

MISSION INNOVATION



**MISSION
INNOVATION**

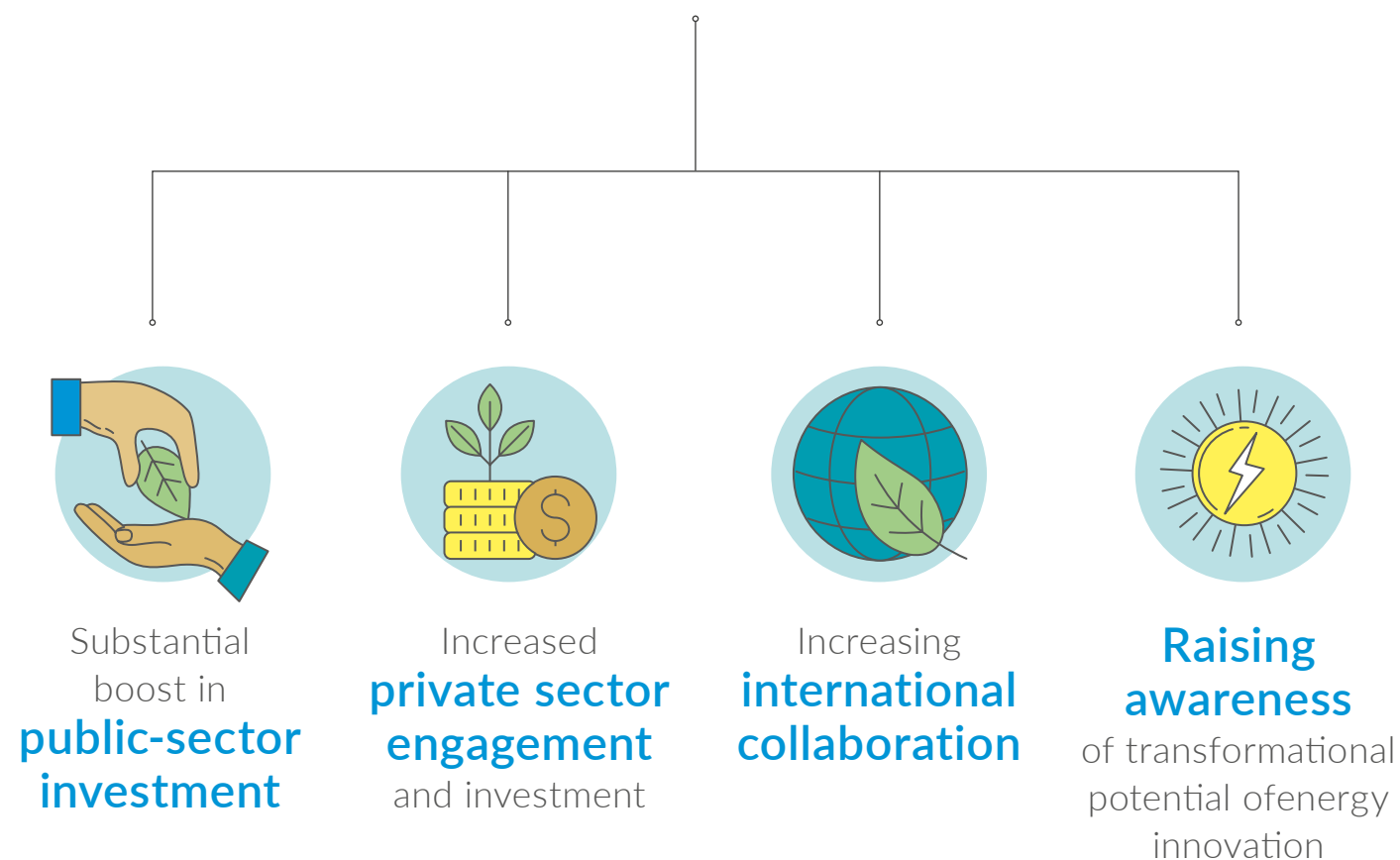
accelerating the clean energy revolution

Mission Innovation is a global intergovernmental initiative working to accelerate clean energy innovation

25 members on 5 continents are working to stimulate innovation with the objective to make clean energy more widely affordable.

This report sets out Mission Innovation members' achievements to date.

Mission Innovation has four goals



mission-innovation.net

ACHIEVEMENTS AND IMPACT

Mission Innovation members are on track to deliver their commitment to seek to **double clean energy innovation funding** over 5 years

SINCE 2015

Mission Innovation members' have delivered:

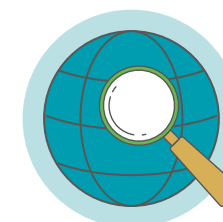
\$4.6bn increase

in annual investment in clean energy innovation



70 international publications

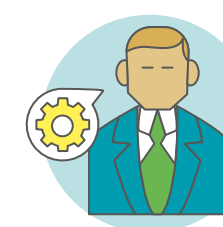
highlighting the work of Mission Innovation



\$1.3bn funding for

59 new international collaborations

supporting clean energy innovation

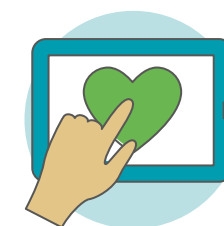


19 innovators

selected as Mission Innovation Champions

100 innovations

identified that will avoid 2 gigatonnes CO₂ emissions per year by 2030



46 events

on 4 continents involving 4300 innovators, investors and policy makers



Timeline

NOVEMBER 2015

Launch of Mission Innovation (MI), COP21, Paris

"Participating countries have come together to launch Mission Innovation to reinvigorate and accelerate public and private global clean energy innovation with the objective to make clean energy widely affordable."

Joint Launch Statement



JUNE 2016

Inaugural Ministerial, San Francisco

- The European Commission, acting on behalf of the European Union, becomes the 21st member, adding \$1 billion to the annual MI member spend on clean energy innovation
- Ministers met with members of the Breakthrough Energy Coalition, including Bill Gates, to discuss the importance of collaborating with the private sector

NOVEMBER 2016

COP22, Marrakesh

- Finland and the Netherlands welcomed as the 22nd and 23rd members
- Launch of seven Innovation Challenges, global calls to action for international collaboration in important technology areas



JUNE 2017

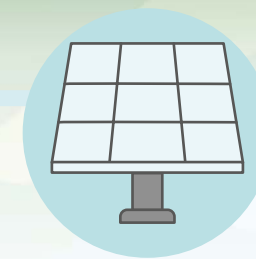
2nd Ministerial, Beijing

- Launch of the MI Action Plan with four goals driving MI's efforts
- Announcement of collaboration with the World Economic Forum to increase linkages with the private sector on MI clean energy innovation investments

MAY 2018

3rd Ministerial, Malmo

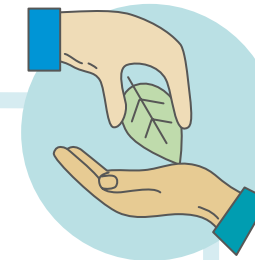
- Austria welcomed as the 24th MI member
- \$3.1 billion annual increase in public funding and 39 collaborations reported
- Delivering the MI Action Plan published
- Announcement of collaborations with the International Energy Agency and International Renewable Energy Agency
- Launch of the 8th Innovation Challenge on Renewable and Clean hydrogen



MARCH 2018

MI Clean Energy Financing Event, Vancouver

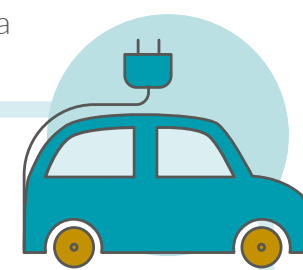
Clean energy companies from MI members had the opportunity to pitch and speak to more than 90 major investors at this event organised by Natural Resources Canada



DECEMBER 2017

One Planet Summit, Paris

The Breakthrough Energy Coalition announces partnerships with five MI members (Canada, United Kingdom, France, Mexico, and the European Commission), representing a new approach to public-private collaboration that supports low carbon energy investments



DECEMBER 2018

COP24, Katowice

- Side event at the UK Pavilion on role of clean energy innovation in pursuing efforts towards 1.5°C
- Strong MI presence contributed to keeping innovation high on the political agenda

MAY 2019

4th Ministerial, Vancouver

- Morocco welcomed as the 25th MI member
- \$4.6 billion annual increase in public funding and 59 collaborations reported
- Announcement of collaborations with the World Bank and Global Covenant of Mayors
- Opened dialogue to increase private sector participation and include women, youth and innovators

2020

Road from Vancouver to Chile

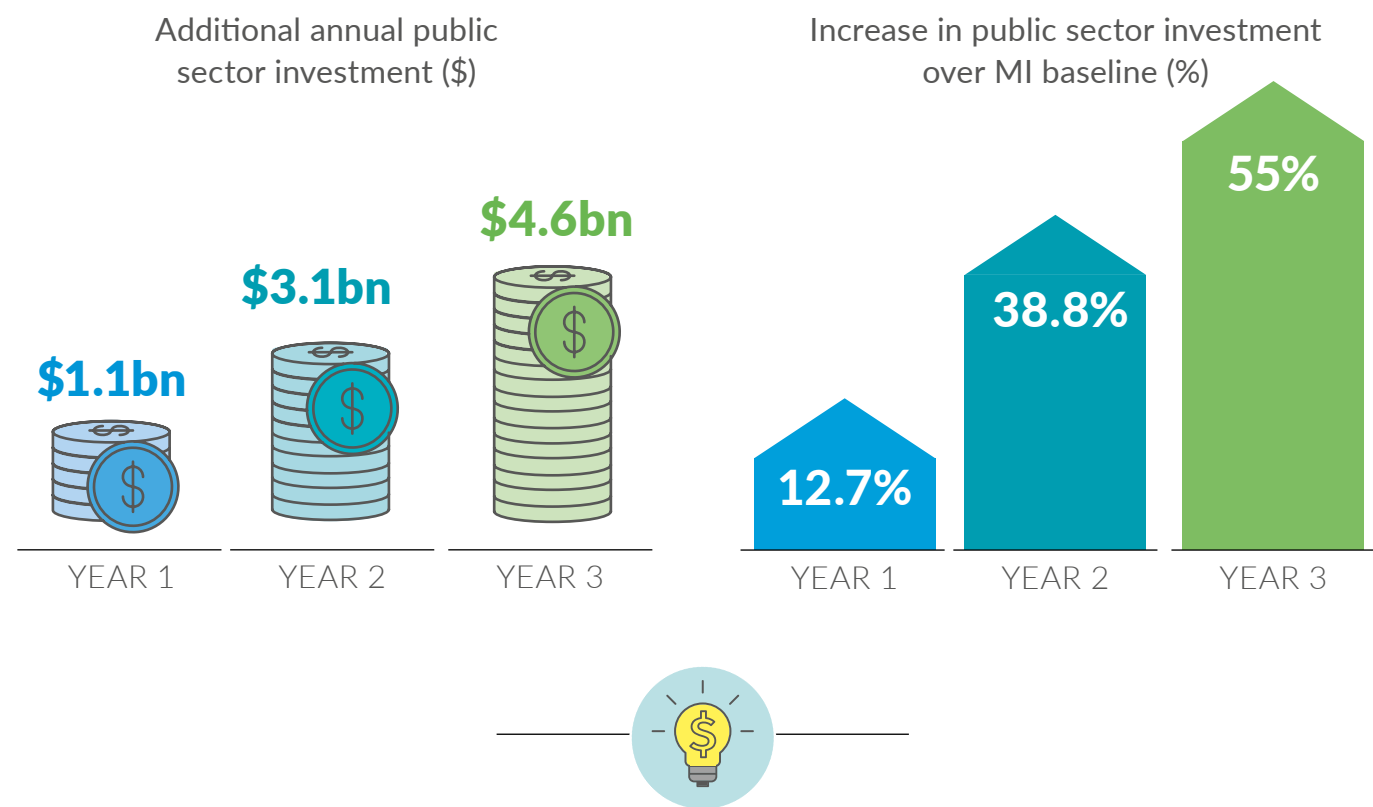
JANUARY 2018

World Economic Forum meeting, Davos

MI represented at the Forum's Stewardship Board on "Shaping the Future" and Accelerating Sustainable Energy Innovation sessions

Substantial boost in public-sector investment

Mission Innovation (MI) members are on track to meet their commitment to seek to double their investment in clean energy innovation over five years. In Year 3, members reported a total annual increase of \$4.6 billion against their baselines.



MI members are investing across a range of technologies depending on national priorities.

Since 2015, cumulative MI-relevant investments by reporting members have included:

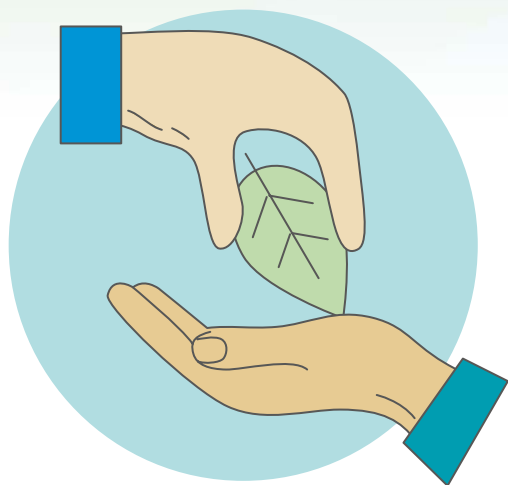
- \$8.7 billion**
on **renewable energy**
including at least:

 - \$1.5bn on solar energy
 - \$1.1bn on biofuels
 - \$844m on wind energy
- \$4.1 billion**
on **grid integration, transmission and storage technologies**

\$1.3 billion
on **transport**
- \$1.2 billion**
on **hydrogen and fuel cells**

\$860 million
on **buildings and appliances**

\$772 million
on **carbon capture and storage**



The Netherlands and UK have already doubled their MI relevant investments. China has had the largest absolute increase in clean innovation investment of reporting members.

CHINA

MI-related funding in China increased from 25 bn RMB in 2015 to 42 bn RMB in 2018, with an increment of more than 68%. Over this time China’s Ministry of Science and Technology (MOST) has launched new research, development and demonstration programs in the areas of energy saving technology, new energy vehicles, smart grids, renewable energy, hydrogen energy and clean and high efficiency utilization of coal.

The “Smart Grid and Equipment” Project supports 120 innovation projects, with total public support of 1.5 billion RMB, whilst the “Renewable Energy and Hydrogen Energy Technology” Project is investing 0.5 billion RMB in 31 innovation projects. CCS and cleaner fossil fuels accounted for about 40% of MI-related spend in China in 2018.

NETHERLANDS

The Netherlands have doubled their MI-related RD&D investments in three years, reaching about €205 million in 2018. Amongst the most successful national programs that supported energy-innovation projects are the Topsector Energy Program, the Demonstration Program for Climate & Energy Innovation, and the Renewable Energy Program. Additional funding for the upcoming National Climate Agreement stimulated research & innovation projects in areas including CO₂ reduction in industry, increased flexibility of the electricity system, hydrogen and spatial integration of large-scale renewable energy production.

MI and the International Energy Agency (IEA) have worked closely together and with members to enhance data collection on government spending for energy RD&D building on the collaboration agreement signed in 2018. In collaboration with MI, the IEA has worked with members including Brazil, India and China through the Clean Energy Transitions Programme to design more effective R&D reporting methods and has brought together their innovation data and analysis in a central portal www.iea.org/innovation

PROGRESS TOWARDS GOAL 2

Increased private sector engagement and investment

Mission Innovation (MI) members are launching new initiatives and investment funds in partnership with the private sector to accelerate the commercialisation and scale-up of new technologies.

UK

The UK has announced a new early stage **Clean Growth Fund**. The government will invest up to £20 million on commercial terms alongside at least £20 million of private sector capital in order to catalyse the market. The fund will support early stage clean technology companies in the UK to accelerate the commercialisation of promising technologies.

SWEDEN

The **MI Avoided Emissions Framework (AEF)** will enable public and private investors to identify the technologies that have the greatest potential to tackle climate change. It has identified 100 innovations globally with the potential to avoid 2 gigatonnes CO₂e per year by 2030.



gigatonnes

of avoided emissions from 100 solutions

misolutionframework.net

INDIA

The world's first **Clean Energy International Incubation Centre (CEIIC)** was launched by the Indian Government and the Tata Trust in Delhi in September 2019. It is providing \$5 million in support to start-ups/innovators from across MI members to test their technologies in the local market. To date CEIIC has incubated 7 Indian start-ups and 2 international start-ups.

CHILE

The Atacama Desert, in the north of Chile, is a natural laboratory, with: the highest levels of solar irradiation, high levels of ultra violet radiation, dust, temperatures above 70°C in the photovoltaics modules, and water scarcity, all these is an opportunity to develop PV systems that will be able to operate in harsh conditions all around the World. In 2016, the **Chilean Government funded AtaMoS-TeC (Atacama Module and System Technology Center)** bringing together the government, and national and international companies and technology centres in a partnership to implement a portfolio of projects to develop and reduce the cost of photovoltaic systems created specifically for desert conditions.

The **World Economic Forum** put forward six bold ideas for accelerating sustainable energy innovation at the 3rd MI Ministerial. The Forum in coordination with MI, is now working to establish one of the bold ideas, a first in its kind **Global Sustainable Energy Innovation Fund (SEIF)** using public and private blended finance to overcome the inherent valley of death for breakthrough energy innovation.

EUROPEAN COMMISSION

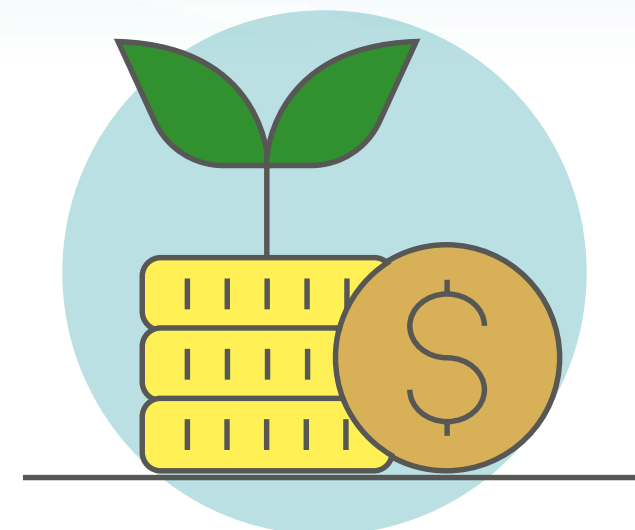
The creation of a new €100M public-private investment fund, **Breakthrough Energy Ventures – Europe (BEV-E)**, was announced in October 2018 by the European Commission and the Bill Gates-led **Breakthrough Energy**. BEV-E is a pilot investment vehicle, which brings patient public and private capital together to support and catalyze European clean energy technologies and entrepreneurs. BEV-E will invest in technologies that can make material greenhouse gas emissions reductions in five key areas that are essential to combat climate change: electricity, transportation, agriculture, manufacturing, and buildings.

CANADA

Canada's partnership with **Breakthrough Energy** will support up to 15 Canadian clean energy technology firms over an initial two-year investment period. This outcomes-based program will target solutions that have significant GHG potential (>0.5 gt) at global scale, across four domains – electricity, buildings, transport, and manufacturing.

AUSTRALIA

The Australian **Clean Energy Innovation Fund** launched in 2016 has committed over AUD\$58 million to provide financial support for innovative and emerging clean energy technologies. This includes an AUD\$10 million cornerstone investment in a **Clean Energy Seed Fund** targeting scalable, high growth potential start-ups. The funds have supported technologies such as hybrid solar generation and storage energy management systems, electric vehicles in medium-duty trucks, and scaling up of the Internet of Things network focused on cutting energy use.



NORWAY

Norway has developed a new support scheme called **PILOT-E** that fast-tracks innovations from idea to market inspired by the American programs ARPA-E and DARPA. The first call launched in 2016 focused on “emissionfree maritime transport” with the first new vessel already in use. “Future of the fjords” is the first all-electric, fully battery-driven, sightseeing vessel that can operate in 16 knots, with 400 passengers, for 2.5 hours. By 2022, around 70 new electric ferries will be operating on the Norwegian fjords and there are projects for hydrogen ferries underway.



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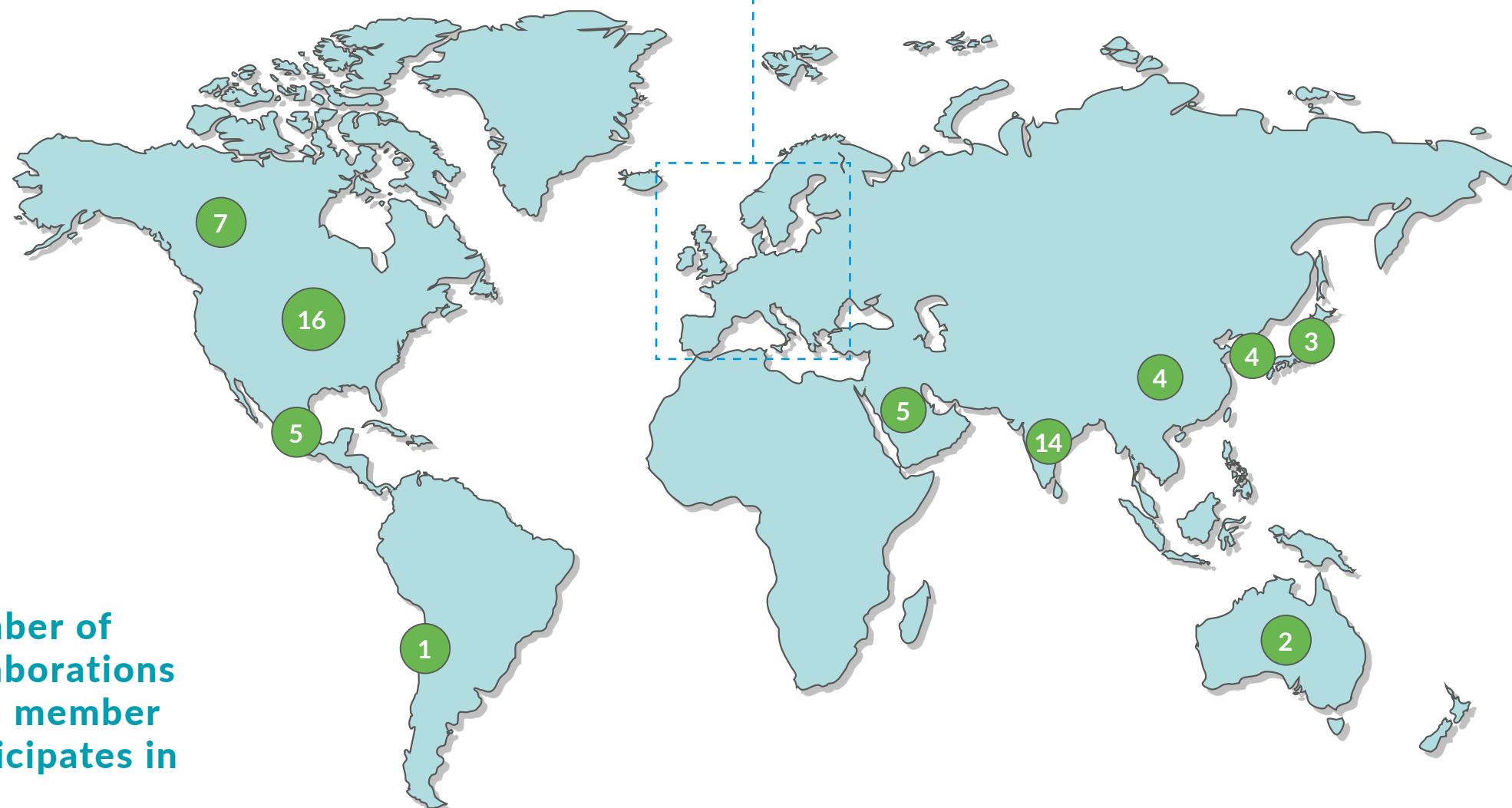
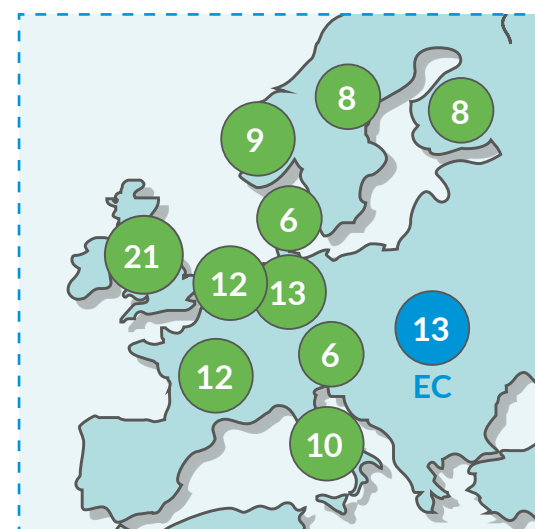
PROGRESS TOWARDS GOAL 3

Increasing international collaboration



Mission Innovation (MI) members have built new international collaborations in clean energy innovation, with \$1.3 billion invested in 59 new cooperation activities since 2015.

These bilateral or multilateral activities include joint RD&D calls, demonstration projects, student and researcher exchanges and coordinated funding calls.



Number of collaborations each member participates in

UK / REPUBLIC OF KOREA

A new \$9 million UK-Republic of Korea collaboration on smart energy was launched in 2018 to accelerate the speed and extent of deployment of smart, flexible energy system solutions. 3 projects have been funded which will demonstrate gamification of electric vehicle charging, an energy flexibility trading platform and a liquid air production and storage system. All projects are expected to be completed and to disseminate learning by March 2021.

INDIA

A total of \$17 million has been allocated to support collaboration between innovators in MI countries and Indian institutions in support of the Innovation Challenges, with 47 projects funded - 20 on Carbon Capture and Storage (IC3), 14 on biofuels (IC4) and 13 on converting sunlight (IC5).

CANADA / UK

The first phase of the **Power Forward Challenge** is funding 21 Canadian and UK companies to develop the best smart energy systems for the 21st Century. \$15 million is available to innovators who can bring disruptive technologies or new thinking to develop clean, robust and flexible power grids and energy systems that anticipate and meet the needs of networks around the world with the aim of having pilot-scale demonstrations by December 2020.

REPUBLIC OF KOREA

The Republic of Korea is supporting collaboration with 5 MI members through a new \$21.6 million joint research programme launched in 2018 to support the Innovation Challenges. Researchers from Canada, the US, India and Germany are working with researchers from Korea on the 8 projects funded to date. Activities include joint workshops, researcher exchanges, research sample exchange and visits to demonstration sites.

AUSTRIA / SWEDEN

The Joint Programming Platform Smart Energy Systems, led by Austria and Sweden, will launch the **MI Call19 multilateral call** in Autumn 2019 focusing on Storage Technology and Storage Systems Integration. Participation in the Call is open to public funders from all MI members and will use an existing model (ERA-NET) as a quick route to support the work of the Innovation Challenges on Smart Grids (IC1), Clean Energy Materials (IC6), Heating & Cooling (IC7) and Hydrogen (IC8). The Call will be a forerunner for future multilateral collaboration.

Increasing International Collaboration: Innovation Challenges (ICs)

ICs are global calls to action aimed at increasing collaboration and accelerating innovation in priority technology areas.



IC1: SMART GRIDS

OBJECTIVE

To enable future grids that are powered by affordable, reliable, decentralised renewable electricity systems

CO-LEADS



18 MEMBERS INVOLVED

IC1 launched the Smart Grids Innovation Accelerator in 2019, as an open platform for gathering information, data, tools, factsheets, results and experience from best practices and successful projects in the field of smart grids with the specific aim to be replicated and adopted broadly. It will become a powerful tool to foster and accelerate smart grids deployment, to enlarge public-private collaborations and to identify innovative enabling technologies and business models to plan long term investments in the smart grids field. IC1 has agreed to cooperate with the International Smart Grid Action Network to improve the link between innovation and deployment.



IC2: OFF-GRID ACCESS TO ELECTRICITY

OBJECTIVE

To develop systems that enable off-grid households and communities to access affordable and reliable renewable electricity

CO-LEADS



17 MEMBERS INVOLVED

MI members have launched two major programmes in support of IC2. France is investing €1.8M in 9 projects in Africa, in Benin, Burkina Faso, Cape Verde, Madagascar, Mauritania, Togo. The projects cover a range of renewable energy technologies (hybrid systems, solar, river stream generator and biomass) and different uses of electricity to enhance economic development (irrigation, agriculture, desalination and mobility). Winners of the Indian \$5 million off-grid competition are collaborating with organisations from 9 MI members - Australia, Canada, France, Germany, Italy, Norway, Sweden, UK and the USA - to improve energy access at affordable cost in diverse geographies for individuals and communities with no or limited access to grid connected power.



IC3: CARBON CAPTURE, UTILISATION AND STORAGE

OBJECTIVE

To enable near-zero CO₂ emissions from power plants and carbon intensive industries

CO-LEADS



18 MEMBERS INVOLVED

The US Department of Energy (\$30 million) and the Accelerating Carbon Capture and Storage Technologies (<http://www.act-ccs.eu/>) consortium (\$35 million) have designed new Calls for Proposals to meet the scientific challenges that were identified by IC3 through an international scientific workshop. The European Commission also has an indicative budget of \$38 million for industrial CCS projects involving partners from MI members, bringing the total funding to \$103 million.

IC3 is addressing critical research gaps in higher Technology Readiness Levels concepts and strengthening cooperation with private sector through an industry focused workshop being organized in Trondheim, Norway, in June 2019.



IC4: SUSTAINABLE BIOFUELS

OBJECTIVE

To develop ways to produce, at scale, widely affordable, advanced biofuels for transportation and industrial applications

CO-LEADS



12 MEMBERS INVOLVED

Since 2017 China has allocated \$62 million to bilateral/multilateral sustainable biofuels projects, including collaboration with the US, Italy, Japan, Korea, Brazil, India and the EU. India announced a funding call in June 2018. The inclusion of researchers from MI members was mandatory to encourage international collaboration. MI members from Australia, Brazil, Canada, China, Czech Republic, the Netherlands, Norway, Saudi Arabia, UK and USA are collaborating with Indian investigators on topics including development of advanced biofuels, production of enzymes for biofuels, methods for improvements of biological feedstock and heterotrophic algal production.

Increasing International Collaboration: Innovation Challenges (ICs)

ICs are global calls to action aimed at increasing collaboration and accelerating innovation in priority technology areas.



IC5: CONVERTING SUNLIGHT

OBJECTIVE

To discover affordable ways to convert sunlight into storable solar fuels

CO-LEADS



19 MEMBERS INVOLVED

The European Commission launched a €5 million Artificial Photosynthesis prize at the One Planet Summit in 2017. The prize, to be awarded in 2021, is open to all legal entities around the world to develop a fully functional, bench-scale prototype of an artificial photosynthesis based system which can produce a useable synthetic fuel.

The IC5 international expert group has also raised global awareness of the potential of solar fuels and artificial photosynthesis. This has resulted in this topic being a focus of the 7th Energy Research Programme of the German Federal Government and India launching a funding opportunity.



IC6: CLEAN ENERGY MATERIALS

OBJECTIVE

To accelerate the exploration, discovery and use of new high-performance, low-cost clean energy materials

CO-LEADS



15 MEMBERS INVOLVED

IC6 is putting its vision and plan for accelerating the rate of materials innovation by at least 10 times into action with the publication of the Materials Acceleration Platforms (MAPs) Report and 15 international activities in 10 countries on 3 continents. The work of the IC has been showcased in Nature Materials Reviews, the 2018 Emissions Gap Report of the United Nations Environmental Program (UNEP), MIT Technology Review and Forbes Magazine. MAPs collaborations are under development with 11 MI members. The CAD\$8 million proof-of-concept project Ada launched in Canada has already demonstrated how artificial intelligence can drive a robotic platform to develop new materials faster and cheaper.



IC7: AFFORDABLE HEATING AND COOLING OF BUILDINGS

OBJECTIVE

To make low-carbon heating and cooling affordable for everyone

CO-LEADS



18 MEMBERS INVOLVED

The work of IC7 has resulted in several new international projects to accelerate low carbon Heating & Cooling technologies. In collaboration with the IEA, members are developing the “Comfort and Climate Box” (CCB), a new solution to provide integrated heating, cooling and energy storage at the same time as working with a smart energy grid. The Global Cooling Prize is rallying a coalition of leaders from around the world to solve the critical climate threat that comes from growing residential air conditioning demand. The \$3 million prize, initiated by the Rocky Mountain Institute and MI with funding from the Indian Government, aims to spur the development of technologies with 5x less climate impact and not more than 2x installed cost than air conditioners being sold today by 2020.



IC8: RENEWABLE AND CLEAN HYDROGEN

OBJECTIVE

To accelerate the development of a global hydrogen market by identifying and overcoming key technology barriers

CO-LEADS



13 MEMBERS INVOLVED

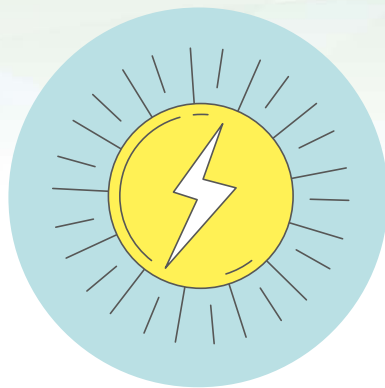
IC8 members are identifying focus areas where global research and innovation effort is likely to generate the most impact in the short term. They have agreed that the “hydrogen valleys” concept, a geographical area – a city, a region, an island or an industrial cluster - where several hydrogen applications are combined together into an integrated hydrogen ecosystem, will be one of the focus areas. The consumption of a significant amount of hydrogen and the coverage of the entire value chain in the “Hydrogen Valley” will offer a pathway for scaling up and will showcase the sectorial integration capability of hydrogen.

PROGRESS TOWARDS GOAL 4

Raising awareness of the transformational potential of energy innovation

Mission Innovation (MI) supports and celebrates the Ideas & Innovators that are driving the pace of the clean energy transition.

MI will continue to champion clean energy innovation on the global stage at events, through press coverage and via social media. The message is clear: by coupling public investment with private sector leadership, by harnessing the power of innovation, fledgling ideas can be brought into the mainstream.



UNITED STATES

In 2018, U.S Department of Energy researchers won or shared 32 of the R&D 100 awards including Special Recognition for “Green Tech”, “Market Disruptor—Products”, and “Corporate Social Responsibility”. The R&D 100 Awards recognise exceptional new products or processes that were developed and introduced into the marketplace.

4,300 innovators, investors and policy makers involved in 46 events on 4 continents

MI reached 60,000 people in 181 countries in 2018 through our new website and also enhanced our social media presence

Over 50 breakthrough innovation solutions published

MI referenced in over 70 international publications and online articles

MI Champions programme

The MI Champions programme celebrates exceptional researchers and innovators who are inventing the clean energy products and services of the future or discovering the science that underpins them. These 19 Champions were selected from across MI member countries, through a rigorous process and were announced at the 4th Ministerial in Vancouver. Over the next year these Champions will work with MI to raise the profile of clean energy around the world.



michampions.net

PROGRESS TOWARDS GOAL 4

Raising awareness of the transformational potential of energy innovation

Mission Innovation members' investments are resulting in breakthrough solutions that have the potential to significantly accelerate the delivery of clean and affordable energy. MI has profiled over 50 Solutions that were supported by public investment and are already delivering impact. A few of these are highlighted here ranging from basic research through to new demonstration facilities.



AUSTRALIA

Australia invested 2.57 million AUD to support **Power Ledger** to trial the use of **blockchain-powered distributed energy and water systems** and assess how cities can use this technology for the integration of renewables. In May 2018, Power Ledger struck a deal with Northwestern University in Chicago, USA, for the first commercial deployment of its technology to trade the power generated by solar panels on university buildings between facilities.



SWEDEN

The **HYBRIT initiative**, supported by the Swedish Energy Agency, aims to **reduce carbon dioxide emissions from ironmaking** by using hydrogen produced from fossil free electricity to eliminate the need to use fossil fuels for iron ore reduction. The project, led by Swedish companies SSAB, LKAB and Vattenfall, started in 2016 with a pre-feasibility study and the construction of a pilot plant in Luleå, Sweden began in 2018. The goal is to have this technology ready for industrial scale by 2035.



INDIA

The Surya Jyoti **Micro solar dome** can provide up to 17 hours of 60W equivalent light, with a lifespan of up to 20 years ensuring access to lighting for remote communities. 4,000 Micro Solar Domes have now been installed in impoverished parts of Delhi, Mumbai, Kolkata and Bengaluru with 54 technicians from 14 states trained in the manufacturing process.



CANADA

With \$7.8 million in funding from the Government of Canada, **Tugliq Energy Co** has demonstrated the ability to **deliver wind energy in isolated off-grid sites** with permafrost and variable wind conditions. The turbine has successfully operated for three consecutive years, delivering 20.1 GWh of renewable energy to the Glencore RAGLAN Mine, abating 5.1 million litres of diesel and 14,424 tons of CO₂ equivalent in greenhouse gas emissions.



JAPAN

In 2016, **Toyota Motor Corporation** and the **Tokyo Institute of Technology** reported in **Nature Energy**, the electronic version of the UK-based science journal, the discovery of superionic conductors with the world's highest lithium-ion conductivity in a project funded by the Japanese government. The conductors have been used to develop an **all-solid-state battery that has achieved a power density three times as high as conventional lithium-ion batteries**.

SWEDEN

EUROPEAN COMISSION

CorPower Ocean has developed a compact high-efficiency **Wave Energy Converter**, with a design inspired by the pumping principles of the human heart. The design enables the converter to oscillate in resonance with the incoming waves, strongly amplifying the motion and power capture while surviving the most powerful storms. Public sector support has been provided through Horizon 2020, InnoEnergy, Wave Energy Scotland and the Swedish Energy Agency. A half-scale unit was tested at the European Marine Energy Centre in Orkney and the company has recently raised equity funding for commercial scale demonstration.



CHINA

Guangzhou Institute of Energy Conversion and the **Chinese Academy of Science** developed a novel method that can **convert whole biomass residues to aviation fuels using an aqueous reforming process**. Construction of a demonstration facility started in 2017 with an anticipated production volume of 1,000 tons of aviation fuel per year. The project will process 12,000 tons of corn stalks per year generating 2.4 million yuan for local farmers.

mission-innovation.net/solutions

Stay in touch

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