release

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	(e.g., in start-ups) (f) Loans, debt financing and loan guarantees (h) Start-up and innovation prizes; (i) Business accelerators / incubators;		7. Other cross-cutting technologies and research			
Energy Catalyst Rounds 8 and 9	Grants	£30m	Clean energy		Accelerating access to clean energy in ODA eligible countries	Energy Catalyst (ukri.org)
SBRI: MRV tools for land based greenhouse gas removal, phase 1	Public procurement	£375k	(Land based) Greenhouse gas removal		Monitoring, reporting and verification technologies and methodologies	Competition overview - SBRI: MRV tools and techniques for land based greenhouse gas removal, phase 1 - Innovation Funding Service (apply-for-innovation-funding.service.gov.uk)
Core funding for Offshore Renewable Energy Catapult and Energy Systems Catapult	Operational funding for institutions	£30.5m	Whole systems and offshore wind, wave and tidal energy		Core funding for national Catapult centres	Home - The Catapult Network
Innovation Loans rounds 1-4	Loans	£100m	Cross cutting but including energy in scope		Loans for SMEs with innovative late stage projects	Innovation loans - UKRI

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Fast start competition	Grants	£30m	Cross cutting but including energy in scope		SME grant and business support for innovators new to Innovate UK	Competition overview - Fast Start: Innovation - Innovation Funding Service (apply-for-innovation-funding.service.gov.uk)
ISCF Foundation Industries demonstrators and small scale CR&D	Grants	£16m	Energy efficiency + others		Resource and energy efficiency for foundation industries	Competition overview - ISCF Transforming Foundation Industries: Demonstrators EoI - Innovation Funding Service (apply-for-innovation-funding.service.gov.uk) Competition overview - ISCF Transforming Foundation Industry - Small Scale R&D Strand 2 - Innovation Funding Service (apply-for-innovation-funding.service.gov.uk)
Floating Offshore Wind Demonstration Programme	(b) Grants	£31.6m	Offshore Wind	Start: January 2022	These projects aim at reducing costs and developing the technology. Industry is matching the investment bringing the total investment to over £60m and supporting project across the UK including in Aberdeen, Swansea and Yorkshire.	https://www.gov.uk/government/publications/floating-offshore-wind-demonstration-programme-successful-projects
Longer Duration Energy Storage Programme – Steam 1 Phase 1	(b) Grants	£6.7m	Energy Storage	Start: February 2022	Stream 1 aims to accelerate commercialisation of innovative longer duration energy storage projects through to actual demonstrations. During Phase 1, projects will be expected to mobilise their proposed	https://www.gov.uk/government/publications/longer-duration-energy-storage-demonstration-programme-successful-projects/longer-duration-energy-storage-demonstration-programme-stream-1-phase-1-details-of-successful-projects

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					technologies to prepare for potential deployment on the UK energy system.	
Flexibility Innovation Programme	(b) Grants	Up to £65m	Energy System Flexibility	Competition Launched April 2022	This programme looks to support innovative solutions to enable large-scale widespread electricity system flexibility	https://www.gov.uk/government/publications/flexibility-innovation
Industrial Hydrogen Accelerator	(b) Grants (j) Public Procurement	Up to £26m	Hydrogen / Fuel Switching	Competition Launched May 2022	The Industrial Hydrogen Accelerator (IHA) competition supports projects generating evidence on end-to-end industrial fuel switching to hydrogen	https://www.gov.uk/government/publications/industrial-hydrogen-accelerator-programme
Energy Entrepreneurs Fund (EEF) Phase 9	(b) Grants	£10m new funding	Energy efficiency, power generation, heat generation, energy storage, reducing greenhouse gas emissions and security of supply	New phase announced May 2022	The Energy Entrepreneurs Fund (EEF) supports the development of technologies, products and processes in the areas of energy efficiency, power generation, heat generation, energy storage, reducing greenhouse gas emissions and security of supply	https://www.gov.uk/government/publications/energy-entrepreneurs-fund-phase-9
Direct Air Capture and other Greenhouse Gas Removal	(b) Grants	£54m	DAC, CCUS, other GHG removal technologies	July 2022	Projects across the UK will benefit from a share of over £54 million to develop technologies that remove carbon emissions from the atmosphere	https://www.gov.uk/government/publications/direct-air-capture-and-other-greenhouse-gas-removal-technologies-competition

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technologies competition: Phase 2						
Green Distilleries Competition: Phase 2	(b) Grants	£12.33m	Low carbon fuels	Start: November 2021 End: 30 June 2023	The Green Distilleries Competition is providing funding for developing technologies that enable the use of low carbon fuel in a distillery. Phase 2 is a demonstration phase.	https://www.gov.uk/government/publications/green-distilleries-competition
Clean Growth Fund	(e) Equity investments	Up to £20m from UK Government; £101m total	innovations that reduce greenhouse gas emissions or improve resource efficiency across power, transport, industry, buildings, waste and water	Start: March 2022	The Clean Growth Fund is 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. The Fund's focus is on commercial returns and UK based innovations that demonstrate clear reductions in greenhouse gases	https://www.cleangrowthfund.com/
UKRI: Industrial Decarbonisation Challenge	(b) Grants	£210 million matched by £261 million from industry	carbon capture and storage and hydrogen fuel switching	2019 to 2024	The Industrial Decarbonisation Challenge supports development of low-carbon technologies and infrastructure, increasing industry competitiveness and contributing to the UK's clean growth	ukri.org/what-we-offer/browse-our-areas-of-investment-and-support/industrial-decarbonisation/

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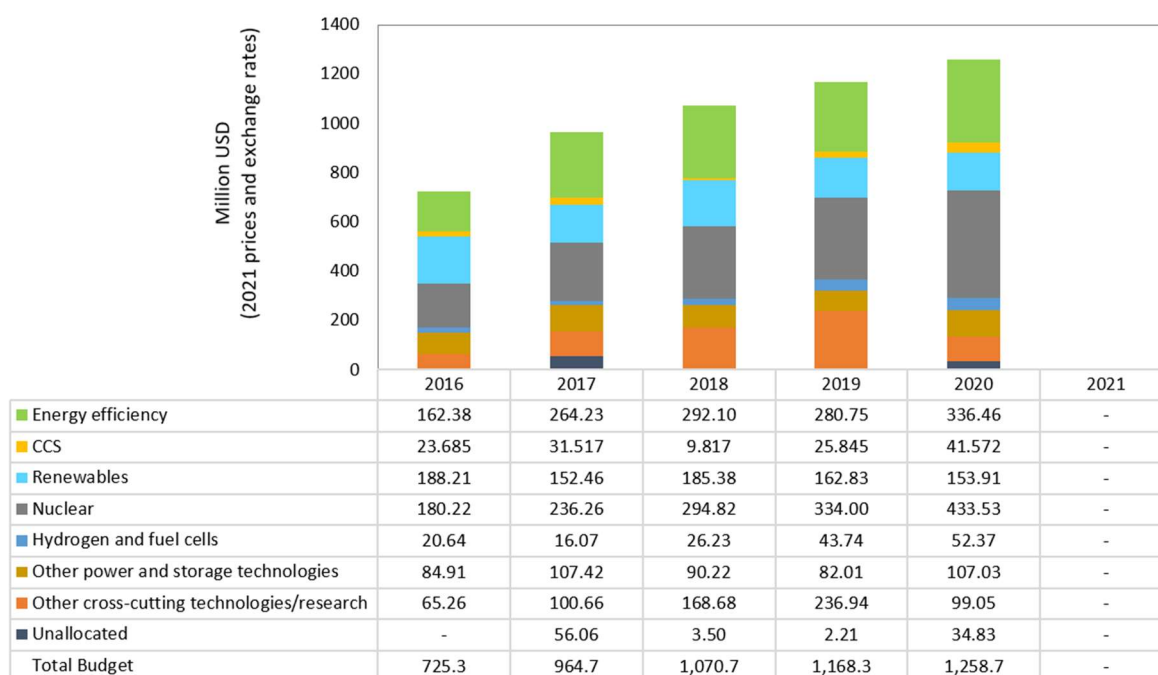
UKRI: Low Cost Nuclear Challenge	(b) Grants	Phase 1: £18m matched by £18m from Industry Phase 2: £210m matched by £250m from Industry	Nuclear	Phase 1 ended June 2021 Phase 2 started Nov 2021	This challenge aims to develop a compact, standardised nuclear power station product based around a UK-designed small modular reactor (SMR), using modern mass production methodology.	www.ukri.org/what-we-offer/our-main-funds/industrial-strategy-challenge-fund/clean-growth/low-cost-nuclear-challenge/
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* 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.

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Public RD&D Data

The United Kingdom's public spend on clean energy RD&D since 2016 is as follows:



Note: The data presented in this graph is available from the IEA Energy RD&D Database, please see the note on page 1 for further background.

Public-private engagement in 2021/22

- 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.
- In March 2022, £206m of research and development funding was allocated to establish the UK Shipping Office for Reducing Emissions (UK SHORE). UK SHORE is a new team within the UK Department for Transport focused on decarbonising the domestic maritime sector. It will work in partnership with industry to tackle supply and demand

side barriers, as well as developing the infrastructure and consumer confidence to support zero emission technologies. UK SHORE interventions will be aimed at addressing different barriers to maritime decarbonisation over a range of technology-readiness levels. These interventions will be rolled out over the next three years (2022-25).

- 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.

Major contributions to Mission Innovation collaborative initiatives in 2021/22

The UK is an active member of Mission Innovation.

- **MI Governance:** The UK is a member of the MI Steering Committee;
- **The UK hosts the MI Secretariat core team:** providing 4 FTE including the Head and Deputy Head of the MI Secretariat;
- **Missions and Platform initiatives:** The UK participates in 4 out of 7 of the MI Missions, and in the Heating and Cooling of Buildings Innovation Community.
- **Technical Advisory Group:** Professor Peter Bruce has agreed to contribute expertise to the Technical Advisory Group on behalf of the UK.

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 the grid;. As co-leads of the GPFM we actively participate in the Governance of the Mission, and have provided resource to support the road-mapping and evidence collection activities of the Mission over the past year, and are now leading on Pillar 3: Data and Digitalisation for System Integration.

Clean Hydrogen Mission (co-lead)

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The UK is a co-lead of the **Clean Hydrogen Mission (CHM)**, which is targeting reducing the cost of clean hydrogen to the end user to 2 USD/kg by 2030. As co-lead of the CHM we actively participate in the Governance of the Mission, have provided resource to support the road-mapping and evidence collection activities of the Mission over the past year, and are now leading on Pillar 1: focussing on R&I. On the 4th August the UK organised a workshop on “Opportunities, Challenges and Way Forward under the R&I pillar” with speakers from IRENA, Hydrogen TCP, Hydrogen Council, CSIRO-Australia and Henry Royce Institute-UK, the workshop sought to galvanise substantive future work through the identification of needs and barriers facing the rapid deployment of clean hydrogen.

Zero-Emission Shipping Mission (core Member)

The UK is a core member of the **Zero-Emission Shipping Mission (ZESM)** where we are playing a leading role on green shipping corridors via the Clydebank Declaration, launched at COP26. The UK has led a number of webinars on the development of green shipping corridors for ZESM members and international stakeholders more broadly, and launched a funding competition for detailed studies on the technical, operational, regulatory and commercial feasibility of establishing UK-based green corridors. The UK is active on its secretariat, its executive committee, and its Port and Fuel Infrastructure pillar

Net-Zero Industries Mission (planning on participating as core Member)

The UK is supporting the development of the **Net-Zero Industry Mission**, which is being led by Austria and Australia. Following the launch of the mission at the Global Clean Energy Action Forum, which convenes the 7th MI Ministerial, the UK will participate as a core coalition member. The UK is keen to work with other countries to accelerate industry transition, building on our own Industrial Decarbonisation Strategy, published in March 2021.

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.

International clean energy collaborations in 2021/22

See Annex A, page 165

Other clean energy innovation activities in 2021/22

- In our role as COP President, the UK has convened and led the Breakthrough Agenda.. 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 Breakthrough Agenda is underpinned by a set of ‘Glasgow Breakthroughs’ – global, 2030 goals in the power, road transport, steel, hydrogen, and agriculture sectors, – aimed at reaching tipping points before 2030 where clean technologies become more affordable, accessible, and attractive than fossil fuels. The Breakthrough Agenda, includes a commitment to review progress towards the Breakthrough goals annually, starting in 2022. This process will be supported by an annual Breakthrough Agenda Report led by the IEA, working with IRENA and the UN High Level Action Champions. The Report will be published on 15 September 2022.
- Financial Year 2021/22 was the first year of the Ayrton Fund – a UK Government [commitment](#) to spend up to **£1 billion** of Official Development Assistance (ODA) on the **Research, Development, and Demonstration (RD&D) of clean energy technologies and business models for developing countries** over the five-year period between April 2021 and March 2026, helping to drive forward the clean energy transition while demonstrating UK leadership and expertise in cutting global emissions through world-leading innovations. Some **notable successes** by individual Ayrton Fund programmes in 2021/22 included: Toyota investment in the UK [circular economy battery storage](#) pioneer Aceleron which was originally co-funded by the Transforming Energy Access (TEA) platform; a [Civil Service Award](#) and a [UN Global Climate Action Award](#) for the TEA-supported [Energise Africa](#) crowdfunding platform which has now raised £31m; a [new partnership](#) between the TEA-supported Kenyan electric vehicle innovator [Roam](#) and Uber which will equip 3,000 Uber drivers in Africa with electric motorcycles.
- The [Green Grids Initiative – One Sun One World One Grid](#) (GGI-OSOWOG) was launched at COP26 by the UK PM Johnson and India PM Modi as a key pillar of the [Glasgow Breakthroughs](#). GGI-OSOWOG is a global clean energy political coalition, aiming to accelerate the construction of the new infrastructure needed for a world powered by clean energy. It is endorsed by over 90 countries through the [One Sun declaration](#). The

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Ayrton Fund [Climate Compatible Growth](#) (CCG) programme played, and continues to play, a key role in this initiative: engaging at senior political level in focus countries; providing analysis for leading climate finance organisations to identify green grid investment opportunities; and providing technical input into GGI-OSOWOG's wider Coordination Group.

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 = public – public or PR = public-private)	Type of collaboration (research, development, and/or demonstration)	Start Date (Year)	Funding amount	Additional information (e.g. link to website)
Germany	Australia-Germany Hydrogen Accord	Acceleration of the development of the hydrogen industry. Including by facilitating industry-to-industry cooperation on demonstration projects in Australian hydrogen hubs. Explore options to export renewable hydrogen and ammonia from Australia to Germany.	PR	Research and development	June 2021	Combined investment of \$130 million	https://www.minister.industry.gov.au/ministers/taylor/media-releases/australia-and-germany-partner-hydrogen-initiatives

Singapore	Low Emissions Maritime Initiative	To accelerate the deployment of low emissions fuels and technologies, to reduce emissions in maritime and port operations.	PR	Pilot and demonstration	June 2021	\$30m from Australia, Singapore & industry	https://www.minister.industry.gov.au/ministers/taylor/media-releases/australia-partners-singapore-hydrogen-maritime-sector
Japan	Japan-Australia Partnership on Decarbonisation through Technology	Commits Australia and Japan to jointly support initiatives to help drive the transition to net zero emissions, including through providing financial support as appropriate.	PR	Research and development	June 2021		https://www.minister.industry.gov.au/ministers/taylor/media-releases/japan-australia-partnership-decarbonisation-through-technology
United Kingdom	Australia-UK Partnership on Low Emissions Solutions	Focus on research and development of key low emissions technologies, including clean hydrogen	PR	Research and development	July 2021		https://www.minister.industry.gov.au/ministers/taylor/media-releases/australia-uk-partnership-drive-low-emissions-solutions
Republic of Korea (ROK)	Australia-Republic of Korea Low and Zero Emissions Technology Partnership	Collaboration across existing and emerging low emission technologies. Early priorities include clean hydrogen and ammonia.	PR	Demonstration and deployment	Oct 2021	\$50m & matched funding from Korea	https://www.minister.industry.gov.au/ministers/taylor/media-releases/strengthening-low-emissions-technology-cooperation-republic-korea

India	Letter of Intent on New and Renewable Energy Technology	Commitment to working together to reduce the cost and scaling up deployment of ultra low-cost solar and clean hydrogen	PR	Deployment	Feb 2022		https://www.industry.gov.au/news/australia-india-to-collaborate-on-new-and-renewable-energy-technology
United States	Australia – United States Net Zero Technology Acceleration Partnership	Drive investment and trade in, and the development and deployment of, low and zero emissions technologies, including long duration energy storage, digital grids, hydrogen, and carbon dioxide removal, including direct air capture, as well as cooperation on critical minerals supply chains.	PR	Development	July 2022		https://minister.dcceew.gov.au/bowen/media-releases/joint-media-release-australia-and-us-join-forces-path-net-zero

AUSTRIA

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 (e.g. link to website)
EC, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Latvia, Lithuania, The Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Spain, Sweden, Switzerland, Turkey and the United-Kingdom.	Driving Urban Transitions; 1st Call	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	from research to innovation and implementation	21 Sept 2022		2.2 Mio. €	Driving Urban Transitions - Sustainable future for cities JPI Urban Europe (jpi-urbaneurope.eu)

Austria, Belgium, Denmark, the Netherlands, Italy, Romania, Sweden, Turkey	MI Call 21 – “Positive Energy districts (PEDs) and neighbourhoods for Climate neutrality	enhance theoretical and practical knowledge for PED development; facilitate the achievement of the PED Programme Mission of large-scale implementation of 100 PEDs by 2025	PR	From applied research to implementation	24 Feb 2022	July 2025	1.5 Mio €	Bericht englisch mit Cover (jpi-urbaneurope.eu)
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, 1st Joint Call	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	14 Sept 2022	Start of funded projects in Sept 2023	4.3 Mio €	Home CETPartnership

		<p>Topics with Austrian Contribution:</p> <p>TRI3: Enabling climate neutrality with storage technologies, renewable fuels and CCUs/CCSs.</p> <p>TRI5: Integrated regional energy systems</p> <p>TRI6: Integrated industrial energy systems</p>						
IEA Member Countries	IEA Research Cooperation, Call 2022	<p>Austrian participation in the tasks and annexes of the IEA technology programmes is financed within the framework of the call for proposals "IEA - Research Cooperation International Energy Agency". This covers the following TCPs:</p>	P	R&D services	18 May 2022	20 July 2022	2.8 Mio. €	Forschungsk Kooperation Internationale Energieagentur (IEA) – Ausschreibung 2022 FFG

		5.1 Energy in Buildings and Communities (EBC TCP) 5.2 Energy Storage (ES TCP) 5.3 District Heating and Cooling (DHC TCP) 5.4 Advanced Fuel Cells (AFC TCP) 5.5 Hybrid and Electric Vehicles (HEV TCP) 5.6 Industrial Energy Technologies and Systems (IETS TCP) 5.7 International Smart Grid Action Network (ISGAN TCP) 5.8 User: inside-centred energy systems (Users TCP) 5.9 Photovoltaics (PVPS TCP) 5.10 Solar Heating and Cooling (SHC TCP)						
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		5.11 Heat Pump Technologies (HPT TCP)						
		5.12 Hydrogen (Hydrogen TCP)						

CANADA

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)
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	PP	Policy discussions leading to potential RD&D collaborations.	2021 (new)	2026	N/A	https://www.nrcan.gc.ca/energy/resources/international-energy-cooperation/memorandum-understanding/23749

		transportation, including in clean electricity, clean fuels, energy efficiency, critical minerals, nuclear energy, and CCUS.						
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,	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

		innovation and applied research. Launched in 2021, the implementation of this Partnership continued in 2022 with the endorsement of the 2022-23 Partnership Action Plan.						
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	PP	Policy discussions leading to potential RD&D collaborations.	2020	Ongoing	N/A	N/A

		exchange and develop sustainable industries.						
European Union	Canada-EU High Level Energy Dialogue (HLED)	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)	<p>The CERT co-ordinates and promotes the development, demonstration and deployment of technologies to meet challenges in the energy sector.</p> <p>Canada currently chairs the CERT committee, participates in its four working parties and 22 of the IEA's 38 Technology</p>	PR (TCPs can include private sector)	RD&D	CERT was created in 1975.	Ongoing	Canada provided \$588,500 (CAD) in 2019-2020 to IEA grants such as TCP membership fees.	https://www.iea.org/about/structure

		Collaboration Programmes (TCPs), including the International Smart Grid Action Network (ISGAN) and the Greenhouse Gas R&D Programme, (IEAGHG), and others.						
25 countries plus the European Commission	Carbon Sequestration Leadership Forum (CSLF) Technical Group	Canada and US worked to develop a strategic plan for continuing engagement of CSLF member countries. The strategic plan, based on the feedback from a recent survey of members, was presented to and accepted by members. It has implications on the focus of accelerating the	PP	Strategic engagement development methodology	2021	2022	N/A	https://www.csforum.org/cslf/

		development and deployment of CCUS via collaborative efforts amongst member countries.						
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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,	Beyond Oil and Gas Alliance	Aims to Raise global climate ambitions and	PP	2021		https://beyondoilandgasalliance.com/

Sweden, Wales and Quebec. Associate members: California, New Zealand, Portugal.		align oil and gas production with the Paris Agreement goal of “well below 2°C, pursuing efforts for 1.5°C”. 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.				
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 & Pension Denmark, the Institutional Investors	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

		Group on Climate Change (IGCC) 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 = public – public or PR = public-private)	Type of collaboration (research, development, and/or demonstration)	Start Date (Year)	End Date (Year)	Funding amount
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	PR	Demonstration	2021	2025	EUR 10.2 million

		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.					
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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	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 January 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	public-private	transformative research, development and innovation programme	The <i>CETPartnership Joint Call 2022</i> has been pre-announced			https://www.horizon-europe.gouv.fr/le-partenariat-clean-energy-transition-30809

		contributes to a wider national, European and global policy context and implementation instruments and contributes to their overarching goals.			ced here and will open on 14 Septem ber 2022			
EU, Israel, Turkey, Russia, Taiwan, Quebec, South Africa	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 Call 2022 was launche d on 15 March 2022.	2022	25 M€	https://m-era.net/joint-calls/joint-call-2022
EU, Turkey, Chile, Quebec, 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 developmen t	2021	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	transformati ve research, developmen t 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	transformati ve research, developmen t 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	transformational 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
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GERMANY

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)
Australia	HySupply	German-Australian Feasibility Study of Hydrogen produced from Renewables	PR	Research	2020	2022	1.7 Mio. €	https://www.fona.de/de/massnahme/foerdermassnahmen/hysupply_machbarkeitsstudie-deu-austr-h2.php
Chile	Haru Oni	Production of climate neutral fuel based on wind-powered hydrogen production and direct air capture of CO ₂ .	PR	Demonstration	2020	2022	8.2 Mio. €	https://www.bmwk.de/Redaktion/EN/Pressemittelungen/2020/12/20201202-haru-oni-ptx-project-minister-altmaier-hands-over-first-approval-notice-for-international-green-hydrogen-project.html

Saudi-Arabia	NEOM Element One	Production of green Hydrogen/ Ammonia based on solar and wind-power	PR	Demonstration with R & D	2020	2024	1.5 Mio. €	https://www.bmwk.de/Redaktion/DE/Pressemitteilungen/2020/12/20201216-altmaier-uebergibt-foerderbescheid-fuer-internationales-projekt-fuer-gruenen-wasserstoff.html
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	PR	Research and Development	2021	2022	3 Mio. €	https://csp-eranet.eu/calls/additional
Norway, Greece, Spain, the Netherlands, UK, USA,	ACT third and fourth calls	Advancing CCUS Technology; aimed at getting carbon capture and utilisation technology closer to being deployed	PR	Research and Development	2021 (3 rd ACT call)	2022 (4 th ACT call)	3 Mio. €	http://www.act-ccs.eu/calls

Turkey, India								
Portugal	7th Energy Research Programme	HPS2-High Performance Solar 2- Demonstration of a solar thermal parabolic trough plant and steam generator system based on liquid salt as the heat transfer medium	PR	Research and Development	2016	2022	4.6 Mio. €	https://www.dlr.de/ content/de/artikel/ news/2022/02/2022 0428_salz-macht- solarthermie- kostenguenstiger.ht ml

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

JAPAN

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)
Thailand	International joint R&D of CO2 direct utilization jet fuel synthesis for carbon recycle	1) Development of Sustainable Aviation Fuel (SAF) synthesis technology using CO2 directly with high selectivity. 2) Development of gasification and green hydrogen production technology. 3) Overall process system construction 4) Social implementation model construction	PR	R&D	2021	2024(planned)	max JPY50M	https://www.nedo.go.jp/content/100939442.pdf
USA	International R&D collaboration for low-cost CO2 recovery technology using novel zeolite adsorbent	Novel zeolite will be developed that maintains adsorption capacity and selectivity under the presence of water, which will be used in a unique heat exchanging module for the temperature swing adsorption process, and its economical efficiency will be assessed.	PR	R&D	2021	2024(planned)	max JPY50M	https://www.nedo.go.jp/content/100939443.pdf

Spain	International collaboration on CCU for circular carbon in Steelmaking	In this project, fundamental technologies to utilize CO ₂ that leads to reduce CO ₂ emissions in steelmaking will be developed. In parallel, methods to evaluate the efficacy of the CO ₂ reduction technology will be developed.	PR	R&D	2021	2024(planned)	max JPY50M	https://www.nedo.go.jp/content/100942510.pdf
Netherlands, France, Korea, Saudi Arabia, UK	International joint research for supply technology of high-pressure and purity of hydrogen by chemical compressor using formic acid	A high-pressure hydrogen generation system including highly efficient catalysts for dehydrogenation of formic acid will be developed based on the characteristic of formic acid as a liquid organic hydrogen carrier.	PP	R&D	2021	2024(planned)	max JPY50M	https://www.nedo.go.jp/content/100942511.pdf
US	Development of advanced low-temperature sintering process using nanocrystals for next generation energy devices	The objective of this project is to develop a next-generation energy storage system consisting of a high-performance oxide-type all-solid-state battery and a high-capacitance ceramic capacitor by combining the development of high-density arrangement technology for functional ceramic nanocrystals with	PP	R&D	2021	2024(planned)	max JPY50M	https://www.nedo.go.jp/content/100939446.pdf

		innovative low-temperature sintering technology.						
Sweden, India	International joint research and development of innovative high-temperature thermal energy storage technology	In this project, innovative high-temperature, large-capacity, and high-throughput heat storage systems by utilizing novel heat storage material, h-MEPCM (Hokkaido univ.-Micro Encapsulated Phase Change Material), and chemical heat pumps will be developed.	PP	R&D	2021	2024(planned)	max JPY50M	https://www.nedo.go.jp/content/100939447.pdf
Germany	International collaboration on CIS-based tandem PVs	This project focuses on the R&D of fundamental technologies in CIS-based tandem solar cells to demonstrate a lightweight flexible high-performance PV.	PP	R&D	2021	2024(planned)	max JPY50M	https://www.nedo.go.jp/content/100939448.pdf
Italy	International joint research and development of lead-free alloyed tin perovskite tandem solar cells	In this project, a highly efficient lead-free alloyed tin perovskite solar cell will be developed, pursuing practical durability.	PP	R&D	2021	2024(planned)	max JPY50M	https://www.nedo.go.jp/content/100939449.pdf
Germany	Long-term stabilization of automotive adhesion and the interfacial design	This project focuses on the adhesive interface. Developing points for longterm stability are (1) original visual evaluation in adhesive mechanism, moisture deterioration, and interface	PP	R&D	2021	2024(planned)	max JPY50M	https://www.nedo.go.jp/content/100939450.pdf

		strength, and (2) innovative laser surface treatment that brings selective adhesive interface.							
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NETHERLANDS

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)
Germany	German-Dutch Innovation and Technology Pact	The pact is intended to foster innovation in important forward-looking areas, such as Industrie 4.0, carbon reduction in the industrial sector, economic policy aspects of mobility, the health sector and key enabling technologies	PP	Research, development and demonstration	2021	Not specified	Not specified	Link to press release

Denmark, Germany, Belgium	The Declaration of Energy Ministers on The North Sea as a Green Power Plant of Europe	<p>Combined targets for offshore wind of at least 65 GW by 2030 and at least 150 GW by 2050, delivering more than half of the capacity needed to reach EU climate neutrality.</p> <p>Combined targets for large-scale onshore and offshore production of green hydrogen: 20GW production capacity by 2030.</p>	PP	Development and demonstration	2022	2050	Not specified	Link to declaration
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EU	Horizon Europe, Cluster 5 on Climate, Energy and Mobility	This clusters aims to fight climate change by better understanding its causes, evolution, risks, impacts and opportunities, and by making the energy and transport sectors more climate and environment-friendly.	PR	Research, development and demonstration	2021	2027	Approximately 15 billion euro's EU wide.	https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/cluster-5-climate-energy-and-mobility_en
EU	The Clean Energy transition Partnership	To boost and accelerate energy transition in all its dimensions and enable joint R&I programmes from regional to national and global level.	PR	Research, development and demonstration	2022	2027	The Netherlands contribution to the CETP is expected to be approximately €9 million per year.	https://cetpartnership.eu/

NORWAY

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)	Start date (Year)	End date (Year)	Funding amount	Additional information (e.g. link to website)
Canada, Denmark, France, Germany, Greece, India, Italy, The Netherlands, Norway, the Nordic Region, Romania, Spain, Switzerland, Turkey, UK and the USA	ACT – Accelerating CCS technologies	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	Ongoing	Approx. EUR 14 mill. For the 4 th 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	Public-private	RD&D		Ongoing		Carbon Sequestration Leadership Forum (CSLF) - Climate Initiatives Platform

		<p>organizations such as CSLF TG, CEMCCUS) and MI CCUS&CDR.</p> <p>In addition, the US (DOE) and Norway (OED) operates under a MoU with special focus on promoting cooperation on CCUS</p>						
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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 (FY 2022)
USA	ROK-US Energy Policy Dialogue	Share information, carry out joint R&D project, etc.	PP	research, development	2011	not decided	800million KRW
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	PP	research, development	2014	not decided	-

		<ul style="list-style-type: none"> · IOT application in energy technologies · Natural resources (shale gas, oil) 					
Spain	·(KETEP) Memorandum of Understanding on Industrial Technology Cooperation in the field of Energy between KETEP and CDTI	Cooperating in below areas <ul style="list-style-type: none"> · 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	617million KRW
Germany	(MOTIE) The German-Korean Energy Partnership	<ul style="list-style-type: none"> ·The expansion and system integration of renewable energies ·Increasing energy efficiency 	PP	research, development	2019	not decided	-

		<ul style="list-style-type: none"> ·energy systems of the future ·Green hydrogen 					
Czech Republic	<ul style="list-style-type: none"> ·(KETEP) Memorandum of Understanding on Information Exchange between the Korea Institute of Energy Technology Evaluation and Planning and the Technology Agency of the Czech Republic 	Cooperating in below areas <ul style="list-style-type: none"> · Nuclear Power and Safety · Renewable Energy · Energy Efficiency · Distributed Power Generation, including Smart Grid, Micro Grid and ESS · Electricity Transmission and Distribution 	PP	research, development	2021	not decided	655million KRW
Norway	<ul style="list-style-type: none"> ·(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 <ul style="list-style-type: none"> · Renewable Energy, · Energy Efficiency · Smart grid · ESS 	PP	research, development	2019	not decided	1,192million KRW
China	<ul style="list-style-type: none"> ·(MOTIE) Memo of the Ministry of 		PP	research, development	2018~	not decided	1,410million KRW

	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						
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	225million KRW
Thailand	·(KETEP) Memorandum of Understanding between Korea Institute of Energy Technology Evaluation and Planning and the Thailand Research	Cooperating in below areas · New and Renewable Energy · Smart grid · Energy efficiency	PP	research, development	2018	not decided	150million KRW

	Fund Kingdom of Thailand						
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) 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	·(KETEP) Cooperating in below areas · Smart Grids including Distributed Power Generation, Micro-grids, ESS, and AMI · Energy Security, IOT applications in energy technologies · Solar energy including offshore floating PV and building integrated PV	PP	research, development	2019	not decided	466million KRW

Australia	·(MOTIE) MoU on Cooperation in Critical Minerals Supply Chains ·(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 · Mineral · Clean hydrogen	PP	research, development	2021	not decided	700million KRW
IEA	TCP (Technology Collaboration Program)	·Doing IEA task professional activities	-	networking	depends on IEA TCP program	depends on IEA TCP program,	
CSLF	Technical Group	·Information sharing, report publication	-	research, development, demonstration	2005	depends on program agreement	

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	<ul style="list-style-type: none"> - Circular Carbon Economy (CDR & H2) - Artificial Intelligence (GPFM) - Climate change and the role of the circular carbon economy at the international level (CDR & H2) 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Circular Carbon Economy (CDR & H2) 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Circular Carbon Economy (CDR & H2) 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Circular Carbon Economy (CDR & H2) - Artificial Intelligence (GPFM) - Climate change and the role of the circular carbon economy at the international level (CDR & H2) 	<ul style="list-style-type: none"> - 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. 	PP PR	

		- Environmental Technology Verification AI in Energy		
Germany	<ul style="list-style-type: none"> - 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) 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Circular Carbon Economy. (CDR & H2) - Artificial Intelligence. (GPFM) - 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM) 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM) 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Circular Carbon Economy (CDR & H2) - Hydrogen - Artificial Intelligence. (GPFM) 	<ul style="list-style-type: none"> - 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

		<ul style="list-style-type: none"> - Low cost & carbon hydrogen production - Blue ammonia collaboration - Collaboration with Grid & Idemitsu companies - Collaborate with MitoyoAI Development 		
Korea	<ul style="list-style-type: none"> - 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) 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Circular Carbon Economy (CDR & H2) 	<ul style="list-style-type: none"> - Hydrogen applications & transportation best practices 	PP	Research development

Norway	<ul style="list-style-type: none"> - Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM) - 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM) - 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM) - 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Circular Carbon Economy (CDR & H2) - Artificial Intelligence. (GPFM) 	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Establishment of Clean Energy (CDR, Hydrogen & GPFM). - Areas of Clean Energy (GPFM). - Projects for Clean Energy (CDR, Hydrogen & GPFM) 	<ul style="list-style-type: none"> - 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
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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 KINGDOM

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)
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	<p>MISSION: 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.</p> <p>The 2021 annual report can be found here.</p> <p>In 2021 completed 3 tasks:</p> <ul style="list-style-type: none"> • TASK 39 – HYDROGEN IN THE MARITIME • TASK 38 – POWER-TO-HYDROGEN AND HYDROGEN-TO-X • TASK 37 – HYDROGEN SAFETY 	Both Public and Private. PP & PR	The strategy is to facilitate, coordinate and maintain innovative research, development and demonstration activities as a hub for international cooperation and knowledge exchange. The strategic plan can be found here .	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	RD&D		Continuing		https://www.iea-dhc.org/home

			Private. PP & PR					
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/
Open to IEA members	IEA Energy Conservation through Energy Storage (ECES) TCP	Collaborative research on various aspects of ECES	Both Public and Private. PP & PR	RD&D		Continuing		https://iea-es.org/
Open to IEA members	IEA Energy in Buildings and Communities (EBC) TCP	Collaborative research on various aspects of EBC	Both Public and Private. PP & PR	RD&D		Continuing		https://www.iea-ebc.org/

UNEP, India, US, Denmark,	The Cool Coalition steering committee	<p>The Cool Coalition is about working together to ensure the transition to efficient, climate-friendly cooling for all is fundamental for climate action and sustainable development.</p> <p>It has 3 pillars</p> <p>Advocacy: Highlighting benefits and opportunities of efficient, climate friendly cooling.</p> <p>Action: Mobilizing commitments to action and targets from leaders in government, business, and civil society and connecting these to global policy processes.</p> <p>Knowledge Exchange: Building an active learning community that breaks down silos and promotes cross-cutting approaches.</p>	PR	Knowledge exchange on Demonstrations	2022	2025		https://www.ashrae.org/conferences/2023-winter-conference-atlanta
UNEP, US, India	Urban Heat Adaptation Working Group	Support local and national governments and financial institutions in raising awareness, increasing capacity to act and developing strategies for the reduction and adaptation to extreme heat in urban areas with comprehensive approaches, including sustainable cooling, at several levels: building, neighbourhood, city and region/state.	PR	Knowledge exchange on Demonstrations	2021	2024		https://onebillionresilient.org/heat-action-platform/

North America	Electric Power research Institute (EPRI)	<p>To share innovative companies who operate within the gas and electricity transmission and distribution space.</p> <p>EPRI run annual competitions to encourage innovation submissions that can win funding/pilot opportunities with utilities for demonstration of their utilities.</p> <p>The Ofgem Strategic Innovation Fund likewise runs competitions focussing on gas and electricity utilities.</p> <p>The collaboration agreement is to allow for the two way sharing of innovations across both parties and their respective utilities network.</p>	PR	Knowledge exchange on Demonstrations	2022	open ended	n/a	https://www.epri.com/
Global	Free Electrons	<p>To share knowledge innovative companies who operate within the electricity transmission and distribution space.</p> <p>Free Electrons run annual workshops and competitions to encourage innovation submissions that can win funding/pilot opportunities with utilities for demonstration of their utilities.</p> <p>The Ofgem Strategic Innovation Fund likewise runs competitions focussing on electricity utilities.</p> <p>The collaboration agreement is to allow for the two-way sharing of innovations across both parties</p>	PR	Knowledge exchange on Demonstrations	2022	open ended	n/a	https://freeelectrons.org/

		and their respective utilities network.						
Europe	Inno Energy	<p>To share innovative companies who operate within the gas and electricity transmission and distribution space.</p> <p>Inno Energy provide commercial and sub-commercial funding to innovative companies creating solutions for European Utility Companies.</p> <p>The Ofgem Strategic Innovation Fund runs competitions focussing on gas and electricity utilities.</p> <p>The collaboration agreement is to allow for the two way sharing of innovations across both parties and their respective utilities network.</p>	PR	Knowledge exchange on Demonstrations	2022	open ended	n/a	https://www.innoenergy.com/
France, Germany, Netherlands, Denmark, Norway, Austria, Finland, Iceland, Canada, Japan, Australia, Italy, Spain, Sweden, Switzerland	World Bank Energy Sector Management Assistance Program (ESMAP)	<p>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</p>	PP	Research	1983	Ongoing	£71m (since 2014)	Home ESMAP

		ensure access to affordable, reliable, sustainable and modern energy for all..						
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
USA, Sweden, Germany (GIZ, EnDev), World Bank, IKEA Foundation, Rockefeller Foundation/GEAP P 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	01/10/2017	Ongoing	£18 million	Efficiency for Access With our contribution coming from the LEIA programme LEIA (efficiencyforaccess.org)

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 (other funding has been provided previously, and is being considered looking forward)	Sustainable Energy for All (SE4ALL) FCDO's current main contribution to SEforALL is from Transforming Energy Access (TEA) Which includes specific support to the SE4All Mini-Grid Partnership
India and Peru	GCRF Energy: GEMdev: Grounded Energy Modelling for equitable urban planning development in the global South	The aim is to use the data co-generated by the project to address the lack of representation of the urban poor in energy models, informing pathways towards dignified housing and habitat for all within a sustainable energy future. GEMDev aims to enable inclusive decision-making towards dignified housing and habitat for all through the co-production of methodologies and tools to inform energy alternative futures and concrete possibility at three different scales – individual,	Public	Research	Mar 20	Sep 23	£1,226,413	GtR (ukri.org)

		<p>neighbourhood and city – in Lima and Ahmedabad. The project will produce:</p> <ul style="list-style-type: none"> - Locally-owned models of communities, mapping their shared spaces, energy and social practices and physical risks and potential for renewable technologies; - Open-source models and data sets of energy use in informal settlements; - Archetypes for redevelopment and upgrading of off-grid communities, which are optimised to the needs of communities, including safe and adequate housing with thermal comfort, reduced energy consumption and enabling adequate habitat for all; - Open negotiation and dialogue spaces to build synergies between actors from different spheres (national and local government, academia, civil society groups, NGOs). 						
Zambia, Lesotho, Nigeria	GCRF Energy: Energy Democracy and the Politics of Energy Transition in African Countries	Impacts of this research are threefold: 1) This research will increase awareness about innovative inclusive policies and regulation that has a potential to impact on energy transition and energy democracy. 2) This	Public	Research	Mar 20	Aug 23	£1,337,142	GtR (ukri.org)

		research will inform stakeholders on issues surrounding poverty, structural inequalities, unemployment and multi-level responses to manage and care about energy democracy when implementing clean energy transition. 3) Experienced researchers will collaborate with starting or in mid-career researchers which will help to have impacts through the training and career development of these young scientists. The research project will also establish a long-term partnership among researchers in the UK and in African countries and a post-funding collaboration will be set up to strengthen and foster research uptake activities and knowledge exchange						
Ethiopia, Malawi, Mozambique	GCRF Energy: Community energy and sustainable energy transitions in Ethiopia, Malawi, Mozambique (C ESET)	CESET will deliver recommendations to improve the delivery of CESs in situ, which will benefit directly low-income communities. It will provide country-specific evidence on what works for energy access, which will benefit governmental and non-governmental actors working to advance energy access in Ethiopia, Malawi, and Mozambique.	Public	Research	Mar 20	Sep 24	£1,317,217	GtR (ukri.org)

		It will develop new ways of thinking about community energy, which will benefit ODA-related organisations that question dominant paradigms on energy and development						
Kenya, Uganda, Tanzania	GCRF Energy: Harvesting the sun twice: Enhancing livelihoods in East African agricultural communities through innovations in solar energy	<p>The project aims to provide a real test case for the application and adaptation of AV systems to the needs of communities in Eastern Africa by:</p> <p>a) Identifying areas in Kenya, Uganda and Tanzania that are most physically suitable (e.g. climate, existing land use, lack of energy access) for realising the benefits of AV systems and their uptake by communities.</p> <p>b) Field testing of AV systems in communities in Kenya & Uganda to provide data on resulting livelihood enhancement (increasing crop yield and farmer income, access to sustainable energy) as well as perceptions and attitudes of rural communities to AV systems.</p> <p>c) Using the data collected to develop a decision support tool for regional and national governments and NGOs to deliver AV systems effectively and in line with community needs.</p>	Public	Research	Mar 20	Sep 23	£1,290,888	GtR (ukri.org)

		The findings from this project will reveal the potential this technology to lead to livelihood improved access to energy and increased incomes through production of higher-value crops, as well as the barriers within local communities to the uptake of AV systems. It will also show which economic, social, cultural and political factors help or hinder the expansion of AV systems in this region. We will assess how AV technology can best be co-designed with the users and seek input from national and regional policymakers to inform the potential rollout of AV systems across East Africa and potentially beyond.						
Nigeria, Senegal, Kenya, Tanzania	GCRF Energy: Sustainability, inclusiveness and governance of mini-grids in Africa (SIGMA)	The main aim of this proposal is to improve our understanding of sustainability, inclusiveness and governance of mini-grids in general and those in sub-Saharan Africa in particular, by developing an improved evidence base and a multi-dimensional appreciation of issues and challenges that can support better decision-making for universal electrification globally.	Public	Research	Mar 20	Feb 22	£1,243,899	GtR (ukri.org)

Colombia, Cuba and Mexico	GCRF Energy: Energy Solidarity in Latin America: generating inclusive knowledge and governance to address energy vulnerability and energy systems resilience	The aim is to bring about systemic change for EV alleviation, whilst simultaneously enhancing energy system resilience, and fostering energy solidarity, as to maximise social welfare and equitable development. The impact will be commensurate with the ambitions of this international collaborative project, which is to bring about sustainable energy systems in a way that maximises social welfare and equitable development by co-creating inclusive and transformative understanding, evidence and governance to alleviate energy vulnerability (EV) and foster resilience in energy systems and societies within Cuba, Colombia, Mexico and beyond.	Public	Research	Mar 20	Sep 23	£1,095,452	GtR (ukri.org)
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UNITED KINGDOM CONTINUED

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)
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Japan	UK-Japan Civil Nuclear Phase 5	The removal of fuel debris and environmental safety around reactor core decommissioning of the TEPCO Fukushima Daiichi Nuclear Power Plant (NPP).	PP	Research	Oct 2018	Sept 2021	TOTAL UK: £501,450.73 MEXT: Matched effort	This collaboration is a result from negotiations between the Foreign and Commonwealth Office (FCO), EPSRC and MEXT in Japan. These negotiations culminated at a meeting at the FCO in October 2013 where it was agreed that a joint collaborative programme of research should be initiated and initial subject areas were set.
					Oct 2018	June 2021	£240,355.37	EP/S020411/1 <i>Thin neutron detector on a chip utilising silicon carbide</i> Lancaster University
					Oct 2018	Sept 2021	£261,095.36	EP/S020659/1 <i>Environmental behaviour and management of U-containing fuel debris particles</i> University of Bristol
Japan	UK-Japan Civil Nuclear Phase 6	The removal of fuel debris and environmental safety around reactor core decommissioning of the TEPCO Fukushima Daiichi Nuclear Power Plant (NPP), and Sellafield's decommissioning challenges.	PP	Research	Nov 2019	Apr 2023	TOTAL UK: £503,528.37 MEXT: Matched effort	This collaboration is a result from negotiations between the Foreign and Commonwealth Office (FCO), EPSRC and MEXT in Japan. These negotiations culminated at a meeting at the FCO in October 2013 where it was agreed that a joint collaborative programme of research should be initiated and initial subject areas were set.
					Nov 2019	Dec 2022	£253,537.70	EP/T013524/1 <i>Safe, efficient cementation of challenging radioactive wastes using alkali activated materials with high-flowability and high-anion retention capacity</i> University of Sheffield

					Nov 2019	April 2023	£249,990.67	EP/T013532/1 Radiation tolerant rapid criticality monitoring (REACTION) Lancaster University
Japan	UK-Japan Civil Nuclear Phase 7	The removal of fuel debris and environmental safety around reactor core decommissioning of the TEPCO Fukushima Daiichi Nuclear Power Plant (NPP), and Sellafield's decommissioning challenges.	PP	Research	Nov 2020	Dec 2023	TOTAL UK: £743,470.17 MEXT: Matched effort	This collaboration is a result from negotiations between the Foreign and Commonwealth Office (FCO), EPSRC and MEXT in Japan. These negotiations culminated at a meeting at the FCO in October 2013 where it was agreed that a joint collaborative programme of research should be initiated and initial subject areas were set.
					Nov 2020	Dec 2023	£283,148.37	EP/V027387/1 Development of technology to reduce environmental problems via innovative water purification agents Diamond Light Source
					Oct 2021	April 2023	£210,431.42	EP/V027522/1 Development of technology to reduce environmental problems via innovative water purification agents University of Sheffield
					Nov 2020	May 2023	£249,890.38	EP/V027379/1 ASUNDER - Adaptable Semiautonomous Underwater Decommissioning Sample Retrieval Robot Lancaster University
Japan	UK-Japan Civil Nuclear Phase 8	The removal of fuel debris and environmental	PP	Research	Nov 2021	Sept 2024	TOTAL UK: £902,761.79	This collaboration is a result from negotiations between the Foreign and Commonwealth Office (FCO), EPSRC and MEXT in Japan. These

		safety around reactor core decommissioning of the TEPCO Fukushima Daiichi Nuclear Power Plant (NPP), and Sellafield's decommissioning challenges.					MEXT: Matched effort	negotiations culminated at a meeting at the FCO in October 2013 where it was agreed that a joint collaborative programme of research should be initiated and initial subject areas were set.
					Nov 2021	Mar 2024	£505,252.72	EP/W016265/1 <i>'OptiClean' - Optimised laser cleaning for safe nuclear decontamination and decommissioning</i> University of Bristol
					Nov 2021	Sept 2024	£397,509.07	EP/W016168/1 <i>A Nuclear Decommissioning Manipulator with Novel Variable Impedance Actuator</i> University of Sussex
US US	NEUP (Nuclear Energy University Programs (NEUP) US/UK Collaborative Funding Opportunity)	Support UK-US collaboration in nuclear through participation in the DoE NEUP programme. The U.S. Department of Energy's Office of Nuclear Energy created Nuclear Energy University Program (NEUP) in 2009 to consolidate its university support	PP	Research	Jan 2018	Sept 2021	TOTAL UK: £756,855.49	Note: other projects funded under this call but not live during June 2021 onwards.
					Mar 2018	Sept 2021	£319,922.13	EP/R005745/1 Mechanisms of Retention and Transport of Fission Products in Virgin and Irradiated Nuclear Graphite Loughborough University
					Jan 2018	Jun 2021	£436,933.36	EP/R006245/1 RADIATION RESISTANT HIGH ENTROPY ALLOYS FOR FAST REACTOR CLADDING APPLICATIONS University of Oxford

		under one programme.						
Republic of Korea	Nuclear Decommissioning		PP	Research	Aug 2019	May 2023	TOTAL UK: £1,655,450.20	
					Aug 2019	May 2023	£378,286.97	EP/S032797/1 <i>Electrokinetic Separation for Enhanced Decontamination of Soils and Groundwater Systems</i> University of Leeds
					Sept 2019	Aug 2022	£252,932.31	EP/S03286X/1 <i>Digital twin-based Bilateral Teleautonomous System for Nuclear Remote Operation</i> The University of Manchester
					Sept 2019	Aug 2022	£257,026.17	EP/S032894/1 <i>Digital-twin-based Bilateral Tele-autonomous System for Nuclear Remote Operation</i> CCFE/UKAEA
					Sept 2019	Aug 2022	£386,163.78	EP/S032959/1 <i>Isolation of 14C species from spent ion exchange resins and their stabilisation</i> University of Sheffield
					Sept 2019	Feb 2023	£381,040.97	EP/S033009/1 <i>DAWNMANTLE - Decontamination and waste minimisation strategies for and using advanced molten salt nuclear technologies</i> The University of Manchester
US	NEUP 5	Support UK-US collaboration in nuclear through	PP	Research	Jan 2020	Dec 2023	TOTAL UK: £2,573,893.57	

		participation in the DoE NEUP programme. The U.S. Department of Energy's Office of Nuclear Energy created Nuclear Energy University Program (NEUP) in 2009 to consolidate its university support under one programme.			Jan 2020	Dec 2023	£543,314.18	EP/T002808/1 <i>Simultaneous Corrosion/Irradiation Testing in Lead and Lead-Bismuth Eutectic: The Radiation Decelerated Corrosion Hypothesis (RC-3)</i> University of Oxford
					Jan 2020	Dec 2022	£419,373.96	EP/T003332/1 <i>Investigations of HTGR Reactor Building Response to Break in Primary Coolant Boundary</i> Imperial College London
					Jan 2020	Dec 2023	£367,530.53	EP/T002395/1 <i>Liquid metal-cooled fast reactor instrumentation technology development - CFD model development and validation</i> University of Sheffield
					Jan 2019	Nov 2022	£499,728.34	EP/T002441/1 <i>Ni-based ODS alloys for Molten Salt Reactors</i> University of Oxford
					Jan 2020	Dec 2023	£367,530.50	EP/T002417/1 <i>Mixing of helium with air in reactor cavities following a pipe break in HTGRs - High fidelity and engineering CFD model development and validation</i> University of Sheffield
					Jan 2020	Dec 2022	£376,416.06	EP/T003359/1 <i>Development of versatile liquid metal testing facility for lead-cooled fast reactor technology</i> The University of Manchester

Numerous	GCRF Engineering and Digital	Tackling global development challenges through engineering and digital technology research Sustainable infrastructure development Engineering for disaster resilience Engineering for humanitarian aid Access to digital services Use of data for vital services Secure and trusted digital infrastructures	PP	Research	May 2017	July 2021	TOTAL UK: £2,611,927.73	Note: other projects funded under this call but not live during June 2021.
Ethiopia Kenya					May 2017	July 2021	£1,341,747.87	EP/P028829/1 Geothermally Sourced Combined Power and Freshwater Generation for Eastern Africa (Combi-Gen) University of Glasgow
United Republic of Tanzania South Africa The Sudan					May 2017	July 2021	£1,270,179.86	EP/P029434/1 Developing performance-based design for foundation systems of WIND turbines in AFRICA (WindAfrica) Durham University
India	GCRF Grow Research Capability	SUNRISE is an ambitious programme to rapidly accelerate and prove low cost printed PV and tandem solar cells for use in off grid Indian communities	PP	Research	Oct 2017	Mar 2022	£6,580,123.39	EP/P032591/1 Strategic University Network to Revolutionise Indian Solar Energy (SUNRISE) Swansea University http://www.sunrisenetwork.org/

		within the lifetime of the project.						
Numerous	GCRF Energy Networks	Focus on sustainable local energy networks, including off-grid to grid transitions. Emphasis on energy distribution which is maintainable, has good longevity, has low cost and addresses a range of energy uses beyond home lighting.	PP	Research	May 2018	April 2022	TOTAL UK: £5,564,784.12	
Liberia Kenya Rwanda					May 2018	Mar 2022	£1,276,906.31	EP/R030111/1 Robust Extra Low Cost Nano-grids (RELCON) University of Oxford
Nepal Rwanda					May 2018	April 2022	£984,148.38	EP/R030235/1 Resilient Electricity Networks for a productive Grid Architecture (RENGA) Imperial College London
Uganda The Congo United Republic of Tanzania					May 2018	Dec 2021	£1,259,750.37	EP/R030243/1 Creating Resilient Sustainable Microgrids through Hybrid Renewable Energy Systems University of Leeds
Malaysia China					May 2018	Dec 2021	£1,024,785.66	EP/R030294/1 TERSE: Techno-Economic framework for Resilient and Sustainable Electrification The University of Manchester
Kenya Uganda					May 2018	Mar 2022	£1,019,193.40	EP/R030391/1 FORTIS UNUM: CLUSTERING MINI-GRID NETWORKS TO WIDEN ENERGY ACCESS AND ENHANCE UTILITY NETWORK RESILIENCE University of Southampton
India	Newton Fund: UK-India Energy Demand (Energy Demand)	Three topics identified: Peak demand reduction through improved building	PP	Research	Nov 2017	June 2023	TOTAL UK: £3,313,192.40	The call topic of reducing energy demand in the built environment was agreed upon through a dialogue between the RCUK Energy Programme and DST. The topic was discussed at a joint India/UK workshop in New Delhi in

	Reduction in the Built Environment)	envelopes, low-energy cooling & heating, social practices of adaptive thermal comfort and post-occupancy evaluation. City- and community-level energy efficient technologies, research to provide guidance to urban planning, and community design and management for energy. Integration of information, communication and renewable energy technologies at building, community, and city level interventions						April 2016 and a number of priority areas were identified. The report of the workshop can be found at: http://www.rcuk.ac.uk/documents/india/indo-uk-workshopreport-pdf/ .
					Nov 2017	June 2023	£772,178.04	EP/R008434/1 <i>Residential building energy demand reduction in India (RESIDE)</i> Oxford Brookes University
					Nov 2017	Oct 2022	£985,227.24	EP/R008612/1 <i>Zero Peak Energy Building Design for India (ZED-i)</i> University of Bath
					Nov 2017	April 2022	£962,435.00	EP/R008620/1 <i>iNtelligent Urban Model for Built environment Energy Research (iNumber)</i> University College London
					Nov 2017	Mar 2022	£593,352.12	EP/R008655/1 <i>Community-scale Energy Demand Reduction in India (CEDRI)</i> Heriot-Watt University
India	Joint UK-India Clean Energy Centre (JUICE)	Brings together leading energy researchers from ten UK universities with their	PP	Research	Oct 2016	Mar 2022	UK: £5,094,436.61	https://www.juice-centre.org.uk/

		counterparts across India to share experience and develop technologies critical to the future of sustainable energy systems.						
China	UK-China Low Carbon Manufacturing Call	<p>This programme has the following overarching aims:</p> <p>To reduce worldwide CO2 production</p> <p>To ensure energy affordability and security for each country</p> <p>To build lasting best-with-best academic relationships between China and the UK in an area vital to both countries.</p> <p>Projects to cover</p> <p>1. Thermal Energy Management, Recovery, Storage and Use.</p>	PP	Research	Jan 2019	June 2023	TOTAL UK: £2,429,757.80	
					Apr 2019	Dec 2022	£812,910.43	EP/S018190/1 <i>Research on the theory and key technology of laser processing and system optimisation for low carbon manufacturing (LASER-BEAMS)</i> The University of Manchester
					Jan 2019	Dec 2022	£804,042.04	EP/S018573/1 <i>High efficiency value-added bulk recycling of polymers by solid state shear milling</i> University of Bradford
					Jan 2019	Oct 2022	£812,805.33	EP/S018204/1 EP/S018204/2 <i>Sustainable Processing of Energy Materials from Waste</i> Imperial College London
					April 2019	June 2023	£784,270.46	EP/S018352/1 <i>Green Recycling And re-manufacturing of Carbon fibre composites for a circular Economy (GRACE)</i>

		b. Recycling and Remanufacturing. c. Novel Low Carbon Manufacturing Design, Production and Optimised Systems. d. Low Carbon Manufacturing of Bulk Materials and Chemicals.						The University of Manchester
China	Sustainable power supply		PP	Research	Jan 2020	Sep 2023	TOTAL UK: £3,744,237.81	
					Apr 2020	Mar 2023	£604,561.56	EP/T021985/1 Sustainable urban power supply through intelligent control and enhanced restoration of AC/DC networks Cardiff University
					July 2020	Jun 2023	£775,785.47	EP/T021713/1 Resilient Operation of Sustainable Energy Systems (ROSES) Imperial College London
					July 2020	Mar 2023	£808,758.62	EP/T021780/1 Technology Transformation to Support Flexible and Resilient Local Energy Systems Imperial College London
					April 2020	Sept 2023	£812,743.90	EP/T021969/1 Multi-energy Control of Cyber-Physical Urban Energy Systems (MC2) Cardiff University

					Jan 2020	Dec 2022	£742,388.26	EP/T021829/1 Resilient Future Urban Energy Systems Capable of Surviving in Extreme Events (RESCUE) University of Strathclyde
India	UK-India Civil Nuclear Phase 4		PP	Research	Aug 2018	Aug 2023	TOTAL UK £2,454,868.68 DAE: matched effort	
					Jan 2019	Dec 2021	£261,258.18	EP/R021988/1 A Resilience Modelling Framework for Improved Nuclear Safety (NuRes) University of Nottingham
					Jan 2019	Dec 2021	£244,581.80	EP/R021759/1 A Resilience Modelling Framework for Improved Nuclear Safety (NuRes) Loughborough University
					Aug 2018	Jan 2022	£196,142.44	EP/R021546/1 Development of Radiation Damage Resistant High Entropy Alloys for Advanced Nuclear Systems The University of Manchester
					Sept 2018	Jan 2022	£595,241.29	EP/R021805/1 Development and Validation of Thermal- Hydraulic ... in BWR's and PWR's: Can modern CFD models reliably predict DNB for nuclear power applications? Imperial College London

Dec 2018	Feb 2022	£292,833.99	EP/R022062/1 Fault tolerant control for increased safety and security of nuclear power plants University of Portsmouth
Aug 2018	Jan 2022	£24,350.33	EP/R021724/1 India - UK Civil Nuclear Collaboration: Development of Radiation Damage Resistant High Entropy Alloys for Advanced Nuclear Systems Loughborough University
Jan 2019	Dec 2021	£218,435.90	EP/R020558/1 EP/R020558/2 A Resilience Modelling Framework for Improved Nuclear Safety (NuRes) University of Liverpool
Aug 2018	Jan 2022	£169,796.40	EP/R021864/1 India - UK Civil Nuclear Collaboration: Development of Radiation Damage Resistant High Entropy Alloys for Advanced Nuclear Systems University of Sheffield
Aug 2018	Jan 2022	£216,079.37	EP/R021775/1 India - UK Civil Nuclear Collaboration: Development of Radiation Damage Resistant High Entropy Alloys for Advanced Nuclear Systems University of Oxford
Oct 2018	Aug 2023	£236,148.98	EP/R021961/1 Fault tolerant control for increased safety and security of nuclear power plants

								Leeds Beckett University
India	UK-India Civil Nuclear Phase 5		PP	Research	Aug 2020	July 2025	TOTAL UK £2,627,073.20 DAE: matched effort	
					Dec 2020	May 2023	£651,532.21	EP/T016728/1 Cobalt-free Hard-facing for Reactor Systems Open University
					Aug 2020	Jul 2025	£257,242.78	EP/T016663/1 UKINN: UK India Nuclear Network University of Liverpool
					Jan 2021	Jun 2024	£863,375.46	EP/T016337/1 Intermediate range order effects in radioactive waste glasses: implications for aqueous durability and mechanical properties University of Liverpool
					Jul 2022	Jun 2025	£628,950.60	EP/T016566/1 Intermetallic Dispersion Strengthened 'IDS-Steels' for Generation IV Nuclear University of Birmingham
					Jan 2022	Jan 2025	£854,922.75	EP/T016329/1 Enhanced Methodologies for Advanced Nuclear System Safety (eMEANSS) University of Bangor





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