



सत्यमेव जयते

Ministry of Science & Technology,
Government of India



MISSION
INNOVATION

MISSION INNOVATION INDIA HIGHLIGHTS

www.mission-innovation-india.net

ABOUT US

- ❑ Mission Innovation was announced on **NOVEMBER 30, 2015**, in Paris to undertake ambitious efforts to combat climate change
- ❑ Global initiative of **23 COUNTRIES** and **EUROPEAN UNION (EU)** to accelerate clean energy innovation
- ❑ Accelerating **CLEAN ENERGY INNOVATION** is essential to limiting the rise in global temperatures to well below 2 °C
- ❑ **COMMITMENT TO DOUBLE** their governments clean energy R&D investments over five years while encouraging greater level of private sector investments
- ❑ Accelerate the availability of **ADVANCED TECHNOLOGIES** that will define a clean, affordable & reliable global energy mix



**India is Co-lead in
Smart Grids, Off Grids and
Sustainable Biofuels Challenges**

SMART GRIDS INNOVATION CHALLENGE – IC#1

To enable future grids that are powered by affordable, reliable, decentralised renewable electricity systems. Interest areas identified are:

- Regional grid innovation
- Distribution grid innovation
- Micro grid innovation & cross innovation
- Efficient appliances design
- Innovation on technologies includes renewable sources integration, storage and smart mini-grids management technologies (systems safety, reliability, interoperability and scalability, etc.)
- Skilled labour and infrastructure financing
- Local implementation conditions

OFF-GRID ACCESS TO ELECTRICITY INNOVATION CHALLENGE – IC#2

To develop systems that enable off-grid households and communities to access affordable and reliable renewable electricity. Areas of interest include:

- Off grid electricity systems utilizing poly generation and also solar, wind, micro-hydel, biogas, and various other forms individually or hybridized for heating/cooling/thermal applications.
- Augment the existing fossil with renewable sources including roof top solar as an off grid solution.
- Frequency and voltage stability of off grid system and developing robust control algorithm.
- Village Distributed Energy resource (DER) Grid.
- Hybrid distribution system (AC and DC grid).
- Development of efficient DC appliances and smart centralized distribution control to ensure disciplined and efficient end use of energy

CARBON CAPTURE INNOVATION CHALLENGE – IC#3

To enable near-zero CO₂ emissions from power plants and carbon intensive industries. Interest areas identified are:

- Advances in gas separation of CO₂ concentration
Geologic storage of CO₂.
- Utilization CO₂ for value added chemicals
- Use of captured CO₂ to create plastics
- Algal biofuels
- Carbonate materials or other uses under discovery phase.
- All R&D in CO₂ utilization that could result in revolutionary & is not just incremental

SUSTAINABLE BIOFUELS INNOVATION CHALLENGE – IC#4

To develop ways to produce, at scale, widely affordable, advanced biofuels for transportation and industrial applications. Identified interest areas include:

- Advanced, or second generation, biofuels which can be produced from non-food biological materials (biomass) such as forest and farming residues and other waste materials, Specially grown high yield plants or algae to biofuels/ bioproducts, and refined into fuels for use in transportation or industry.
- Use of MSW for biogas/biofuels
- LCA for production of biofuels in agriculture, forestry, and land management; take advantage of mitigation and adaptation practices that are synergistic
- Economic development by growing the market share of advanced biofuels coupled with high value products Microbial fermentation of industrial waste gases for Biofuel Production of low cost high performance Enzymes and yeasts for Biofuel/bioproducts Biogas production from low cost materials
- Improve the large-scale production and supply of biological feedstocks including , harvesting, collection, handling, transport and pre-treatment practices
- Research and improve upon new technologies for the high efficiency utilization of biofuels in transport and industry, including biogas applications
- High-efficiency combustion engine applications, and applications combining electric, fuel cell and biofuels

CONVERTING SUNLIGHT INNOVATION CHALLENGE – IC#5

To discover affordable ways to convert sunlight into storable solar fuels. Some of the identified interest areas include:

- Producing carbon-neutral clean fuels (such as hydrogen) Developing breakthrough energy storage chemicals Catalysts for water splitting and CO₂ reduction,
- Light harvesting through micro-algae, Photo-electrochemical cells,
- Concentrated solar light to energy rich chemicals and engineering of production devices.

CLEAN ENERGY MATERIALS INNOVATION CHALLENGE – IC#6

To accelerate the exploration, discovery, and use of new high-performance, low-cost clean energy materials. Specific application areas for new materials include:

- Advanced batteries and solar cells,
- Low energy semiconductors,
- Thermal storage
- Coatings for various applications,
- Structural materials with better properties
- Catalysts for the conversion and capture of CO₂.
- End-to-end materials innovation platform
- R&D in chain of new materials, such as the discovery, synthesis, data and performance assessment, and process design and scale-up
- Materials innovation process (model, simulate, predict, synthesize, characterize, and test the properties and performance) of new clean energy materials

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AFFORDABLE HEATING AND COOLING OF BUILDINGS INNOVATION CHALLENGE – IC#7

To make low-carbon heating and cooling affordable for everyone. Identified interest areas include:

Thermal energy storage

- Heat pumps;
- Non-atmospheric heat sinks and sources;
- Predictive maintenance and optimization;
- Building-level integration; and
- Equipment development for heating and cooling

RENEWABLE AND CLEAN HYDROGEN INNOVATION CHALLENGE – IC#8

To accelerate the development of a global hydrogen market by identifying and overcoming key technology barriers to the production, distribution, storage, and use of hydrogen at gigawatt scale.

Hydrogen has the potential to play an essential part in achieving deep cuts in emissions and improved security and resilience of the global energy system at a scale. Pure Hydrogen is made from splitting hydrogen-rich substances and is a promising energy-dense energy carrier with multiple uses.

The potential of producing Hydrogen from renewable energy and water in a cost effective manner shall help solve energy problems in the near future. The key areas of Interests include:

- Making hydrogen
- Sharing hydrogen
- Using hydrogen and cross-cutting issues
- Mature end-use applications like automotive fuel cells
- Make hydrogen cost-competitive in the broader energy system
- Fuel Cells: Increase Efficiency
- Fuel Cells: Increase Robustness
- Fuel Cells: Reduce Costs



IC#1: SMART GRIDS

Co-leads: China, India, Italy

PARTICIPANTS

Australia, Austria, Brazil, Canada, Denmark, European Union, Finland, France, Germany, Indonesia, Mexico, Netherlands, Norway, Republic of Korea, Saudi Arabia, Sweden, United Kingdom, United States.

THE OBJECTIVE

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

- ❖ Smart grid and storage research is a vital opportunity for governments and the private sector to join hands with the goal of finding the best technology solutions for realizing the future grid.
- ❖ The smart grid innovation challenge aims over the next decade to develop and demonstrate the use of smart grid technologies and storage in a variety of grid applications, including demonstrating the robust, reliable operation of MW-sized micro grids in diverse geographic conditions. By 2030, the objective is to develop technology solutions that can accommodate 100% renewable based power plants in large scale across the globe.

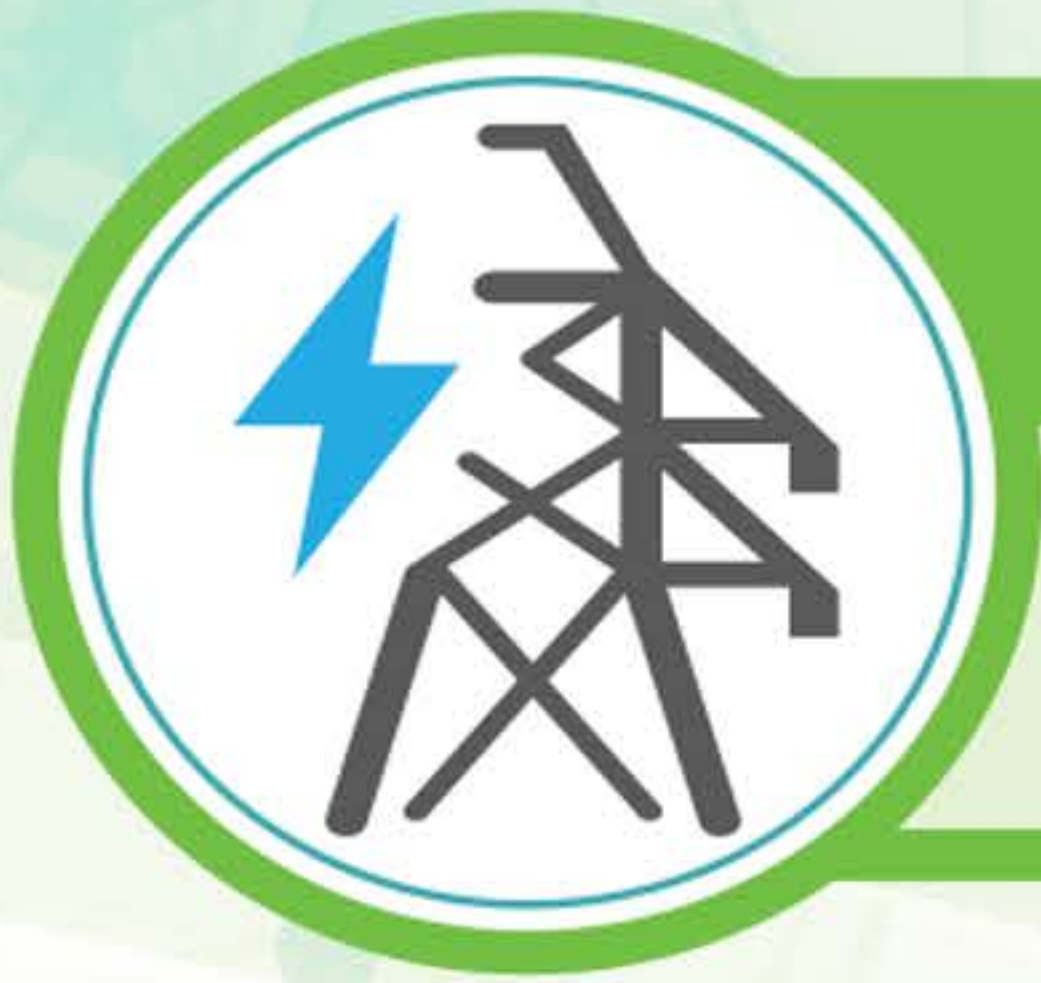
PROGRESS HIGHLIGHTS

- ❖ The fourth IC#1 Deep Dive Workshop, held in Rome, Italy in November 2018, brought together experts, industry leaders and Mission Innovation representatives to discuss how this emerging technology can help accelerate the growing capacity of renewable energy generation in electricity grids.
- ❖ A three-day deep dive workshop was held by IC#1 on the margins of the third Mission Innovation Ministerial in May 2018, including a workshop in Copenhagen that was open to the public.

- ❖ Fourteen IC#1 member countries have contributed to a major output, the “Smart Grids Innovation Challenge Country Report 2017”.
- ❖ The report, released in November 2017 at the second IC#1 deep dive workshop in New Delhi, details the strategy, trend, vision and ongoing activity in the smart grids field from each contributing country.
- ❖ India-UK Joint Virtual Clean Energy Centre Conference: The conference held in the UK (18-20 September 2018), focused on bringing together academics in the Clean Energy field from UK and India and enabled valuable discussions on key challenges and collaborative work in the integration of solar, PV, Energy Storage and electrical networks.
- ❖ Ten smart grid R&D priorities have been identified through the work on the Country Report and surveys of member countries. The top 6 tasks have been prioritized for elaboration and launch.

MI INDIA ACTIVITIES

- ❖ IC#1 held the Second MI Smart Grid Innovation Workshop at the Indian Institute of Technology (IIT) – Delhi in November 2017.
- ❖ In addition to the multi-lateral activity the IC#1-member countries have signed several bilateral collaboration agreements India with Italy, the UK and the US.
- ❖ Smart Grids Innovation Contest (Planned Activity 2019) - Competing on outcomes has the potential to improve the value delivered by the entire smart grid innovation challenge. The IC#1 project outcomes can be encouraged to go to the markets by organizing the competition among interested start-ups along with industries from all over the world. The assessment of the competition would be done by major smart grid stakeholders from industries, utilities and academicians along with the IC#1 co-leads.



IC#2: OFF-GRID ACCESS TO ELECTRICITY

Co-leads: France, India

PARTICIPANTS

Australia, Brazil, Canada, China, European Union, Finland, Indonesia, Italy, Mexico, Netherlands, Norway, Republic of Korea, Saudi Arabia, Sweden, United Kingdom, United States

THE OBJECTIVE

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

Every 1 USD invested in the power sector generates more than 15 USD in incremental GDP. Technology innovation needs include renewable sources integration, storage and smart small-scale grid management technologies (e.g. systems safety, reliability and scalability, interoperability between grid components to allow demand growth, smart and integrated control, etc.) and efficient DC appliances

For individual homes, the objective is to reduce significantly over the next 5 to 10 years the price of renewable power systems for lighting and communication device charging, while expanding the range of services deliverable on household system.

PROGRESS HIGHLIGHTS

- ❖ Side event on 'Energy Access' on 13 December 2018 at COP24 at Katowice, Poland.

MI INDIA ACTIVITIES

- ❖ The results of the Calls for Proposals from India and France on Off-Grid Access to Electricity were announced at the third Mission Innovation Ministerial in May 2018.

- ❖ IC#2's second international meeting took place March 1-2, 2019 in New Delhi, India. Leaders and visionaries from government, the scientific community, and the private sector debated the entire value chain in a holistic way and discussed the development of these complex changes.
- ❖ MI Project partner meeting held on 12-13th December 2018 on "Cooperative Isolated Renewable Energy System for Enhancing Reliability of Power in Rural Areas" in Jaipur, India (Knowledge partner: India-Australia-Canada).
- ❖ MI Project workshop held on 12 Dec 2018 "Biomass-Solar electricity and Cooling solution for Rural India" in Gurugram, India (Knowledge partner: India-Italy France-Norway).
- ❖ MI Project partner held on 6th Feb 2019 on "Uneven Span Greenhouse integrated Semitransparent Photovoltaic Thermal (GiSPVT) System for Agricultural Applications" in New Delhi, India (Knowledge partners: India-UK-Japan).



IC#3: CARBON CAPTURE

Co-leads: Mexico, Saudi Arabia, United Kingdom

PARTICIPANTS

Australia, Canada, China, Denmark, European Commission, Finland, France, Germany, India, Indonesia, Italy, Japan, Netherlands, Norway, Republic of Korea, Sweden, United Arab Emirates, United States

THE OBJECTIVE

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

CCUS is one of the only technologies able to achieve significant decarbonization of our fossil fuel-based economies, particularly in carbon-intensive industries such as cement, iron and steel production. The goal of the Carbon Capture Innovation Challenge is twofold: first, to identify and prioritize breakthrough technologies; and second, to recommend research, development, and demonstration (RD&D) pathways and collaboration mechanisms.

PROGRESS HIGHLIGHTS

- ❖ IC#3 is demonstrating the impact of international collaboration with the allocation of \$103 million in funding for carbon capture, from the European Commission, the U.S. Department of Energy, and the Accelerating Carbon Capture and Storage Technologies (ACT-CCS) consortium.
- ❖ A report on the Mission Innovation (MI) Carbon Capture, Utilisation, and Storage (CCUS) Experts' Workshop held by IC#3 in September 2017 in Houston, Texas was launched at the third Mission Innovation Ministerial in May 2018.

MI INDIA ACTIVITIES

A national workshop on Carbon Capture and Utilization was organized on 13th September 2017 at New Delhi, India. A US\$ 6 Million National RD&D Funding Opportunity Announcement (FoA), where participation of member of IC country is mandatory, has been made to support the IC#3 challenge. A total of 20 applications have now been recommended for funding disbursement.



IC#4: SUSTAINABLE BIOFUELS

Co-leads: Brazil, Canada, China, India

PARTICIPANTS

Australia, European Commission, Finland, France, Indonesia, Italy, Mexico, Netherlands, Norway, Sweden, United Kingdom, United States.

THE OBJECTIVE

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

- ✦ Use of fossil fuels in transportation and industrial production contributes up to 35% of global greenhouse gas (GHG) emissions. Although sustainable biofuels can have an important role to play in tackling these emissions, many of the most exciting biofuels remain at the pre-commercial stage of development. The Sustainable Biofuels Innovation Challenge aims to accelerate biofuels research, development, and demonstration in order to achieve performance breakthroughs and cost reductions with the potential to substantially lower GHG emissions.
- ✦ A key challenge for some countries constraining wider adoption of biofuels is the limited availability of inexpensive biomass, and the high costs of advanced conversion technologies that are at various stages of development. Research and development aimed at accelerating advanced biofuels availability must address key challenges ranging from the sustainable generation and supply of biological feedstocks which takes into account life-cycle impacts and increasing competition for food, feed and material production, to demonstrating the economic feasibility of technologies to produce biofuels that meet current fuel specifications and that can be blended with existing fuels.

PROGRESS HIGHLIGHTS

- ✧ The Mission Innovation India Unit with support from Department of Biotechnology, Government of India, organized the International Conference on Sustainable Biofuels (ICSB) in February 2018 in New Delhi.

The participating countries adopted “New Delhi Declaration” which calls for a time bound action plan to achieve the objectives of Sustainable Biofuels innovation challenge.

- ✧ Pursuant to the ICSB 2018, a Funding Opportunity Announcement (FoA) of US \$5 Million for Sustainable Biofuels, with mandatory participation of IC4 member countries, has been launched. A total of 14 Projects has been recommended for fund disbursement.
- ✧ China, a co-lead in the Innovation challenge organised 2nd International Conference at Yantai on Biofuels, focusing on Sustainability, Innovation and Connectivity for Biofuels. Indian delegation to the International Conference was led by Dr. Sangita Kasture Department of Biotechnology (DBT), Gol.
- ✧ China Issued 42 calls for proposals with IC#4 member countries (clean energy including biofuels): Funding 952 million RMB on Chinese Side.



IC#5: CONVERTING SUNLIGHT

Co-leads: European Commission, Germany

PARTICIPANTS

Australia, Brazil, Canada, Chile, China, Denmark, Finland, France, India, Italy, Japan, Mexico, Netherlands, Norway, Saudi Arabia, Sweden, United Arab Emirates, United Kingdom, United States

THE OBJECTIVE

To discover affordable ways to convert sunlight into storable solar fuels.

Solar energy's potential contribution to a clean energy future is far from being fully exploited. The production of clean fuels from sunlight has the potential to not only mitigate climate change but also to enhance energy security and provide opportunities for economic development. Despite the potential opportunity, the global collaborative activity in this field is currently limited. The IC#5 members are collaborating to exploit the significant opportunity of using sunlight to produce carbon-neutral fuels (such as hydrogen) and to develop energy storage chemicals.

PROGRESS HIGHLIGHTS

- ❖ Funding opportunities in this area are increasing, including the European Commission's Prize for Artificial Photosynthesis and the recently published German 7th Energy Research Programme includes photovoltaics and fuel cells.
- ❖ The challenge is to build a fully functional, bench-scale prototype of an artificial photosynthesis-based system which can produce a useable synthetic fuel.
- ❖ Artificial photosynthesis is widely considered to be among the most promising new technologies to deliver sustainable alternatives to current fuel supplies.

- ✧ The EC Prize value of €5 million will accelerate the development of new innovative energy conversion systems using solar light and natural elements to produce renewable fuels to be used in industry, housing and transport.

MI INDIA ACTIVITIES

- ✧ The Mission Innovation India unit with support from Ministry of Science & Technology, Government of India, organized the National Workshop on Converting Sunlight Innovation Challenge on 23rd September 2017 At New Delhi, India.
- ✧ Funding Opportunity Announcement (FoA) (US\$ 6 Million) with mandatory participation of IC#5-member countries, for Converting Sunlight Innovation Challenge has been advertised and details for this FoA were shared with all member countries. A total of 13 project have been recommended for funding disbursement.



IC#6: CLEAN ENERGY MATERIALS

Co-leads: Canada, Mexico

PARTICIPANTS

Australia, Denmark, European Commission, Finland, France, Germany, India, Italy, Netherlands, Norway, Republic of Korea, Saudi Arabia, Sweden, United Kingdom, United States

THE OBJECTIVE

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

- ✧ This Innovation Challenge aims to accelerate the innovation process for high-performance, low-cost clean energy materials and automate the processes needed to integrate these materials into new technologies. Even with current state-of-the-art technologies, the innovation process for the translation of new materials from laboratory to market can take 10 to 20 years and is very expensive. Accelerating and improving this process through international collaborative research and development (R&D) could result in major breakthroughs for the energy sector.
- ✧ This clean energy materials innovation initiative will build on and expand multidisciplinary and international research collaborations.

PROGRESS HIGHLIGHTS

- ✧ An IC#6 European meeting, held in Rome, Italy in October, 2018, brought together experts from around the world to identify critical research and development priorities and gaps in clean energy materials innovation processes and explore opportunities for deeper collaboration.
- ✧ An IC#6 industry meeting on Self-driving materials laboratories: The next paradigm for accelerated discovery was held in May 2018 in

Toronto, Canada. The goal of the meeting was to explore opportunities for private sector companies to collaborate in this initiative and work with researchers to develop and deploy this disruptive new approach to materials discovery.

- ✧ An IC#6 workshop on Structural materials and 3D printing was held in March 2018 in Toronto, Canada. Attendees engaged in technical discussions on the state of the field, pre-competitive R&D opportunities, and promising R&D directions.
- ✧ The IC#6 workshop report *Materials Acceleration Platform: Accelerating Advanced Energy Materials Discovery by Integrating High-Throughput Methods with Artificial Intelligence* was published in January 2018. Workshop aim was to support the Innovation Challenge's goal of accelerating the exploration, discovery, and use of new, high-performance, low-cost clean energy materials by at least ten times.

MI INDIA ACTIVITIES

- ✧ Mission Innovation India workshop on Clean Energy Materials was organized on August 17, 2017 New Delhi. Under the National Funding Programme, a Call for proposal on Clean Energy Materials (Materials for Energy Storage (MES) and Material for Energy Conservation and Storage Platform (MECSP) has been proposed.
- ✧ Second International Meeting on Clean Energy Materials Innovation Challenge during February 21st-22nd, 2019 in New Delhi, India, aims to bring together leaders and visionaries from government, scientific community, and the private sector that are looking at the entire value chain in a holistic way and can speak about and debate the development of these complex changes, which are redefining the future of energy worldwide.



IC#7: AFFORDABLE HEATING AND COOLING OF BUILDINGS

Co-leads: European Commission, United Arab Emirates, United Kingdom

PARTICIPANTS

Australia, Austria, Brazil, Canada, China, Denmark, Finland, France, Germany, India, Italy, Mexico, Netherlands, Norway, Republic of Korea, Saudi Arabia, Sweden, United States

THE OBJECTIVE

To make low-carbon heating and cooling affordable for everyone.

Currently, three-quarters of the global energy requirement for heat is met by burning fossil fuels, and one third of global energy-related CO₂ emissions can be attributed to the provision of heat. Energy consumption for space cooling is primarily dependent on electricity and to a lesser extent natural gas, so is also associated with a high carbon load.

Innovation using new materials, processes, and systems provides a significant opportunity to reduce energy consumption and CO₂ emissions. Such innovative technologies and practices have important economic and social potential with respect to reducing energy bills, enhancing global access to energy, increasing the competitiveness of renewable technologies and improving energy security.

This Innovation Challenge will provide a platform for international collaboration with the potential to considerably accelerate innovation in the heating and cooling arena.

PROGRESS HIGHLIGHTS

- ❖ Regular new letter available on IC#7's activities from 2018.
- ❖ Horizon 2020, the multi-annual programme for research and innovation of the European Union (EU), is launching two new

funding opportunities for thermal storage projects to support the implementation of IC#7. Deadlines are in February 2019.

- ✧ An IC#7 meeting on gas heat pumps took place in July 2018 in Pisa, Italy.
- ✧ A technical workshop on an IC#7 priority, Predictive Maintenance and Control Optimization of Buildings, was held September 2018 in Montreal, Canada.
- ✧ In November 2017, IC#7 held an Expert Workshop in Abu Dhabi, United Arab Emirates. The summary of this workshop defines the work-streams and priority areas under IC#7 and has spurred the results described in this page.

MI INDIA ACTIVITIES

- ✧ India's Ministry of Science and Technology is supporting the Global Cooling Prize, a \$3 million prize to develop and scale breakthrough affordable cooling solutions. Preliminary application deadline: June 2019.



IC#8: RENEWABLE AND CLEAN HYDROGEN

Co-leads: Australia, European Commission, Germany

PARTICIPANTS

Austria, Canada, Chile, China, France, India, Italy, Japan, Netherlands, Norway, Saudi Arabia, United Kingdom, United States.

THE OBJECTIVE

To accelerate the development of a global hydrogen market by identifying and overcoming key technology barriers to the production, distribution, storage, and use of hydrogen at gigawatt scale.

- ❖ Hydrogen is a promising energy-dense (mass density) energy carrier with multiple uses and the potential to play an essential part in achieving deep cuts in emissions and improved security and resilience of the global energy system at scale. Pure hydrogen is made from splitting hydrogen-rich substances.
- ❖ To date the approach to hydrogen production has centred on fossil fuels, such as natural gas or coal. In the future, producing hydrogen from renewable energy and water has potential to deliver large volumes of Members will collaborate to identify and accelerate key breakthroughs needed to achieve a cost-competitive hydrogen value chain.
- ❖ Innovation Challenge 8 will provide a platform to understand and progress selected issues around how a global hydrogen market would function as a system hydrogen for multiple uses at low cost. Creating the supply chain for hydrogen will be equally important.

PROGRESS HIGHLIGHTS

- ❖ IC#8 was launched at the third Mission Innovation Ministerial to address the need for further technology improvements to enable hydrogen to be cost-competitive in the energy system.

- ❖ IC#8 participants met in Berlin, Germany in October 2018 for a deep dive workshop involving industry, government and academics.
- ❖ Mission Innovation “Hydrogen Valleys” Workshop, Antwerp, 26-27 March 2019.

MI INDIA ACTIVITIES

- ❖ The Department of Science and Technology participated in the Renewable and Clean Hydrogen Challenge of Mission Innovation (IC#8) at Berlin, Germany. India country status report on Renewable and Clean Hydrogen detailing Hydrogen technology, Storage and local distribution, Hydrogen in energy intensive industries, and cross-cutting issues was presented.