MISSION INNOVATION

COUNTRY HIGHLIGHTS

6TH MI MINISTERIAL 2021

MISSION INNOVATION

accelerating the clean energy revolution

CONTENTS

INTRODUCTION

Mission Innovation (MI) Members[1] agreed to provide information on strategies and plans for their respective governmental and/or state-directed clean energy research and development investment over five years. New investments are focused on transformational clean energy technology innovations that can be scaled to varying economic and energy market conditions that exist in participating countries and in the broader world.

Information-sharing promotes transparency and integrity. It allows for broad stakeholder engagement, gives rise to opportunities for collaboration, and can inspire and inform investment decisions by the private sector.

Accordingly, MI Members have shared narratives, available on the MI website, describing the nature of their clean energy research, development, and demonstration (RD&D) investments; current strategies and priorities for engagement in Mission Innovation.

MI Members initially submitted narrative and funding information prior to the Inaugural MI Ministerial in June 2016. They submitted updated information in November 2016, at the one-year anniversary of the MI launch in Paris then prior to the Second MI Ministerial (June 2017), Third MI Ministerial (May 2018), Fourth MI Ministerial (May 2019) and Fifth MI Ministerial (September 2020). Once again, MI members have submitted information prior to the Sixth MI Ministerial hosted by Chile in May 2021. This updated information focuses on key highlights over the past year including recent developments in members plans, policies and strategies, innovation successes, activities delivered in support of the Innovation Challenges, public sector RD&D investment, new collaborations and the impact of their activities.

This document provides a compilation of the most recent information that has been submitted by MI Members. In addition to promoting transparency and integrity, it is hoped that the information shared in the document will facilitate collaboration among Members and encourage further private sector engagement.

All data is based on information submitted by members. Baselines are determined independently by each member based on national priorities and relevant activity under Mission Innovation, it therefore differs by member and, for International Energy Agency (IEA) member countries, is often a subset of the IEA datasets[2]. All funding amounts presented in this report are in USD using a single set of foreign exchange rates[3]. There may be small differences in USD amounts compared to previous MI country highlights. Numbers denoted by “zero” in the following tables may indicate that no information has been provided for spend in that category.

[1] Mission Innovation Members, as of May 2021, include 24 countries and the European Commission on behalf of the European Union. A complete list is provided at: http://mission-innovation.net/our-members/

[2] Please see Annex A for full data set

[3] The exchange rates used were taken from the OECD Monthly Monetary and Financial Statistics https://stats.oecd.org/Index.aspx?DataSetCode=MEI_FIN# .

AUSTRALIA

Update on clean energy innovation policies and strategies

In 2020 Australia developed the Technology Investment Roadmap as an enduring framework with a strategic and system-wide view for the investment and deployment of low emissions technologies in the short, medium and long term. The first Low Emissions Technology Statement was released in September 2020. The statement outlines five priority low emissions technologies and economic stretch goals based on their potential to deliver abatement and economic outcomes, their alignment with Australia's comparative advantage and technological readiness[4].

In September 2020 the Government committed further support to the next generation of energy technologies with an extra AUD $1.62 billion for the Australian Renewable Energy Agency (ARENA) to invest, as well as expanding the focus of ARENA and CEFC to back new technologies that will cut emissions in agriculture, manufacturing, industry and transport[5].

Major innovation initiatives and programmes in 2020/21

Following the release of Australia's National Hydrogen Strategy, the Government has announced setting up a hydrogen export hub worth $70.2 million to scale-up demand and take advantage of the advancements in this low emissions, high powered source of energy

The Australian Government through the Australian Renewable Energy Agency's (ARENA) has launched the AU$71.9 million Future Fuels Fund, announced as part of the 20/21 Federal Budget, aimed at addressing barriers to the roll out of new vehicle technologies. The first round of the Fund will see AU$16.5 million of grant funding made available to fund battery electric vehicle (BEV) public fast charging infrastructure to expand the network and reduce blackspots. Subsequent funding rounds, commencing later in 2021, will focus on supporting business fleets to transition to BEVs, as well as explore opportunities with hydrogen and biofuels[6].

In July 2020, the ARENA announced a shortlist of seven projects under the $70 million Renewable Hydrogen Deployment Funding Round, who were invited to submit a full application by January 2021. ARENA expects to select the preferred projects by mid- 2021. Successful projects are expected to reach financial close by late 2021 and commence construction in 2022.

Private sector engagement in 2020/21

The Government increased its support for businesses in the agriculture, manufacturing, industrial and transport sectors to adopt technologies that increase productivity and reduce emissions through a new $95.4 million Technology Co-Investment Fund. This aims to help businesses to adopt technologies that increase productivity and reduce emissions.

Australia has established a Technology Investment Advisory Council with members who lead in their respective fields across private and public sector investment and industry[7].

[4] https://www.industry.gov.au/sites/default/files/September%202020/document/first-low-emissions-technology-statement-2020.pdf

[5] https://www.pm.gov.au/media/investment-new-energy-technologies

[6] https://arena.gov.au/news/future-fuels-fund-off-and-racing/

[7] https://www.directory.gov.au/portfolios/industry-science-energy-and-resources/technology-investment-advisory-council

The Technology Investment Advisory Council provides advice on low emissions technology investment priorities, economic stretch goals and pathways that will drive economic prosperity and lower emissions.

Major activities in support of the Innovation Challenges in 2020/21

IC#1 Smart Grids

- Planning for the International Conference on the Integration of Renewable and Distributed Energy Resources (IRED) – This was originally planned for Adelaide in October 2020 and was the first time this conference was to be held in Australia. Due to COVID, this has now been rescheduled to 2022 & an online seminar series has been setup to maintain these international relationships & discussions on research priorities/pathways and to promote Australian expertise in renewable energy technology.

- Sharing international experiences to support the development of international standards and guidelines. A particular aspect here has been the use of the CSIRO Renewable Energy Integration Facility as part of the IEA ISGAN laboratory testing annex in testing interactions within inverter dominated networks. Multiple international laboratories have collaborated in this testing & this has been used to support the development of the updated Australian inverter standards (AS/NZS4777).

IC#7 Affordable Heating and Cooling of Buildings

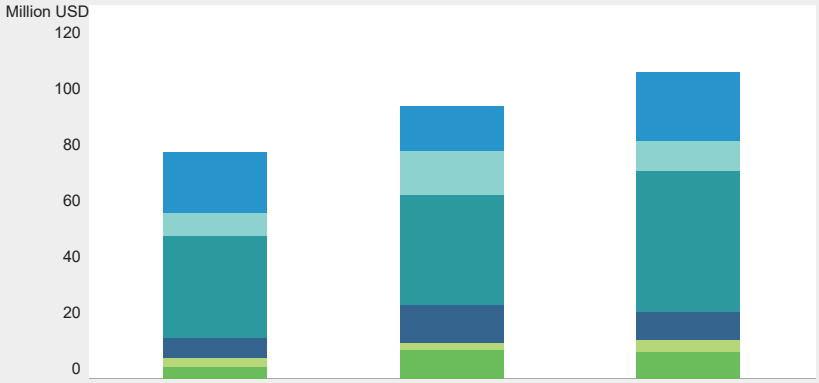
- We continue to chair (operating agent for) the International Energy Agency "Data-Driven Smart Buildings" which was created under Mission Innovation IC#7 priority D 'predictive maintenance and control'. The collaboration now includes 19 countries and over 50 organisations. We are currently running our first global machine learning competition on data-driven management of buildings as distributed energy resources in grid applications. We have run 3 Research webinars, sharing knowledge on data management and data-driven applications.

- The $18million AIRAH led "Affordable Heating and Cooling Innovation Hub" (i-Hub) has approved over 20 projects under three activities (i) Living Laboratories, (ii) Integrated Design Studios and (iii) Data Clearing House. The Data Clearing House platform is being used to validate energy efficiency and flexible demand resources in CSIRO buildings (Commonwealth Government's 2nd largest building portfolio). Approved projects commit to more than 25 buildings active on the platform. Substation by substation resource assessments have identified 1.2GW of flexible demand potential from HVAC. Demonstrations of HVAC demand management will highlight the technology pathway for unlocking flexible demand potential.

Other Mission Innovation related activity in 2020/21

Australia co-leads along with UK, Chile, Germany and the EU the development of Mission Innovation's new clean hydrogen mission. This will be launched in June 2021 at the 6th Mission Innovation Ministerial. The aim of this work is to stimulate international R&D collaboration aimed at accelerating clean hydrogen development.

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year
Energy Efficiency	20.04	14.93	22.43
CCS	7.57	14.21	10.12
Renewables	33.57	36.39	46.73
Nuclear Fission & Fusion	6.34	12.20	8.96
Hydrogen & Fuel Cells	2.88	2.70	3.80
Other Power & Storage Technologies	4.14	9.48	9.01
Other Cross-cutting Technologies/ Research	-	-	-
Unallocated	-	-	-
TOTAL	**74.6**	**89.9**	**101.0**

Australia's MI baseline includes research and development but not demonstration.

Australia will not have data on R&D investment for clean energy in 2020–21 until early in the 2022 calendar year.

Progress towards our 2020 R&D commitment is not expected to be linear. Growth in clean energy R&D expenditure to 2020 is expected to be primarily driven by increased investments through the Australian Renewables Energy Agency (ARENA). While full data is not yet available, we have provided the investments from ARENA for the past two financial years.

The Government released Australia's Technology Investment Roadmap in September 2020. Australia is now working on new metrics which focus on the leveraging of private sector funding through the provision of government funding and financing through ARENA and the Clean Energy Finance Corporation (CEFC) in low emissions technologies.

Since 2012, ARENA has supported 543 projects with $1.58 billion in grant funding, unlocking total investment of almost $6.48 billion in Australia's renewable energy industry. ARENA provided funding of $120 million to a total of 49 new projects in 2019-20. Funding was provided to one or more new projects in each of ARENA's investment priority areas[8].

[8] https://arena.gov.au/assets/2020/06/arena-annual-report-19-20.pdf

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
Japan	Hydrogen Energy Supply Chain (HESC) pilot project	Establishing a hydrogen supply chain, with the first trial cargo of hydrogen expected to be shipped in November 2020.	Public-private	Demonstration	2017-2022	$500 million	https://hydrogenenergysupplychain.com/
Germany	Joint Declaration of Intent on an Australian-German Supply Chain Feasibility Study of Hydrogen Produced from Renewables (September 2020).	A competitive process to select an Australian consortium to partner with German industry to deliver the renewable hydrogen supply chain feasibility study.	Public-private	Research	2020-2022	Australian Government contribution $363,000 to the consortium to deliver the study. Australian industry consortia contributing $1,103,000 of in-kind and cash contributions.	https://www.minister.industry.gov.au/ministers/pitt/media-releases/exploring-australias-hydrogen-future-germany

AUSTRIA

Impact of your national clean energy innovation activity

Since the beginning of the Austrian MI Membership in 2018, activities of the energy research and innovation community were bundled, and collaborations were intensified. Highlight of the MI Austria activities is the annual Mission Innovation Austria week[9], the platform for all drivers and shapers of innovation in the energy system of the future.

Due to the COVID-19 restrictions, the Mission Innovation Week Austria 2020 and 2021 have been held as online events. The conference days were scheduled for April 28-29, 2021.

Moreover, Austria has initiated new partnerships with India and Morocco who were participating in the MI Calls.

Update on clean energy innovation policies and strategies

In 2020, the Austrian government[10] has committed itself in the framework of the new government agreement (2020 – 2024) to a fast track to decarbonisation with the overall goal to reach climate neutrality by 2040. A corresponding reduction path of CO_2 emissions will be elaborated in the near future. Energy research and technology development will be key elements of this roadmap.

The current framework of the clean energy innovation policies in Austria are the Climate and Energy Strategy #mission2030 (published in 2018) and its implementation plan (National Climate- and Energy Plan ; submitted to the European Commission in 2019). By 2030[11], Austria pursues ambitious goals including:

- reduction of CO_2 emissions by 36% compared to 2005.
- providing 100% of its total electricity consumption (national balance) from renewable energy sources.
- increase in the share of renewable energy in the gross final energy demand to 45-50%.

In 2020 Austria has published an updated Implementation Plan for the Energy Research Initiative[13] (Research Chapter of the NECP). It covers missions and related innovation goals, public R&D measures and concrete innovation activities.

Major innovation initiatives and programmes in 2020/21

New RD&D initiatives were started in 2021 with national COVID recovery funds of 15 M€:

"100%-Renewable-Energy Regions"– prototyping model solutions for 100% renewable energy in a regional context (industrial region, wind-region, agricultural region) should be developed and demonstrated.

Climate Neutral City: urban energy labs should be installed with the goal of accelerating climate neutrality in cities (demo projects in districts…)

[9] https://missioninnovationaustriaweek.at/en/

[10] https://www.bmk.gv.at/en.html

[11] https://www.bmk.gv.at/dam/jcr:36595bff-3fbb-40f2-b573-9bc75f30f75b/mission2030_oe_climatestrategy_ua.pdf

[12] https://www.bmk.gv.at/themen/klima_umwelt/klimaschutz/nat_klimapolitik/energie_klimaplan.html

[13] https://nachhaltigwirtschaften.at/de/e2050/publikationen/schriftenreihe-2020-22-umsetzungsplan-eforschungsinitiative.php

A new R&D initiative "Circular Economy" was launched. It aims to accelerate the development of a circular economy, thus achieving positive climate and environmental effects while at the same time promoting the development of relevant knowledge. A first R&D call with national COVID recovery funds of 10 M€ was opened in 2021, focussing on:

- Innovation for circular economy
- Circular procurement and manufacturing
- Intensification of the use of goods
- Recycling

A next MI/ERA-Net Call is planned on the topic of Heating and Cooling.

Private sector engagement in 2020/21

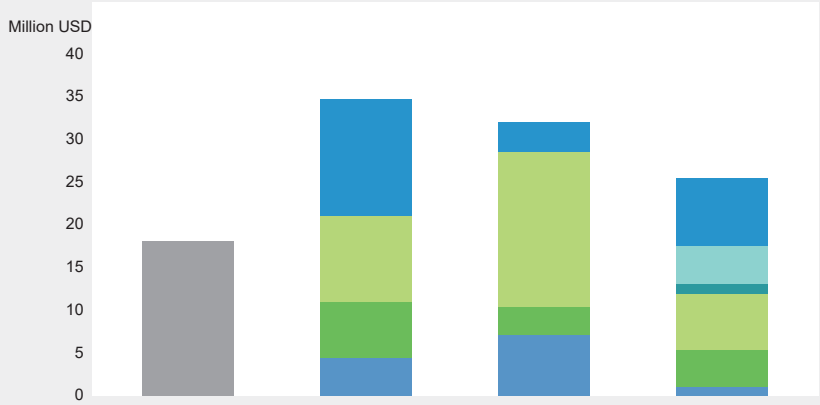
The engagement of the private sector in clean energy innovation and research policies and projects has a long tradition in Austria. For more than ten years, the Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (former Ministry of Transport, Innovation and Technology) 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 new programmes such as the Flagship Regions Energy where more than doubling of public money by the private sector is expected. As a consequence, leading industries were involved in Austrian Mission Innovation activities from the very beginning. This was manifested in the cooperation with an advisory board of CEOs. The Mission Innovation Austria advisory board meets once a year and advises the Federal Minister and the Ministry on Austria's engagement in Mission Innovation and Austria's RDI policy.

Major activities in support of the Innovation Challenges in 2020/21

Initiation of the MICall series for cooperative RD&D projects. The scope of the MICalls was designed in an ongoing co-creation process with the MI-ICs #1, #6, #7 and #8.

Austria was actively involved in the development of the MI2.0 missions and the MI2.0 platform, in particular the module collaborate which combines MI Innovation Challenges/Innovation Communities and Funding Dialogues and Calls.

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year	Third Year
Energy Efficiency	-	13.53	3.58	7.72
CCS	-	-	-	4.52
Renewables	-	-	-	1.07
Nuclear Fission & Fusion	-	-	-	-
Hydrogen & Fuel Cells	-	10.03	18.05	6.45
Other Power & Storage Technologies	-	6.59	3.19	4.43
Other Cross-cutting Technologies/ Research	-	4.48	7.35	1.17
Unallocated	18.22	-	-	-
TOTAL	**18.2**	**34.6**	**32.2**	**25.4**

The baseline is calculated by averaging the budget for project funding of the Flagship Projects in the national programmes for energy research (City of Tomorrow and Energy Research Programme). On average €16 million of funding have been granted each year between 2014 and 2016 for flagship projects. An allocation of R&D expenditures was not foreseen in the calculation of the baseline.

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
~40 IEA and partner countries	IEA Research Cooperation Call 2020	Funding of collaborations in Tasks and Annexes and Executive Committees of IEA Technology Collaborations Programmes.	Public-public	Research	2018 to 2021	3 M€	https://nachhaltigwirtschaften.at/en/iea/
Austria, Finland, Germany, Italy, Sweden India + 11 further regions and countries in Europe (non MI-countries)	MI-Call 19 / ERA-NET Smart Energy Systems Call 2019 Integrated regional Energy Systems	A Transnational Joint Programming Platform to Initiate Co-Creation and Promote Energy System Innovation	Public-public	Research, development and demonstration		2.9 M€	https://www.eranet-smartenergysystems.eu/
18 Countries (including India and Morocco as MI-Partners outside the ERA-NET)	MI-Call 20 ERA-NET Smart Energy Systems Joint Call 2020 On digital transformation for green energy transition	A Transnational Joint Programming Platform to Initiate Co-Creation and Promote Energy System Innovation	Public-public	Research, development and demonstration		2 M€	eranet-smartenergysystems.eu
16 European Countries including MI Members: Austria, Denmark, France, Germany, Italy, Netherlands, Norway, Sweden, UK	JPI Urban Europe Call 2020- ERA-NET Cofund Urban Accessibility and Connectivity	JPI Urban Europe was created in 2010 to address the global urban challenges of today with the ambition to develop a European research and innovation hub on urban matters and create European solutions by means of coordinated research.	Public-public	Research, development and demonstration		2.7 M€	https://jpi-urbaneurope.eu/
11 European Countries and Regions including MI members: Austria, Germany, Netherlands, Sweden	SOLAR-ERA.NET Cofund 2 Additional Joint Call	A European network of national and regional funding organisations in the field of solar electricity generational.	Public-public	Research, development		0.3 M€	http://www.solar-era.net/

BRAZIL

High impact innovation activity triggered by MI

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

One of the axes of this project was dedicated to the consolidation of a database of public and publicly oriented investments in energy R&D, following the classification of the IEA. In 2020, the final reports of the first cycle of the EBP Project were released and a new phase started, with support from the British government, for the implementation of an Energy Innovation Platform, containing the consolidated information on energy R&D, to be released in 2021.

These data have been relevant to support the improvement of policies and governance of science, technology and innovation activities in the Mining and Energy sectors. An example of this is Interministerial Ordinance No. 464, of December 12, 2019, that instituted an Interministerial Working Group (between the Ministry of Mines and Energy and the Ministry of Science, Technology and Innovation), with the objective of proposing a new governance that could foster innovation at energy and mining sectors in Brazil. Other important improvement in governance is the National Energy Policy Council (CNPE) Resolution nº 2, of February 2021, that establishes guidelines for prioritizing R&D in strategic areas, such as hydrogen, biofuels, energy storage, digital transformation and others.

Update on clean energy innovation policies and strategies

According to the IEA (2018), Brazil has the greenest energy mix amongst large economies. In 2019, the proportion of renewables in the Brazilian energy matrix was around 46,1% and 83% in its electricity mix. In line with its goal to expand the use of renewable energy sources, it is expected to reach a share of 48% from renewable sources (electricity and biofuels) by 2030, according to the 2030 Ten Year Energy Expansion Plan.

In the transportation sector, Brazil has strong biofuels mandates (27.5% ethanol mix in gasoline and 12% biodiesel mix in diesel) and it aims to increase biofuels in the energy mix to 18% by 2030 (RenovaBio). The Rota 2030 programme, announced in 2018, requires vehicle manufacturers to increase energy efficiency of their fleet by 11% by 2022, and grants tax cuts on the purchase and import of electric and hybrid vehicles.

The Science, Technology and Innovation Plan for Renewable Energies and Biofuels 2018-2022 is a strategic orientation document of the Ministry of Science, Technology, Innovation and Communications to operate in the areas of renewable energies and biofuels, being part of the National Science, Technology and Innovation Strategy (ENCTI 2016-2022).

In energy efficiency, given the current structure of our economy, a combination of policies has driven efficiency gains of 14% between 2005 and 2019, with emphasis on the residential and transport sector.
In the power sector, auction design has led Brazil to the addition of 30 GW renewables (wind, solar and biomass) in 15 years, using effective planning tools to combine hydropower, gas power, biomass and a continental-size transmission infrastructure to maximize integration of renewables

Nuclear is also part of the solution. Brazil is developing efforts to make new nuclear plants viable, seeking synergies and externalities in other uses of nuclear technology, as well as assessing the sharing of costs and benefits and paying attention to the communication process with society.

In 2020, the Ministry of Mines and Energy (MME) published Brazilian National Energy Plan 2050 (PNE 2050). The Plan represents the long-term strategy for the energy sector in Brazil aiming to promote the energy transition in Brazil. The strategy recognizes the importance of market design and effective institutional governance to drive innovation and foster sustainable development. In order to implement this strategy, the Ministry of Mines and Energy (MME) with the Ministry of Science, Technology and Innovations (MCTI) invested in strengthening governance for innovation in energy. An example is the Resolution proposed by National Energy Policy Council (CNPE) that establishes guidelines for prioritizing R&D in strategic areas, such as hydrogen, biofuels, energy storage, digital transformation and others. Another example is the engagement of MME and other public institutions in the continuity of the Energy Big Push project and process. One of the results of this process is the implementation of a Platform, with the support of Prosperity Fund/British government, with data on investments in R&D in energy in Brazil whose first phase begins at the end of 2020 and ends in May 2021.

Major innovation initiatives and programmes in 2020/21

The main initiatives were mapped under the Energy Big Push project[14] The executive summary of the project is available[15].

Private sector engagement in 2020/21

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

In the case of the electricity sector, ANEEL's R&D Program was established in the 2000s through Law No. 9,991 / 2000 and provides that companies in the electricity sector must employ, every year, a percentage of their net operating revenue in technological research and development projects in benefit of the electric sector: 1% in the case of energy generation and transmission companies, and 0.5% in the case of energy distributors (as they must also invest another 0.5% in energy efficiency). The regulatory agency is responsible for managing and operationalizing this public policy, which has invested an average of R $ 580 million annually.

In this context of this policy and the ANEEL's R&D program, Public Calls has been an important instrument for mobilizing private investments with a focus on strategic areas. This is the case of the Strategic Call "Development of Efficient Electric Mobility Solutions" (nº 022/2018), based on a concept of Innovation Network in the Electricity Sector (RISE, in Portuguese), which approved 30 projects across the country and mobilized R$ 463.8 million in investments[16], including a counterpart of R$ 72.2 million from the companies involved.

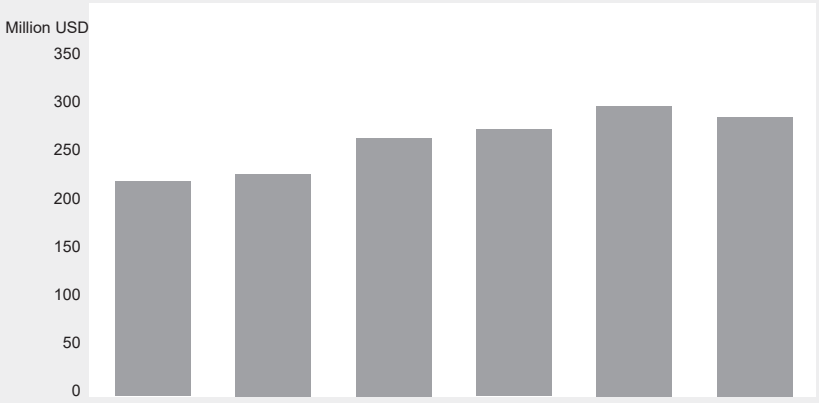
It is important to highlight that ANEEL's regulated R&D Program has invested in several improvements to increase the results of investments in R&D of companies in the sector.

[14] https://www.cepal.org/en/publications/46012-overview-energy-innovation-investments-brazil-data-energy -big-push

[15] https://www.cepal.org/en/publications/46007-big-push-sustainability-brazils-energy-sector-input-and-evidence-policy

[16] https://www.aneel.gov.br/sala-de-imprensa-exibicao-2/-/asset_publisher/zXQREz8EVIZ6/content/mobilidade-eletrica-aneel-aprova-30-projetos-com-investimento-de-r-463-8-milhoes/656877?inheritRedirect=false

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Energy Efficiency	-	-	-	-	-	-
CCS	-	-	-	-	-	-
Renewables	-	-	-	-	-	-
Nuclear Fission & Fusion	-	-	-	-	-	-
Hydrogen & Fuel Cells	-	-	-	-	-	-
Other Power & Storage Technologies	-	-	-	-	-	-
Other Cross-cutting Technologies/ Research	-	-	-	-	-	-
Unallocated	215.13	222.70	258.97	265.57	289.43	280.12
TOTAL	**215.1**	**222.7**	**259.0**	**265.6**	**289.4**	**280.1**

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
Brazil, CEPAL (UN-ECLAC), GIZ (Germany)	Energy Big Push: Accelerating clean energy innovation in Brazil	In 2020: - Publication of Energy Big Push Project reports. - Conducting webinar for dissemination	Public-public	Research	2018-2020	Approximately US$ 90,000 from ECLAC, through the ECLAC-BMZ / GIZ Technical Cooperation Program[17].	https://www.cepal.org/en/publications/46012-overview-energy-innovation-investments-brazil-data-energy-big-push
UK	Energy Innovation Platform (EIP) - implementing a digital platform for energy innovation in Brazil	Development of a Platform that consolidates strategic information on public and publicly oriented R&D investments, previously mapped under the Energy Big Push Project	Public-public	Development	Nov 2020 to May 2021	£90,000	

[17] It is noteworthy that Brazil co-sponsored this project with an additional estimated amount of R$ 340,000 via the Management Agreement between Brazilian Ministry of Science, Technology and Innovation (MCTI) and the Center for Management and Strategic Studies (CGEE)

CANADA

High impact innovation activity triggered by MI

MI has played a significant role in spurring increased federal investments in clean energy RD&D such as major fiscal announcements made in Budget 2017[18] that specifically referenced Canada's commitment to the MI doubling commitment. Budget 2017 implemented a number of measures in the areas of green infrastructure and clean technology that helped Canada meet and exceed the doubling commitment while generating more good, well-paying jobs in the clean growth economy. Canada remains committed to supporting and investing in clean energy RD&D.

Update on clean energy innovation policies and strategies

Canada is working to address the threat of climate change by bringing together innovation from across the financial sector, businesses, and communities to exceed its current 2030 greenhouse gas reduction target and reach the target of net-zero greenhouse gas emissions by 2050. In the fight for climate action and in response to COVID-19, the Government of Canada outlined in the 2020 fall economic statement[19] investments that will lay the foundation for a green recovery enabling Canadians to reduce their carbon footprint and lower their energy use and expenses. In December 2020, the Government of Canada released A Health Environment and a Healthy Economy[20], Canada's strengthened climate plan of federal policies, programs and investments to build a stronger, cleaner, more resilient and inclusive economy. Notably, the plan announced plans to increase the price on carbon pollution to $170/tonne by 2030, and includes 64 new measures and $15B CAD in new investments. The strengthened climate plan also ensures the Government of Canada's operations reflect Canada's ambition; the Government has updated its Greening Government Strategy[21] to align with the new federal target of net-zero emissions by 2050 and accelerates the interim target for federal facilities and conventional fleet to a 40% reduction by 2025 (instead of 2030). A new Hydrogen Strategy for Canada[22] was also released in December 2020.

Canada has successfully met and exceeded the MI doubling pledge and remains committed through the Pan-Canadian Framework on Clean Growth and Climate Change[23] to keep pace with the global economy in moving towards a greener future. Natural Resources Canada (NRCan)[24] continues work towards increasing the creation and adoption of clean technology in energy, mining, and forestry, the three key Canadian economic sectors.

Major innovation initiatives and programmes in 2020/21

In 2020-21, NRCan continued to award funding through its existing programs[25], while also supporting proponents through COVID-19 by exercising maximum flexibilities within programming parameters to provide real-time support through increased funding allocations and timeline extensions. Highlights include:

[18] https://www.budget.gc.ca/2017/docs/themes/innovation-en.html

[19] https://www.budget.gc.ca/fes-eea/2020/themes/building-back-better-rebatir-mieux-en.html

[20] https://pm.gc.ca/en/news/news-releases/2020/12/11/prime-minister-announces-canadas-strengthened-climate-plan-protect

[21] https://www.canada.ca/en/treasury-board-secretariat/services/innovation/greening-government/strategy.html

[22] https://www.nrcan.gc.ca/climate-change/the-hydrogen-strategy/23080

[23] https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework.html

[24] https://www.nrcan.gc.ca/home

[25] https://www.nrcan.gc.ca/science-and-data/funding-partnerships/funding-opportunities/office-energy-research-development-oerd/office-energy-research-and-development-programs/23287

- Two projects with a combined value of over $56M CAD were selected under the Canadian Emissions Reduction Innovation Network (CERIN)[26] call in July 2020, as part of NRCan's flagship Energy Innovation Program (EIP)[27].

- Forty-two projects were underway through the Clean Growth Program (CGP)[28] in 2020, including six new agreements totalling $16.3M CAD in contributions.

- The five finalists of the $4.5M CAD Charging the Future Challenge[29] were announced in July 2020. The challenge aims to accelerate battery innovations that have the potential to reduce greenhouse gas emissions. Prize winners will be announced in 2022.

- The Green Infrastructure (GI) Program[30] launched a third call for proposals in 2020, with $20M CAD available for Energy Efficient Buildings RD&D to spur deeper energy retrofits for commercial and institutional buildings. The demonstration component of the GI program for Smart Grids[31] is investing up to $35M CAD over 5 years (FY 2018/19 to 2022/23) for 13 demonstration projects to enable cleaner, more efficient and resilient electrical grids which will improve service delivery, reduce pollution and create jobs.

- The Indigenous Off-Diesel Initiative[32], which is aimed at reducing diesel reliance in remote Indigenous communities, announced $7M CAD for 14 Energy Champions[33] ($500K CAD each) to deliver training and develop community energy plans and clean energy implementation plans. In January 2021, the first Energy Champion was awarded $800K CAD in prize[34] funding to begin implementing a community clean energy project.

As part of Canada's December 2020 strengthened climate plan, $5B CAD over 5 years was announced for the Strategic Innovation Fund Net Zero Accelerator to rapidly expedite decarbonization projects with large emitters, scale up clean technology and accelerate Canada's industrial transformation across all sectors.

Private sector engagement in 2020/21

In December 2020, NRCan hosted the first Breakthrough Energy Solutions Canada (BESC)[35] Accelerator session for the 10 BESC finalists[36]. This Accelerator session was the first delivery of Tech to Market (T2M) support from the program, enabling proponents to access additional capital from investors such as the Business Development Bank of Canada (BDC) and Breakthrough Energy Ventures. To date, BDC has closed two deals with BESC finalists: a $2.3M CAD investment in e-Zinc and a $3M CAD investment in Ekona Power Inc. A second Accelerator event will take place in 2021.

[26] https://www.nrcan.gc.ca/science-data/funding-partnerships/funding-opportunities/funding-grants-incentives/energy-innovation-program/canadian-emissions-reduction-innovation-network/21778

[27] https://www.nrcan.gc.ca/science-data/funding-partnerships/funding-opportunities/funding-grants-incentives/energy-innovation-program/18876

[28] https://www.nrcan.gc.ca/climate-change/canadas-green-future/clean-growth-programs/20254

[29] https://impact.canada.ca/en/challenges/charging-the-future

[30] https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/19780

[31] https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/smart-grids/19793

[32] https://impact.canada.ca/en/challenges/off-diesel

[33] https://www.canada.ca/en/natural-resources-canada/news/2020/12/celebrating-indigenous-leadership-in-clean-energy.html

[34] https://www.canada.ca/en/natural-resources-canada/news/2021/01/indigenous-led-solar-energy-project-wins-prize-funding-to-implement-a-community-clean-energy-project-in-nwt.html

[35] https://www.nrcan.gc.ca/science-and-data/funding-partnerships/funding-opportunities/funding-grants-incentives/energy-innovation-program/breakthrough-energy-solutions-canada/21913

[36] https://www.nrcan.gc.ca/science-data/funding-opportunities/funding-grants-incentives/energy-innovation-program/breakthrough-energy-solutions-ca/meet-10-besc-2020-cohort-winners/23159

The Clean Growth Collaboration Community 2.0 was launched at the end of 2020 to bring together key players of the innovation ecosystem including federal research centres, provinces and territories, and clean tech producers. The Collaboration Community was originally created for the CGP[37] but has since been expanded to NRCan's other funding programs. By the end of 2020, fourteen projects under CGP had received funding for resources at federal research centres to help proponents overcome a lack of technical expertise and research infrastructure.

NRCan also provided funding for the 2021 Indigenous Clean Energy Gathering[38] , an integral event for networking and engagement on Indigenous clean energy projects in Canada.

Major activities in support of the Innovation Challenges in 2020/21

Canada participates in all eight Innovation Challenges (IC) and co-leads IC4 (Sustainable Biofuels)[39] and IC6 (Clean Energy Materials)[40]. Additionally, playing a leadership role co-leading the Analysis and Joint Research (AJR)[41] Sub-Group, identifying and analysing clean energy innovation needs, priorities, challenges and opportunities for collaboration amongst MI members.

As MI members prepare to launch a second phase of MI ('MI 2.0'), Canadian IC representatives have contributed their expertise and engaged stakeholders to inform the development of new and refreshed RD&D activities under MI 2.0 including:

- The Power Mission ("Green Powered Future") (IC1 on Smart Grids[42]),
- A proposed MI Mission related to the Bioeconomy (IC4),
- The continuation of IC4,
- The continuation of IC7 (Affordable Heating and Cooling of Buildings)[43], and
- Leading the development of a proposal for future and expanded international collaboration on clean energy materials through a continuation of IC6.

Canada contributed to wrap-up activities for IC1, including efforts to transition the Smart Grid Innovation Accelerator (SGIA) to the new work program under the Power Mission.

[37] https://www.nrcan.gc.ca/climate-change/canadas-green-future/clean-growth-programs/20254

[38] https://indigenouscleanenergy.com/the-gathering/

[39] http://mission-innovation.net/our-work/innovation-challenges/sustainable-biofuels/

[40] http://mission-innovation.net/our-work/innovation-challenges/clean-energy-materials/

[41] http://mission-innovation.net/about-mi/analysis-and-joint-research/

[42] http://mission-innovation.net/our-work/innovation-challenges/smart-grids/

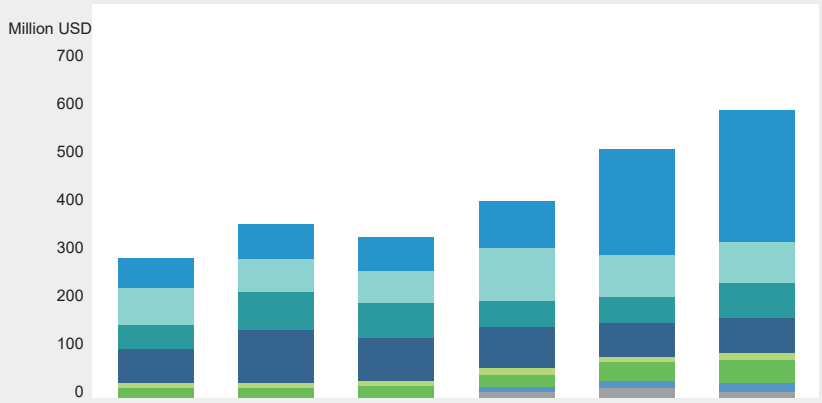
[43] http://mission-innovation.net/our-work/innovation-challenges/affordable-heating-and-cooling-of-buildings/

Other Mission Innovation related activity in 2020/21

Canada continues to play a leadership role within MI as Vice-Chair of the Steering Committee, leading on elements of the Beyond 2020 workstream, and contributing resources to the MI Secretariat. Canada continues participating through the MI Steering Committee and MI Secretariat to provide feedback and advice on the framing, structure, and governance for the second phase of MI. Additionally, as former host of MI-4[44], Canada participates in the Ministerial Planning Team, working to support Chile in the development of MI-6.

Canada is also a participating member of the MI Champions program and developed a fulsome program for the first cohort of Champions at MI-4. Canada's 2020-21 Champion, Phil De Luna leads a $57M CAD multi-disciplinary collaborative research program to develop made-in-Canada technology for a sustainable energy and chemicals sector. Dr. De Luna was named to the 2019 Forbes Top 30 Under 30 – Energy list[45] and was a finalist (1 of 10 worldwide) in the $20M CAD Carbon XPRIZE[46].

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Energy Efficiency	63.41	71.65	64.81	96.72	215.49	264.82
CCS and Fossil Fuels	73.25	68.22	66.94	106.08	87.33	87.54
Renewables	47.63	74.91	69.50	50.62	50.64	70.08
Nuclear Fission & Fusion	70.56	109.85	88.95	88.45	70.01	73.02
Hydrogen & Fuel Cells	9.02	8.35	9.61	9.57	9.89	11.58
Other Power & Storage Technologies	21.59	20.99	23.91	27.79	39.13	47.35
Other Cross-cutting Technologies/ Research	2.91	3.27	2.84	7.49	13.56	17.46
Unallocated	-	-	-	15.30	23.11	14.91
TOTAL	**288.4**	**357.2**	**326.6**	**402.0**	**509.2**	**586.8**

[44] http://mission-innovation.net/events/fourth-mission-innovation-ministerial-mi-4/

[45] https://www.forbes.com/profile/phil-de-luna/?sh=617e89ea6fe6

[46] https://www.xprize.org/prizes/carbon

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
Japan	Canada-Japan Energy Policy Dialogue	Collaboration between Canada and Japan will focus on the following key areas: oil and gas, carbon capture and storage/carbon recycling, hydrogen, atomic energy, and critical minerals. Working together, this relationship aims to advance technical cooperation and build on existing partnerships to deepen knowledge exchange and develop sustainable industries.	Public-public	Policy discussions leading to potential RD&D collaborations	2020-2022		
Germany	Canada-Germany Energy Partnership	Canada and Germany to foster energy transformation through exchanges on policy, best practices and technologies as well as through cooperative activities and projects focused on: energy policy, planning and regulations; resilient electricity systems that can integrate high levels of renewables; energy efficiency; sector coupling and low-carbon fuels; and, innovation and applied research.	Public-public	Policy discussions leading to potential RD&D collaborations	2021 – ongoing		Memorandum of Understanding between the Department of Natural Resources Canada and the Federal Ministry for Economic Affairs and Energy of the Federal Republic of Germany on the establishment of an energy partnership[47]
EU	Canada-EU High-Level Energy Dialogue (HLED)	Updated the Canada-EU High-Level Energy Dialogue (HLED) Cooperation Framework to better reflect collaboration opportunities in clean energy innovation.	Public-public	Policy discussions leading to potential RD&D collaborations	2021 – ongoing		eranet-smartenergy systems.eu

[47] https://www.nrcan.gc.ca/our-natural-resources/energy-sources-distribution/international-energy-cooperation/memorandum-understanding-between-the-department-natural-resources-canada-and-the-federal-ministry/23423

EUROPEAN COMMISSION

Update on clean energy innovation policies and strategies

The European Green Deal is a set of policy initiatives by the European Commission with the overarching aim of reaching Europe's climate neutrality by 2050, as well as the strategy for a sustainable recovery and growth. The European Green Deal makes consistent use of all policy levers: regulation and standardisation, investment and innovation, national reforms, dialogue with social partners and international cooperation.

The Commission has, over the past year, put forward initiatives under the Green Deal, among others, on energy systems integration, clean hydrogen, the renovation of buildings, offshore renewable energy and batteries. These strategies contain specific sections on promoting research and innovation.

The Commission will also increase its 2030 climate ambitions by cutting emissions by at least 55% compared to 1990, with a series of measures to put this vision into practice – the 'Fit for 55' package.

Major innovation initiatives and programmes in 2020/21

Stakeholders from EU Member States, and in most cases their international research and innovation partners, can benefit from funding through Horizon Europe, while larger-scale demonstration projects and early deployment projects may be funded through the Innovation Fund and Invest EU. Last year, the Green Deal call under Horizon 2020, with a total budget of €1 billion, addressed, among others, key energy and system integration challenges. In this call, €403 million will be directed towards energy projects, including the production of offshore and onshore energy, support for large-scale electrolysers, and the use of clean energy in ports, airports, a carbon-neutral industry, and energy and resource efficient building and renovation.

Horizon Europe, the new EU research and innovation programme (2021-27) with a budget of around €95.5 billion, will devote at least 35% of these funds to climate action, enabling the transition to climate neutrality, including of the energy sector. For clean energy research and innovation up to €13 billion will be invested, which is a circa 50% increase in EU funding compared to the 2014-2020 period. These funds will target primarily European research and innovation cooperation, but will be - in most cases - opened to other countries. Novel funding instruments, such as EU Missions, a new set of public-private partnerships, and the European Innovation Council are designed to mobilise a wider range of actors in research and innovation, achieve greater impact and ensure that innovative solutions can be deployed more quickly.

In addition to Horizon Europe funds, devoted to research and innovation, EU budget will also support high TRL technologies through market pilots and demonstrators, seeking to create early markets for emerging technologies. The Innovation Fund will provide €10 billion until 2030 for the commercial demonstration of innovative low-carbon technologies. The European Investment Bank has actually become the EU Climate Bank, committing to support €1 trillion of investments in climate action and environmental sustainability from now until 2030. High risk innovation projects will benefit from the EU budget guarantee under InvestEU. The innovative cleantech and energy projects are expected to be a sizeable part of these programmes' portfolios and mobilise considerable interest among private investors.

Private sector engagement in 2020/21

Horizon Europe will see a wave of public-private partnerships in critical areas such as clean hydrogen and batteries. Horizon Europe will provide €1 billion in support for research and innovation through the so-called Clean Hydrogen Partnership as successor to the current Fuel Cells and Hydrogen Joint Undertaking. In a similar vein, Horizon Europe has earmarked more than € 900 million to support the development of a new generation of sustainable, high-performing batteries through a first-of-its-kind dedicated public-private partnership on batteries.

Furthermore, the European Commission has established industrial alliances in the field of batteries and hydrogen. These alliances are an important tool to identify technology needs, investment opportunities and regulatory barriers and enablers at all stages of the value chain.

The Breakthrough Energy Europe fund invested into its first three companies.

Major activities in support of the Innovation Challenges in 2020/21

In IC1 ('Smart Grids'), the European Commission contributed €28.5M to the joint actions of IC1 through the two calls of Smart Energy Systems ERA-NET and the third call that was directly launched by the EC and India.

In IC2 ('Off-grid Access to Electricity'), the EC in 2019 and 2020 awards the RESponsible Island Prize of €1.7M to islands with innovative and sustainable local renewable energy production for electricity, heating, cooling and transport.

In IC3 ('Carbon Capture, Utilisation and Storage'), the EC contributed through the ACT ERA-NET with the joint funding from United States, Canada and India. The EC issued three targeted international cooperation Horizon 2020 calls on CO_2 Utilisation and CCUS in Industry, with MI countries. As a result, six funded projects include MI partners from Japan, China, Saudi Arabia, United Stated, Canada and Brazil.

In IC4 ('Sustainable Biofuels'), the EC issued three targeted international cooperation calls, with Canada, USA-China and Japan. Overall EU invested about €25M of the H2020 budget in the year 2020 to the seven multilateral international projects resulting from those calls.

In IC5 ('Converting Sunlight'), the EC continued its co-lead role and had developed a 'Converting Sunlight into Solar Fuels and Chemicals Roadmap for 2020–2050'. To support this work, the EC funded a study on 'Solar Fuels Research & Invest: Defining and Developing the Global Solar Fuel Value Chain: techno-economic analysis and pathways for sustainable implementation'.

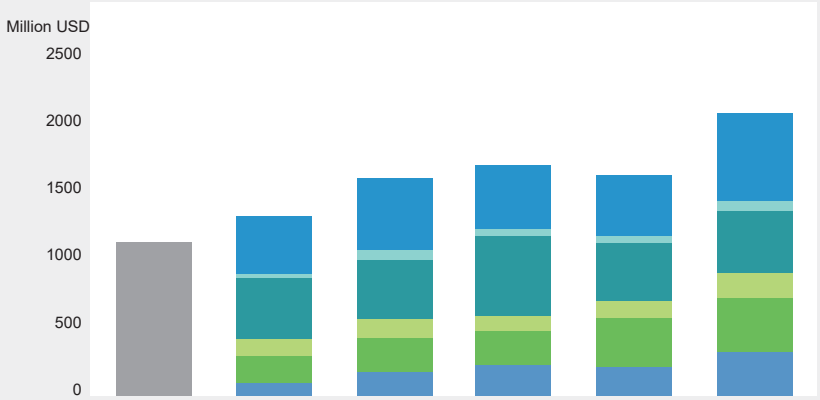
In IC7 ('Affordable Heating and Cooling of Buildings'), the EC continued its co-lead role, steering with UK and India the preparation of the concept for IC7 for its relaunch under Mission Innovation 2.0.

In IC8 (Renewable and Clean Hydrogen), the EC continued its co-lead role concentrating on the setting up of an online information sharing Hydrogen Valleys platform on hydrogen valley projects in MI countries (www.h2v.eu). The EU financed the platform with a €0.5 M contract through its Fuel Cells and Hydrogen Joint Undertaking programme. The platform is fully operational since early 2021, and now presents 29 valleys in 19 countries with a total investment of almost EUR 30 billion.

Other Mission Innovation related activity in 2020/21

The 2020 (second) cohort of MI Champions was announced during a virtual ceremony hosted by the European Commission on June 12, 2020.

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Energy Efficiency	-	415.38	524.03	456.15	438.15	648.06
CCS	-	19.48	75.97	53.42	43.85	80.41
Renewables	-	445.33	425.51	578.47	432.92	442.14
Nuclear Fission & Fusion	-	-	-	-	-	-
Hydrogen & Fuel Cells	-	129.61	140.32	118.11	111.62	184.17
Other Power & Storage Technologies	-	196.58	256.83	242.71	363.55	397.38
Other Cross-cutting Technologies/ Research	-	108.88	174.15	232.92	217.43	328.25
Unallocated	1,126.42	-	-	-	-	-
TOTAL	**1,126.4**	**1,315.3**	**1,596.8**	**1,681.8**	**1,607.5**	**2,080.4**

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
Canada	EUCANWin	European-Canadian partnership for climate-positive heat and power generation through improved biomass feedstock supply and innovative conversion technologies	Public – private	Research and Development	2021-2025	€3.5M EU, €0.36M Canada	https://cordis.europa.eu/project/id/101022829
Canada	FlexSNG	Flexible Production of Synthetic Natural Gas and Biochar via Gasification of Biomass and Waste Feedstocks	Public – private	Research and Development	2021-2024	€4.2M EU, €0.25M Canada	
USA, China	NEFERTITI	Innovative photocatalysts integrated in flow photoreactor systems for direct CO_2 and H_2O conversion into solar fuels	Public – private	Research and Development	2021-2025	€3.8M EU, €0.7M USA and China	https://cordis.europa.eu/project/id/101022202

USA, China	METHASOL	International cooperation for selective conversion of CO_2 into METHAnol under SOLar light	Public – private	Research and Development	2021-2024	€4M EU, €1.2M USA and China	
Japan	LAURELIN	Selective CO_2 conversion to renewable methanol through innovative heterogeneous catalyst systems optimised for advanced hydrogenation technologies (microwave, plasma and magnetic induction)	Public – private	Research and Development	2021-2025	€4.5M EU, €0.4M Japan	https://cordis.europa.eu/project/id/101022507
Japan, Brazil	4AirCRAFT	Air Carbon Recycling for Aviation Fuel Technology	Public – private	Research and Development	2021-2024	€2.2M EU, €0.7M Japan	https://cordis.europa.eu/project/id/101022633
Japan, Switzerland	ORACLE	Novel Routes and catalysts for synthesis of Ammonia as alternative renewable fuel	Public – private	Research and Development	2021-2025	€4.5M EU, €0.4M Japan	https://cordis.europa.eu/project/id/101022738
India	Joint Call 2020 (MICall20) on digital transformation for green energy transition	The aim is to support transnational research and innovation activities unleashing the potential of digital transformation for a sustainable energy society.	Public – private	Research, development, and/or demonstration	2021-2025	€10M EU	https://www.eranet-smartenergysystems.eu/Calls/EnerDigit_Calls_funding/Joint_Call_2020
India	Integrated local energy systems (Energy islands): International cooperation with India LC-SC3-ES-13-2020	To develop and demonstrate solutions which analyse and combine, in a well delimited system, all the energy vectors that are present and interconnect them, where appropriate, to optimise their joint operation that is demonstrated by an increased share of renewables in and higher energy efficiency of the local energy system.	Public – private	Demonstration	2021-2025	€9M EU	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/pportunities/topic-details/lc-sc3-es-13-2020
India	Joint Call 2019 on Energy Storage Solutions	Focuses on the development of integrated storage systems and will support solutions answering to identified challenges within this area. It is highly encouraged to identify and involve "need-owners" in the solution development answering to the specified challenge	Public – private	Research, development, and/or demonstration	2020-2024	€9.5M EU	https://www.eranet-smartenergysystems.eu/Calls/SG_Plus_Calls/SG_Joint_Call_2019

FINLAND

High impact innovation activity triggered by MI

To meet the targets set in the Government Programme for climate neutral Finland by 2035, The Finnish Government, in cooperation with the major industries, has prepared the low-carbon roadmaps for different sectors. The roadmaps show that for example electrification, sector integration and digitalisation are among the key concepts to be advanced to reach the targets. These roadmaps include technology roadmaps regarding solutions needed to achieve climate targets. The Finnish Government is using the information when planning its next energy and climate strategy's clean energy innovation policies. The strategy will take into account and coordinate the Government Programme's energy and climate policies, the long- and medium-term climate change policy plans referred to in the Climate Change Act, and the EU's energy and climate targets for 2030. The Strategy will also note Finland participation in the MI and will state Finland's priorities in the MI. The strategy will be published in autumn 2021.

Finland has participated in the MI joint calls. The Joint Calls have deepened global cooperation in the fields which are important for Finland and the calls complement Finnish national innovation actions well.

Currently the key innovation themes in clean energy sector in Finland include the following.

- **Power-to-X** technology including different hydrogen solutions. It can be used to produce different raw-materials and products, such as synthetic methane, ammonia and even protein.
- **Electricity storage**
- Energy-sector **cybersecurity** and other **digital energy solutions**
- **Circular economy solutions**, **such as waste heat** from data centers

Update on clean energy innovation policies and strategies

Prime Minister Sanna Marin's Government Programme was published in December 2019. According to the Programme, Finland aims at carbon neutrality by 2035.

Finland submitted its integrated National Energy and Climate Plan (NECP) to the European Commission on 20 December 2019. The plan covers all five dimensions of the EU Energy Union, including research, innovation and competitiveness. The plan lays down the 2030 targets for these five dimensions, and the policy measures to achieve them.

Finland is currently preparing its climate and energy strategy. One of the key aspects to be state in the strategy is funding of energy and climate innovations. Sector integration and digital solutions, among others, will be included in the priority sectors. The strategy will also highlight solutions for hard-to-abate-sectors.

Major innovation initiatives and programmes in 2020/21

There are three major innovation initiatives and programmes up and running. Joint funding volume is over 200 MEUR and the programmes are being implemented with private sector and other stakeholders.

- Smart Energy program (2017-21)
- Batteries from Finland campaign (2018-2020)
- Smart Mobility program (2018-22)

Private sector engagement in 2020/21

Public-private testbeds and innovation platforms are listed below. These public-private partnerships involve more than 100 companies in total. In addition, there are several business-led ecosystem initiatives ongoing.

There are several innovation ecosystems and testbeds operating:

- **Smart Otaniemi platform**[48] over 100 companies involved, joint initiatives involving companies, research organizations and other actors from the energy and high-tech sphere. Several pilots operating in field including AI and blockchain, aggregator business models, smart EV charging infrastructure and 5G and IoT services.

- **Åland Island Smart Energy Platform**, over 20 companies and research entities are involved. The project aims to create a piloting area for new smart energy technologies and a 100 % renewable energy system on Åland Islands. The platform was awarded a capital loan from the State of Finland in 2019 and is now in implementation phase.

- **Power to X innovation ecosystem** spearheaded by the Lappeenranta University of Technology and VTT, and involving several companies. The aim is to produce an operating model for a dynamic ecosystem based on clean, affordable and unlimited resource of electricity. The cornerstone of the ecosystem is the rapid electrification of society, including Power to X to Power solutions combined with maximum utilization of digitalization. In addition to the ecosystem theme, the project aims to produce a road map for the commercialization and research activities of the topic for coming years.

- **BatCircle innovation ecosystem**, involving 30 companies and research organizations and focusing on sustainable primary resources, value addition in metal refining, battery recycling, precursor and active materials, circular business ecosystems. This ecosystem was recognized by EU commission and Finland was asked to lead the Battery Recycling sub working group under the Battery Implementation plan.

- **BEI innovation ecosystem** focusing on research and production incl. machine learning, artificial intelligence and extensive automation, EV systems and energy storage solutions with modern design methods and tools.

- **Baltic Offshore innovation ecosystem** exploring the utilization of offshore wind power in the Baltic Sea.

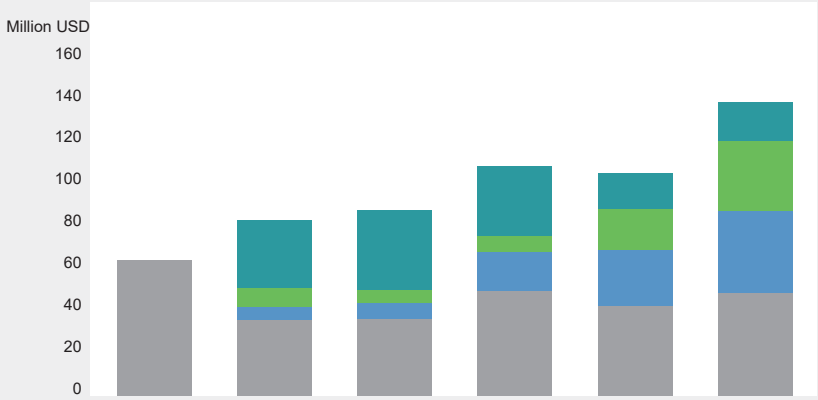
Major activities in support of the Innovation Challenges in 2020/21

Finland has been actively involved in the operation of the EU SET-Plan. The SET-Plan combines the promotion and better coordination of energy technology in the EU and the EEC countries. A total of 14 implementation plans have been prepared in the SET-Plan between 2016 and 2019. Finland has participated actively in the preparation and introduction of these implementation plans.

Set Plan key action no 7. “Batteries for e-Mobility and Stationary Storage” where Finland is leading WG related battery recycling. Finland has launched an innovation ecosystem named BatCicle, where over 30 companies, universities and research institutes are involved.

[48] https://smartotaniemi.fi/

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Energy Efficiency	-	-	-	-	-	-
CCS	-	-	-	-	-	-
Renewables	-	30.75	36.45	32.57	16.06	17.31
Nuclear Fission & Fusion	-	-	-	-	-	-
Hydrogen & Fuel Cells	-	-	-	-	-	-
Other Power & Storage Technologies	-	9.34	6.04	6.72	19.02	33.71
Other Cross-cutting Technologies/ Research	-	5.13	7.18	18.00	24.83	36.79
Unallocated	62.53	35.54	35.99	48.52	42.03	47.38
TOTAL	**62.5**	**80.8**	**85.6**	**105.8**	**101.9**	**135.2**

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
Several, 17 countries and regions in total	MI Call 19	Joint funding call under EU ERA-Net umbrella	Public-private	Research and development	2019-2020	3 MEUR	https://www.eranet-smartenergysystems.eu/Calls/SG_Plus_Calls/SG_Joint_Call_2019
Several, 18 countries and regions in total	MI Call 20	Joint funding call under EU ERA-Net umbrella	Public – private	Research and Development	2020-2022	2 MEUR	https://www.eranet-smartenergysystems.eu/Calls/EnerDigit_Calls_funding/Joint_Call_2020

FRANCE

High impact innovation activity triggered by MI

The involvement of France in IC2 as co-lead has had a significant impact for the launching of support activities in the field of off-grid energy access. It enabled or at least accelerated the launch of the call for projects completed in 2018, making possible the funding of 9 projects targeting energy innovation on the African continent. It allows also to develop a tight cooperation between France and India on off-grid access to energy innovation programs sharing objectives and projects accomplishments.

The international dimension of MI gives strong emphasis to all the activities performed under its umbrella. As an example, the calls for projects launched in the frame of IC2 obtained international visibility and the project nominees could have access to a worldwide audience (pitch at MI-3, presentation of the projects at the IC2 international workshops…).

Update on clean energy innovation policies and strategies

To meet the energy transition challenges the world is facing, France has made a firm political commitment, through the implementation of a range of key legislative, regulatory and strategic tools, both to guiding technological and societal choices and to supporting the research and development (R&D) effort necessary to ensure a continuous improvement in existing pathways and the emergence of new pathways.

The national regulatory framework

The Law on Energy Transition for Green Growth

The aim of the Law on Energy Transition for Green Growth (LTECV) adopted in 2015 is to enable France to contribute more effectively to preventing climate disruption and to protecting the environment, and to strengthen the country's energy independence while offering French companies and citizens access to energy at a competitive cost. The LTECV is also intended to promote sustainable economic growth and the creation of sustainable jobs that cannot be relocated.

The LTECV therefore constitutes the foundation on which the policy of innovation for ecological and energy transition can be built. **The law establishes the National Energy Research Strategy (SNRE), setting the major levers in terms of RD&D to fulfill the priorities of the government in terms of energy and green-house gas emissions, defined by:**

- The National Low-Carbon Strategy (SNBC), which describes the roadmap to 2050 for France for the implementation of its climate change mitigation policy, and the measures that make it possible to achieve carbon neutrality, including in innovation

- The Multiannual Energy Plan (MEP) to 2028, which sets the priorities for action by the public powers in relation to energy in order to ensure a successful transition towards a more effective and more simple energy system that is more diversified and therefore more resilient, with a focus on innovation

The Law on Energy and Climate

The Law on Energy and Climate (LEC), promulgated on 9 November 2019, enshrines the concept of ecological and climatic emergency in the law and carbon neutrality for France by 2050 with a range of measures.

The transition to a low-carbon economy involves a stepping-up of energy-related research and innovation measures aimed at developing the technologies and behaviours that will promote reductions in missions, while ensuring that France can compete on future markets for low-carbon goods and services.

In other respect, the law foresees the possibility of launching specific calls for projects for innovative energy production facilities. Experimentation contracts can be defined on a case-by-case basis.

Response to the Covid 19 crisis – setting a recovery plan for the economic, social and ecological overhaul of the country

With the desire to amplify the efforts implemented with the support plan, The French Prime Minister presented on September 3, 2020 the plan "France Relance", a roadmap for the economic, social and ecological recovery of the country. The allocated resources are substantial, €100 billion, of which 40% are funded by the European Union, turned towards:

- The ecological transition;
- An increased competitiveness of the French economy;
- A stronger social and territorial cohesion.

To achieve these objectives, the new Program of Investments for the Future (PIA 4), consisting in the continuation of a major national program launched in 2010 to support innovation (€57 billion invested from 2010 to 2020 to enhance innovation in all sectors), will mobilize €11 billion to support the recovery plan, along 4 axis:

- The development of innovations and green technologies (€3.4 Bn);
- Economic resilience and sovereignty (€2.6 Bn);
- Support higher education, research and innovation ecosystems (€2.55 Bn);
- Support innovative companies at each stage of their development (€1.95 Bn).

Other resources of the Recovery Plan will support the deployment of (often) innovative energy transition solutions in different economic sectors. For instance the Recovery Plan allocates 1,2 G€ to projects aiming at decarbonizing industry, and also supports the emergence of hydrogen local ecosystems or the production of decarbonized hydrogen (support to investment and operating expenses), in the framework of a National Hydrogen Strategy adopted in September 2020 (7 G€ of public support until 2030, among which 2,3 G€ brought by the Recovery Plan).

The Citizen's Convention on Climate

An unprecedented democratic exercise was carried out to give citizens a voice to accelerate the fight against climate change. 150 citizens chosen randomly worked for 9 months and made 149 measures that will allow to reach the targets in terms of reduction of greenhouse gas emissions, keeping in sight the spirit of social justice, indispensable to ensure social acceptance of change. On the basis of this proposal, a bill is currently discussed in the Parliament.

Major innovation initiatives and programmes in 2020/21

The Programme of Investments for the Future (PIA)

Alongside the funding of public research bodies, the Government supports R&D actions in the energy sphere implemented by ADEME, BPI France, the Caisse des Depôts et Consignations (CDC), and by the ANR (energy transition institutions, generic calls for projects).

Between 2010 and 2017, ADEME implemented two actions for the first two sections of the PIA: "energy and ecological transition demonstrators" and "vehicles and transport of the future", thus covering numerous themes divided among four broad aspects:

- Production of renewable energies, energy storage and smart electricity networks;
- Energy efficiency in buildings, industry and agriculture and bio-based chemistry;
- Circular economy and waste;
- Transport (including all its components) and mobility.

Various funding tools were provided, such as calls for projects for demonstrators, SME initiatives and equity interventions, enabling the funding, through 85 calls for projects, of 745 projects for a total grant amount of €2.5 billion (total project budget: €7.22 billion).

Continuing on from PIA 1&2, ADEME has implemented several actions as part of the third section of the PIA (commenced in late 2017), for a total amount of €1 billion: demonstration actions with €400 million in equity and €300 million in State aid (the CDC is also an operator, with separate loans for the regional component), Innovation competition dedicated to SMEs, with €150 million in State aid, Support for 'innovation ecosystems' in the area of sustainable mobility, with €150 million in State aid.

In parallel the PIA enabled the Public Investment Bank (Bpifrance) to finance companies in the field of sustainable development and energy transition. Bpifrance finances companies regardless of their size, from start-ups to SMEs or mid-caps, with financial solutions both during the feasibility study stage of innovation projects and during their implementation and launch in France or abroad. The public bank also invests in companies' equity with high grow potential via innovation capital or seed capital, with the aim to create a ripple effect with regards to private funding.

Funding innovation to accelerate the pace of the energy transition is a top priority of the French government for the period 2020-2030

The Government is launching for the period 2021-2025, its 4th strand of the Programme of Investments for the Future (PIA4), endowed with €20 billions for innovation. It will combine two intervention approaches aimed at accelerating innovation in all sectors, while simplifying the readability of intervention and financing tools: (i) strategic and priority investments (aims to finance exceptional investments that meet the challenges of transition of our economy and our society), (ii) long-term financing for higher education, research and innovation (amplify the efficiency of higher education and research ecosystems created by previous programmes and support innovative companies).

The strategic and priority investments will target high potential technology innovation sectors and will be derived in terms of so-called "Acceleration strategies" defining the key stages of development according to the maturity of the innovations, from their design to their deployment. All levers will be taken into account (funding, standardisation, research, education…)

"Zero-carbon Hydrogen" is the first validated strategy in the energy field. €7 billion will be invested, including €2 billion by 2022, in order to provide additional responses to the intermittence of renewable energies and to make France a major player worldwide in the field of carbon-free hydrogen. Several other strategies related to the energy field are currently in progress: decarbonisation of industry, bio-sourced products and bio-fuels, circular economy, advanced technologies for energy systems, batteries, digitization and decarbonisation of mobility.

Private sector engagement in 2020/21

The projects supported by the PIA in the field of the energy transition as well as innovative transportation involve the private sector in a co-investment spirit. This philosophy will remain at the heart of the investment strategy of the fourth strand of the PIA starting in 2021.

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

Major activities in support of the Innovation Challenges in 2020/21

France participates to the 8 innovation challenges, all considered very relevant to contribute to accelerate the deployment of innovative low-carbon solutions to tackle the energy transition. Among all the activities performed may be highlighted several specific actions. Namely:

IC2: Among the 8 Challenges identified by Mission Innovation, the Challenge on "innovation for off-grid electricity access from renewable" is co-leaded by France and India.

- Two calls for proposals (CFP) on innovative solutions for off-grid access to energy were launched by France and India respectively, enabling the selection of round 10 projects in each country for a global budget beyond 10 M€. The selected projects address various innovative technologies (hybrid electricity production, solar, river stream generator), different uses of electricity enhancing economic development (irrigation, agriculture, desalination, mobility) and electricity payment issues (pay as you go, leasing…).

- This experience is repeated in France in 2020 with an additional call for project, within the frame of a collaboration between the ADEME and the French Development Agency (AFD).

- Two international workshops were held in Paris and New-Delhi (2017 and 2019 respectively). These events gave the opportunity to gather stakeholders, government representatives, entrepreneurs and researchers and exchange on projects related to innovation for off-grid energy access.

IC3: France joined the CCUS innovation challenge from its foundation in 2016. This topic is addressed by the French low-carbon national strategy as one of the levers to reach the goal of neutrality carbon, notably by coupling CCUS with biomass combustion. Hence, France:

- Pursues its participation to the ERANET ACT CCUS (European funding programme), which aims at supporting projects dealing with the priorities set by this innovation challenge;

- Took part in June 2019 in Trondheim, Norway at the MI#IC3 workshop, chairing the sessions dealing with storage and utilization. Aim of the workshop was notably to follow up on the implementation of the priority research directions established during the 2017 CCUS Experts Workshop (Houston, US);

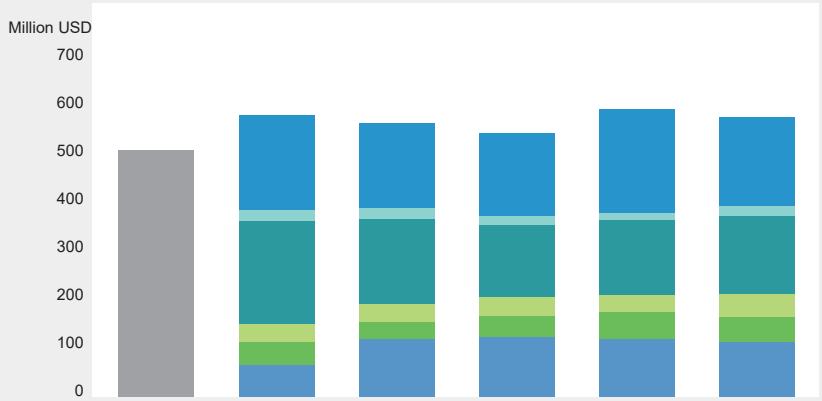
- Contributed in 2019 to the definition of the action plan of the challenge

IC8: France joined the hydrogen innovation challenge from is foundation in 2018, this topic being considered as a major lever of the energy transition.

Other Mission Innovation related activity in 2020/21

France participates from the beginning to the champions programme. In 2019, an inspiring project “Energy observer” consisting in the designing and demonstrating the feasibility of operating an autonomous ship powered with hydrogen produced on board thanks to renewable energies. In 2020, Ondine Suavet, general director and co-founder of “My Light Systems”, was awarded. This successful company promotes smart solar self-consumption solutions for households and companies.

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Energy Efficiency	-	189.59	173.08	172.24	209.69	176.95
CCS	-	23.34	16.70	13.98	17.31	20.85
Renewables	-	209.63	178.09	149.22	150.11	157.13
Nuclear Fission & Fusion	-	-	-	-	-	-
Hydrogen & Fuel Cells	-	35.51	32.41	31.93	32.06	43.16
Other Power & Storage Technologies	-	46.72	37.12	46.85	58.53	52.85
Other Cross-cutting Technologies/ Research	-	66.51	118.11	122.21	116.84	114.34
Unallocated	501.14	-	-	-	-	-
TOTAL	**501.1**	**571.3**	**555.5**	**536.4**	**584.5**	**565.3**

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
Germany	Joint call ANR-BMBF for collaborative research projects on smart grids and renewable energy storage	Collaborative projects between German and French partners that conduct application-oriented basic research (TRL 1-5) aiming at highly innovative, cross-sectoral solutions for economically, ecologically and socially sustainable and secure energy storage and distribution in France, Germany and Europe	Public – private	Research	2018	20 M€	http://www.agence-nationale-recherche.fr/en/information/news/single/pre-announcement-opening-soon-a-bilateral-french-german-call-for-proposals-in-the-domain-of-sustainable-energy/
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	2nd call is currently in preparation		http://www.geothermica.eu/
EU	ERANet Smart Energy Systems	The initiative deals with the key challenges and topics of the future energy system: • Smart Power Grids • Integrated Regional Energy Systems • Flexible Heating and Cooling Systems • Smart Smart ServicesPower Grids	Public – private	A Transnational Joint Programming Platform to Initiate Co-Creation and Promote Energy System Innovation			http://www.eranet-smartenergysystems.eu/
EU, Norway, UK, US, Switzerland, Canada, Turkey	ERANET ACT (Accelerated CCUS Technologies)	The project aims to develop and implement the techniques and conditions for the deployment of CO_2 capture, transport and storage. The use of CO_2 is also part of the perimeter. This project follows the main directions of MI's IC3.	Public – private	Demonstration and technology development projects to accelerate CCUS deployment	2019 2nd call and 2020 third call is currently in preparation	2019 Call - 20 M€	http://www.act-ccs.eu/about-us
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	2020, 2nd call 2021 available 3rd call	2019 Call - 27 M€ 2020 Call - 21 M€ 2021 Call -15 M€, with 5 M€ for batteries	https://m-era.net/
EU, Turkey, Chile, Quebec, South Africa	Eramin 2	Raw Materials for Batteries: Supply of raw materials from exploration and mining (also for batteries, namely Li), Design, Processing, Production and Remanufacturing, Recycling and Re-use of End-of-life products (as well batteries), Cross-cutting topic	Public – private	Research and development	2019 Call 2021 Eramin 3 available	2019 Call - 10 M€	https://www.era-min.eu/

GERMANY

High impact innovation activity triggered by MI

German energy research policy was completely geared towards the energy transition by the 7th Energy Research Programme published in September 2018. The topics emphasized within MI were considered in the design of the programme. For example, the research topic of artificial photosynthesis, as being explored within IC5, was included as an important research topic for the first time. In addition, the funding for clean energy research has increased substantially since the launch of MI.

Update on clean energy innovation policies and strategies

Germany intends to be climate neutral by 2050, in line with the wider European ambition to become the first climate neutral continent. Innovation plays an important role in reaching this goal.

In June 2020 Germany launched its National Hydrogen Strategy[49]. The National stimulus package for the COVID-recovery provides 7 billion euros for the implementation of the National Hydrogen Strategy domestically, and another 2 billion euros for fostering international cooperation in the field of hydrogen. Under the scope of the National Hydrogen Strategy Germany established the National Hydrogen Council as well as the Innovation Commissioner for Green Hydrogen at the Federal Ministry of Education and Research (BMBF). The Federal Ministry for Economic Research and Energy has launched a new Energy Research Network on hydrogen which has already been joined by more than 1000 experts from science, industry and society.

Major innovation initiatives and programmes in 2020/21

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 2020 and 2021. 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 electrolysers 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.

Seven large scale Several Living Labs for the Energy Transition were started. These address climate neutral cities as well 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.

[49] https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/the-national-hydrogen-strategy.html

Furthermore, many smaller projects and initiatives were launched addressing various areas of clean energy such as battery storage, smart meters, resource efficiency, digital technologies, societal aspects of the energy transition, CO_2-technologies and more. In addition, Germany responded effectively 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[50].

Private sector engagement in 2020/21

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 304 million Euros for clean energy research in 2020. 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 nine Energy Research Networks. Currently more than 4500 experts from industry, academia and society are organized in these open networks.

Major activities in support of the Innovation Challenges in 2020/21

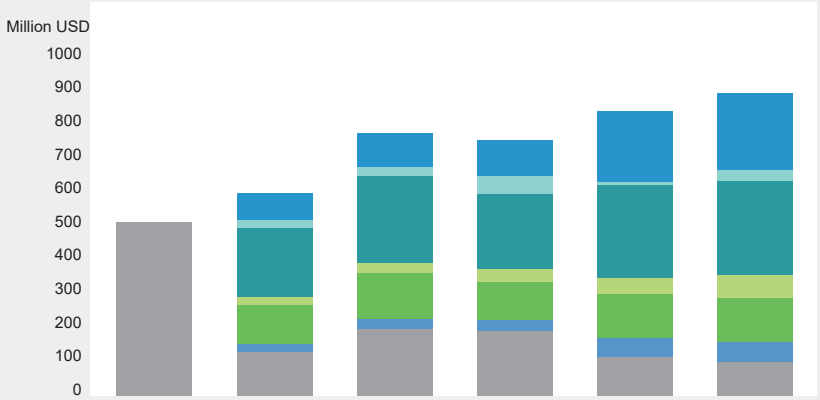
In 2020/2021 representatives from Germany participated in different workshops, in particular with respect to the innovation challenges 5 and 8. With respect to IC8, the main goal was to integrate the IC8 results (such as the hydrogen valleys platform) into the upcoming Mission Hydrogen. In IC5 an international roadmap was published, an important result of the first phase of MI. In addition, with respect to IC1, Germany participated in the MICall20 and contributed to the SGIA platform. Furthermore, Germany supports the work of IC7 via the IEA TCP Heat Pumping Technologies and the IEA TCP Solar Heating and Cooling. Germany is promoting MI within its research communication activities, for example in the yearly Federal Government Report on Energy Research.

Other Mission Innovation related activity in 2020/21

Germany is participating in the second round of the MI Champions Programme. Also, Germany is actively participating in the development of a second phase of Mission Innovation.

[50] https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/federal-government-report-on-energy-research-2020.html

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Energy Efficiency	-	82.70	102.38	108.99	209.53	226.39
CCS	-	19.81	21.30	48.30	6.26	29.03
Renewables	-	205.18	257.23	225.19	272.51	276.29
Nuclear Fission & Fusion	-	-	-	-	-	-
Hydrogen & Fuel Cells	-	17.55	24.97	31.41	43.47	68.54
Other Power & Storage Technologies	-	124.01	141.90	112.50	134.20	130.10
Other Cross-cutting Technologies/ Research	-	17.13	20.69	31.52	54.24	55.96
Unallocated	512.87	132.23	202.93	195.11	117.57	104.21
TOTAL	**512.9**	**598.6**	**771.4**	**753.0**	**837.8**	**890.5**

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
Australia	HySupply	German-Australian Feasibility Study of Hydrogen produced from Renewables	Public – private	Research	2020-2022	1,7 Mio. Euro	https://www.fona.de/de/massnahmen/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.	Public – private	Demonstration	2020-2022	8,2 Mio. Euro	https://www.bmwi.de/Redaktion/EN/Pressemitteilungen/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	Public – private	Demonstration with R & D	2020	1,5 Mio. €	https://www.bmwi.de/Redaktion/DE/Pressemitteilungen/2020/12/20201216-altmaier-uebergibt-foerderbescheid-fuer-internationales-projekt-fuer-gruenen-wasserstoff.html

INDIA

High impact innovation activity triggered by MI

India successfully led three MI Innovation Challenges viz. Smart Grids, Off Grid Access to Electricity and Sustainable Biofuels and actively participating in other five challenges. A unique funding opportunity was provided to the scientists and technologists in MI countries to collaborate and develop solutions in consonance with Mission Innovation objectives of accelerating clean energy research, development and demonstration. The clean energy investment has exponentially hiked during the last five years and a major portion of expenditure in Clean Energy RD&D has been made on international collaborations under the umbrella of MI. DST spear headed the global cooling prize to develop a 5 times lesser climate impact cooling solution. This initiative has been hailed as one of the major success stories of MI 1.0. DST has launched a Micro Solar Dome- Surya Jyoti, a unique solar energy operated lighting device, which has the potential to reduce CO_2 generation by about 12.5 ton per annum and save of 1750 million units of energy generation. The funding in Clean Energy has directly supported many scientists and has been successful in attracting an increase in number of researchers working in clean energy sector. The programme has enabled the developed technologies "from the lab to the market" and resulted in knowledge sharing among MI member countries.

Mission programmes on clean coal technologies, alternative fuels such as methanol and Di-Methyl Ether (DME), Energy Storage Materials, Building Energy Efficiency and Hydrogen Economy are helping us in fulfilling our commitment for a Clean Fuel. MI offered a unique opportunity to create a collaborative framework and network of researchers, innovators and industries in this endeavour. This strategic ecosystem would help foster long-term technology innovation growth, including in focus areas that may seem niche today.

Proposal(s) under MI2.0 (B2020): India is also committed to new Missions under MI 2.0 and continuation of activities under the Innovation Platform. Govt. of India has set out national missions to promote India's sustainable development objectives, which are as follows:

- National Solar Mission: is a major initiative of the Government of India targeting installing 100 GW grid-connected solar power plants by the year 2022[51].
- National Biofuel Policy has the objective of reaching 20% ethanol-blending and 5% biodiesel-blending of fuel by the year 2030[52].
- National Mission for Enhanced Energy Efficiency aims to strengthen the market for energy efficiency through implementation of innovative business models in the energy efficiency sector[53].
- National Mission on Sustainable Habitat at aims to make cities sustainable through improvements in energy efficiency in buildings, management of solid waste & shift to public transport[54].
- National Water Mission integrates water resource management helping to conserve water, minimize wastage and ensure more equitable distribution both across and within states[55].
- National Mission for Sustaining the Himalayan Ecosystem aims to facilitate formulation of appropriate policy measures and time-bound action programmes to sustain ecological resilience and ensure the continued provisions of key ecosystem services in the Himalayas[56].

[51] https://www.mnre.gov.in/solar/current-status/

[52] http://petroleum.nic.in/sites/default/files/biofuels.pdf

[53] https://beeindia.gov.in/content/nmeee-1

[54] http://mohua.gov.in/cms/National-Mission-on-Sustainable-Habitat.php

[55] http://nwm.gov.in/?q=objective-national-water-mission

[56] http://dst.gov.in/sites/default/files/NMSHE_June_2010.pdf

- National Mission for a Green India is aimed at protecting, restoring and enhancing diminishing forest cover and responding to climate change by a combination of adaptation and mitigation measures.[57]
- National Mission for Sustainable Agriculture seeks to address issues regarding 'Sustainable Agriculture' in the context of risks associated with climate change.[58]
- National Mission on Strategic Knowledge for Climate Change aims to build a dynamic and vibrant knowledge system that informs and supports national policy and action for responding effectively to climate change challenges, while not compromising on the nation's growth goals.[59]
- National Bioenergy Mission aims to boost rural economy by utilizing bio-resources and create a large number of jobs at village level[60].
- National Hydrogen Mission for generating hydrogen from green power sources, its storage, transport and utilization.[61]

Update on clean energy innovation policies and strategies

- **Science, Technology and Innovation Policy, 2020:** The Government of India initiated process of formulation of Science, Technology and Innovation policy with energy as major vertical[62]
- **'NATIONAL BIOTECHNOLOGY DEVELOPMENT STRATEGY- 2020-25'':** Document outlines India's strength and confidence in delivering a knowledge Driven Bioeconomy. Implementation plan includes Mission on the scaling of indigenous cellulolytic enzymes for 2G Ethanol and development of technologies for next-generation clean fuels including Bio-Butanol, Bio-Hydrogen and Bio-Jetfuel.
- Planning to launch a platform on **"Hydrogen Valley"** covering the entire hydrogen value chain (production, storage, distribution and final use) for several hydrogen applications.
- India is first among the MI member countries to establish **a Clean Energy International Incubation Center (CEIIC)** for supporting and promoting clean energy-based start-ups. It is a joint initiative of Government of India (GoI) and TATA trusts designed to offer "lab to market" support for national/international clean energy enterprises.
- Considering the role in IC1 activities, India is keen to actively participate in the Green Powered Future Mission & continue the momentum created in the last five years.
- India is actively contributing to the development of Innovation Communities for affordable heating and cooling of buildings as part of MI 2.0.
- Facilitating academia – industry collaboration and stakeholder engagement through liaison programs such as ACREX 2020 and Smart Cities India 2021.

[57] http://moef.gov.in/wp-content/uploads/2018/03/Green-India-Mission.pdf

[58] https://nmsa.dac.gov.in/

[59] https://dst.gov.in/climate-change-programme

[60] https://mnre.gov.in/Bio%20Energy/policy-and-guidelines

[61] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1698195

[62] https://www.mygov.in/campaigns/stip-2020

- "Pradhan Mantri JI-VAN Yojana" for providing financial support to Integrated Bio-Ethanol Projects using lignocellulosic biomass & biomass & another renewable feedstock. In first phase, four commercial scale cellulosic ethanol plants, each with 100KL/day ethanol capacity and using agricultural residues have been selected for viability gap funding. [63]A report submitted by NITI Aayog (National Institution for Transforming India) which serves as a Think Tank of the Government has suggested a roadmap for 20% Ethanol blending in Petrol by 2025. The report suggests year-wise targets for the production & supply of ethanol; manufacture of compliant vehicles and regulatory simplification.

- India approved modified scheme to enhance ethanol distillation capacity in the country modified scheme for extending interest subvention for those setting up grain-based along with molasses-based ethanol distilleries. [64]

- Initiated in February 2019, the KUSUM scheme aims to support farmers to replace existing diesel pumps with solar PV pumps (with both on-grid and off-grid features). The scheme aims to allow farmers to sell power to the DISCOMs at a predetermined price and aims to add solar and other renewable capacity of 28 GW by 2022.

- Net-metering policies are being implemented in 28 states aimed to enable faster expansion of distributed solar PV.

- Custom and excise duty benefits to the solar rooftop sector, with an aim to lower the cost of setting up as well as generate power.[65] In November 2020, the government announced production-linked incentive (PLI) scheme worth Rs. 4,500 crores (US$ 610.23 million) for high-efficiency solar PV modules manufacturing over a five-year period.

- In December 2020, SJVN Limited, a PSU under Ministry of Power entered into an MoU with Indian Renewable Energy Development Agency Ltd. (IREDA), a PSU under Ministry of New & Renewable Energy, to provide its services to SJVN for green energy projects.

- The Indian Cooling Action Plan (ICAP) was launched in March 2019and provides a 20-year perspective and outlines actions needed to provide access to sustainable cooling. India is the first country in the world to have a Cooling Action Plan.

- Recently, the Finance Minister in the Union budget for 2020-21 formally announced the NHM which aims for generation of hydrogen from green power resources. The Ministry of New and Renewable Energy (MNRE) has also disclosed that the draft regulations for NHM will be finalised by the end of this month and will thereafter proceed for approval of the Union Cabinet [3]. Though it is speculated that NHM will emphasize on generating green hydrogen and enabling its commercial use as a transportation fuel, however, it is yet to be seen what roadmap the government has envisioned in its draft regulations.

- Recently, the National Hydrogen Mission was announced which aims for generation of hydrogen from green power resources. The Ministry of New and Renewable Energy (MNRE) is drafting regulations and road map for NHM.

Major innovation initiatives and programmes in 2020/21

India launched five R&D program calls in the year 2020-2021; MI Call 2019, National Innovation Challenge Awards for 1) Designing and Developing Energy Storage Devices for Rural Household/ Enterprise Applications, 2) Integrated Clean Energy Material Acceleration Platform (IC-MAP), 3) India-Sweden Collaborative Industrial Research and Development Programme on Smart Grid, 4)Carbon Capture Innovation Challenge (IC3) and 5) Integrated Local Energy Systems with European Union (EU).

[63] https://pib.gov.in/Pressreleaseshare.aspx?PRID=1566711

[64] https://pib.gov.in/Pressreleaseshare.aspx?PRID=1684627

[65] https://mnre.gov.in/solar/schemes

- India-Sweden Collaborative Industrial Research & Development Programme 2021 aims to foster and support the development of collaborative R&D projects in Smart and sustainable cities and transport systems and Clean technologies, IoT and digitalization (DST will support up to Maximum limit of INR 1.5 crore per project of the total Indian Project Cost) and Vinnova (Swedish) will provide funding to Swedish side participants up to 2,500,000 (two million five hundred thousand) Swedish Krona.

- In collaboration with MI and Joint Programming Platform of ERA-NET Smart Energy System launched a Joint call 2020 entitled 'Digital transformation for green energy transition (MICALL20)' and has committed 1 million Euros.

- India participated in ACT-3 call focussed on carbon capture, utilisation and storage with a commitment of 2 million Euros and set two virtual centres on CCUS at IIT Bombay and JNCASR, Bangalore.

- India announced a call on local energy systems with European commission committing an investment of 9 million Euros.

- IC1 Smart Grids: Under the MI mandate to support smart grids ISGAN MI IC1 collaboration has been initiated. A Letter of Intent (LOI) has been signed between IC1 and ISGAN, identifying common interests within R&D Tasks - Storage Integration and Flexibility Options. Smart-Grids team developed Smart Grids Innovation Accelerator (SGIA) framework to foster and accelerate the deployment of the smart grid by providing access to critical documents in the smart grids field, such as policies, strategies, technical reports, case studies, best practices, roadmaps, implementation plans, and digital twin objects.

- India-European Union Flagship Call on Integrated Local Energy Systems US $ 5 million

- LOTUS-HR (Reserve Activity: Management of Solid Waste (Barapullah Drain- Floating Debris Clean-up) at Barapullah site in collaboration with the Danish partner-aims to remove floating debris including plastics from Drain and process such waste by way of disposing it by the most efficient method/ technology such as Carbonization.

- Local Treatment of Urban Sewage Streams for Healthy Reuse (LOTUS), aims to demonstrate a novel holistic (waste) waste water management approach, that will produce clean water that can be reused for various purpose (e.g. industry, agriculture, construction etc.)

- Innovative Algae Platform for Industrial Wastewater Valorization InWAP in collaboration with Denmark aims to Lab-scale optimized process development for various industrial wastewater treatment using potential algal strains

Private sector engagement in 2020/21

Clean energy research program has over 60 industries actively participating in different projects. For instance:

- Tata Power DDL is participating in MICall19 project entitled "Mobile Substation and Grid Storage System"

- A Request for Proposal (RFP) was announced in collaboration with Sweden "India-Sweden Collaborative Industrial Research and Development Programme on Smart Grid" for Indian and Swedish companies along with R&D organizations.

- DST is nurturing start-ups through its R&D initiatives and have facilitated industry liaising and visibility to research outcomes through the start-up galleries at ACREX 2020 and Smart Cities India 2021.

- A national consortium of smart grids stakeholders involving leading industries provide support in policy and decision making in the smart grids

- The Department of Biotechnology DBT and its Public Sector Undertaking, BIRAC has joined hands with Tata Trusts in successfully setting up the Clean Energy International Incubation Centre (CEIIC) in 2018, to provide end-to-end support to start-ups. CEIIC Incubation expanded its Portfolio to 24 start-ups and one of the Start-ups (Takachar), was selected as UNEP Champion of the Earth for 2020. Under the Avoided Emissions Framework: India-Sweden Collaboration: eight start-ups incubated at CEIIC have a combined potential to help avoid more than 98 million tonnes of GHG emissions per year by 2030.

- Global Cooling Prize - This international innovation competition (announced by Hon'ble Minister of S&T, ES and H&FW) led by the Government of India alongside the Rocky Mountain Institute (RMI) and Mission Innovation is spurring the development of super-efficient and climate-friendly residential cooling solutions for homes. The eight finalists of the Global Cooling Prize were announced on 15th November 2019.The finalists have been awarded US$200,000 each to develop, ship their prototypes to India for testing and grand award ceremony is scheduled for 29th April 2021.

Major activities in support of the Innovation Challenges in 2020/21

1. Smart Grid Challenge:

- India being co-lead of IC1 smart grid proposed a closure event and consolidated report with involvement from all member countries to exhibit the IC1 achievements till date and plans to release it at theMI-6 event. DST, India also participated in Annex 6 ISGAN Power System workshop held in November 2020 and delivered a technical talk on "Localized Power Balancing for Flexibility Advancement" under the theme "Capturing Flexibility from Local Energy Systems"[66]. India actively contributed to creating momentum and preparing the draft pitch for the Green Powered Future Mission.

2. Off Grid Access to Electricity Challenge:

- Under the MI mandate India collaborated with following countries to support RD&D collaboration in Off-grid access to electricity: Australia: Solution for Pacific Island Countries; Canada: Canmet: Solar–Diesel – Storage Power plant; China: Technologies & Equipment Development: 5 Projects worth 1 Million US$ (2019); European Commission: Horizon 2020 WP- "Secure, Clean and Efficient Energy"- Island projects (36 M Euros) across Europe; Netherlands: Results-Based Financing (RBF)- Decentralized energy access in developing countries; Energizing Development; Dutch Coalition for Humanitarian Innovation Crowd Funding Skills development and capacity building within communities.

3. Carbon Capture, Utilisation and Storage:

- Supported 22 RD&D projects addressing various research areas related to Carbon Capture, Utilisation and Storage. DST is also a joint multilateral call on Accelerating CCUS Technologies (ACT Call 3) launched along with the other 13 ACT member consortia countries.

4. Sustainable Biofuels:

- Launched a MI Call on Sustainable Fuels to undertake joint R&D with a total cost of 8.74 Cr to develop ways to produce sustainable biofuels. India funded 14 projects under this initiative in the field of advanced biofuels, the production of enzymes for biofuels, and methods for improving biological feedstock and heterotrophic algal production. A network of 14 India, 21 International and 4 industries was established.

[66] https://www.youtube.com/watch?v=wahRx1ZStYs&list=PLVQFc2zOj3J9suoD5YJOtTawGWaJnX9QF&index=4

5.Converting Sunlight:

- Launched a MI Call on Converting Sunlight to Storable Fuels, Energy Rich Chemicals and Biochemicals (IC5) to undertake joint Research & Development (R&D) with member Mission Innovation (MI) countries in the field of Converting Sunlight, the next generation of technologies that can capture and bottle the energy of the sun. Supported 13 projects.

6. Clean Energy Materials:

- supported a total of 81 projects with a total cost of Rs. 93 Cr to develop high performance low cost clean energy materials for energy harnessing, energy storage and energy efficiency for diverse sectors such as power, buildings, transportation, storage and construction.

7. Heating and Cooling of Buildings:

- Created new benchmarks in energy efficient technologies through programmes like global cooling prize pushing the climate impact reduction by 5 times. Bilateral international programs as a part of the challenge helped in reducing energy demands. DST is taking an active role in furthering thermal comfort research and its dovetailing with building energy efficiency. A research program on comfort driven HVAC system control is being conceived. Actively participating in shaping the Innovation Communities on Affordable Heating and Cooling of Buildings. Targeting to initiate R&D on ultra-efficient low energy cooling technology during the next five years.

8. Hydrogen:

- DBT has supported 3 national projects on Biohydrogen productions through fermentation route. Experts Working Group constituted by DBT to develop R&D roadmap on Biomass to Hydrogen. A focused mission programs will be developed by Department to take forward promising technologies for Hydrogen production using fermentation or MEC routes. DST has supported a total of 29 projects with a total cost of Rs. 30 Cr covering areas of Hydrogen production, storage, transportation and utilization. Hydrogen production by biomass gasification is taken as a major initiative.

Other Mission Innovation related activity in 2020/21

- India has actively supported applications for MI Champions program and identified two National Energy Champions who are developing novel ways of making energy cleaner, cheaper, and more reliable and using it more efficiently. Prof. S.P Gon Chaudhuri and Dr Purnima Jalihal were funded with an initial grant from DBT to pursue technology development and demonstrate activity.

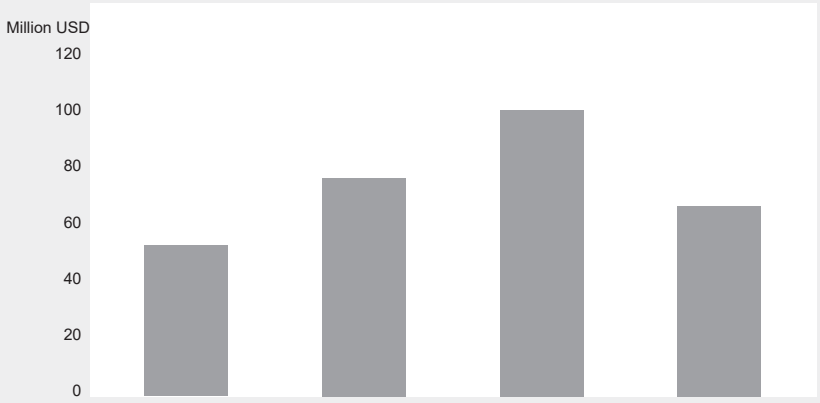
- India is planning to launch a platform on “Hydrogen Valley” to combine several hydrogen applications into an integrated hydrogen eco-system covering the entire hydrogen value chain (production, storage, distribution and final use).

- Initiatives and outcomes relating to IC1, IC7, global cooling prize and other Mission Innovation related activities of DST are exhibited at 6th Smart Smarty Cities Expo 2021, DST technology pavilion. DST is currently administering an international survey with MI member countries on thermal comfort research and development. The survey administered to leading researchers and funding agencies intends to capture research directions in thermal comfort and challenges are being addressed. Organised an international deep-dive workshop on low energy heating and cooling of buildings with specific focus on thermal comfort to prepare future roadmap on this priority area.

- Outreach Activity: The Mission Innovation India Unit with support from Department of Biotechnology has launched a dedicated website for Mission Innovation and related activities.

- Centers of Excellence: Five large bioenergy research centres are being supported by the Department of Biotechnology, Govt of India. These Centers of Excellence cover areas for research and international cooperation in Fermentation (2G-Ethanol), Enzyme Technology, Pre-treatment of Biomass, Biomethanation technologies, Systems and Synthetic Biology, Life Cycle Analysis, Algal Biotechnology etc.

Public sector RD&D investment



*All amounts are in million USD	First Year	Second Year	Third Year	Fourth Year
Energy Efficiency	-	-	-	-
CCS	-	-	-	-
Renewables	-	-	-	-
Nuclear Fission & Fusion	-	-	-	-
Hydrogen & Fuel Cells	-	-	-	-
Other Power & Storage Technologies	-	-	-	-
Other Cross-cutting Technologies/ Research	-	-	-	-
Unallocated	53.35	77.22	100.70	67.30
TOTAL	**53.3**	**77.2**	**100.7**	**67.3**

New Collaborations

See full list on the Mission Innovation website.

ITALY

High impact innovation activity triggered by MI

Mission Innovation has:

- strengthened the development of collaboration activities among international public research centers;
- facilitated the interaction among the National Research Centers involved in the development of cleantech technologies;
- favoured the synergy among the various Ministries involved in the research activities' support;
- given substance and resources to the Italian R&I activities planned under the 5th Dimension (R&I&C) of the National Plan for Energy and Climate (NPEC), together with the participation in the EU – Strategic Energy Technology - SET Plan in the frame of the European New Green Deal which foresees a strong effort on clean energy innovation activities;
- focused the attention of major stakeholders in Italy on the opportunities that smart grids, advanced materials and hydrogen can offer in the decarbonisation perspective. To this end the Ministry of Economic Development has launched a collaboration agreement with the main public research organisations to actively participate in the activities carried out in the context of the ICs. These activities will be also open to industries involved in the related value chains to ensure a correct finalization of the results.

Update on clean energy innovation policies and strategies

In early 2021 the Italian Government published its "Long-term strategy with low greenhouse gas emissions" to 2050 as part of the commitments of the Paris Agreement on climate change which invites signatory countries to communicate their strategies by 2020. The national long-term strategy identifies the possible paths to reach, in our country, by 2050, a condition of "climate neutrality", in which the residual emissions of greenhouse gases are offset by the absorption of CO_2. An objective in line with that indicated by the President of the EU Commission Ursula Von der Leyen, in her Communication on the European Green Deal, outlined a growth strategy towards "a modern, resource-efficient and competitive economy that in 2050 will not generate net greenhouse gas emissions ". The strategy starts from the Integrated National Energy and Climate Plan (PNIEC), which indicates the path up to 2030, "dragging" the consequent virtuous energy-environmental trends until 2050. The types of levers that can be activated to achieve climate neutrality by 2050 are therefore identified: a dramatic reduction in energy demand, linked in particular to a drop in consumption for private mobility and consumption in the civil sector; a radical change in the energy mix in favour of renewables (RES), combined with a deep electrification of end uses and the production of hydrogen[67].

At the end of 2020 the Italian Government launched a public consultation on the Guidelines for the National Hydrogen Strategy, developed by the Ministry of Economic Development, in order to identify the sectors in which this energy vector could become competitive in a short time but also to verify the areas of intervention that are best suited to develop and implement the use of hydrogen. The National Hydrogen Strategy will allow Italy to accelerate the achievement of the objectives set by the PNIEC, favouring the energy transition towards a green, sustainable and technologically advanced economy, which represents one of the central points of the action carried out by the Government.

[67] https://ec.europa.eu/clima/sites/lts/lts_it_sum_en.pdf

Major innovation initiatives and programmes in 2020/21

At the end of 2020 the Ministry of Economic Development launched a call-for-proposals of the National Electric System Research Fund for the private sector on a co-funding basis within the end of 2020. The activities are aimed at innovating and improving the performance of the system in terms of economics, safety and the environment. The resources allocated amount to EUR 16 million. The programme's coverage ranges from high efficiency PV to storage systems and energy efficiency in industrial processes. It is financed through a specific component of the end-user electricity tariff[68].

In early 2021 ENEA and the Ministry of Economic Development signed a collaboration agreement in order to create the first Italian Hydrogen Valley to develop a national supply chain for production, transport, storage and use of hydrogen, focusing on research, technologies, infrastructures and innovative services. The project, conceived by ENEA, kicks off with a 14 million euro investment (in the frame of the Italian additional budget for the activities of Mission Innovation) to set up the first Italian technological incubator for the development of a hydrogen supply chain, in collaboration with universities, research institutes, associations and companies, to boost the energy transition and decarbonisation[69].

Private sector engagement in 2020/21

The European Commission gave the green light to a second Important Project of Common European Interest (IPCEI) on batteries, in which Austria, Belgium, Croatia, Finland, France, Germany, Greece, Italy, Poland, Slovakia, Spain and Sweden participate. The objective of the Project is to create a sustainable and innovative value chain that will lead Europe to produce next generation raw materials, cells, modules and battery systems and that will allow the reconversion and recycling of batteries with innovative and more efficient. Italy participates in this important project, on the initiative of the Ministry of Economic Development with 12 companies and 2 research centers, consolidating their innovative presence in the field of new generation batteries thanks to the investments planned through this large project: the provision of state aid for over 600 million euros, will produce a total investment of over 1 billion nationwide[70].

Major activities in support of the Innovation Challenges in 2020/21

IC1: in the year 2020 Italy, with the support of IC1 members, successfully finalized the Smart Grid Innovation accelerator (SGIA) platform that was then publicly released in early 2021. The news about the publication of the SGIA platform was posted on the MI website and reported on the February 2021 Mission Innovation Newsletter. Italy provided both the financial support needed for the SGIA development and selected through a national effort a large number of documents to enrich the SGIA repository. The SGIA is a cloud-based online platform to share knowledge on smart grids and the energy sector as a whole with 1100+ key documents selected and shared by IC1 country members from the public and the private sector.

IC6: the Italian representatives in IC6 have always participated to the virtual meetings organized by the Canadian coordinator. These meetings aimed at 1) consolidating bi- and multilateral technological-scientific collaborations between the members of the IC6 with particular emphasis on the theme of waste heat harvesting; 2) defining the cross-cutting role of IC6 in the organization of the next interministerial initiative with a view to the creation of Platforms alongside the wider Missions. The Italian representatives also actively contributed to the discussion within the National Scientific Associations and the European Energy Research Alliance to facilitate the alignment of the European Community's contribution to the organization of the next MI 2.0.

[68] http://www.ricercadisistema.it/#/page/Bandi/Bando%20di%20tipo%20b%20-%202020

[69] https://www.enea.it/en/news-enea/news/energy-enea-makes-14-million-euro-bet-on-italian-hydrogen-valley

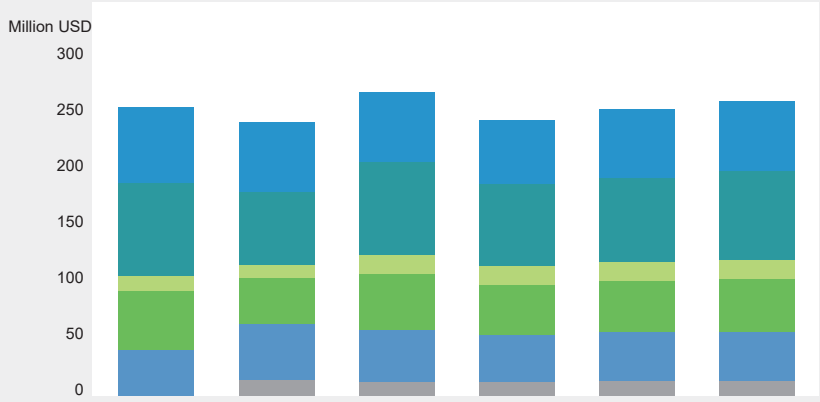
[70] https://www.mise.gov.it/index.php/it/198-notizie-stampa/2041956-via-libera-dell-ue-al-secondo-importante-progetto-di-comune-interesse-europeo-ipcei-sulle-batterie

IC8: following the Mission innovation activities on Hydrogen Valleys, the Ministry of Economic Development launched at the end of 2020 a public consultation on the Guidelines for the National Hydrogen Strategy, in order to identify the sectors in which this energy vector could become competitive in a short time.

Other Mission Innovation related activity in 2020/21

Italy has participated in the second part of the MI Champions event and a young lady researcher has been nominated. It was organised in a way to allow the Champions to intervene and say a few words on their activity and how they see the future in a post-COVID world. The difficulties encountered in the communication reveal the need to reinforce the broadband connections globally. However, the great majority could express their thoughts. Italy has also had a judge (Ms. Alicia Mignone) on both Cohorts and she enjoyed very much the interesting and stimulating experience. We do think it is an excellent idea to reward the Energy Innovation capabilities and efforts of people motivated to tackle climate change and hopefully the MI Champions Initiative will be continued in the future.

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Energy Efficiency	66.68	59.50	61.04	55.81	59.23	61.50
CCS	-	-	-	-	-	-
Renewables	80.96	66.34	81.08	72.89	75.17	77.45
Nuclear Fission & Fusion	-	-	-	-	-	-
Hydrogen & Fuel Cells	13.43	10.21	16.97	14.81	14.81	15.95
Other Power & Storage Technologies	51.25	41.00	50.11	45.56	46.70	47.84
Other Cross-cutting Technologies/ Research	41.55	48.31	44.99	39.86	41.00	42.14
Unallocated	-	15.60	12.72	13.67	14.81	14.81
TOTAL	**253.9**	**241.0**	**266.9**	**242.6**	**251.7**	**259.7**

JAPAN

Update on clean energy innovation policies and strategies

"Environment Innovation Strategy,"[71] formulated in January 2020, targeted the global level reduction of GHG emissions toward carbon neutrality and further reduced atmospheric CO_2 level "Beyond Zero"[72] by 2050. The "Innovation Action Plan" in the Strategy categorizes a total of 39 potential technologies for reducing GHG emissions. Japan's government also established the "Green Innovation Strategy Meeting"[73] and its working group in July 2020 to implement the Innovation Action Plan's PDCA cycle.

The Ministry of Economy, Trade and Industry (METI) formulated a "Green Growth Strategy Through Achieving Carbon Neutrality in 2050"[74] in collaboration with related ministries and agencies. This strategy is an industrial policy to lead the challenging goal of achieving carbon neutrality by 2050, a vision that is upheld by the Suga administration and aims toward a positive cycle of economic growth and the environmental protection.

Major innovation initiatives and programmes in 2020/21

Tokyo "Beyond-Zero" Week[75] features six leading international conferences organized and hosted by Japan, held between October 7th and 14th 2020. Each conference offers a forum for high-level discussions about the key innovations required to build a global roadmap to carbon neutrality and find pathways to go "beyond zero"—namely reducing the levels of CO_2 emissions already in the atmosphere.

Six international conferences:

- ICEF2020
- RD20
- TCFD summit 2020
- LNG Producer-Consumer Conference 2020
- International Conference on Carbon Recycling 2020
- Hydrogen Energy Ministerial Meeting 2020

National Institute of Advanced Industrial Science and Technology (AIST) established the Global Zero Emission Research Center (GZR)[76] on January 29, 2020, to conduct global joint research in the field of innovative environmental and energy technologies. The GZR hosted the second international conference of Research and Development 20 (RD20)[77] in October 2020, which creates the necessary environment for international joint research by strengthening collaboration among leading institutions of G20 countries.

[71] https://www.kantei.go.jp/jp/singi/tougou-innovation/pdf/kankyousenryaku2020_english.pdf

[72] https://www.meti.go.jp/english/policy/energy_environment/global_warming/roadmap/innovation/index.html

[73] https://www.meti.go.jp/english/press/2020/0707_003.html

[74] https://www.meti.go.jp/english/press/2020/1225_001.html

[75] https://www.meti.go.jp/english/policy/energy_environment/global_warming/roadmap/tokyo_beyond-zero_week/index.html

[76] https://www.gzr.aist.go.jp/en/

[77] https://rd20.jp/

Japan launched the "Moonshot Research and Development Program,"[78] aiming to solve various difficult issues in today's society and to promote disruptive innovations by aggressively encouraging challenging R&D from domestic and foreign researchers and others. New Energy and Industrial Technology Development Organization (NEDO) selected 13 R&D projects and the project managers for the program of Moonshot Goal #4, "Realization of sustainable resource circulation to recover the global environment by 2050." Seven Moonshot Goals in total have been set since the program foundation and the Moonshot fund provides 100 billion JPY to support the selected projects for a five-year period.

Japan launched a global collaboration program, "Research and Development Program for Promoting Innovative Clean Energy Technologies Through International Collaboration" (FY2020–FY2024)[79], which is led by research institutes or universities between Japan and other countries mainly from G20 members in order to create new and innovative clean energy technologies that will have practical use after 2030. The total program budget is 900 million JPY per project/per year. 13 projects[80] were selected for FY2020.

Private sector engagement in 2020/21

On September 11, 2020, the Ministry of Economy, Trade and Industry (METI) held the fifth meeting of the Study Group on Environmental Innovation Finance (chaired by Dr. Ito Kunio, Professor, Ph.D., Graduate School of Business Administration, Hitotsubashi University), and compiled the "Climate Innovation Finance Strategy 2020," an interim report to convey Japan's approaches to climate innovation finance to the rest of the world. Toward achievement of the Sustainable Development Goals (SDGs) and the goals set in the Paris Agreement, METI, through the strategy, will convey Japan's message to the rest of the world, stating the importance of simultaneously advancing finance to each of three types of efforts for: [i] "transition" to steadily advance low carbonization and decarbonization, [ii] "green" to achieve decarbonization, e.g., renewable energy and [iii] "innovation"

Toward the 2050 carbon-neutral target, the Green Innovation Fund of 2 trillion yen was established in the New Energy and Industrial Technology Development Organization (NEDO) under the FY2020 Tertiary Supplementary Budget.

Sharing ambitious and concrete goals, METI will continue to support private companies that tackle these goals as their management issue for the coming ten years, from research and development (R&D) to application of newly developed technologies into actual business.

Major activities in support of the Innovation Challenges in 2020/21

IC5: Converting Sunlight

- Followed the workshop for developing the Converting Sunlight into Solar Fuels and Chemicals Roadmap 2020–2050 in Hiroshima in November 2019, Japan actively participated in the virtual US workshop and also contributed to support editing the roadmap.

IC8: Hydrogen

- Japan participated in IC8 from its foundation in 2018. The Fuel Cell and Hydrogen Joint Undertaking (FCH JU), the Hydrogen Valley Platform was launched in January 2021. The Fukushima Hydrogen Energy Research Field (FH2R)[81] [82] in Japan has selected. The FH2R has the world-largest electrolyser with 10 MW capacity, powered by solar PV with 20 MW capacity and the annual hydrogen production capacity amounts to about 200 tons per year.

[78] https://www.nedo.go.jp/english/news/ZZCA_100007.html

[79] https://www.nedo.go.jp/content/100903472.pdf

[80] https://www.nedo.go.jp/activities/ZZJP_100173.html

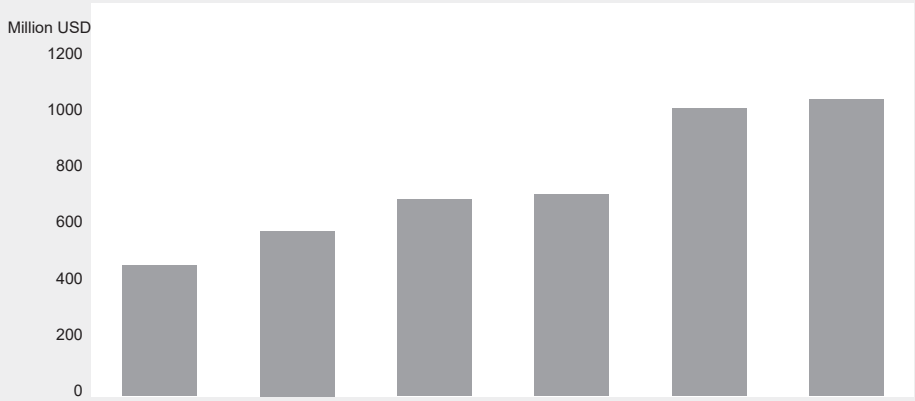
[81] https://www.nedo.go.jp/english/news/AA5en_100422.html

[82] https://www.h2v.eu/hydrogen-valleys/fukushima-plan-new-energy-society

Other Mission Innovation related activity in 2020/21

Japan participated in the second cohort of Champion Program. Yoshiki Takagiwa[83]– Principal Researcher at National Institute for Materials Science was selected as Japan Champion. Takagiwa developed an environmentally friendly Fe-Al-Si-based thermoelectric (FAST) materials, combined with experiments, theoretical calculation, and machine learning toward social implementation.

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
TOTAL	421.5	595.7	683.8	708.1	1,006.0	1,075.3

The figures in the table below include overlapping areas therefore the sum is not equal to the total amount of public R&D investment.

*In Billion Japanese Yen	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Production process	9.1	16.1	16.3	18.1	21.0	23.0
Structural material	21.2	31.6	32.7	29.6	25.8	27.4
Storage Battery	9.8	14.4	19.0	21.6	24.6	36.2
Hydrogen	12.2	16.4	20.7	20.4	28.2	44.8
Photovoltaic	6.9	11.5	14.3	15.6	18.8	31.6
Geo-thermal	1.6	3.5	4.1	4.6	7.1	20.9
CCUS	11.1	18.1	22.0	24.1	49.4	36.7
Core technologies for Systems	16.3	29.3	33.6	40.5	45.3	53.8

[83] https://samurai.nims.go.jp/profiles/takagiwa_yoshiki?locale=en

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
UK, France	International Collaborative R&D for Low-Cost and High-Durability Solar Cells	R&D of component cell technologies to realize high-efficiency (>30%), low-cost and high-durability perovskite/Si tandem solar cells.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925820.pdf
France	International Joint R&D for Multi-Junction Solar Cells Based on Novel Structures	R&D of core technologies to realize ultra-high efficiency solar cells with lightweight and flexible feature.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925821.pdf
Finland	Development of Microbial Production of Next-Generation Polylactate from Biomass-Derived Sugars	Process engineering for biopolymer production from cellulose-derived sugars.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925825.pdf
US	International Joint Research on Innovative Artificial Apomixis Induction Technology	Development of an artificial apomixes using a chimeric repressor gene silencing technology.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925826.pdf
Germany, UK, (Swiss)	International Joint Research on Intermediate Temperature Solid Oxide Electrolysis Cell	Development of intermediate temperature solid oxide electrolysis cells to effectively convert excess renewable power to hydrogen.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925827.pdf
US	International Joint Research on Solid Oxide Reversible Electrolyzer Cells	Development of solid oxide reversible cells (SORCs), which have a reversible 1000 cycle durability and 40,000 hours durability.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925828.pdf
France	Chemical Productions through Formate Intermediates by Solid Bis-metallic Catalysts	Development of a novel solid bimetallic catalyst to directly produce fine chemicals with amides from CO_2 and H_2.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925829.pdf
France, Germany, Korea	International Joint Research on Innovative Thermoelectric Devices and their Evaluation Technology	Development of high-efficiency and highly reliable thermoelectric power generation devices.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925830.pdf

US	International Joint Research and Development of Solar Concentrating Reactor for Carbon Dioxide Decomposition	R&D for CO_2 decomposition system consists of efficient solar thermal receiver technology and a porous reactor system.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925831.pdf
France	Development of innovative solution-growth technology that improves productivity and quality of SiC crystals	Investigation on novel alloy solvents to strike a balance between high growth rate and growth stability of SiC crystals.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925832.pdf
Italy	International Joint Research for Metal-free Redox Flow Battery (RFB)	Development of innovative metal-free RFBs using new organic materials as redox centers and electrocatalysts for the cost reduction and avoiding resource constraints.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925834.pdf
Italy	International Joint Research for Metal-free Redox Flow Battery (RFB)	Development of innovative metal-free RFBs using new organic materials as redox centers and electrocatalysts for the cost reduction and avoiding resource constraints.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925834.pdf
Germany, US, (Swiss)	International Joint Research on High Voltage Devices and Power Electronics Element Technologies	R&D of process Technologies for cost reduction of ultra-high voltage SiC Power devices.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925835.pdf
UK, US	Reliability Assessment Methodology for Advanced Ceramic Matrix Composites (CMC)	Development of evaluation methods for CMC components using multiple inspection techniques, including international standardization of methodology and equipment.	Public-public	research and development	2020 – 2023 (planned)	max JPY50M	https://www.nedo.go.jp/content/100925836.pdf

NETHERLANDS

High impact innovation activity triggered by MI

The Netherlands supports a proposal of India to launch a multilateral call on aviation fuels; in line with IC4 and the mission-proposal for bio-economy. This call could be launched in July. The Netherlands aims to contribute through a national funding scheme of €3.5 million. The specific option for international cooperation and active emphasis on the benefits of international cooperation in this national funding scheme would not have occurred without MI.

Update on clean energy innovation policies and strategies

The Netherlands has set an ambitious CO_2-reduction target of 49% in 2030 compared to 1990, with a view on increasing the EU target for CO_2-emission reduction to 55% in 2030. The Netherlands is targeting CO_2-reduction on a sectoral level with the Dutch Climate Agreement of 2019 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 in 2019 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 Netherlands is also currently drafting a mission oriented international innovation agenda, in line with the IKIA, so that our international efforts in various initiatives contributes to the missions of our Climate Agreement.

In 2020 the Netherlands committed roughly €320 million public funds[84] and €590 million private funds on climate and energy innovation, through the Knowledge and Innovation Covenant for 2020[85]. We expect his commitment to increase in 2021 to €355mln public funds and €590mln private funds.

Also, in 2020 The Netherlands has drafted two additional cross-cutting innovation programmes, supporting the MMIP's of the IKIA. One is the mission-oriented innovation program Hydrogen[86] and the other is the innovation agenda for Green Gas[87].

Major innovation initiatives and programmes in 2020/21

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[88]. For climate and energy (the IKIA) this was almost €1 billion in 2020: about €320 million public funding[89] for RDD and €590 million private funding. For 2021 the KIC has been updated, resulting again in almost €1 billion for climate and energy in 2021 (€355 million public and €590 million private).

[84] This budget contains some elements that are not reported via the IEA (for example circular economy). Therefore it is somewhat higher than the budget reported in this survey.

[85] https://www.topsectoren.nl/publicaties/kamerstukken/2019/november/12-11-19/kic-2020-2023

[86] https://www.topsectorenergie.nl/sites/default/files/uploads/Meerjarenprogramma Waterstof - 2e consultatieconcept (3 sept 2019).pdf

[87] https://www.rijksoverheid.nl/documenten/kamerstukken/2020/12/17/bijlage-innovatieagenda-groen-gas

[88] https://www.topsectoren.nl/publicaties/kamerstukken/2019/november/12-11-19/kic-2020-2023

[89] This budget contains some elements that are not reported via the IEA (for example circular economy). Therefore it is somewhat higher than the budget reported in this survey.

On top of the existing 13 MMIPs of the IKIA of the Dutch Climate Agreement, The Netherlands has launched two cross-cutting innovation programmes, supporting the MMIP's of the IKIA. One is an MMIP on Hydrogen and the other is an innovation agenda on Green Gas.

The gained momentum on hydrogen through the Hydrogen MMIP, has led to a proposal on hydrogen in the Dutch 'Growth Fund' of €338 million for the RD&D-part. The proposal has been approved for the RD&D-part under certain conditions and will start in 2022.

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 number of proposals for this call was overwhelming. The original budget of €65 million has been raised in 2021 to €107 million in order to meet demand.

Also, the Energy Innovation Demonstration grant scheme (DEI+) call has received more proposals than could be facilitated. Here too, the original 2020 budget of €86mln has been raised in 2021 to €108 million. The DEI+ call of 2021 is therefore also raised to €126,6 million.

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. This amounts to a total of roughly €44mln for climate and energy.

Furthermore, the Dutch Research Council (NWO) committed €22 million to the missions on climate, energy, circular economy and sustainable mobility. This resulted in four calls for fundamental research that are currently being shaped: Sustainable materials for wind and solar energy; Societal acceptance and integration; Circular resources, products and processes; and Carbon-free and circular shipping.

Private sector engagement in 2020/21

The Netherlands supports public-private collaboration through various policies:

- General policies, such as the public-private allowance, which facilitates private contributions for public-private partnerships for research and innovation within the Top Sectors. (Dutch link)
- 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 2019 public schemes of €172 million, private matching of €181 million)
- Private actors are part of the Mission Innovation Teams, prioritizing innovation efforts within the Mission Oriented Innovation Programs. 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 new 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 creation of the 'Growth Fund', an investment fund to enhance the structural growth of Dutch economy. This fund will focus on education, labor, research, innovation and large transitions in for example energy, industry and agriculture.

- The Dutch declaration of intent on knowledge and innovation (KIC), in which both public and private actors specify their intended contribution to the Dutch mission oriented Topsector policy. This amounts to roughly €355 million public funds[90] and €590 million private funds per year on climate and energy innovation.

Major activities in support of the Innovation Challenges in 2020/21

In 2020/2021 activities from the first phase of MI have been further developed. These are the **ACT ERA-net cofund call** (IC3), the development of a **Comfort climate box** (IC7), and the development of the first **European Hydrogen Valley** (IC8).

Furthermore, The Netherlands has contributed to the mission proposal for bio-economy, related to our activities in IC4.

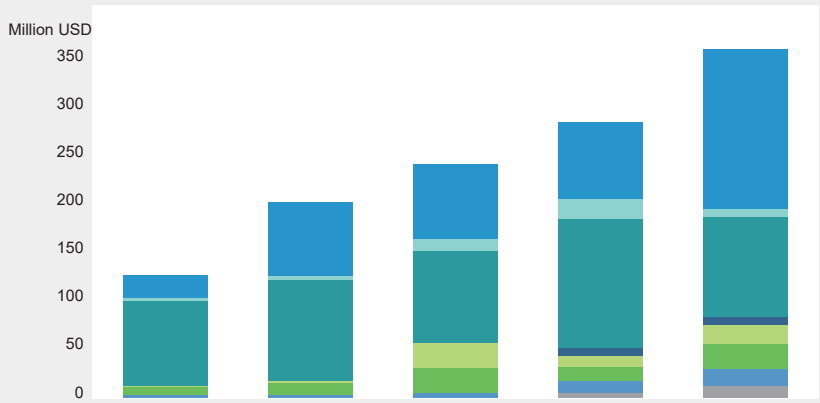
Moreover, The Netherlands supports a proposal of India that will be discussed during MI-6: a multilateral call on aviation biofuels; in line with IC4 and the mission-proposal for bio-economy. This call could be launched in July. The Netherlands aims to contribute through a national funding scheme of €3.5 million.

Other Mission Innovation related activity in 2020/21

The Netherlands has participated in the 2020 MI Champions program.

The Netherlands has developed a draft proposal for their commitment to the missions and the platform of the second phase of MI. Furthermore, we have managed to reserve yearly funding for the MI-Secretariat.

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year	Third Year	Fourth Year
Energy Efficiency	20.16	68.45	69.48	70.39	147.61
CCS	1.25	2.51	12.64	18.68	7.97
Renewables	80.52	94.99	85.08	119.70	92.60
Nuclear Fission & Fusion	-	-	-	7.40	7.97
Hydrogen & Fuel Cells	0.34	1.03	21.64	9.68	16.29
Other Power & Storage Technologies	8.20	11.28	23.69	15.26	25.63
Other Cross-cutting Technologies/ Research	3.42	4.33	5.13	9.68	14.35
Unallocated	-	0.11	0.68	5.69	12.19
TOTAL	**113.9**	**182.7**	**218.3**	**256.5**	**324.6**

[90] This budget contains some elements that are not reported via the IEA (for example circular economy). Therefore it is somewhat higher than the reported budget in answer to question 1 of this survey.

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
United States	Statement of Intent (SOI) NL-US	Statement of intent to collaborate with focus on green hydrogen. In the process of identifying potential other topics, such as AI/quantum and clean tech/efficiency.	Public – private	RD&D	2020 - 2025		
India and other MI- members	Multilateral call on aviation fuels	Proposal of India to be discussed during MI-6: a multilateral call on aviation fuels; in line with IC4 and the mission-proposal for bio-economy	Public – private	RD&D	2021 - 2025	€3,5mln budget for a national subsidy scheme	
Denmark	Memorandum of Understanding (MoU) NL-DK	MoU on cooperation in the Energy Transition, signed June 2020. The objective of this MoU is to establish a framework for mutually beneficial cooperation between the Participants in the field of the implementation of the Paris Agreement, the European Green Deal and the global energy transition	Public – public	Research	2020		
Denmark	Additional Memorandum of Understanding (MoU) NL-DK	In December 2020 the Netherlands and Denmark have signed an additional MoU allowing national grid operators Tennet, Gasunie and Energinet to continue undertaking research under the North Sea Wind Power Hub Programme into a joint energy hub in the North Sea	Public – public	Research	2020	The research under the NSWPH programme is co-financed by the Connecting Europe Facility of the European Union	
Germany	Call to action NL-DE	The call to action is a follow-up on the MoU signed in 2019 between the two countries and it pinpoints where the interesting leads are for public-private collaboration. The MoU on energy collaboration was meant to underline the cooperation in the field of the energy transition, including research and innovation by means of bilateral or multilateral research projects. Furthermore, in January 2021 both countries have signed the innovation pact in the field of an innovative and sustainable industry. In 2021 a joint call for research on electrochemical conversion and materials is foreseen	Public – private	Research	2019	5M€ (budget for research in the Netherlands in the joint ECCM call)	

REPUBLIC OF KOREA

High impact innovation activity triggered by MI

Korea clean energy technology R&D investment in the public sector in 2021 is about 1,132.6 billion KRW, 106% up since 2016.

This includes the government budget of 860 billion won increased by 89.6% since 2016 and state-owned company budget is 270 billion won, increased by 152.6% since 2016.

Update on clean energy innovation policies and strategies

In December 2020, the Korean government announced '2050 Net-zero strategy' in order to actively respond to the era of global economics transition toward Net-zero.

Three major policy directions have been established: Low carbonization of the economic structure, creation of an ecosystem for low carbon industries, and fair transition to a Net-zero society. The foundation of a Net-zero system will be strengthened.

1. Acceleration of energy transition
2. Innovation of high-carbon industrial structure
3. Transition to future mobility
4. Low carbon in city and land
5. Fostering of new industry
6. Establishment of innovative ecosystem
7. Activation of circulation economy
8. Protection of vulnerable industrial levels
9. Realization of region-oriented net-zero
10. Increase public awareness of net-zero society

Major innovation initiatives and programmes in 2020/21

Ministry of trade, Industry, and Energy plans to increase the investment in energy R&D continuously.

In 2020, the government invested 956.6 billion KRW in strengthening renewable energy competitiveness, efficient energy consumption by technology convergence, improving system reliability, and building infrastructure.

Accomplished in commercializing floating solar PV, development and commercialization of the 4.3M wind-power system, and the world's first 500kV scale HVDC cable technology.

In 2021, the MOTIE plans to invest 1,132.6 billion KRW in energy R&D in which has increased by 19% from last year.

Private sector engagement in 2020/21

On September 2020, MOTIE announced 'Energy innovative company support strategy' to foster new business models and revive the new energy industry system.

The government sets six promising fields and established three supporting strategies considering the systematic change in the energy industry, the company capacity and potential, and political direction.

Six promising fields: Solar PV Management, Distributed Generation Virtual Power Plant, Wind Power supporting Service, Electric Vehicle Battery Service, Material and Parts of Energy Industry, Management of Building Energy Efficiency.

Three supporting strategy: Supporting Tech R&D, Fostering Private Investment, Establishing the Framework of Support

On March 2020, KETEP and other organizations founded 'Technology Innovation Fund' on the scale of 280 billion KRW to actively support strengthening industrial competitiveness of small and medium enterprises.

KETEP (Korea Institute of Energy Technology Evaluation and Planning), KEIT (Korea Evaluation Institute of Industrial Technology), and KIAT (Korea Institute for Advancement of Technology) cooperate as the specialized agencies, and Industrial Bank of Korea, Shinhan Bank cooperate as the specialized banks.

The cooperators sets Korea Growth Investment Corporation, manages the Technology Innovation Fund and invests a proper amount of money in small and medium enterprises that need R&D funding.

Major activities in support of the Innovation Challenges in 2020/21

Korea has been participating in the Innovation Challenges, a group of experts in clean energy technology, since November 2016 to clarify the implementation of Mission Innovation.

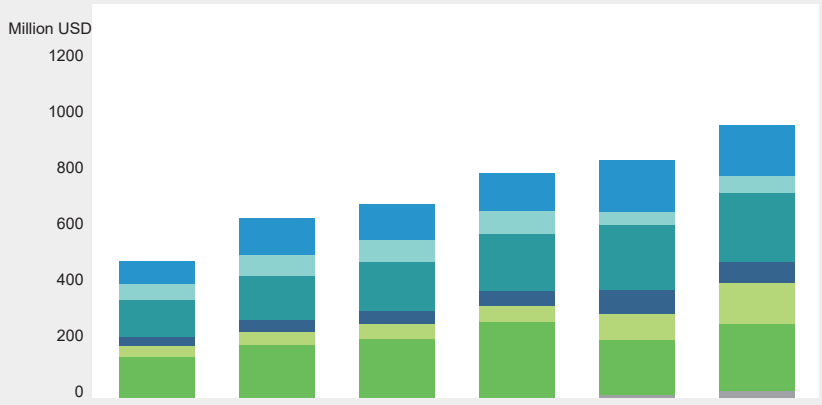
Since the 4th MI Ministerial meeting in Canada, Korea declared its participation in the Hydrogen IC and participated in 6 of the total 8 ICs.

The MOTIE funds MI-oriented international joint research projects from Dec 2018 to Jan 2021. The budget is around $1 million per project every year.

This is delivered in cooperation with the USA, Canada, Germany, and India.

The government funds a total of eight projects in the field of innovation challenges and conducting various activities such as joint workshops, manpower dispatch, joint thesis discussion, research sample exchange, and demonstration plant visits.

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Energy Efficiency	76.35	127.22	128.20	128.20	177.00	180.42
CCS	55.90	70.90	72.13	76.65	49.65	55.53
Renewables	128.99	157.63	175.75	201.74	226.85	246.61
Nuclear Fission & Fusion	31.38	35.36	41.42	44.86	84.21	68.44
Hydrogen & Fuel Cells	37.57	43.34	46.03	58.15	88.49	139.90
Other Power & Storage Technologies	144.80	189.76	213.49	268.92	197.32	235.29
Other Cross-cutting Technologies/ Research	-	-	-	-	-	-
Unallocated	-	-	-	-	7.21	27.42
TOTAL	**475.0**	**624.2**	**677.0**	**778.5**	**830.7**	**953.6**

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
China	Bilateral Call for Key technology and demonstration of distributed CHP from biomass gasification combined with fluidized bed electrode SOFC system	Fabricating the combined Heat and Power system using dual fluidized-bed gasification with fluidzed bed electrode solid oxide fuel cell. Dual fluidized -bed gasifier realizes the low N2 contents in producer gas and supplies Heat energy to fuel cells operating temperature. Tar remover cleans the producer gas suitable to Fuel Cell and CO_2 absorption technology reduces CO_2 emissions.	Public-Public	Demonstration	2020 to 2023	KRW 1,320,000,000	
India	Bilateral Call for Development of microgrid-linked solid oxide fuel cell system using diesel fuel	Developing reformer that can eliminate the harmful emissions of diesel & produce clean fuel. Generating clean, highly efficient and reliable electricity using solid oxide fuel cells. Testing proof of concept system (SOFC-3kW+SolarPV-2kW+Battery-10kWh) under simulated load conditions of rural micro-grid in laboratory conditions.	Public-Public	Development	2020 to 2022	KRW 500,000,000	

SWEDEN

High impact innovation activity triggered by MI

Mission Innovation gives increased weight to national efforts on clean energy research and innovation through the synergies of ambition and objectives.

It adds interest and opportunities for visibility for start-ups, innovation and new products and services.

MI shows the state and pace of clean energy innovation and demonstrates the needs for Swedish researchers, companies and other actors to be part of the development, as well as the global demand for new solutions.

Update on clean energy innovation policies and strategies

The Energy R&I programme continues; the 2021 budget is 1,515 million SEK.

The Industry Leap programme supports pilot studies, research, demonstration, and investment to decrease greenhouse gas emissions from industry, to achieve net-zero emissions and to strategic industry projects contributing to climate mitigation. The 2021 budget is 750 million SEK.

The government has launched work on a national strategy for electrification of industry and transport with a 2045 perspective.

An electrification commission was established to advice the government on a quicker electrification of the transport sector

The Swedish Energy Agency has initiated a programme for pilot and demonstration projects with annual calls.

The Swedish Energy Agency supports the creation of an electromobility test centre, to open in March 2023. The agency also supports special efforts in electromobility research broadly, e.g. on batteries, fuel cells, charging, shipping, aviation, and machinery.

Sweden participates in a European Important Project of Common European Interest (IPCEI) called European Battery Innovation.

The Swedish Energy Agency supports a special R&I effort for aviation biofuels or electric aviation with a funding of 50 million SEK 2021 and 50 million SEK 2022.

A special R&D effort of 50 million SEK 2021 and 50 million SEK 2022 on construction equipment, tractors, excavators etc.

Major innovation initiatives and programmes in 2020/21

The Swedish Energy Agency continues to support Small and Medium Enterprises for product development and commercialisation. An evaluation from 2020 shows that portfolio companies increase their revenue and their numbers of employees in a promising way.

The Swedish Energy Agency is one of the leaders for the new European partnership Clean Energy Transition to be part of the coming Horizon Europe framework programme on RD&I.

Sweden has taken an active position in the planning for the EU Mission on Climate-Neutral and Smart Cities through its Strategic Innovation Programme Viable Cities. In December 2020, the first climate contracts in Europe were signed by nine Swedish cities, four Swedish government agencies and Viable Cities, meaning that the cities must reach their set climate goals and contribute sustainable, climate neutral cities by 2030.

In the budget bill for 2021, the Swedish government proposed a system of state credit guarantees for green investment projects. The proposal aims to enable large industrial investment projects in Sweden that contribute to achieving environmental goals and the climate policy framework. In 2021, the credit guarantees amount to a maximum of 10 billion SEK.

The Swedish Energy Agency has been asked to develop a hydrogen strategy.

A support scheme for vehicle charging stations has a budget of 500 million SEK in 2021 and 550 million SEK in 2022; including support for regional electrification pilots, where local governments and companies collaborate to establish pilot projects for electrification of goods transport.

Private sector engagement in 2020/21

A large part of the national energy research and innovation programme is implemented in collaboration with the industry and business sector.

This includes applied research programmes, centres, and consortia, as well as specific development, pilot, and demonstration projects.

The overall financing of the programme is 45 % by the Swedish Energy Agency and 55 % for industry and others.

Some high-profile projects of the latter type include the Hybrit fossil free steel project, the NortVolt batter development and production plant, the development and demonstration of electric roads (ElvägE16 and eRoadArlanda), a successful demonstration of electrified trucks for copper or at the Aitik copper mine, as well as a major RD&D effort to develop application and uses for the lignin, a rest product from the forest industry.

Also, a number of innovative start-ups supported by the Energy Agency have had considerable success:

- The Swedish innovative company Exeger, which produces solar cell products, has received capital investment of more than 200 million SEK during the last year.
- The Swedish company Climeon has received investments from the Breakthrough Energy Ventures and are now building baseload renewable electricity generation plants in in Japan, California and on Iceland.
- The Swedish MI Champion company Azelio is seeing a large interest in their energy storage technology.
- The Swedish financing company Trine has so far funded solar projects around the world for about 450 million SEK, giving almost 3 million persons access to clean electricity.

Major activities in support of the Innovation Challenges in 2020/21

Sweden has participated in the IC#5 on Solar fuels, and the IC#7 on affordable heating and cooling. In addition, Sweden has taken a leading role in the joint programming activities of the MI Call, and in the Net-Zero Compatible Innovations Initiative.

Sweden participated in the 2020 second cohort of Champions.

Other Mission Innovation related activity in 2020/21

Sweden has during 2020 participated in the MI Steering Committee and in the Analysis and Joint Research working group (AJR).

Public sector RD&D investment

*All amounts are in million USD	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Energy Efficiency	-	-	-	-	-	-
CCS	-	-	-	-	-	-
Renewables	-	-	-	-	-	-
Nuclear Fission & Fusion	-	-	-	-	-	-
Hydrogen & Fuel Cells	-	-	-	-	-	-
Other Power & Storage Technologies	-	-	-	-	-	-
Other Cross-cutting Technologies/ Research	-	-	-	-	-	-
Unallocated	14.55	13.14	21.61	23.34	23.34	25.73
TOTAL	**14.5**	**13.1**	**21.6**	**23.3**	**23.3**	**25.7**

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
IC7, IEA HPT, IEA ES ; 7 countries	Comfort & Climate Box	NL leading with SE Co-lead CCB project on speeding up market development for integrating heat pumps and storage packages. CCB concept denotes a combined package, consisting of a Heat Pump, an Energy Storage Module and Controls.	Public-private	Research, development, demonstration and innovation	2019 – 2021	2,6 MEUR total, 400 000 EUR SE budget	https://heatpumpingtechnologies.org/annex55/
SE, AT, DE, DK, FI, IN, UK, IT	MICall	Joint R&D call for projects on energy storage solutions	Public-private	Research, development, demonstration and innovation	Q2 2019 to Q4 2023	€22.5M total, €2M SE budget	https://www.eranet-smartenergysystems.eu/Calls/SG_Plus_Calls/SG_Joint_Call_2019
EU countries	Battery 2030+	SE coordinates EU Large-scale Research Initiative on battery research https://battery2030.eu/	Public-public; public-private	Large-Scale, Long-Term Research	2019 - ongoing		https://ec.europa.eu/digital-single-market/en/news/battery-2030-inventing-batteries-future
IC5, EC; 8 MI countries.	SUNRISE merging efforts with CSA ENERGY-X to the joint initiative on SUN-ERGY	SE participates in EU Large-scale Research Initiative on the production of fuel and chemicals from sunlight. https://sunriseaction.com/	Public-public	Large-Scale, Long-Term Research	2019 to 2020 (first step)	€1M from the EC	https://docs.wixstatic.com/ugd/8993fb_d548a65940774debabf4645423c6f83a.pdf
SE, EC, India et al	Net-Zero Compatible Innovations Initiative / Avoided emissions framework	Project supporting efforts to limit the global temperature increase to 1.5 degrees Celsius, including the development of an avoided emissions framework that provides guidance for how to quantify the potential for clean energy innovations to reduce emissions in society.	Public-private	Analysis, research	2018 - ongoing		

UNITED ARAB EMIRATES

Update on clean energy innovation policies and strategies

Energy Strategy 2050: In 2017, the UAE launched 'Energy Strategy 2050', which is considered the first unified energy strategy in the country that is based on supply and demand. The strategy aims to increase the contribution of clean energy in the total energy mix 50% by 2050 and reduce carbon footprint of power generation by 70%. It also seeks to increase consumption efficiency of individuals and corporates by 40%.

The national DSM program has been developed with the target of 40% reduction in energy and 50% reduction in water over business as usual by 2050. Significantly the proposed DSM program balances between the needs of each Emirate, with the requirement of consistency and alignment to support lower costs, investment, and sustainability.

The proposed DSM program targets four key areas of focus - "pillars"- as having the greatest potential for impact:

1. Agriculture – Paradigm shift from unsustainable abstraction of groundwater to sustainable management of groundwater, by balancing water and food security requirements, promoting efficient irrigation, and using alternative water resources.
2. Built Environment – Optimizing energy and water efficiency within the urban environment through increased phasing in of green building, retrofitting existing building stock, replacing fixtures and equipment and improving public and private irrigation practices.
3. Industry – Fostering responsibility and accountability within industry through regulatory and transparency requirements to encourage efficiency, sustainability and implementation of best practice to drive energy efficiency.
4. Transport - It is noted that the Transport Element may be held from implementation pending alignment with the forthcoming UAE Transport Strategy due to be released in 2019.

National Climate Change Plan 2050: National Climate Change Plan of the UAE 2017–2050 is the UAE's comprehensive framework to address the causes and impacts of climate change, plan the transition into a climate resilient green economy and achieve a better quality of life. The primary objectives of the Climate Plan are to: manage greenhouse gas (GHG) emissions while sustaining economic growth, minimise risks and improve capacity of adaptation to climate change, and enhance the UAE's economic diversification agenda through innovative solutions.

National Strategy for Advanced Innovation: In February 2018, the UAE government approved the National Strategy for Advanced Innovation. The new strategy is the updated version of the National Innovation Strategy and marks a new phase that is based on enabling people to shift from focusing on vital sectors to the goals and outcomes in seven areas: exploration, future skills, quality of health, living and life, green power, transport, harnessing technology to serve humankind.

The innovation strategy aims to position the UAE among the world's top leaders of innovation and to develop a type of thinking that encourages experimentation and taking well-thought-out risks to achieve the goals of UAE Centennial 2071.

National Advanced Sciences Agenda 2031: In April 2018, the UAE government launched the National Advanced Sciences Agenda 2031 and the 2021 Advanced Science Strategy, which falls under the Agenda 2031. The 2031 Agenda aims to utilize advanced sciences in the development and creation of solutions to future challenges and support the government's efforts to achieve the objectives of Vision 2021 and Centennial Plan 2071 through three consecutive strategies starting with 2021 Advanced Science Strategy. The 2031 Agenda sets out eight scientific priorities up to 2031 and 30 scientific targets up to 2021. The eight scientific priorities aim to make the most of all strategic natural resources in the country through: national capacity-building, promoting the sustainable energy sector, enhancing water security using advanced and clean technology, developing advanced scientific food security system, addressing health challenges in the UAE through a national scientific system, developing advanced industries sector, building a system of logistical support based on scientific studies and data, creating a strategic industries complex.

The new strategy from the Ministry of Industry and Advanced Technology ''Operation 300billion'', seeks to fortify the nation's well-established industries like petrochemicals, metals and advanced machinery and equipment, while stimulating new levels of productivity and performance in strategic sectors like healthcare and food security. The Strategy will pay special focus on unleashing a wave of locally driven future industries such as space, medical technologies, and hydrogen. The strategy aims to more than double the industrial sector's GDP contribution to AED300 billion by 2031 and elevate the UAE's status to a global hub of unrivalled industrial expertise.

Major innovation initiatives and programmes in 2020/21

The UAE government and XPRIZE will invest $81 million towards research and development of new technologies as part of the Ghadan 21 programme. The programme will direct $13.6 billion to accelerate the Abu Dhabi economy through digital technologies, new business models and partnerships with local, regional and international players in various industries. The $81 million Ghadan investment will be directed towards research and development of solutions to address water scarcity, energy efficiency, food security, artificial intelligence, human ageing, and environmental conservation.

In 2017, Abu Dhabi fund Mubadala announced plans for its Aerospace, Renewables & ICT platform to invest a further AED82.5 million ($22.4 million) in research and development (R&D) over the next five years.

Solar Decathlon Middle East is a collegiate competition of 10 contests that challenge students to design and build solar-powered houses. On June 17, 2015, the Dubai Supreme Council of Energy, Dubai Electricity and Water Authority, and the U.S. Department of Energy signed an agreement to collaborate on the development of Solar Decathlon Middle East (SDME 2018-2020), a competition that will integrate unique local and regional characteristics. In 2018, 18 university teams from 16 countries competing at Solar Decathlon.

In 2014, DEWA launched the R&D Centre in Mohammed bin Rashid Al Maktoum Solar Park, which focuses on four key operations: producing electricity using solar energy, integration of smart grids, energy efficiency, and water. 500 AED million is being dedicated towards the R&D and the Centre will be ready in 2020.

From its inception in 1971 up to December 2018, Abu Dhabi Fund for Development (ADFD), the leading national entity for international development aid, has financed hundreds of development projects in the renewable energy sector around the world worth AED4.4 billion (US$1.187 billion). Driving the objectives of the United Nations' Sustainable Development Goals (SDGs), these projects have contributed to the production of about 2,584 MW of renewable energy in different countries. Since 1974, ADFD has contributed to financing about AED2.7 billion (US$737 million) in renewable energy projects through joint financing agreements with the governments of many developing countries. The remaining funds were allocated through innovative and strategic partnerships including the seven-cycle AED1.285 billion (US$350 million) IRENA/ADFD Project Facility, the AED183.4 million (US$50 million) UAE-Caribbean Renewable Energy Fund (UAE-CREF), as well as the UAE-Pacific Partnership Fund (UAE-PPF) valued at AED183.4 million (US$50 million). In addition to supporting sustainable development in key socio-economic sectors, ADFD has funded important renewable energy projects. Notable projects include:

Sheikh Zayed Solar Power Complex in Jordan

In line with the Jordanian government's objective of generating 20 per cent of energy from renewables by early-2020, ADFD contributed AED550 million (US$150 million) to funding the Sheikh Zayed Solar Power Complex. The project involved the installation of 328,320 photovoltaic panels that will produce 227 GWh of solar power annually over a period of 20 years, enough to illuminate about 50,000 homes.

Project works included the provision of electrical switches, a medium voltage and signal cable system, transformers and all required equipment to connect the plant to the national power grid. The support also covered civil construction works, roads and safety systems as well as overall project operation and management.

The plant contributed to the creation of about 1,000 jobs during the construction phase and is set to provide 30 permanent jobs for its sustained operation and maintenance.

Upper Atbara and Setit Dam Complex in Sudan

ADFD allocated a US$90 million concessionary loan and contributed to the construction of the Upper Atbara and Setit Dam Complex in Eastern Sudan. With a storage capacity of 2.7 billion cubic metres of water, the twin dams provide the hydroelectric power plant with enough power to generate 320 megawatts of electricity.

Merowe Dam in Sudan

ADFD provided AED735 million for the construction of the Merowe Dam in north Sudan. One of the largest hydropower projects in Africa and the second major hydropower project in Sudan, this strategic project helps the country fill its power deficit by producing electricity totalling 1,250 megawatts – benefitting more than 30 million people.

Located nearly 350 km north of the capital Khartoum, the dam is about 1.1 km across the river and is 9 km long and 60 metres tall. The project included all the necessary civil works including the power plant to accommodate 10 generators, each with a capacity of 125 megawatts, and the electromechanical works. The works also comprised the transmission lines and connectivity to the national grid.

Waste-to-energy facility in the emirate of Sharjah

ADFD allocated an AED121 million (US$33 million) concessionary loan for the development of a waste-to-energy facility in the emirate of Sharjah.

Expected to treat more than 300,000 tonnes of municipal solid waste (MSW) each year, or 37.5 tonnes per hour, the plant will have the capacity to generate around 30 megawatts of energy. Due for completion by early 2021, the facility aims to help attain Sharjah's zero-waste-to-landfill target and the UAE's objective of diverting 75 per cent of its municipal solid waste from landfills by 2021.

Producing electricity using wind power in Seychelles

In the Republic of Seychelles, ADFD allocated AED103 million (US$28 million) to produce clean electricity using wind turbine technology.

Known for being costly to operate and maintain as well as harmful to the environment, diesel-powered electrical power plants were replaced with wind power. This project included the supply, installation and activation of wind turbine farms for electric power generation in several different areas of the island of Mahé.

Eight farms were built to generate between 4 to 6 MW of electrical power. The project also included maintenance and the development of the transmission network, as well as technical services for the studies of wind power and project management.

IRENA/ADFD Project Facility

In 2013, ADFD committed US$350 million over seven funding cycles for the IRENA/ADFD Project Facility. After the announcement of the sixth funding cycle in January 2019, the cumulative funding to date is US$245 million. The Facility helps developing countries access low-cost capital for renewable energy projects to increase energy access, improve livelihoods and advance sustainable development.

Since the selection of projects for the first cycle in 2014, ADFD's funding has benefitted 24 renewable energy projects in 23 countries, covering up to 50 per cent of the total project costs. They will bring more than 157 megawatts of renewable energy capacity online and create electricity access for over seven million people, significantly improving their livelihoods. Spanning Asia, Africa, Latin America and Small Island Developing States, the projects encompass a broad spectrum of renewable energy sources – wind, solar, hydro, geothermal and biomass – and technologies.

In 2019, the sixth cycle of this Project Facility has approved projects worth $31 Million USD with the following projects:

In **Guyana**, a project will receive a loan of US$8 million to install 5.2 megawatt (MW) grid-connected solar PV systems in the hinterland regions to reduce fossil fuel consumption and increase the reliability of electricity supply. An estimated 34,700 people in the target areas will benefit and around 120 direct and indirect jobs are set to be created throughout the project lifecycle.

In **Liberia**, the loan of US$8 million will contribute to the construction of a 2.1 MW run-of-river hydropower plant on the Gee River. The project will benefit over 30,000 people through providing a clean, reliable and affordable source of energy to households, schools, health facilities and small businesses, enhancing living conditions and helping to reduce poverty.

In **Togo**, a 30 MW grid-connected solar PV plant will be constructed with the investment of a US$15 million loan. The project aims to bring clean, reliable power to around 700,000 households and small businesses and reduce greenhouse gas emissions by 9,242 tonnes/year. Local communities will benefit from greater access to drinking water, education and healthcare as well as job creation that prioritises women.

UAE-Caribbean Renewable Energy Fund (UAE-CREF)

Launched at Abu Dhabi Sustainability Week 2017, UAE-CREF aims to deploy renewable energy projects with a capacity of 11 MW in 16 Caribbean countries to help reduce reliance on fossil fuel imports, stimulate economic activity and enhance climate change resilience. The fund is also a testament to the UAE's efforts to advance the UN Sustainable Development Goals.

At Abu Dhabi Sustainability Week 2019, the third cycle of the US$50 million UAE-Caribbean Renewable Energy Fund (CREF), was allocated to projects delivered in Jamaica, Cuba, Suriname, Trinidad & Tobago.

UAE-Pacific Partnership Fund (UAE-PPF)

ADFD earmarked US$50 million in funding to the UAE-Pacific Partnership Fund (UAE-PPF), a pillar of the UAE's wider strategy to support sustainable development projects around the globe through the deployment of renewable energy, with the supervision of the UAE's Ministry of Foreign Affairs and International Cooperation. Abu Dhabi Future Energy Company, Masdar was appointed to develop and implement renewable energy projects in 11 countries under UAE-PPF.

The first cycle of UAE-PPF funding enabled the completion of small-scale solar and wind power projects in Kiribati, Fiji, Samoa, Tonga, Tuvalu and Vanuatu. The project deliverables included cyclone-proof wind turbines and space-optimising solar power solutions. In some cases, the installed projects met as much as 50% of local power requirements.

In May 2016, phase 2 of UAE-PPF supported the delivery of renewable energy projects in the Solomon Islands, Nauru, the Marshall Islands, Palau and the Federated States of Micronesia – with a combined power generating capacity of 3.25 megawatts, displacing more than 4,000 tonnes of carbon dioxide annually, and reducing diesel imports by as much as 1.5 million litres per year.

In 2019, the Abu Dhabi Sustainable Finance Declaration (the Declaration) was signed by 25 public and private sector entities at the inaugural Abu Dhabi Sustainable Finance Forum (ADSFF) on 16 January as a united front to foster positive economic, social and environmental impacts and advocate sustainable finance and investments for the long-term well-being and growth of the country's economy.

UAE is host to the world's largest battery bank in Abu Dhabi, with a capacity of 108 megawatts distributed over 10 sites across the emirate. We believe storage has tremendous potential in the long term.

In 2019, DEWA launched its first Smart Grid Station (SGS) which comprises a 200-kilowatt (kW) photovoltaic solar power production system; a 9-kilowatt (kW) wind turbine; and a 500-kilowatt hour (kWh) lithium-ion battery energy storage system, which stores energy for later use. The station also includes over 2,000 sensors based on the Internet of Things (IoT) technology, and smart meters distributed throughout the facility to monitor power and water demand data in real-time for the purpose of improved energy and water management, with the potential to reduce demand when required by eliminating non-critical loads through smart lighting, smart power outlets, and smart air conditioning system.

Masdar and Beeah launched the Bee'ah Waste Management Center in Sharjah, the new plant will process more than 37.5 tonnes of municipal solid waste (MSW) per hour to generate electricity sustainably. Once operational, it will contribute significantly to reaching the UAE's target of diverting 75 per cent of its solid waste from landfills by 2021, as well as Sharjah's zero-waste-to-landfill goal.

The Dubai Centre for Waste Processing, located in the Warsan area, will treat 5,666 tonnes of municipal solid waste produced by Dubai per day. A total of 1,900,000 tonnes of waste per year will be converted into renewable energy. The approximate 200 MW of electricity generated will be fed into the local grid as clean energy. The facility will have the capacity to process up to 45 per cent of Dubai's current municipal waste generation, significantly minimising the volume of municipal waste in landfills.

Emirates Water and Electricity Co. and Abu Dhabi Waste Management Center (Tadweer) have launched a competitive tender for the development of a greenfield waste-to-energy independent power project (IPP). The plant will be located near the existing Al Dhafra landfill in Abu Dhabi, will have an expected processing capacity of between 600,000 and 900,000 mt/year of waste. Under this plan, it will generate enough electricity to power up to 22,500 households in the UAE, which would make it one of the largest waste-to-energy facilities in the region.

The Al Dhafra Solar Photovoltaic (PV) facility is located about 35 kilometers from Abu Dhabi city, and will supply power to Emirates Water and Electricity Company (EWEC). Once operational, it will be the world's largest single-site solar power plant, using approximately 4 million solar panels to generate enough electricity for approximately 160,000 homes across the UAE. The plant will reduce carbon dioxide emissions by 2.4 million metric tonnes annually - equivalent to taking out 470,000 cars from the roads.

On its completion, the fourth phase of the Mohammed bin Rashid Al Maktoum Solar Park, that Dubai Electricity and Water Authority (DEWA) is building, will have the largest energy storage capacity in the world of 15 hours, allowing for energy availability around the clock. This phase will provide clean energy for 320,000 residences and will reduce 1.6 million tonnes of carbon emissions a year. The 950MW 4th phase is the largest investment project in the world that combines Concentrated Solar Power (CSP) and photovoltaic solar power with investments totalling AED15.78 billion based on the Independent Power Producer (IPP) model. It uses three hybrid technologies to produce clean energy: 600MW from a parabolic basin complex (three units of 200MW each), 100MW from a solar power tower (based on Molten Salt technology), and 250MW from photovoltaic solar panels.

The UAE is pursuing a peaceful nuclear energy program that upholds the highest standards of nuclear safety, security, operational transparency and non-proliferation. Once all four units of the plant are commercially operating, the UAE's Barakah Nuclear Energy Plant will produce up to 25 percent of the country's electricity requirements while in parallel preventing the release of 21 million tons of carbon emissions each year (this is equivalent to removing 3.2 million cars off the roads annually). The 1400 MW Unit 1 is now providing constant, reliable, and sustainable electricity.

The UAE's disbursement to SDG 7 was AED 3.06 billion (USD 832.9 million) towards this cause – expanding renewable energy and increasing electrification.

Private sector engagement in 2020/21

As co-leads of the Affordable Heating and Cooling in buildings Challenge along with the United Kingdom and the European Commission, the UAE is proud of the progress of this challenge which comes as a result of the efforts of the co-leading countries as well as India, Sweden and Australia, who have provided substantial support along with the member countries that have actively participated.

The UAE is pleased to have hosted the first workshop for IC7 which was held in November last year in its capital, Abu Dhabi. This IC7 workshop brought together 70 international experts from 13 countries to discuss the priority areas in Heating and Cooling and develop ideas and actions moving forward. The workshop provided the necessary platform for experts to discuss ideas for technological advancements and resulted in innovative ideas and research actions that aim for the development of commercially viable solutions.

The UAE is championing one of the main priority areas under IC7; Alternative Heat Sinks and Sources.

A conference call was hosted by the UAE in April 2019 to discuss progress and actions moving forward with different member countries.

Public sector RD&D investment

*All amounts are in million USD	Baseline	First Year
Energy Efficiency	-	-
CCS	-	-
Renewables	-	-
Nuclear Fission & Fusion	-	-
Hydrogen & Fuel Cells	-	-
Other Power & Storage Technologies	-	-
Other Cross-cutting Technologies/ Research	-	-
Unallocated	10.00	12.20
TOTAL	**10.0**	**12.2**

UNITED KINGDOM

High impact innovation activity triggered by MI

Power Forward Challenge: UK-Canada joint challenge on smart energy systems innovation

This £11 million funding competition, being jointly run by the UK and Canada, is supporting innovative and disruptive proposals for smart energy systems. The competition resulted from UK and Canada understanding shared priorities, which was developed through MI. Seven finalists were selected in June 2019, with £1.8 million made available to each finalist to build demonstration projects for submission in October 2021. The winner will be announced by Spring 2022.

Update on clean energy innovation policies and strategies

In June 2019 the UK became the first major economy to legally commit the UK to reaching Net Zero by 2050. To support this commitment, the UK's Ten Point Plan for a Green Industrial Revolution was announced in November 2020, outlining a broad set of policy measures to drive the UK to net zero. This included announcing a new £1 bn net zero innovation portfolio to accelerate commercialisation of innovative low-carbon technologies, systems and business models from 2021-2025.

The net zero innovation portfolio is double the £505 million Department for Business, Energy and Industrial Strategy's (BEIS) Energy Innovation Programme, which formed part of the UK's Clean Growth Strategy in 2017. The UK now expects to have invested more than £3bn in low carbon energy innovation between 2015 and 2021, exceeding the £2.5bn set out in the Strategy. This includes funding from UK Research and Innovation and department-specific funds, including Department for Transport and the Foreign, Commonwealth and Development Office.

The UK also committed to doubling its International Climate Finance to at least £11.6 billion between 2021 and 2025 at the Climate Ambition Summit in December 2020, which was convened by the United Nations, the United Kingdom, and France, alongside partners Chile and Italy. The increased funding will enable a step-change in the UK's impact long-term and support COP26 objectives short-term, with a key focus being unlocking affordable and clean energy.

Major innovation initiatives and programmes in 2020/21

The UK's Ten Point Plan for a Green Industrial Revolution included announcement of a new £1 billion Net Zero Innovation Portfolio, aiming to set the UK on the path to Net Zero. The portfolio will accelerate the commercialisation of innovative low-carbon technologies, systems and business models in power, buildings and industry over the next four years.

Further UK initiatives include:

- Launching the first phase of a £100 million investment in brand-new Greenhouse Gas Removals including Direct Air Capture in November 2020.
- Commitment to provide £100 million for Energy Storage and Flexibility innovation challenges, which will focus on long-term energy storage.
- A £50 million UK International Climate Finance Programme – (the Clean Energy Innovation Facility) which aims to accelerate innovative clean technologies in key sectors in developing countries.
- The Climate Finance Accelerator, with the full programme being launched in November 2020. This supports development of a pipeline of bankable, low-carbon projects, with pilot activities in Mexico, Colombia and Nigeria between 2017 and 2019.

Private sector engagement in 2020/21

Clean Growth Fund – In May 2020 BEIS launched the Clean Growth Fund, a £40 million Fund that combines a £20 million investment from BEIS' Energy Innovation Programme, alongside £20 million from a private sector investor. The Fund is commercially run and is managed by Clean Growth Investment Management LLP (CGIM). The Fund aims to accelerate the deployment of innovative clean technologies that reduce greenhouse gas emissions, alongside catalysing the UK clean growth venture capital market and leveraging private sector funding into early-stage clean tech start-ups.

Energy Entrepreneurs Fund – The 8th round of the Energy Entrepreneurs Fund closed for applications on 30th March 2021. £11 m of grants are available to support the development of technologies, products and processes in energy efficiency, power generation and storage, with successful applicants expected to kick off projects in July and August 2021. To date, the fund has given £72 m of grants to 156 companies, who have raised more than £500m in private investment.

UK Research and Innovation has also awarded many millions of pounds in grants to the private sector for clean energy innovation. Precise allocations are difficult to disaggregate given the way the competitions were structured. They include £32 million for round 7 of the Energy Catalyst competition and £8 million for Industrial Strategy Challenge Fund Decarbonisation of Industrial Clusters.

Major activities in support of the Innovation Challenges in 2020/21

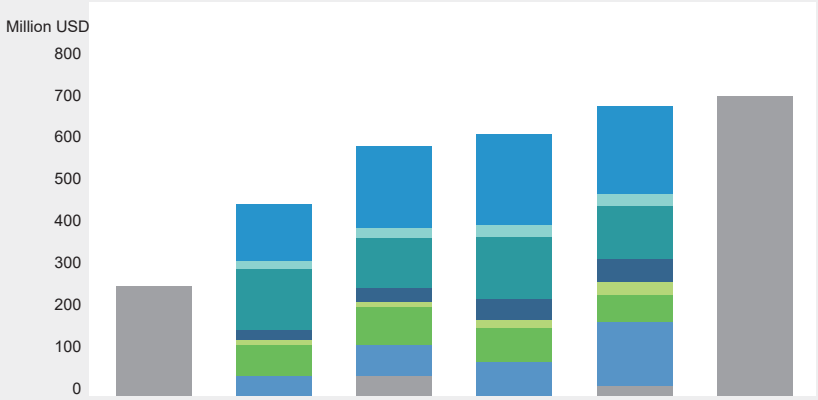
IC5

Converting Sunlight - The UK IC5 leadership has played a key role in the development of the IC5 roadmap for Sunlight Conversion, which has included co-leadership of four international workshops to establish global consensus on innovation efforts needed. The IC5 roadmap was published in February 2021, discussing the value chain for sunlight conversion, technological approaches and integration with existing infrastructure. The UK IC5 leadership is also working closely with the UK's Solar Fuel Network and other stakeholders to highlight the potential of sunlight conversion in preparation for COP26.

IC7

Affordable Heading and Cooling of Buildings - As a co-leader of IC7, the UK has supported the US$3 million Global Cooling Prize, the winner of which was announced in April 2021. Barocal Ltd, a firm based at the University of Cambridge, was one of the finalists and were awarded $200,000 for their entry – developing non-vapor compression technology. IC7 has also been developing an urban cooling roadmap for cities in conjunction with the Cool Coalition, UN Environment Programme, Global Covenant of Mayors and the Kigali Cooling Efficiency Programme, which is expected to be published in September 2021.

Public sector RD&D investment



*All amounts are in million USD	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
Energy Efficiency	-	125.68	193.23	215.28	207.95	-
CCS	-	17.96	26.87	24.83	27.15	-
Renewables	-	149.73	114.59	150.55	121.01	-
Nuclear Fission & Fusion	-	16.95	32.38	45.59	55.62	-
Hydrogen & Fuel Cells	-	16.72	13.71	22.82	34.00	-
Other Power & Storage Technologies	-	70.32	91.58	78.65	67.55	-
Other Cross-cutting Technologies/ Research	-	49.50	71.42	77.26	145.53	-
Unallocated	256.41	-	47.79	3.05	24.99	705.13
TOTAL	**256.4**	**446.9**	**591.6**	**618.0**	**683.8**	**705.1**

The figure for the Fifth Year is an estimate. The final figure is expected to be higher.

New Collaborations

Collaborators	Name of Collaboration	Brief Description	Sectors	Type of Collaboration	Duration	Funding amount	Additional information
IC7, UNEP, KCEP, GCoM, RMI	Urban Cooling Roadmap	Development of an urban cooling roadmap	Public-private	Development and demonstration	Dec 2020 to July 2021	$180,000	
China, France, Italy, Sweden, Switzerland, UK and USA	Solar cooling for the sunbelt region	IC7 has endorsed a new IEA collaboration in the area of "Solar cooling for the sunbelt regions". The task will focus on innovations for affordable, safe and reliable solar cooling systems for the sunbelt regions worldwide.	Public-private	Development and demonstration	July 2020 to July 2022		https://task65.iea-shc.org

ANNEX A

Full data set

The full datasets submitted by members according to IEA research, development and demonstration (RD&D) categorisations are provided overleaf. Please note that this data only refers to Mission Innovation baselines and Mission Innovation relevant spend. Each country — according to its own priorities, policies, processes, and laws — has independently determined its baseline and the best use of its RD&D funding and defines its own RD&D priorities and path to reach the doubling goal. This data may not therefore be the same as other RD&D public sector data sets. Numbers denoted by "zero" in the following tables may indicate that no information has been provided for spend in that category.

Australia

Category	Million AUD			
	Baseline	First Year	Second Year	Third Year
1. Energy Efficiency				
1.1 Industry	2.43	1.18	1.71	0
1.2 Residential and commercial buildings, appliances and equipment	2.55	4.55	4.78	0
1.3 Transport	1.95	1.46	1.56	0
1.4 Other energy efficiency	6.95	5.17	5.24	0
1.5 Unallocated energy efficiency	14.96	9.12	18.99	0
2. Cleaner Fossil Fuels				
2.1 Oil and gas	0	0	0	0
2.2 Coal	0	0	0	0
2.3 CO2 capture and storage	10.9	20.45	14.56	0
2.4 Unallocated fossil fuels	0	0	0	0
3. Renewable Energy Sources				
3.1 Solar energy	32.5	43.1	48.69	0
3.2 Wind energy	0.42	0.5	0.29	0
3.3 Ocean energy	0.8	1.24	1.53	0
3.4 Biofuels (including liquid & solid biofuels and biogases)	3.9	5.23	3.77	0
3.5 Geothermal energy	0.24	0.57	0.7	0
3.6 Hydroelectricity	0	0	0.19	0
3.7 Other renewable energy sources	0	0	0.24	0
3.8 Unallocated renewable energy sources	10.45	1.73	11.83	0
4. Nuclear Fission and Fusion				
4.1 Nuclear fission	7.4	15.3	11.45	0
4.2 Nuclear fusion	1.72	2.14	1.26	0
4.3 Unallocated nuclear fission and fusion	0	0.11	0.18	0
5. Hydrogen and Fuel Cells				
5.1 Hydrogen	2.41	2.32	3.75	0
5.2 Fuel cells	1.74	1.57	1.72	0
5.3 Unallocated hydrogen and fuel cells	0	0	0	0
6. Other Power and Storage Technologies				
6.1 Grid communication, control systems and integration	1.37	8.28	6.41	0
6.2 Electricity transmission and distribution	4.59	5.36	6.55	0
6.3 Energy storage (non-transport applications)	0	0	0	0
6.4 Unallocated other power and storage technologies	0	0	0	0
7. Other Cross-cutting Technologies or Research				
7.1 Energy system analysis	0	0	0	0
7.2 Basic energy research that cannot be allocated to a specific category	0	0	0	0
7.3 Other	0	0	0	0
8. Unallocated	**0**	**0**	**0**	**188**
TOTAL BUDGET	**107.28**	**129.38**	**145.40**	**188.00**

	Austria			
	Million euros			
Category	Baseline	First Year (2018)	Second Year(2019)	Third Year(2020)
1. Energy Efficiency				
1.1 Industry	0.00	11.88	3.14	2.42
1.2 Residential and commercial buildings, appliances and equipment	0.00	0.00	0.00	4.36
1.3 Transport	0.00	0.00	0.00	0.00
1.4 Other energy efficiency	0.00	0.00	0.00	0.00
1.5 Unallocated energy efficiency	0.00	0.00	0.00	0.00
2. Cleaner Fossil Fuels				
2.1 Oil and gas	0.00	0.00	0.00	0.00
2.2 Coal	0.00	0.00	0.00	0.00
2.3 CO2 capture and storage	0.00	0.00	0.00	3.97
2.4 Unallocated fossil fuels	0.00	0.00	0.00	0.00
3. Renewable Energy Sources				
3.1 Solar energy	0.00	0.00	0.00	0.00
3.2 Wind energy	0.00	0.00	0.00	0.00
3.3 Ocean energy	0.00	0.00	0.00	0.00
3.4 Biofuels (including liquid & solid biofuels and biogases)	0.00	0.00	0.00	0.94
3.5 Geothermal energy	0.00	0.00	0.00	0.00
3.6 Hydroelectricity	0.00	0.00	0.00	0.00
3.7 Other renewable energy sources	0.00	0.00	0.00	0.00
3.8 Unallocated renewable energy sources	0.00	0.00	0.00	0.00
4. Nuclear Fission and Fusion				
4.1 Nuclear fission	0.00	0.00	0.00	0.00
4.2 Nuclear fusion	0.00	0.00	0.00	0.00
4.3 Unallocated nuclear fission and fusion	0.00	0.00	0.00	0.00
5. Hydrogen and Fuel Cells				
5.1 Hydrogen	0.00	4.29	12.75	5.66
5.2 Fuel cells	0.00	4.52	0.00	0.00
5.3 Unallocated hydrogen and fuel cells	0.00	0.00	3.10	0.00
6. Other Power and Storage Technologies				
6.1 Grid communication, control systems and integration	0.00	2.06	0.00	0.00
6.2 Electricity transmission and distribution	0.00	3.73	0.00	0.00
6.3 Energy storage (non-transport applications)	0.00	0.00	0.00	0.00
6.4 Unallocated other power and storage technologies	0.00	0.00	2.80	3.89
7. Other Cross-cutting Technologies or Research				
7.1 Energy system analysis	0.00	1.45	1.43	0.00
7.2 Basic energy research that cannot be allocated to a specific category	0.00	0.00	0.00	0.00
7.3 Other	0.00	2.48	5.02	1.03
8. Unallocated	**16.00**	**0.00**	**0.00**	**0.00**
TOTAL BUDGET	**16.00**	**30.41**	**28.24**	**22.27**

Canada						EC					
Million CAD						Million euros					
Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
1. Energy Efficiency											
11.92	30.46	30.68	31.51	87.77	120.67	0.00	151.30	130.80	113.50	68.30	168.30
17.09	20.64	19.41	31.98	39.18	53.13	0.00	96.90	96.10	90.60	103.30	181.90
45.74	30.56	21.78	53.99	98.47	103.77	0.00	41.60	101.50	28.60	68.20	46.40
10.26	13.20	13.83	10.22	58.55	75.70	0.00	74.90	131.70	167.80	144.90	172.40
0.02	1.23	1.22	2.00	5.01	1.86	0.00	0.00	0.00	0.00	0.00	0.00
2. Cleaner Fossil Fuels											
64.17	69.80	65.57	114.06	99.41	95.66	0.00	0.00	0.00	0.00	0.00	0.00
6.91	5.18	4.93	5.05	4.52	2.87	0.00	0.00	0.00	0.00	0.00	0.00
26.70	15.15	17.17	21.92	12.37	17.53	0.00	17.10	66.70	46.90	38.50	70.60
0.44	1.36	2.08	1.23	0.81	1.33	0.00	0.00	0.00	0.00	0.00	0.00
3. Renewable Energy Sources											
19.34	13.95	12.47	21.45	19.31	17.50	0.00	112.80	104.80	95.60	115.80	66.60
3.89	2.80	2.93	3.92	5.08	7.25	0.00	33.10	55.70	69.00	42.50	81.50
10.97	4.22	1.59	2.65	3.08	2.04	0.00	47.00	47.10	30.40	23.50	35.30
25.34	73.66	70.58	31.54	28.69	42.45	0.00	90.00	84.30	58.60	66.80	98.40
1.81	0.77	0.89	2.81	3.00	14.67	0.00	25.20	31.90	20.70	17.60	12.80
1.87	3.73	3.47	3.52	5.38	4.00	0.00	22.90	8.30	10.00	23.10	10.00
0.31	0.94	0.51	0.52	2.54	3.81	0.00	60.00	4.90	0.90	90.80	83.60
0.34	0.38	0.76	1.47	0.83	2.26	0.00	0.00	36.60	222.70	0.00	0.00
4. Nuclear Fission and Fusion											
88.11	138.90	106.79	116.22	88.85	92.07	0.00	0.00	0.00	0.00	0.00	0.00
6.51	8.41	12.49	2.39	5.04	5.86	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Hydrogen and Fuel Cells											
3.18	3.03	2.25	6.46	7.16	7.76	0.00	67.70	40.60	47.10	71.80	137.60
8.91	8.17	10.65	6.38	6.11	7.78	0.00	38.90	74.40	52.10	26.20	18.20
0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.20	8.20	4.50	0.00	5.90
6. Other Power and Storage Technologies											
1.56	2.31	1.89	2.10	2.31	2.09	0.00	3.60	7.20	0.00	0.00	0.00
17.97	15.04	15.41	17.41	30.29	32.88	0.00	134.00	175.00	148.80	141.60	173.40
9.37	10.18	14.71	15.41	18.54	26.97	0.00	34.90	39.50	64.30	157.30	157.50
0.06	0.62	0.06	2.35	1.34	1.56	0.00	0.10	3.80	0.00	20.30	18.00
7. Other Cross-cutting Technologies or Research											
2.58	1.59	1.20	5.86	8.53	10.38	0.00	31.20	24.00	33.70	9.30	54.60
0.56	1.48	1.14	0.13	6.35	6.36	0.00	17.40	27.50	6.30	59.20	37.50
0.76	1.31	1.47	4.05	3.30	6.67	0.00	47.00	101.40	164.50	122.40	196.10
0.00	**0.00**	**0.00**	**20.52**	**31.00**	**20.00**	**989.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.00
386.69	**479.06**	**437.92**	**539.11**	**682.78**	**786.85**	**989.00**	**1154.80**	**1402.00**	**1476.60**	**1411.40**	**1826.60**

	Finland					
	Million euros					
Category	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
1. Energy Efficiency						
1.1 Industry	0.00	0.00	0.00	0.00	0.00	0.00
1.2 Residential and commercial buildings, appliances and equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.3 Transport	0.00	0.00	0.00	0.00	0.00	0.00
1.4 Other energy efficiency	0.00	0.00	0.00	0.00	0.00	0.00
1.5 Unallocated energy efficiency	0.00	0.00	0.00	0.00	0.00	0.00
2. Cleaner Fossil Fuels						
2.1 Oil and gas	0.00	0.00	0.00	0.00	0.00	0.00
2.2 Coal	0.00	0.00	0.00	0.00	0.00	0.00
2.3 CO2 capture and storage	0.00	0.00	0.00	0.00	0.00	0.00
2.4 Unallocated fossil fuels	0.00	0.00	0.00	0.00	0.00	0.00
3. Renewable Energy Sources						
3.1 Solar energy	0.00	0.00	0.00	0.00	0.00	0.00
3.2 Wind energy	0.00	0.00	0.00	0.00	0.00	0.00
3.3 Ocean energy	0.00	0.00	0.00	0.00	0.00	0.00
3.4 Biofuels (including liquid & solid biofuels and biogases)	0.00	0.00	0.00	0.00	0.00	0.00
3.5 Geothermal energy	0.00	0.00	0.00	0.00	0.00	0.00
3.6 Hydroelectricity	0.00	0.00	0.00	0.00	0.00	0.00
3.7 Other renewable energy sources	0.00	0.00	0.00	0.00	0.00	0.00
3.8 Unallocated renewable energy sources	0.00	27.00	32.00	28.60	14.10	15.20
4. Nuclear Fission and Fusion						
4.1 Nuclear fission	0.00	0.00	0.00	0.00	0.00	0.00
4.2 Nuclear fusion	0.00	0.00	0.00	0.00	0.00	0.00
4.3 Unallocated nuclear fission and fusion	0.00	0.00	0.00	0.00	0.00	0.00
5. Hydrogen and Fuel Cells						
5.1 Hydrogen	0.00	0.00	0.00	0.00	0.00	0.00
5.2 Fuel cells	0.00	0.00	0.00	0.00	0.00	0.00
5.3 Unallocated hydrogen and fuel cells	0.00	0.00	0.00	0.00	0.00	0.00
6. Other Power and Storage Technologies						
6.1 Grid communication, control systems and integration	0.00	0.00	0.00	0.00	0.00	0.00
6.2 Electricity transmission and distribution	0.00	3.90	3.50	2.30	4.90	3.80
6.3 Energy storage (non-transport applications)	0.00	4.30	1.80	3.60	11.80	25.80
6.4 Unallocated other power and storage technologies	0.00	0.00	0.00	0.00	0.00	0.00
7. Other Cross-cutting Technologies or Research						
7.1 Energy system analysis	0.00	4.50	6.30	15.80	21.80	32.30
7.2 Basic energy research that cannot be allocated to a specific category	0.00	0.00	0.00	0.00	0.00	0.00
7.3 Other	0.00	0.00	0.00	0.00	0.00	0.00
8. Unallocated	**54.90**	**31.20**	**31.60**	**42.60**	**36.90**	**41.60**
TOTAL BUDGET	**54.90**	**70.90**	**75.20**	**92.90**	**89.50**	**118.70**

France						Germany					
Million euros						Million euros					
Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
1. Energy Efficiency											
0.00	14.61	13.88	12.04	12.02	13.70	0.00	33.38	47.10	52.41	66.20	64.88
0.00	31.67	32.95	25.05	26.19	16.17	0.00	26.33	28.44	29.17	72.90	78.90
0.00	97.03	87.75	91.72	125.32	108.53	0.00	12.90	14.35	14.11	34.21	41.87
0.00	23.16	17.39	22.42	20.57	16.96	0.00	0.00	0.00	0.00	10.65	13.11
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Cleaner Fossil Fuels											
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	20.49	14.67	12.28	15.20	18.30	0.00	17.39	18.70	42.41	5.49	25.48
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Renewable Energy Sources											
0.00	71.17	62.77	56.22	54.66	47.11	0.00	78.61	99.35	92.68	110.16	99.51
0.00	9.62	6.94	6.23	6.56	15.37	0.00	49.69	75.11	59.70	72.95	76.06
0.00	7.58	4.37	6.90	8.87	6.75	0.00	0.00	0.00	0.00	0.00	0.00
0.00	84.81	73.45	52.80	48.92	54.29	0.00	37.30	32.74	28.54	40.59	49.38
0.00	6.59	4.67	3.22	7.19	7.87	0.00	12.54	16.50	15.38	13.85	15.38
0.00	2.71	1.93	1.88	1.81	0.42	0.00	2.01	2.15	1.40	1.71	2.26
0.00	1.59	2.23	3.78	3.78	6.15	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4. Nuclear Fission and Fusion											
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Hydrogen and Fuel Cells											
0.00	19.51	14.67	15.65	16.34	26.90	0.00	0.00	0.00	0.00	21.49	42.78
0.00	10.43	12.64	11.36	10.72	10.99	0.00	0.00	0.00	0.00	16.68	17.39
0.00	1.24	1.15	1.02	1.09	0.00	0.00	15.41	21.92	27.58	0.00	0.00
6. Other Power and Storage Technologies											
0.00	1.92	1.25	0.79	2.18	3.84	0.00	0.00	0.00	0.00	21.43	19.21
0.00	16.53	10.37	15.54	23.52	19.54	0.00	66.92	89.24	71.45	67.63	65.05
0.00	22.55	20.97	24.80	25.61	22.69	0.00	41.96	35.35	27.33	26.00	27.10
0.00	0.02	0.00	0.00	0.08	0.33	0.00	0.00	0.00	0.00	2.77	2.87
7. Other Cross-cutting Technologies or Research											
0.00	15.46	15.83	18.80	5.43	4.82	0.00	15.04	18.17	27.67	28.17	24.43
0.00	12.91	55.45	58.76	66.46	65.88	0.00	0.00	0.00	0.00	19.45	20.80
0.00	30.03	32.41	29.74	30.70	29.70	0.00	0.00	0.00	0.00	0.00	3.91
440.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**450.30**	**116.10**	**178.17**	**171.31**	**103.23**	91.50
440.00	**501.60**	**487.74**	**470.99**	**513.22**	**496.31**	**450.30**	**525.58**	**677.29**	**661.15**	**735.57**	**781.87**

	Italy					
	Million euros					
Category	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
1. Energy Efficiency						
1.1 Industry	0.00	0.00	0.00	0.00	0.00	0.00
1.2 Residential and commercial buildings, appliances and equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.3 Transport	0.00	0.00	0.00	0.00	0.00	0.00
1.4 Other energy efficiency	0.00	0.00	0.00	0.00	0.00	0.00
1.5 Unallocated energy efficiency	58.55	52.24	53.59	49.00	52.00	54.00
2. Cleaner Fossil Fuels						
2.1 Oil and gas	0.00	0.00	0.00	0.00	0.00	0.00
2.2 Coal	0.00	0.00	0.00	0.00	0.00	0.00
2.3 CO2 capture and storage	0.00	0.00	0.00	0.00	0.00	0.00
2.4 Unallocated fossil fuels	0.00	0.00	0.00	0.00	0.00	0.00
3. Renewable Energy Sources						
3.1 Solar energy	0.00	0.00	0.00	0.00	0.00	0.00
3.2 Wind energy	0.00	0.00	0.00	0.00	0.00	0.00
3.3 Ocean energy	0.00	0.00	0.00	0.00	0.00	0.00
3.4 Biofuels (including liquid & solid biofuels and biogases)	0.00	0.00	0.00	0.00	0.00	0.00
3.5 Geothermal energy	0.00	0.00	0.00	0.00	0.00	0.00
3.6 Hydroelectricity	0.00	0.00	0.00	0.00	0.00	0.00
3.7 Other renewable energy sources	0.00	0.00	0.00	0.00	0.00	0.00
3.8 Unallocated renewable energy sources	71.08	58.25	71.19	64.00	66.00	68.00
4. Nuclear Fission and Fusion						
4.1 Nuclear fission	0.00	0.00	0.00	0.00	0.00	0.00
4.2 Nuclear fusion	0.00	0.00	0.00	0.00	0.00	0.00
4.3 Unallocated nuclear fission and fusion	0.00	0.00	0.00	0.00	0.00	0.00
5. Hydrogen and Fuel Cells						
5.1 Hydrogen	0.00	0.00	0.00	0.00	0.00	0.00
5.2 Fuel cells	0.00	0.00	0.00	0.00	0.00	0.00
5.3 Unallocated hydrogen and fuel cells	11.79	8.96	14.90	13.00	13.00	14.00
6. Other Power and Storage Technologies						
6.1 Grid communication, control systems and integration	0.00	0.00	0.00	0.00	0.00	0.00
6.2 Electricity transmission and distribution	0.00	0.00	0.00	0.00	0.00	0.00
6.3 Energy storage (non-transport applications)	0.00	0.00	0.00	0.00	0.00	0.00
6.4 Unallocated other power and storage technologies	45.00	36.00	44.00	40.00	41.00	42.00
7. Other Cross-cutting Technologies or Research						
7.1 Energy system analysis	0.00	0.00	0.00	0.00	0.00	0.00
7.2 Basic energy research that cannot be allocated to a specific category	0.00	0.00	0.00	0.00	0.00	0.00
7.3 Other	36.48	42.42	39.50	35.00	36.00	37.00
8. Unallocated	**0.00**	**13.70**	**11.17**	**12.00**	**13.00**	**13.00**
TOTAL BUDGET	**222.90**	**211.57**	**234.35**	**213.00**	**221.00**	**228.00**

Netherlands					Republic of Korea					
Million euros					Million Won					
Baseline	First Year	Second Year	Third Year	Fourth Year	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
1. Energy Efficiency										
7.40	34.20	20.50	25.90	35.00	35,910	52,771	60,131	51,348	10,000	10,882
5.70	10.20	13.30	14.30	28.40	21,420	34,338	34,300	43,636	156,543	153,132
0.00	2.50	12.90	2.70	41.40	32,767	63,027	56,858	56,307	42,340	48,902
4.60	13.20	14.30	18.90	24.80	0	0	0	0	0	0
0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0
2. Cleaner Fossil Fuels										
0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0
0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0
1.10	2.20	11.10	16.40	7.00	65,966	83,669	85,122	90,458	58,588	65,529
0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0
3. Renewable Energy Sources										
33.90	24.60	21.70	25.50	15.50	60,842	72,198	78,601	99,956	95,616	106,834
12.90	17.50	20.00	40.20	46.50	40,844	40,679	50,636	64,063	91,623	102,276
2.20	0.10	0.70	0.10	0.00	0	0	0	0	0	0
20.30	28.80	20.50	17.40	8.20	34,267	40,510	45,442	40,294	52,238	48,342
1.40	8.50	11.60	21.70	10.90	0	0	0	0	0	0
0.00	3.70	0.00	0.00	0.00	0	0	0	0	0	6,000
0.00	0.20	0.20	0.20	0.20	16,266	32,638	32,731	33,767	28,238	27,580
0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0
4. Nuclear Fission and Fusion										
0.00	5.80	6.20	6.50	7.00	0	0	0	0	0	0
0.00	0.50	0.10	0.00	0.00	0	0	0	0	0	0
0.00	0.00	0.00	0.00	0.00	37,038	41,733	48,882	52,935	99,381	80,765
5. Hydrogen and Fuel Cells										
0.30	0.10	15.90	8.00	14.30	4,892	12,370	12,750	29,510	38,301	64,865
0.00	0.80	3.10	0.50	0.00	39,441	38,773	41,569	33,707	59,490	94,401
0.00	0.00	0.00	0.00	0.00	0	0	0	5,410	6,635	5,834
6. Other Power and Storage Technologies										
0.00	0.00	0.00	0.00	0.00	46,769	60,693	60,843	95,110	90,376	102,871
3.10	3.90	5.20	7.10	2.30	85,156	109,016	135,006	167,757	78,775	76,595
4.10	6.00	15.60	6.30	20.20	38,957	54,231	56,095	44,741	37,860	49,580
0.00	0.00	0.00	0.00	0.00	0	0	0	9,755	25,848	48,626
7. Other Cross-cutting Technologies or Research										
0.00	0.80	0.30	1.90	11.70	0	0	0	0	0	0
3.00	3.00	4.20	6.60	0.90	0	0	0	0	0	0
0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0
0.00	**0.10**	**0.60**	**5.00**	**10.70**	**0**	**0**	**0**	**0**	**8,509**	32,357
100.00	**166.70**	**198.00**	**225.20**	**285.00**	**560,535**	**736,646**	**798,966**	**918,754**	**980,361**	**1,125,371**

	UK					
	Million GBP					
Category	Baseline	First Year	Second Year	Third Year	Fourth Year	Fifth Year
1. Energy Efficiency						
1.1 Industry	0.00	2.32	3.31	0.00	0.00	0.00
1.2 Residential and commercial buildings, appliances and equipment	0.00	11.55	22.10	0.00	0.00	0.00
1.3 Transport	0.00	79.46	94.37	0.00	0.00	0.00
1.4 Other energy efficiency	0.00	2.86	2.50	0.00	0.00	0.00
1.5 Unallocated energy efficiency	0.00	1.84	28.44	167.92	162.20	0.00
2. Cleaner Fossil Fuels						
2.1 Oil and gas	0.00	0.00	0.00	0.00	0.00	0.00
2.2 Coal	0.00	0.00	0.00	0.00	0.00	0.00
2.3 CO2 capture and storage	0.00	14.01	20.96	19.37	21.18	0.00
2.4 Unallocated fossil fuels	0.00	0.00	0.00	0.00	0.00	0.00
3. Renewable Energy Sources						
3.1 Solar energy	0.00	24.52	20.90	0.00	0.00	0.00
3.2 Wind energy	0.00	36.10	26.54	0.00	0.00	0.00
3.3 Ocean energy	0.00	5.47	15.10	0.00	0.00	0.00
3.4 Biofuels (including liquid & solid biofuels and biogases)	0.00	15.82	19.45	0.00	0.00	0.00
3.5 Geothermal energy	0.00	4.95	0.63	0.00	0.00	0.00
3.6 Hydroelectricity	0.00	8.84	3.31	0.00	0.00	0.00
3.7 Other renewable energy sources	0.00	14.78	0.28	0.00	0.00	0.00
3.8 Unallocated renewable energy sources	0.00	6.31	3.17	117.43	94.39	0.00
4. Nuclear Fission and Fusion						
4.1 Nuclear fission	0.00	8.84	24.35	0.00	0.00	0.00
4.2 Nuclear fusion	0.00	0.00	0.00	0.00	0.00	0.00
4.3 Unallocated nuclear fission and fusion	0.00	4.38	0.91	35.56	43.38	0.00
5. Hydrogen and Fuel Cells						
5.1 Hydrogen	0.00	7.17	4.21	0.00	0.00	0.00
5.2 Fuel cells	0.00	5.22	6.46	0.00	0.00	0.00
5.3 Unallocated hydrogen and fuel cells	0.00	0.65	0.02	17.80	26.52	0.00
6. Other Power and Storage Technologies						
6.1 Grid communication, control systems and integration	0.00	0.31	0.08	0.00	0.00	0.00
6.2 Electricity transmission and distribution	0.00	18.62	37.50	0.00	0.00	0.00
6.3 Energy storage (non-transport applications)	0.00	12.67	17.03	0.00	0.00	0.00
6.4 Unallocated other power and storage technologies	0.00	23.25	16.82	61.35	52.69	0.00
7. Other Cross-cutting Technologies or Research						
7.1 Energy system analysis	0.00	7.87	0.95	0.00	0.00	0.00
7.2 Basic energy research that cannot be allocated to a specific category	0.00	0.00	0.00	0.00	0.00	0.00
7.3 Other	0.00	30.74	54.76	60.26	113.51	0.00
8. Unallocated	**200.00**	**0.00**	**37.28**	**2.38**	**19.49**	**550.00**
TOTAL BUDGET	**200.00**	**348.55**	**461.43**	**482.07**	**533.36**	**550.00**


MISSION INNOVATION
www.mission-innovation.net