EINDHOVEN UNIVERSITY OF TECHNOLOGY

Compilation of good practices

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United Nations
Framework Convention on
Climate Change

TECHNOLOGY EXECUTIVE COMMITTEE

COMPILATION OF GOOD PRACTICES

and lessons learned on international collaborative research, development and demonstration initiatives of climate technology

TABLE OF CONTENTS

1. FOREWORD

The Paris Agreement, adopted by Parties in 2015, stipulates that accelerating, encouraging and enabling innovation is critical for an effective, long-term global response to climate change and promoting economic growth and sustainable development.

Three years after Paris, in Katowice, Poland, Parties adopted the technology framework and further emphasized the importance of technological innovation in achieving the purpose and goals of the Paris Agreement.

The technology framework, which provides overarching guidance to the work of the Technology Executive Committee (TEC) while serving the Paris Agreement, recognizes that there is a pressing need to accelerate and strengthen technological innovation so that it can transfer environmentally and socially sound, cost-effective and better-performing climate technologies on a larger scale. It also indicates that fostering innovation could be done inter alia through new collaborative approaches to climate technology research, development and demonstration (RD&D).

Responding to this mandate, the TEC, which has been working on technology innovation and RD&D since 2013, agreed to produce a compilation of good practices and lessons learned on countries' RD&D.

This compilation analyses selected bilateral and multilateral projects and programmes in Asia and the Pacific, Africa, Latin America and the Caribbean, Europe and North America in sectors such as energy supply, agriculture and water management.

It elaborates on inter alia, collaborative designs, policy and financial drivers, inclusiveness, intellectual property rights, and approaches to communication and outreach drawn from various case studies. It also considers, where applicable, the alignment of RD&D projects and programmes with countries' needs as reported in their nationally determined contributions (NDCs), national adaptation plans (NAPs) and technology needs assessments (TNAs).

The desired outcome is to extract good practices and lessons learned, with the aim of facilitating the sharing of information on international technology RD&D partnerships and initiatives. We believe that the information contained in the compilation may also facilitate the effective participation of developing countries in collaborative RD&D initiatives on climate technologies.

We would like to express our heartfelt appreciation to all experts and TEC task force members who have provided their valuable contributions to this compilation and we look forward to further work of the TEC in the area of innovation.

Mareer Mohamed Husny
Chair of the Technology Executive Committee

Stephen Minas
Vice-chair of the Technology Executive Committee

2. HIGHLIGHTS

As stipulated in Article 10, paragraph 5, of the Paris Agreement, accelerating, encouraging and enabling innovation is critical for an effective, long-term global response to climate change and promoting economic growth and sustainable development. Fostering innovation can be done through various means, one of which is effective international collaborative approaches to enhance climate technology RD&D.

This compilation aims to facilitate the sharing of information on international technology RD&D partnerships and initiatives. From a broad compilation of such initiatives, it selects and analyses a set of representative case studies, from which it draws some good practices and lessons learned.

General observations from a broad mapping of initiatives can be summarized as follows:

- While there is a large number of international collaborations on climate technology RD&D, only a limited number are engaged in actual funding or implementation of RD&D of 'hardware'. Instead, many focus on RD&D strategies, policy dialogues, information-sharing and capacity-building, or on the commercialization and deployment of technology. This confirms earlier work by the TEC (TEC, 2016);

- Among the joint (funding of) RD&D initiatives, there are relatively few that cover climate change adaptation;

- While some initiatives are set up specifically to address identified RD&D needs, with dedicated institutions set up for this purpose, in other cases, the initiative is a result of a primary objective to strengthen international relations;

- The bulk of initiatives identified are public sector led. Although various initiatives have made a special effort to engage with the private sector, its involvement in the early stages of the technology cycle is limited. Private sector mostly gets involved in the demonstration, incubation, commercialization and diffusion phases.

Eight case studies have been selected from the mapping. While each case study initiative has been declared a success, with no reason to doubt that the initiative is reaching its goal, only limited independent evaluations are available. A large number of independent, public evaluations would allow for robust conclusions on factors that contribute to the success or failure of the initiatives and the further identification of lessons that can be learned from them.

Having said that, on the basis of the publicly available information, the case studies suggest the following good practices:

1. High-level political buy-in, combined with structural, pragmatic implementation processes;

2. Joint ownership and funding, and equal partnership between developed and developing country participants;

3. Broad participation and stakeholder engagement from the beginning;

4. Alignment with national priorities, needs and capabilities;

5. Alignment of the initiative's design with the technology and its context;

6. Suitable governance and management processes of initiatives;

7. Structured evaluation and continual adjustment;

8. Design for long-term sustainability;

9. Combination of technological hardware RD&D with software and orgware activities.

The core recommendations are as follows:

1. Assessment and learning on successful collaborative RD&D initiatives should be strengthened, so that lessons learned are transparent and independently established. Currently, only a few initiatives undertake regular independent, publicly available evaluations that are transparently reflected in organizations and allow others to learn as well. Universities also play a role in this regard;

2. Flexible and evolving participation of countries in line with national needs and capacities should be facilitated, taking into account that these can be very different depending on context;

3. Particular attention needs to be paid to the "how" of private sector participation. Relevant private sector actors (and other stakeholders) often become involved too late to incorporate their needs, for instance for intellectual property (IP) arrangements;

4. More hardware technological RD&D is needed as many initiatives are focused only on dialogue or coordination. However, to enable smooth transition into deployment and diffusion, such enhanced RD&D needs to be consistently accompanied by software and orgware activities such as policy dialogue and research, standard- and norm-setting, capacity-building and public engagement.

Importantly, in the context of the Paris Agreement goals of international collaborative RD&D initiatives, local presence and capacity-building in developing countries appears to be a crucial part of effective of such countries. For international RD&D collaboration, all engaged researchers need to be able to cooperate on an equal footing. Given the weaker innovation systems and funding of academics and researchers, this is a much greater challenge in developing countries than in developed countries. All initiatives that are successful in terms of developing country participation have invested considerably in local capacity. Meaningful participation of developing country researchers requires some external funding by donors, which needs to be structured in such a way that ownership is not negatively affected.

Although much can be said already from the assessment in this brief, gaps in knowledge remain. While some initiatives are set up specifically to address identified RD&D needs, with dedicated institutions established for this purpose, in other cases the initiative is a result of a primary objective to strengthen political relations. The case studies were selected as initiatives of significance and have indeed demonstrated various good practices and valuable lessons learned. However, this does not address whether they actually represent the optimal response to the need for international RD&D collaboration in the climate change space, or whether other forms would have been more effective in addressing that need. This could be a worthwhile area for further analysis.

3. CONCEPTS, DEFINITIONS AND APPROACH

"Climate technology" is defined as "any piece of equipment, technique, practical knowledge or skills for performing a particular activity that can be used to face climate change". (IPCC, 2000) It covers both mitigation and adaptation.

"RD&D" covers activities in the technology life cycle stage from research (TRL1) to demonstration (TRL7).[1]

Thus, "**international collaborative climate technology RD&D initiatives**" refer to initiatives in which different countries or regions jointly conduct (or fund) such RD&D activities.

Activities such as commercialization, market introduction, deployment and scaling up are crucial for achieving large-scale implementation of climate technology, but they are not part of RD&D. Therefore, initiatives solely focusing on these activities are not included here. Activities that include both such activities and RD&D activities are covered.

Similarly, initiatives that promote dialogue among research, industry and policy actors as well as knowledge-sharing and capacity-building are not considered as part of RD&D, though they are crucial in supporting RD&D. Initiatives solely focusing on this type of activity are also not covered here, while combinations of such supporting activities with RD&D activities do fall within the scope of the analyses.

Each collaborative RD&D initiative is characterized in terms of its (1) geography, (2) number of countries involved, (3) the form of cooperation and (4) the scale of activities, as elaborated below.

In terms of geography, the initiatives are characterized based on their geographical scope (national, regional, global), the types of countries involved and the specific countries and regions that participate in the initiative. The types of countries involved are reflected in the cooperation, in terms of North-North, North–South, South–South or triangular cooperation, in line with the definitions in the framework of operational guidelines on United Nations support to South–South and triangular cooperation (UNDP, 2017).

North–South cooperation occurs when a developed country supports a less-developed country economically or with another type of resources.[2] **South–South cooperation** is defined in the above-mentioned framework as "a process whereby two or more developing countries pursue their individual and/or shared national capacity development objectives through exchanges of knowledge, skills, resources and technical know-how, and through regional and interregional collective actions, including partnerships involving Governments, regional organizations, civil society, academia and the private sector, for their individual and/or mutual benefit within and across regions. South–South cooperation is not a substitute for, but rather a complement to, North–South cooperation". **Triangular cooperation** is defined as "southern-driven partnerships between two or more developing countries, supported by a developed country(ies) or multilateral organization(s), to implement development cooperation programmes and projects".

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1 Technology readiness levels (TRL), reflects a scale ranging from 1 (basic principles observed) to 9 (actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies). TRL7 is defined as "system prototype demonstration in the operational environment".

2 See https://bit.ly/37eS2Nb.

The organization of the collaboration is further characterised in terms of:

- **Number of countries involved**

This distinguishes **bilateral** cooperation (between two countries), **plurilateral** cooperation (involving more than two countries but limited to a relatively small number) and **multilateral** cooperation (involving a large number of, or all, countries);

- **Form of cooperation**

Collaboration can be organized as a **consortium** (i.e. consisting of a number of organizations participating in a joint RD&D effort through a contractual arrangement, e.g. a specific project), a **network** (i.e. involving organizations that can cooperate on activities in different compositions at different points in time) or as a **platform** facilitating cooperation between interested parties. In other words, from consortium through network to platform the extent of organization and formalization decreases;

- **Scale of activities**

This specifies whether activities comprise a single **project** or are organized in a **programme** of multiple projects.

The initial list of collaborative RD&D initiatives was created following a broad scoping exercise that involved desk research and inputs from TEC members, members of the innovation task force and the UNFCCC secretariat. The individual case studies draw on primary literature sources, including self-reported information by the initiatives in the form of planning documents, informational and evaluation reports and websites, as well as third-party evaluations, where available.

4. INTRODUCTION AND MAPPING OF COLLABORATIVE INITIATIVES

Article 10, paragraph 5, of the Paris Agreement states that "accelerating, encouraging and enabling innovation is critical for an effective, long-term global response to climate change and promoting economic growth and sustainable development" (UNFCCC, 2016) and that this should be supported by collaborative research and development (R&D).

The objective of this compilation is to understand what lessons can be learned from existing international RD&D collaborations relevant to the technology framework under the Paris Agreement. To this end, an overview of known existing international collaborative RD&D initiatives is provided, a number of selected case studies is further analysed, and a set of good practices and lessons learned on collaborative RD&D is compiled.

The selection of case studies was undertaken as a three-step process:

1. A long-list (57) of international collaborative RD&D initiatives on climate technology was created, outlining their main characteristics, including scope (mitigation/adaptation, sector/technology, geographical scope), maturity, objectives and the type of activities (including the stage of the technology cycle);[3]

2. A shortlist (25) of initiatives suitable for providing lessons learned was drawn up on the basis of the criteria and definitions outlined in the previous section, and inputs from members of the TEC and its innovation task force and the UNFCCC secretariat. These initiatives were further examined in terms of the organization of the initiatives, the activities implemented, budgets and outcomes;[4]

3. Eight case studies were selected from this shortlist for further analysis, keeping in mind the need for diverse and sufficiently representative observations. This list and some key characteristics are set out in table 1.

The cases cover various regions and type of country involvement (North-North, North–South, South–South, triangular), as well as a range of activities in terms of mitigation and/or adaptation and sector/technology focus. Other considerations in the selection of case studies include:

- Whether the initiative would be replicable in other countries or regions and/or could be scaled up;
- Whether the results would be sustainable in the longer term;
- Whether the initiatives are inclusive in terms of the actors involved;
- Whether private sector involvement and/or private sector funding is involved.

The case studies were analysed in detail to understand their origin, organization, governance, scope and outcomes, with the aim of providing lessons learned and identifying good practices that could be relevant for other RD&D collaboration efforts.

The next section describes the selected initiatives, providing lessons learned and identifying good practices that may be relevant for a broader audience. The subsequent sections bring together the cross-cutting good practices and lessons learned and provide recommendations for strengthening and scaling up international collaboration on climate technology RD&D.

3 See https://unfccc.int/ttclear/tec/rdandr.
4 See https://unfccc.int/ttclear/tec/rdandr.

Table 1 Overview of key characteristics of the selected case studies

#	Name of initiative	Mitigation/ adaptation	Technology cycle stage	Type of collaboration	Project or programme	Sector/ technology focus5	Rationale	Geography		Size
								Geographical scope	Region	
1	Indo-US JCERDC	Mitigation	R&D	Bilateral; network of consortia	Programme	Energy	Seen as a success story; good information availability	National, N–S	United States, India	Small
2	Mission Innovation	Mitigation	R&D to demonstration	Multilateral; platform	Programme	Energy	Major initiative	Global; N–N, N–S, S–S, TrC	All	Large
3	IEA TCP	Mitigation	R&D to commercialization	Plurilateral; platform	Programme	Energy	Major initiative	Global, N–N, N–S, S–S, TrC	All	Large
4	DEWFORA	Adaptation	Prototype, demonstration	Plurilateral; consortium	Project	Water/drought management	Joint development of tools, geography	Regional; N–S	Africa, Europe	Small
5	CGIAR	Mitigation, adaption (not climate specific)	R&D to commercialization	Plurilateral; network	Programme	Agriculture	Major initiative, long-standing, much studied	International, N–N, S–S, N–S	All	Large
6	JIRI	Mitigation, adaptation (not climate specific)	R&D financing	Plurilateral; platform	Programme	Cross-cutting	Format of cooperation, shift to more S–S	International/regional; N–S, S–S	Europe, LAC, SIDS	Small
7	CYTED	Mitigation, adaptation (not climate specific)	R&D to commercialization	Multilateral; platform	Programme	Cross-cutting	Format of cooperation, N–S/S–S	International/regional, national; N–S, S–S	Spain, Portugal, LAC	Large
8	AFACI	Adaptation (not climate specific)	R&D to commercialization	Multilateral; network	Projects/ Programme	Agriculture	Significant regional initiatives; replicated across regions	Regional; S–S, TrC	Asia-Pacific	Small

Abbreviations: N–N = North–North, N–S = North–South, R&D = research and development, S–S = South–South, TrC = triangular.

5 All cases (except DEWFORA) cover a multitude of technologies, including all energy technologies and/or all climate technologies, or on an even broader scale (for non-climate-specific initiatives). Therefore, it is not possible to list the specific technologies covered. The individual case studies provide more detail on the technology scope covered.

5. CASE STUDIES

5.1. Indo-US Joint Clean Energy Research and Development Centre

5.1.1. Key characteristics

Focus	Mitigation/adaptation	Mitigation
	Technology cycle stage	Research and development
	Sector	Energy
	Geographical scope	National; North–South
	Geographical participation	United States, India
Organization	Type of collaboration	Bilateral network of consortia
	Actors	Governments, government implementing agencies, research and academic organizations, industry
Budget	Phase 1 (2012–2017)	USD 125 million (USD 25 million each from the United States and Indian Governments; USD 75 million from participating private partners)
	Phase 2 (2017–2022)	USD 30 million (USD 7.5 million each from the United States and Indian Governments; 50% cost share by consortium partners)

5.1.2. The initiative

The Indo-U.S. Joint Clean Energy Research and Development Centre (JCERDC) was established as a virtual centre in November 2010 through an agreement between the United States Department of Energy and the Government of India. JCERDC, the first **bilateral initiative** designed specifically to promote clean energy innovation by teams of scientists and engineers from India and the United States of America, was seen as a priority initiative of the 2009 Partnership to Advance Clean Energy, which was part of the a memorandum of understanding between India and the United States to enhance cooperation on energy security, energy efficiency, clean energy and climate change. (JCERDC, 2012)

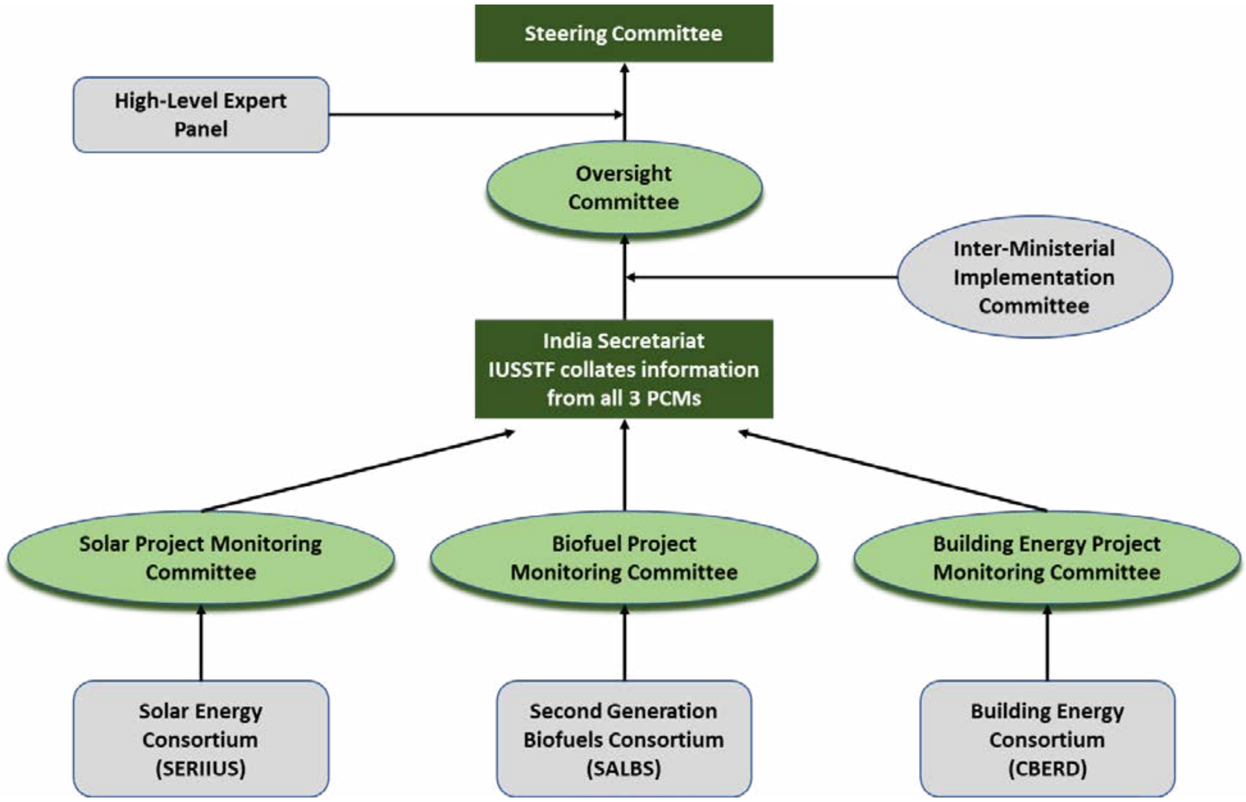
The overall **objective** of JCERDC is to facilitate joint R&D on clean energy to improve energy access and promote low-carbon growth. JCERDC is a bilateral partnership that has supported a number of **multi-institutional consortia** using a public–private partnership funding model with the intention of enabling research, the results of which can be translated into quick deployment.

In phase 1 (2012–2017), the JCERDC **focus** was on three areas seen as critically important and of mutual interest: (1) solar energy, including solar electricity production, nanoscale designs of interfaces and cells, advanced photovoltaic technologies, concentrating solar power technologies; (2) second generation biofuels, including conversion technologies for advanced biofuels, optimal characterization for lignocellulosic feedstock, algal biofuel, standards and certification for different biofuels and co-product with end-use applications; and (3) energy efficiency of buildings, including cooling, cool roofs, advanced lighting, energy-efficient building materials, software for building design and operations, and building-integrated photovoltaics.

In terms of **governance and organization**, JCERDC is overseen by the Indo-U.S. Steering Committee on Clean Energy Science and Technology Cooperation, co-chaired by India's Deputy Chairman of the Planning Commission and the United States Secretary of Energy (see Figure 1). This committee provided high-level review and guidance for the activities of JCERDC. A Joint High-Level Experts Panel of 12 prominent experts from the private and public sectors and academia provided JCERDC with critical suggestions and insights and acted as an advisory body for the committee. Additionally, project monitoring committees – consisting of relevant technical experts and government representatives – were set up to monitor progress in each of the three areas in relation to their defined objectives and targets.

The programme was administered by the Indo-U.S. Science and Technology Forum (IUSSTF), an existing institution with a well-developed administrative infrastructure.[6]

Figure 1: Governance structure of phase 1 of JCERDC



Source: JCERDC, 2015

Note: For phase 2, the topic-specific virtual centres changed (bottom rows), while the rest of the structure remained the same.

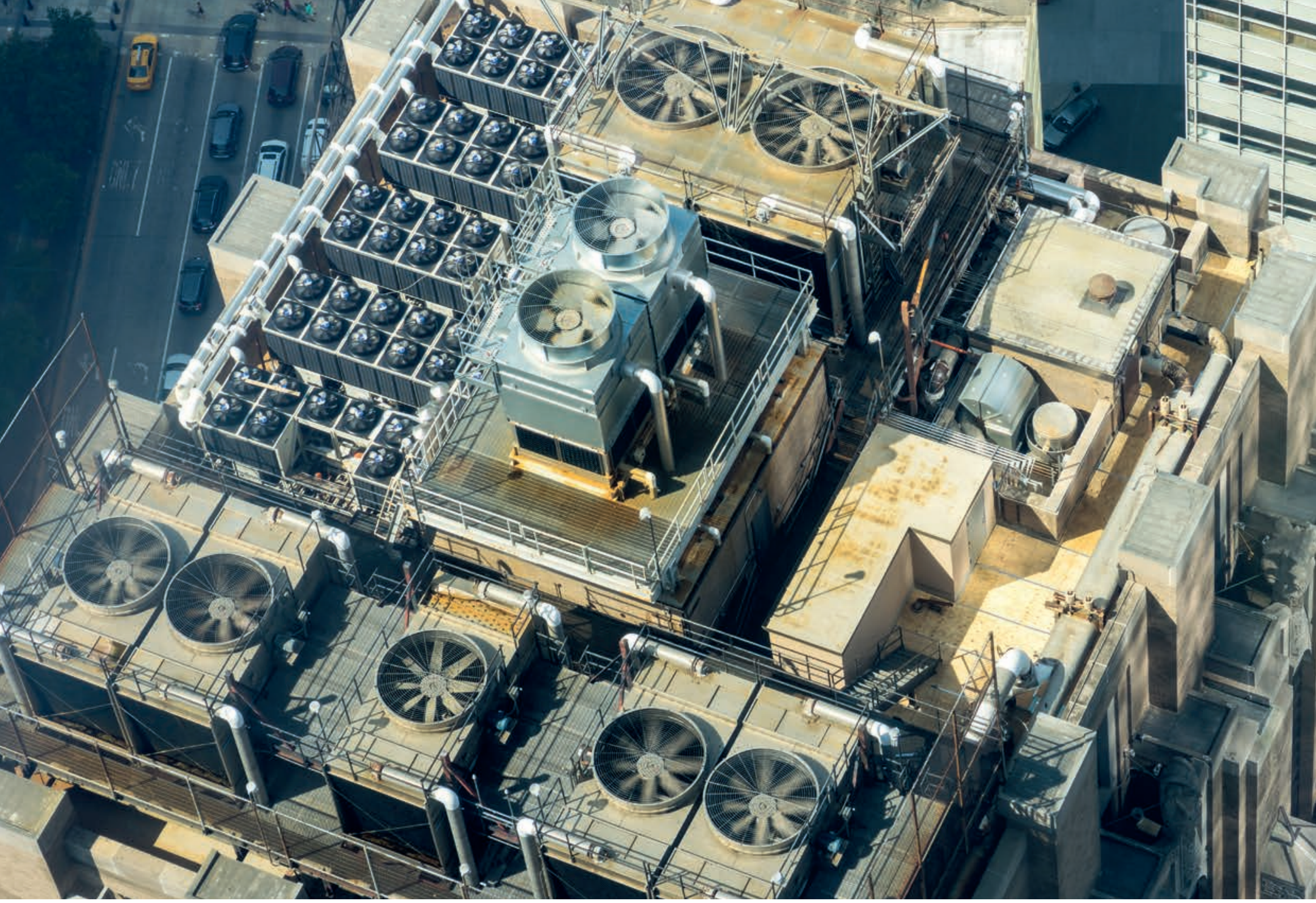
Table 2: Government funding allocation in phase 1

	Solar energy	Building energy efficiency	Second-generation biofuels
Government of India funding (total USD 25 million)	59%	26%	15%
United States Department of Energy funding (total USD 25 million)	54%	23%	23%

Source: IUSSTF, 2019

JCERDC established virtual entities to coordinate and shepherd the work in each area, namely the Solar Energy Research Institute for India and the United States (SERIIUS), the U.S.-India Joint Center for Building Energy Research and Development (CBERD) and the U.S.-India Consortium for Development of Sustainable Advanced Lignocellulosic Biofuel Systems (SALBS). The parties to set up and manage each of these virtual entities were selected through a **public tendering procedure**. Government funds allocated to each of the areas are show in Table 2.

6 IUSSTF is an autonomous bilateral entity established in 2000 to promote science and technology and innovation through interactions with academia, industry and government, jointly funded by India and the United States.



The process of selecting the winning consortia started with a meeting in New Delhi to provide potential applicants with an overview of JCERDC and engage them in an open discussion. Subsequently, potential applicants had a chance to comment on a draft funding opportunity announcement, after which the final announcement and call for proposals was posted online and advertised in national newspapers and journals. For phase 1, IUSSTF and United States Department of Energy received a total of 21 applications, 19 of which were found to comply with the requirements of the call and were suitable for further review. A joint merit review panel for each priority area was constituted, with equal representation from the United States and India to evaluate the applications.[7] Additional reviews were also requested from guest evaluators to supplement the views of each review panel. The reviews, scores and recommendations of the panels were then provided to a Joint Appraisal Committee, which consisted of senior officeholders from relevant Indian and United States government agencies. The committee then selected the consortia to receive the award.

SERIIUS was led jointly by the Indian Institute of Science and the National Renewable Energy Laboratory of the United States. The **overall goal** of SERIIUS was to accelerate the development of solar electric technologies by lowering the cost per watt of photovoltaics and concentrated solar power through the development of deployable technologies. SERIIUS **focused** not only on fundamental and applied research to develop novel and disruptive technologies, but also on the analysis of critical technical, economic and policy issues for solar energy development and deployment in India, workforce development and outreach. This would contribute to India's Jawaharlal Nehru National Solar Energy Mission and the United States Department of Energy SunShot Initiative. The consortium approach involving participants from academia and industry from both countries was chosen to accelerate the translation of knowledge from research to application. SERIIUS's **governance structure** comprised the SERIIUS Council – which included the joint United States and Indian Directors of this entity, research thrust leaders, competency coordinators and industry representatives – and an Executive Oversight Board, which included the leadership of the key organizations in the consortium.

7 Evaluation criteria outlined in the final funding opportunity announcement are as follows: Scientific and Technical Merit (35%); Technical Approach, Management Plan, Understanding of Project Objectives (35%); Applicant/Team Capabilities, Experience, Organization, Facilities, Management Capabilities (30%).

CBERD was led jointly by CEPT University (Ahmedabad, India) and Lawrence Berkeley National Laboratory (California, United States). Its overall **objective** was the improvement of energy efficiency in commercial and high-rise residential buildings through the integration of information technology with building systems. In order to achieve this objective, CBERD efforts **focused** on building energy models and energy simulations; monitoring and energy benchmarking; integrated sensors and controls; advanced heating, ventilation and air-conditioning systems; building envelopes and climate-responsive design. The work programme of CBERD was overseen by a Consortium Management Office.

The major **objective** of SALBS, jointly led by the Indian Institute of Chemical Technology and the University of Florida, was to develop and optimize selected non-food biomass-based advanced biofuels systems and bio-based products like biogas and lignin-based by-products for the United States and India. In order to do so, the consortium **focused** on a range of activities, including improving feedstock production and quality of locally adapted cultivars; helping to optimize the production system through the development of soil criteria, catalysts, logistics and waste stream minimization and recovery; certification protocols and standards; and supply chain management. SALBS was managed by a Project Steering Committee, while the technical aspects were reviewed and guided by a Technical Advisory Committee.

A review of the phase 1 activities carried out by a committee of eminent experts and representatives from the Indian Government and IUSSTF in 2019 concluded that the three programmes had all been successful in achieving their objectives and mandates. Table 3 lists the **key achievements** in the three areas of phase 1 and Table 4 lists the **key deployable outcomes** in each area.

Table 3: Key outcomes in phase 1

	Solar energy	Building energy efficiency	Second-generation biofuels
Journal publications	266	21	79
Conference proceedings	396	57	108
Patents	9	3	6
Joint workshops	14	–	–
PhD and post-doctoral researchers trained	51	12	7
Student exchanges	39	54	31

Source: IUSSTF, 2019

Table 4: Key deliverables and deployable outcomes in phase 1

Solar energy	Building energy efficiency	Second-generation biofuels
Heliostat development	COMFEN India and eDOT	High biomass yielding abiotic stress tolerant sorghum, pearl millet and bamboo
Reliability studies for photovoltaics in India	Cool roof calculator	Low-input advanced feedstock production system
Soiling mitigation for photovoltaic modules	Phase change material ceiling tiles	Efficient pre-treatment and fermentation process
Supercritical CO_2 laboratory scale test loop facility	Laser cut panels	Standardization and certification protocols
Small-scale solar receivers for supercritical CO_2	Dedicated outdoor air system	
New absorber coating material with high thermal stability and high corrosion-resistant property	Indirect evaporative space cooling	
Flexible glass for substrates and encapsulation	Affordable smart power strip	
Novel processing for silicon solar cells	Low-energy wireless motion sensor	
	Energy information system packages	

Source: IUSSTF, 2019

Given the successful review of phase 1, both countries agreed to continue with a second phase of JCERDC (2017–2022) in two new research areas, smart grids and energy storage, that could help to strengthen the ability of the electric power system to support a clean energy transition. Each government has committed USD 1.5 million annually for a five-year period (with 50% cost share coming in from the consortium partners). The consortium (U.S.-India Collaborative for Smart Distribution System With Storage), selected through a process similar to that in phase 1, involves multiple academic and industrial partners and is led by researchers from the Indian Institute of Technology Kanpur and Washington State University. The objectives of this consortium's work are to develop and demonstrate the distribution system operator functions for optimal utilization and management of distributed energy resources, while also exploring the broader implications and requirements of such an energy system, for example data and security needs, resilience and workforce requirements. The consortium has started engaging on its research programme, with exchange visits, workshops and some journal publications. However, it is too early to conclude whether its objectives will be met. The governance structure for phase 2 is broadly along the same lines as those of phase 1.

5.1.3. Key success factors and lessons learned

JCERDC is a high-profile effort that has **high-level political buy-in** in both India and the United States. In fact, the joint centre was established under the 2005 umbrella Agreement on Science and Technology Cooperation between India and the United States. The success of JCERDC also rests on other factors: **the topics chosen were seen as being salient and important to both countries** and had sufficient ongoing academic and industrial efforts in both countries to underpin the R&D programmes.

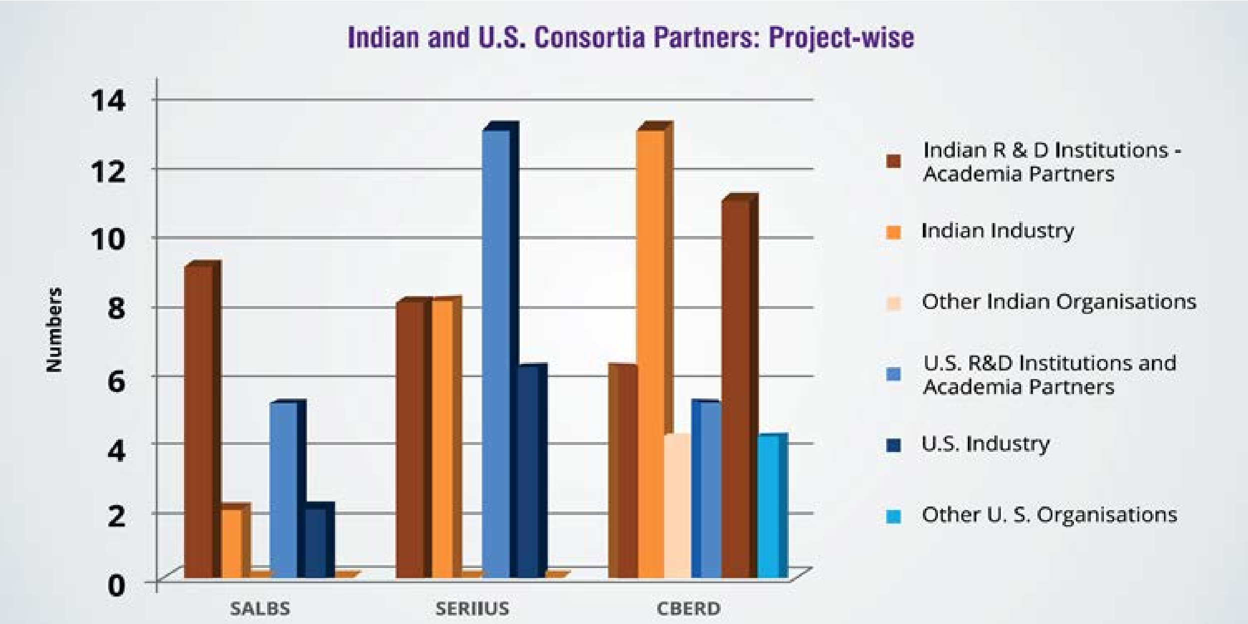
The award and establishment of the virtual entities in each of the research areas were the result of a **competitive and systematic process**, as detailed in the previous section. The **inclusive and transparent nature of the selection process**, even though quite lengthy (taking almost 18 months), ensured that the call was **responsive to the views of the stakeholders**, there was wide participation in the application process and the selection was carried out systematically with the appropriate expert input.

Intellectual property rights (IPR) arrangements were clear from the beginning: they were to follow the detailed and comprehensive IPR annex to the 2005 Agreement on Science and Technology Cooperation between the United States and Indian Governments and the respective IPR provisions of the governments and the project annexes of the participants to the extent these did not contravene with the IPR annex and the associated IPR framework allocation document.

The **consortium approach** was successful in attracting a large number of participants from academia and the **private sector** (see figure 2) and, moreover, funding from private players to complement the public funding. Part of this was due to the choice of work areas attractive to a large number of actors. The administration of JCERDC by IUSSTF is also likely to have helped. IUSSTF has a track record of engaging with a variety of actors in the science and technology space and having a solid organizational and management infrastructure that served it well in programmatically administering JCERDC.

Regular reviews by the Project Monitoring Committee (six over the course of phase 1) ensured that the projects were moving forward appropriately and were given feedback as necessary.

Figure2: Participation in JCERDC consortia, phase 1



Source: IUSSTF, 2019

5.1.4. Identified good practices

- **Ensuring an inclusive and transparent process** to sensitize and inform stakeholders about the possible opportunity, engaging with them during the call design and making the selection on the basis of pre-announced criteria ensures both broad and fruitful participation by stakeholders and trust in the process;
- **Providing sufficient funding and a reasonable time horizon** for the projects to make participation both attractive and feasible;
- **Employing a multi-institutional consortium model for the virtual entities**, which allows for broad participation by a range of stakeholders and therefore allows horizontal learning even among the members of the group;
- **Having clear IPR rules** together with industry participation facilitates the development of deployable technologies;
- Understanding that the successful deployment of technologies needs a **focus not just on technical issues** but also on topics such as economics, policy, workforce development and standards;
- **Establishing secondary objectives such as strengthening human resources** through PhD and post-doctoral training and student exchange opportunities (along with the main objective of developing deployable technologies) helps in the long-term and ecosystem-level benefits of the programme;
- **Ensuring smooth and streamlined management** of the programme by anchoring it to an existing institution with a well-developed administrative infrastructure.

5.2. Mission Innovation

5.2.1. Key characteristics

Focus	Mitigation/adaptation	Mitigation
	Technology cycle stage	Research, development and demonstration
	Sector	Energy
	Geographical scope	Global, North–North, North–South, South–South, triangular
	Geographical participation	Americas, Europe, Asia
Organization	Type of collaboration	Multilateral platform
	Actors	Governments, government implementing agencies, research and educational organizations, industry
Budget		Mission Innovation does not have a central budget, but members reported investments of USD 1.3 billion for international cooperation in clean energy innovation between 2015 and 2019

5.2.2. The initiative

Mission Innovation (MI), announced at the twenty-first session of the Conference of the Parties, held in Paris, France, in November 2015, is a global intergovernmental initiative now involving 24 countries and the European Union (EU) working to reinvigorate and accelerate global clean energy innovation with the objective of making clean energy widely affordable. MI members together account for about 80% of the global clean energy RD&D spending.[8]

The **objective** of MI, "in support of economic growth, energy access and security, and an urgent and lasting global response to climate change", is "to accelerate the pace of clean energy innovation to achieve performance breakthroughs and cost reductions to provide widely affordable and reliable clean energy solutions that will revolutionize energy systems throughout the world over the next two decades and beyond." Not surprisingly, given these lofty ambitions and broad scope, MI effectively involves all parts of the energy sector (i.e. energy supply, conversion, storage and use).

At the time of the launch, MI members committed to:

1. Seek to double their governmental and/or state-directed clean energy RD&D investments over five years;

2. Work closely with the private sector as it increases its investment in the early-stage clean energy companies that emerge from government programmes;

3. Build and improve technology innovation road maps and other tools to help in innovation efforts, to understand where RD&D is already happening, and to identify gaps and opportunities for new kinds of innovation;

4. Provide, on an annual basis, transparent, easily accessible information on their respective clean energy RD&D efforts.

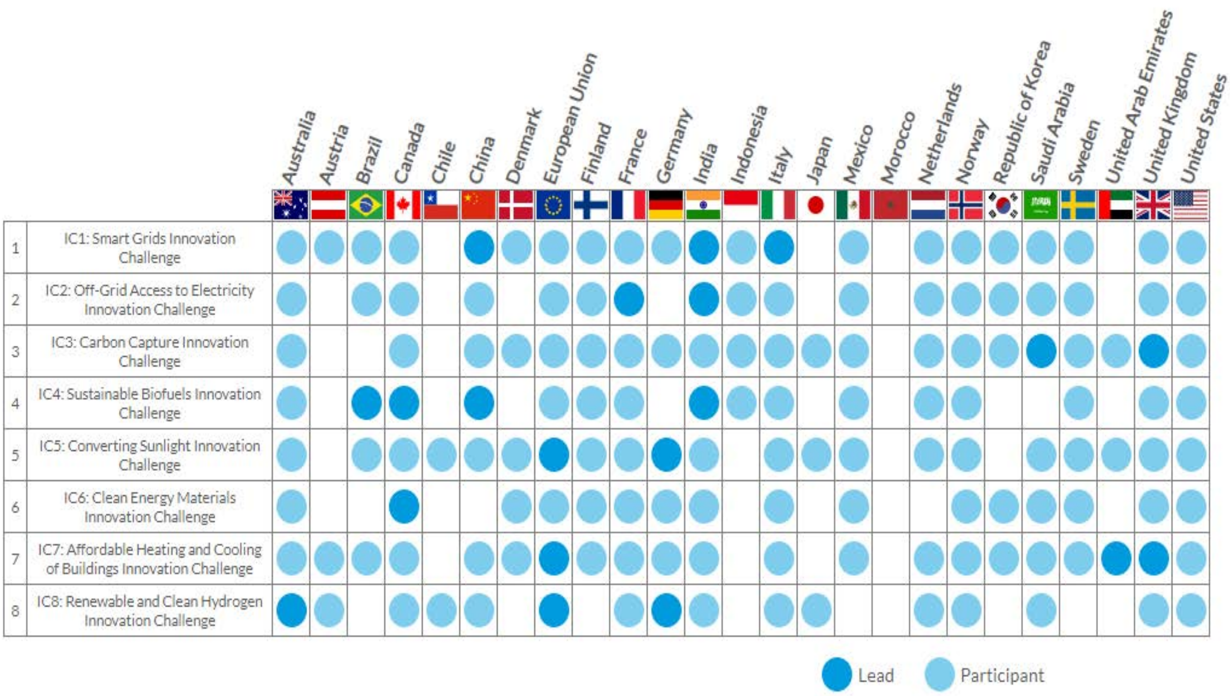
In terms of **organization**, the work programme of MI is guided by a Steering Committee comprising a subset of MI member representatives serving one-year, renewable terms. The Steering Committee provides high-level strategic guidance to facilitate the implementation of the enabling framework and

8 See http://mission-innovation.net/about-mi/overview/.

the action plan. The MI secretariat supports the MI Steering Committee, members and sub-groups to help to drive forward MI activities and achieve the desired outcomes and impact. The Analysis and Joint Research (AJR) sub-group identifies and analyses clean energy innovation needs, priorities, challenges and opportunities for collaboration across MI members.

Much of the collaboration in MI has been driven though the **innovation challenges (ICs)**, which are a key part of the MI action plan intended to accelerate RD&D in technology areas that could "provide significant benefits in reducing greenhouse gas emissions, increasing energy security and creating new opportunities for clean economic growth". At present, there are eight ICs (see figure 3), which span a significant part of the technology cycle, ranging all the way from early-stage research needs assessments to technology demonstration projects.

Figure 3: Mission Innovation member participation in innovation challenges



Source: http://mission-innovation.net/our-work/innovation-challenges/

In terms of **organization**, each IC is led by at least two countries, with a number of other countries voluntarily participating in the challenge. The workplans of the ICs have drawn on insights from scientific experts and stakeholders. This has resulted in a plethora of outcomes, including international collaborative efforts, the launch of specific ICs, development of programmatic funding efforts, and the establishment of an accelerator (see table 5). The ICs have also helped to bring together a diverse set of stakeholders such as researchers, practitioners from industry and finance, and policymakers.

The main **achievements** of MI include the following:

- MI members are **continuing to work towards meeting their commitment of doubling clean energy public RD&D** within five years, having already reported an additional USD4.9 billion in public-sector investment by the fourth year (which is 60% of the overall goal);[9]

- At the same time, by its own estimates, MI has resulted in **greatly strengthened bilateral and multilateral collaborative activities** in clean energy innovation, with USD 1.4 billion invested in 70 new cooperation activities between 2015 and 2019. These include joint RD&D programmes, coordinated funding calls, demonstration projects, and student and researcher exchanges (MI, 2019a);

- MI has also successfully engaged with the **private sector** to try to ensure that the results of the R&D carried out by MI partners is successfully translated into commercial applications.

MI's **private sector engagement** has included a collaboration with Breakthrough Energy Coalition, an international group of investors committed to accelerating the commercialization of new reliable and affordable energy technologies to help to tackle climate change. This has resulted in a public–private partnership with five MI member countries as well as the establishment of Breakthrough Energy Ventures Europe, which is a joint EUR 100 million investment by the European Commission and Breakthrough Energy (an investment vehicle for Breakthrough Energy Coalition investors). Another example is the partnership between MI and the World Economic Forum to enhance engagement between leading businesses and MI members. Individual countries have also made efforts to work with the private sector: the Indian Government launched the Clean Energy International Incubation Centre, which is a partnership between the Indian Government and Tata Trusts, intended to support start-ups from across MI members to explore the Indian market; Norway has launched a scheme PILOT-E, inspired by the United States Advanced Research Projects Agency – Energy and the Defense Advanced Research Projects Agency, which is intended to bring innovations to market faster; and Canada, through its USD 30 million partnership with Breakthrough Energy, is also supporting firms in commercializing their technologies.

9 See http://mission-innovation.net/our-work/tracking-progress/.

Table 5: Innovation Challenges for Mission Innovation: objectives and outcomes

Innovation challenge	Objective	Key outcomes
IC1: Smart grids	To enable future grids that are powered by affordable, reliable, decentralized renewable electricity systems	India is funding smart grids research and development (USD 5 million), with nine MI member countries contributing additional technical expertise. Since 2017, IC1 has held six international events to explore ways to accelerate smart grids solutions worldwide. IC1 also collaborates with the International Smart Grid Action Network to improve the link between innovation and deployment. In 2019 IC1 launched the Smart Grids Innovation Accelerator, an online platform that consolidates expertise on smart grids.
IC2: Off-grid access to electricity	To develop systems that enable off-grid households and communities to access affordable and reliable renewable electricity	France and India funded 18 off-grid demonstration projects that seek to advance off-grid access to energy. France raised EUR 5.8 million for its call for proposals focused on access to energy in African countries; India raised USD 5 million for its call for proposals focused on off-grid projects in India, with funding recipients partnering with at least one MI country to deliver on their projects.
IC3: Carbon capture and storage	To enable near-zero CO_2 emissions from power plants and carbon-intensive industries	IC3's report, *Accelerating Breakthrough Innovation in Carbon Capture, Utilization, and Storage* (MI, 2019b), identified 28 priority research directions for carbon capture, utilization and storage technologies. In keeping with these research directions, IC3 members have worked with the Accelerating Carbon Capture and Storage Technologies platform, which provides a mechanism for countries to pool funding for carbon capture, utilization and storage research and enable collaboration between members on priority areas.
IC4: Sustainable biofuels	To develop ways to produce, at scale, widely affordable, advanced biofuels for transportation and industrial applications	In 2018, India launched a funding call (USD 5 million) to support the development of advanced biofuels, with nine IC4 members contributing additional technical expertise. IC4 informed the development of funding calls under the EU Horizon 2020 programme for advanced biofuels in the transport, power and heating sectors. IC4 also provided technical expertise and supported the launch of Canada's Sky's the Limit Challenge (5 million Canadian dollars) for sustainable aviation fuels.
IC5: Converting sunlight	To discover affordable ways to convert sunlight into storable solar fuels and/or solar chemical products	IC5 workshops and reports have informed RD&D priority areas. In 2018, India launched a funding call (USD 6 million) for joint research and development with six MI members in the field of converting sunlight. The Horizon 2020 Converting Sunlight to Storable Chemical Energy funding opportunity (EUR 7 million) is designed around IC5 objectives and collaboration with non-EU members. IC5 expertise was also instrumental in defining the terms of the European Commission's Prize for Artificial Photosynthesis (EUR 5 million).
IC6: Clean energy materials	To accelerate the exploration, discovery and use of new high-performance, low-cost clean energy materials	IC6 has provided a vision for how materials acceleration platforms can accelerate the discovery and development of new materials. Canada, for example, invested 8 million Canadian dollars in Project Ada, which aims to optimize materials for advanced solar cells and CO_2 conversion. IC6 has also initiated new, cross-border discussions with IC3, IC5, IC7 and IC8.
IC7: Affordable heating and cooling of buildings	To make low-carbon heating and cooling affordable for everyone	Led by the Indian Government, the Rocky Mountain Institute and IC7, the Global Cooling Prize (USD 3 million) aims to develop residential cooling technologies with the potential for five times less climate impact than market offerings at no more than twice the investment cost. IC7 members are collaborating with the International Energy Agency to develop Comfort and Climate Box solutions, which integrate heating, cooling and energy storage solutions into one device. In 2019, IC7 launched the Horizon 2020 funded COMBIOTES (compact bio-based thermal energy storage for buildings) project (EUR 4 million from the EU and China), which supports the development and testing of compact energy storage solutions for domestic heating, hot water and cooling.
IC8: Renewable and clean hydrogen	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	IC8 is developing an online information-sharing platform on 'hydrogen valleys', where multiple hydrogen applications are implemented in an integrated manner. In addition, IC8 and the International Partnership for Hydrogen and Fuel Cells in the Economy set up a working group on hydrogen in the gas grid.

Source: MI, 2020

5.2.3. Key success factors and lessons learned

Perhaps the most important success factor for MI is the **political buy-in** for the programme. The programme was supported by the governments of the member countries at a high level, which helped to ensure support from the relevant agencies in the individual countries.

The design of the overall programme – governance and activities – also proceeded in a **structured fashion**. The first step was the development of an enabling framework, approved on 1 June 2016 at the first ministerial meeting, which laid out the overall approach to MI. This included listing the key actions that would be taken by each member[10] as well as outlining the broader approach.[11] This allowed each individual member to make choices regarding how to implement its obligations under MI, as well as which MI collaborative activities to participate in. In other words, the initiative provided **flexibility** to member countries as to how to participate in MI activities. It also put the **focus on activities of common interest** such as information-sharing, innovation analysis and road mapping. This has been beneficial in two ways: it started building a common framework for data collection on RD&D investments and road mapping for the future; and it allowed members to learn from each other's approaches towards, and experiences with, innovation.

In line with the above-mentioned flexibility, participation in the ICs was on a **voluntary** basis, that is, countries volunteered to lead and participate in a challenge. At the same time, the choice and design of activities under a challenge was also the result of deliberation by experts who had a perspective on the technological landscape and opportunities as well as the opportunities for application. Thus, each challenge ended up taking a unique path that was tailored to that particular area. It should be noted, though, that participation in the ICs turned out to be somewhat uneven in that some members ended up participating in only a few ICs. On the other hand, focusing on engagement with the private sector meant that new approaches to RD&D could be explored and additional investments raised to advance the commercialization of clean energy technologies.

10 For example, doubling investment, information-sharing, innovation analysis and road mapping, joint research and capacity-building, and business and investor engagement.

11 This included allowing a member to "independently determine the best use of its own clean energy research and development funding and define its own path to reach the doubling goal according to its own priorities, policies, processes, and laws; as well as the extent to which it participates in any international collaborations", indicating that "any steps impacting all Members would occur on a non-objection basis following an opportunity for input from all Members" but "collaborative efforts that develop organically over time may proceed with the support of two or more interested Members and not require approval by all Members. Members not adhering to a specific collaboration will not be obligated by its results."

The AJR subgroup played an important role in **supporting these processes through analysis and research** to underpin the design, implementation and assessment of the challenges, share knowledge and learning across challenges, and develop analytical products to advance the MI work programme, including planning for new activities. AJR has supported MI, for example, by carrying out reviews of the programme (MI, 2017), assessment of ongoing ICs and assessing proposals for new ICs.[12] AJR also developed a paper on international collaboration models on clean energy innovation to provide guidance to countries in this area (MI, 2019c). The plans for MI phase 2 (post-2020) are also being shaped by an evaluation of the experiences in phase 1.

5.2.4. Identified good practices

- Providing different actors with the **flexibility** to participate in activities as perceived **relevant to their individual needs/context**. In other words, actors can choose which activities enabled by the initiative are meaningful and relevant to them;
- **Soliciting expert views systematically** in the early stages of the programme's definition to ensure that objectives, approach and organization of the programme are as fruitful as possible. Since different issues and topics may require very different approaches depending on the technological landscape, the exploration of programme objectives and the specific approach is well served by inputs from experts;
- **Assessing and learning from collaborative efforts**, especially on matters of programme design, implementation and impact, is useful for its continuing effectiveness over time as well as in the design of other programmes. Therefore, investment in these processes from the early stages can yield benefits.

12 See http://mission-innovation.net/about-mi/analysis-and-joint-research/.

5.3. International Energy Agency Technology Collaboration Programmes

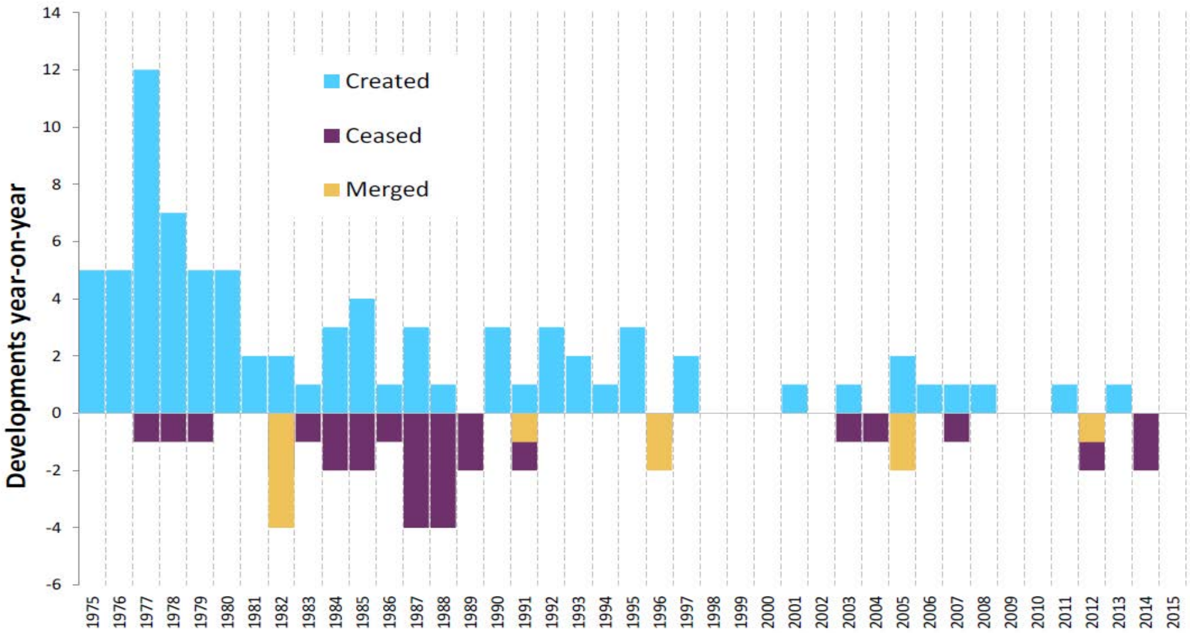
5.3.1. Key characteristics

Focus	Mitigation/adaptation	Mitigation
	Technology cycle stage	Research and development to commercialization (as well as policy, industry and research dialogue)
	Sector	Energy, including industry, transport, buildings
	Geographical scope	Global, North–North, North–South, South–South, triangular
	Geographical participation	All regions, gravitating to member countries of the Organisation for Economic Co-operation and Development
Organization	Type of collaboration	Plurilateral platform involving about 40 programmes
	Actors	National government agencies, industry, and research institutes
Budget	Depending on the specific Technology Collaboration Programme, cost-sharing (pooling funds) or task-sharing (practically budget-neutral to members)	

5.3.2. The initiative

The International Energy Agency IEA Technology Collaboration Programmes (TCPs) were established in 1975 with the **aim** of enabling "IEA member countries to carry out programmes and projects on energy technology research, development and deployment". In practice, this means that all TCPs share information and experiences between countries, industries and academia related to specific energy technologies or energy-related sectors. Sometimes, TCPs also share funding in a common fund and work together, which limits an individual country's freedom to dispose over its own RD&D resources but enhances the effectiveness of the spending for all countries that are a member of that TCP. While the IEA TCPs (formally known as IEA Implementing Agreements) differ according to the needs of various technologies and industries, they are based on the shared principle of "collective innovation to meet shared challenges", meaning that rather than acting alone, cooperation in innovation enables energy questions that are common to the group of countries aligning themselves with a TCP to be addressed (IEA, 2016).

Figure 4: Numbers of TCPs created, ceased or merged, 1975-2015



Source: IEA, 2016

Over their 40-year history, several TCPs were created and terminated (and some merged) (see figure 4). In terms of their **organization**, TCPs are governed by the IEA Governance Framework, which regulates the start, management and end of a TCP (IEA, 2016). TCPs can be established by two or more IEA member countries, with the proposal of a new TCP to be approved by the IEA Committee on Energy Research and Technology and the IEA Governing Board. The Committee on Energy Research and Technology is an IEA standing committee made up of representatives of IEA member countries that coordinates and promotes the development, demonstration and deployment of technologies to meet challenges in the energy sector. It also decides on the admittance of non-IEA member countries and other actors as members of TCPs. The IEA Governing Board is "the main decision-making body of the IEA composed of energy ministers or their senior representatives".[13] Each TCP is overseen by an executive committee, and its activities are often organized in "annexes", which are projects (with a start and an end date) that provide a framework to conduct technologies that are more specific than the topic of the TCP, and often feature a workshop or result in a report.

The 39 TCPs active as at December 2015 were in the following categories: cross-cutting (2), end-use industry (1), end-use electricity (3), end-use buildings (5), end-use transport (5), renewable energy and hydrogen (10), fossil fuels (5) and fusion power (8). In terms of **R&D cycle stage**, in addition to the technology-oriented work, all cover socioeconomic issues and most concern market introduction and sectoral analysis, as well as characterization and in-situ testing of new energy or energy-related technologies. All TCPs in the transport, renewable energy and hydrogen, fossil fuels and fusion categories also work on basic science, although this does not necessarily mean that fundamental research experiments are actually conducted, funded or initiated by the TCP. The TCPs gravitate towards the steps that need to be taken to advance the commercialization of the technology (IEA, 2016).

While initially the topics of the TCPs were related to strengthening energy security from both the demand-side and the supply-side perspective, in the 1980s the **focus** shifted to more environmentally friendly and safer technologies, for instance in nuclear energy. In the late 1990s, in response to the UNFCCC and its Kyoto Protocol, there was a further shift to technologies related to greenhouse gas emission reduction and novel renewables. Over the past decade, new TCPs have reflected current concerns and opportunities related to the spread of technologies such as information and communication technologies (ICT), comprising the likes of electricity networks, smart grids and energy use of appliances, including networked equipment. Furthermore, existing TCPs have incorporated cross-cutting issues (such as finance) and multi-disciplinary approaches (such as research related to social acceptance and policy for technologies).

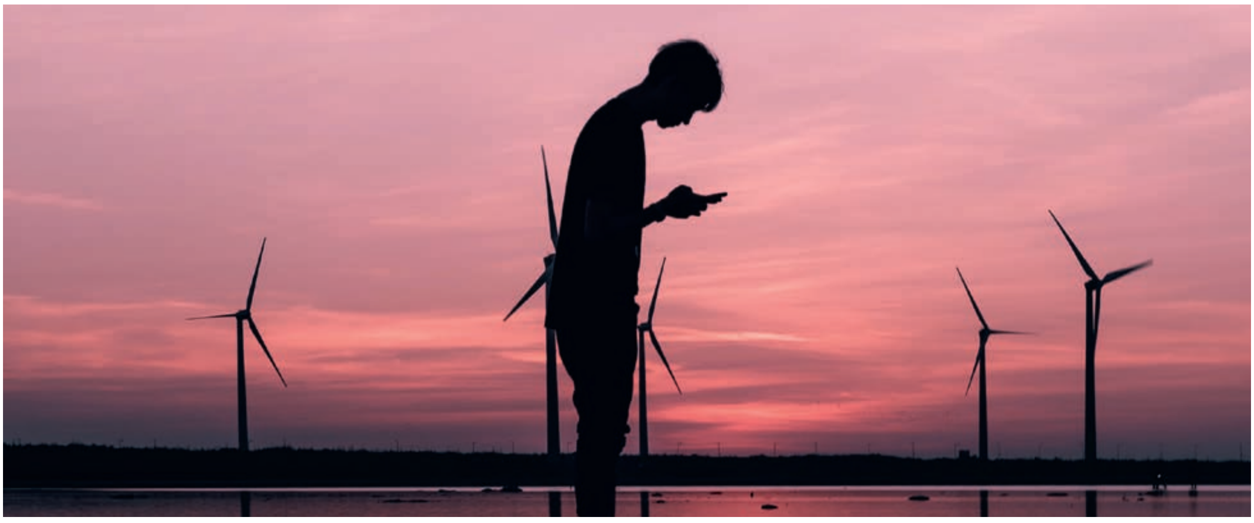
13 See https://www.iea.org/about/structure.

As there are many TCPs, and many have been operational for decades, there is a long list of **achievements** of the IEA TCPs, including demonstrations and meetings. Several aims have been common to all TCPs and can be evaluated as follows:

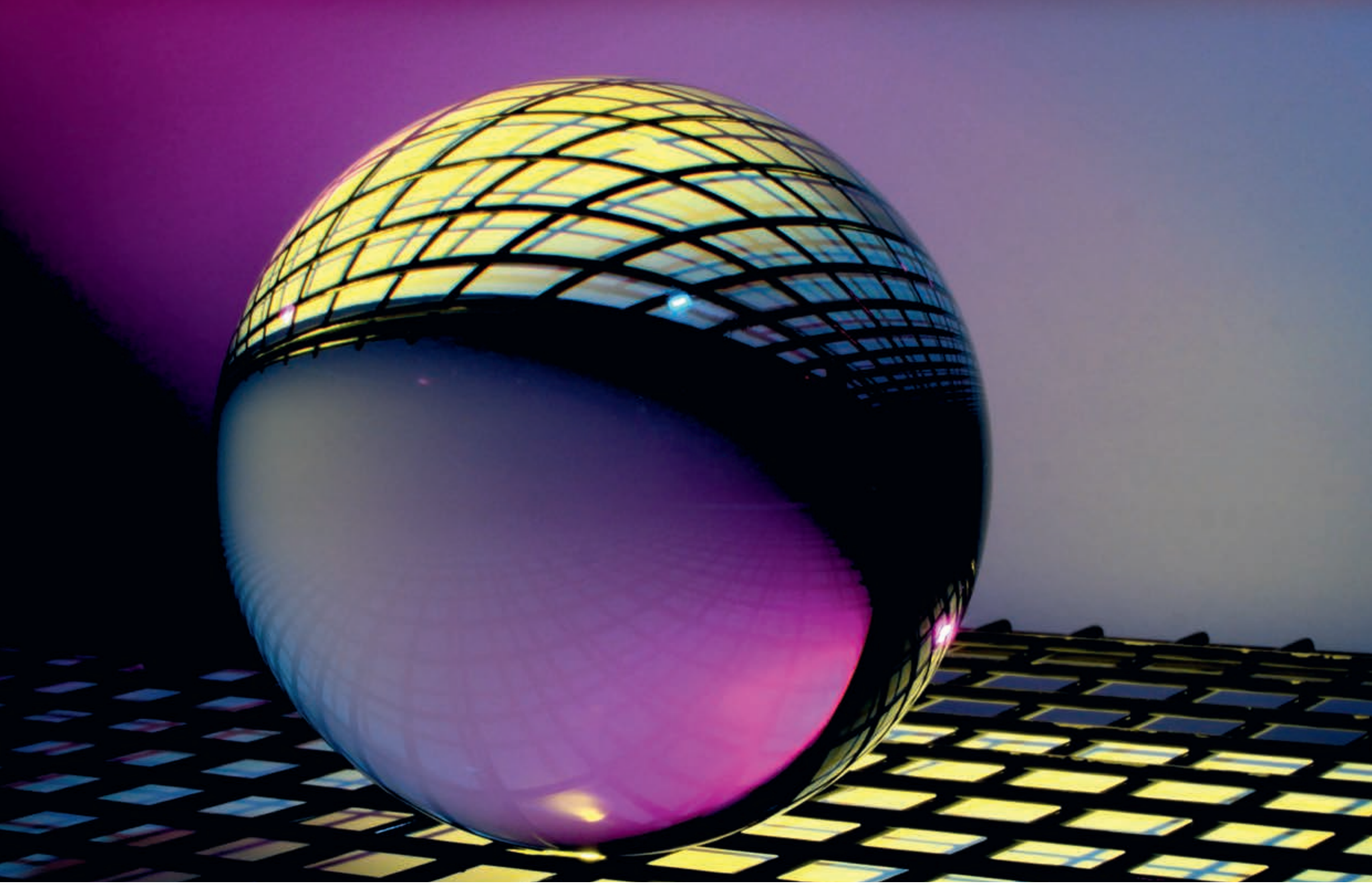
- In all TCPs, **research coordination** is an important aim, which is generally achieved, depending on the number of participants. Meetings put together by a TCP are generally seen to reflect the cutting edge of the technology or sector;
- **Awareness-raising** was an aim of every TCP. Whether or not this aim was achieved has not been investigated;
- The **organization of TCPs stayed focused and nimble** through following the IEA Governance Framework.

There are as many **organizational models** as there are TCPs. One distinction that is sometimes made is between task sharing and cost-sharing models (or combinations thereof) (IEA, 2011). In task-sharing TCPs, members all bring their own **funding** and may collaborate on R&D and exchange knowledge. An example is the Industrial Energy-Related Technologies and Systems (IETS) TCP, founded in 2005 out of a merger of several more specific, industry-related programmes. IETS "increases awareness of technology and energy efficiency in industry, contributes to synergies between different systems and technologies, and enhances international cooperation related to sustainable development" (IEA, 2019). Ongoing annexes in IETS include energy efficiency in the iron and steel industry, membrane processes in biorefineries and digitalization.[14] Each annex has its own workplan and activities; for instance, the digitalization annex plans to deliver a white paper on the opportunities and impacts of digitalization on energy efficiency and greenhouse gas emission reduction in industry.

If a cost-sharing approach is taken, the TCP also pools some **funding**, for example for a secretariat and collaborative research funding, in a common fund. One example is the IEA Greenhouse Gas R&D Programme (IEA GHG), which was founded in 1991 and mostly focuses on carbon capture and storage. IEA GHG aims to "assess the role that technology can play in reducing greenhouse gas emissions from both the power system and from industrial processes". Rather than the organization being hosted by one of its members and members conducting studies (such as in the IETS TCP and other task-sharing TCPs), IEA GHG employs a 10-person team that commissions studies on topics related to its mandate. Its 2019 Annual Report mentions 36 members jointly contributing over GBP 1.5 million, with almost 40% of the budget going to technical reports. Recent technical reports were, for instance, reviews of how to get to zero-emission carbon capture and storage or sustainable petrochemicals.[15] Moreover, every 18 months IEA GHG organizes a major global research conference on carbon capture and storage, the Greenhouse Gas Control Technologies Conference, which attracts over 1,000 delegates each time. The 15th conference will take place in 2021.



14 See https://iea-industry.org/annexes/.
15 See https://ieaghg.org/publications/technical-reports/reports-list/9-technical-reports.



Both organizational models and the **type of activities** implemented have shifted over time. In the initial phase, some TCPs actually built **demonstrations**, the largest of which was a pilot plant of a fluidized bed converter, for which 60 people were employed. In recent decades, more TCPs have been coordination bodies and predominantly task-sharing. By far not all TCPs focus on RD&D cooperation. For example, the cross-cutting Climate Technology Initiative has an activity, the Private Financing Advisory Network, which aims to bridge the gap between financeable, mostly renewable energy projects in developing countries and private sector investors, and saw through 19 project deals (for a total of 190 MW).

5.3.3. Key success factors and lessons learned

A key question is whether the IEA TCPs can be seen as international RD&D cooperation as defined in this brief. While some TCPs meet the criterion of different countries or regions jointly conducting (or funding) climate technology RD&D activities, many task-sharing TCPs are focused on knowledge exchange and coordination of an RD&D agenda, for instance through technology reviews or meetings. Nevertheless, a number of lessons learned and success factors for RD&D can be identified.

First, the TCPs are mostly **technology- (and sometimes sector-) specific**. This allows for the engagement of specialists, which benefits the depth of discussion in knowledge exchanges.

Second, the **combination of a top-down framework design with bottom-up flexibility** seems to be replicable. The top-down framework is prescribed and governed by IEA. Within the framework, the TCPs themselves are organized in a bottom-up fashion, by the founding members. The TCP framework leaves sufficient room for a flexible design, adapted to the needs of the technology and the actors. For the purpose of TCPs – international coordination between relatively affluent countries – this model has proved replicable, but it does have difficulty engaging less affluent countries.

Third, the IEA Governing Board consistently maintained its interest in the TCPs. Since the Governing Board is populated by ministers of senior representatives of IEA member States, this means that **high-level support** is maintained. As TCP Executive Committee members are representatives of governmental organizations, feedback of the results to the member States is ensured. In addition, since the organization of the IEA TCPs is with an international organization (and not dependent on any one country, where priorities can change), its design can be considered as **apolitical and content-focused**.

Fourth, **what works for developed countries may not work for developing countries**. Although opening up for countries that are not members of the Organisation for Economic Co-operation and Development (OECD) enhanced the diversity of views brought to the table in TCPs, the TCPs still represent an OECD-dominated group of programmes. Some developing countries, though, are participating in more TCPs than some IEA countries; China and Mexico, for instance, are members of many more TCPs than Poland or New Zealand. However, no least developed countries participate in any TCP.

A final lesson learned is that **synthesis is needed for learning lessons**. Independent assessment and evaluation of the IEA TCPs seems to have happened sparingly, or IEA oversight has kept such evaluations internal. Robust conclusions on replicability could therefore not be drawn. This means that for this case study, only information provided by IEA could be included.

5.3.4. Identified good practices

On the basis of the above-mentioned lessons learned, the following good practices have been identified that may benefit other initiatives:

- **Being adaptable to changes** over time allowed the topic focus of the TCPs to be modernized, reflecting the current themes;
- **Finding a good balance between top-down facilitation and bottom-up control**. In any case, allow each technology-specific programme to design its own organization and course of action;
- **Being apolitical and identifying a broad coalition of countries** with no single country (or politician) clearly in the lead allows for continuity as priorities of individual countries may change;
- There has been little evidence of good practices related specifically to non-OECD involvement in the TCPs. In this context, it is telling that the **least developed countries are largely absent** in the TCPs. Considering pooling funding for enhanced participation could make the TCPs more inclusive.

5.4. Improved Drought Early Warning and Forecasting to strengthen preparedness and adaptation to droughts in Africa

5.4.1. Key characteristics

Focus	Mitigation/adaptation	Adaptation
	Technology cycle stage	Prototype, demonstration
	Sector	Water/drought management
	Geographical scope	Regional; North–South
	Geographical participation	Africa, European Union
Organization	Type of collaboration	Plurilateral consortium
	Actors	Research institutes, universities; science application institutes; operational agencies responsible for meteorological forecasting, drought monitoring and famine warning; and established knowledge networks in Africa
Budget	Project budget	EUR 4.4 million in total (January 2011 to December 2013)

5.4.2. The initiative

Improved Drought Early Warning and Forecasting to strengthen preparedness and adaptation to droughts in Africa (DEWFORA) was a collaborative project that ran from 2011 to 2013 with the **objective** of developing a drought early warning and forecasting system, and to strengthen preparedness and adaptation in Africa.[16] The project traces its origins back to the institutional framework for RD&D and international cooperation of the Africa-EU Partnership, which was established at the first Africa-EU Summit, held in Cairo, Egypt, in 2000. This partnership provides an overarching long-term political framework for Africa-EU economic cooperation in areas of common interest, including climate change, global security and the Sustainable Development Goals.[17]

16 See https://publicwiki.deltares.nl/display/DEWFORA/DEWFORA+-+FP7+project.
17 See https://africa-eu-partnership.org/en.

In July 2009, the European Commission, as part of the Framework Programme for Research and Technological Development (the European Commission's main instrument for funding research and innovation, known as FP7 in its latest instalment), issued a call for proposals titled "Call for Africa" (European Commission, 2009). The aim of the call was to address science- and technology-related objectives of the Africa-EU Strategic Partnership through the funding of a wide range of research projects related to three themes, one of which was "Environment (including climate change)". One of the topics in the call for proposals was "Integrated management of water and other natural resources in Africa", which had three main **goals**:

- Improve the state of knowledge on the relation between drought and climate change and contribute to improved early warning and forecasting systems;
- Help to better identify vulnerable regions and further strengthen preparedness and planning capacities in Africa;
- Contribute to capacity-building.

The call for projects aimed to incorporate knowledge from African countries and to facilitate capacity-building by requiring at least two of the project consortium partners to be from African countries. The winning consortium consisted of 19 partners, including 10 from Africa and 9 from Europe, as shown in Table 6.

Table 6: Overview of participants in the DEWFORA project

Partner type	Partner name	Country
Weather and climate service providers	Nile Forecast Center	Egypt
	Intergovernmental Authority on Development Climate Predictions and Applications Centre	Kenya
	European Centre for Medium-Range Weather Forecasting	United Kingdom
Universities and research institutes	Dinder Center for Environmental Research	Sudan
	Faculty of Engineering, Eduardo Mondlane University	Mozambique
	Council for Scientific and Industrial Research	South Africa
	Deltares	Netherlands
	Joint Research Centre – Institute for Environment and Sustainability	Italy
	UNESCO-IHE Institute for Water Education*	Netherlands
	Potsdam Institute for Climate Impact Research	Germany
	GFZ German Research Centre for Geosciences	Germany
	Technical University of Madrid	Spain
	Mediterranean Agronomic Institute of Zaragoza – International Centre for Advanced Mediterranean Agronomic Studies	Spain
	Faculty of Engineering of the University of Porto	Portugal
Non-governmental organizations	Wetlands International – Sahelian Sub-regional Office	Mali
Private consulting firm	WR Nyabeze & Associates	South Africa
Regional networks for research and capacity-building	WaterNet Trust	Botswana
	Nile Basin Capacity Building Network for River Engineering	Egypt

** Now "IHE Delft Institute for Water Education". Source: https://cordis.europa.eu/project/id/265454.*

The core work packages of DEWFORA focused on the assessment of existing drought forecasting and management practices, evaluation of drought vulnerability and risk, and development of tools for drought forecasting. In parallel, the project also explicitly incorporated work packages for:

- Implementation of the developed tools in six case studies;[18]
- Working in close interaction with potential implementers and users of the drought early warning information system;
- Dissemination of knowledge to the broader scientific and policymaking communities through stakeholder meetings, conferences, development of training courses and two video documentaries (DEWFORA, 2014).

The main **achievements** of DEWFORA include the following:

- An assessment of the current state of drought forecasting and early warning across Africa;
- The development of an approach to assessing vulnerability of exposed societies to drought, and validation of the framework at both a continental and a regional scale;
- The development of projections of changes in frequency of occurrence and severity of droughts across Africa using high-resolution simulations;
- An assessment of the skills with which existing meteorological and hydrological and, to a more limited extent, agricultural models can be used to forecast relevant drought parameters across Africa;
- The development of a protocol that can be used to develop drought forecasting and warning;
- 18 scientific articles in peer-reviewed journals (DEWFORA,2014).

18 Four regional case studies focused on the Eastern Nile Basin, the Limpopo Basin, the Oum-er-Rbia Basin and the Niger Basin. In addition, two more case studies focused on development and testing of a pan-African forecasting system, and a comparative review of drought forecasting in European and African river basins.

5.4.3. Key success factors and lessons learned

DEWFORA's achievements can be attributed to at least three main factors.

First, **long-term frameworks for collaborative RD&D** (specifically, the Africa-EU Strategic Partnership and the EU Framework Programme for Research and Technological Development to fund joint research and technological development projects) helped to ensure high-level political commitment and allocation of resources for projects such as DEWFORA. These frameworks also ensure that DEWFORA is part of a larger portfolio of follow-up projects aiming at addressing other aspects of drought forecasting and warning. For example, Horizon 2020 funded the AfriAlliance project (running from 2016 to 2021), which brings together 16 EU and African partners. It aims at consolidating existing networks consisting of scientists, decision makers, practitioners, citizens and other key stakeholders to work together in the areas of water innovation, research, policy, and capacity development.[19] Similarly, the DOWN2EARTH project[20] (also funded by Horizon 2020) runs from September 2020 to August 2024 and aims at translating climate information into multilevel decision support for social adaptation, policy development and resilience to water scarcity in the drylands of the Horn of Africa.

Second, from its inception, the project's design ensured that **a variety of knowledge sources were combined** to maximize the effectiveness, utility and dissemination of the developed tools and protocols for drought forecasting and warning. For example, the project partners were chosen to represent a range of expertise from different geographical contexts and domains (see table 6), enabling the project to achieve its programme design, implementation and dissemination goals. Furthermore, a systematic review of the state of the art in drought forecasting and warning in Africa revealed that in practice, **traditional knowledge** is applied more often than formal systems for drought management. This pointed towards the need to link formal monitoring and early warning systems to local knowledge systems coupled with methods that support learning and adaptation. In addition, a **user-oriented approach** was taken by integrating groups potentially affected by droughts at an early stage in the development of forecasting tools (learning-by-interacting) to ensure that the tool can provide user-oriented metrics that can inform decisions of local planners and farmers. Finally, a strong emphasis was placed on not only developing the tool, but also implementing it across a wide variety of contexts in the form of four case studies (learning-by-doing). This helped in validating the model, and in refining drought and vulnerability indicators based on learning from contexts with different socioeconomic conditions, organizational set-ups and institutional practices.

Third, DEWFORA placed emphasis on the **development of tools and protocols that are flexible and adaptable** to different geographic (climatic, hydrological and agricultural), socioeconomic and regulatory contexts in Africa. This was done by not only developing solutions for the four case studies, but also developing models that can be applied at different geographic scales (water basin, national and continental levels), and a generalized protocol that can be applied to develop and implement forecasting and warning systems in different contexts.[21]

However, there are some inherent limits to the **replicability and scalability** of the developed tools owing to the highly context-specific nature of resource availability, vulnerability of populations and measures needed for effective drought preparedness, mitigation and recovery. The final project report cited "capacity gaps at different levels (policy and decision makers, researchers, meteorologists, technology transfer, farmers, communities, etc.)" as an impediment to effective drought forecasting and warning (DEWFORA, 2014). Although capacity-building was an explicit goal of the project, the relatively short time scale of the project is likely to have been insufficient to fully address these capacity gaps, thus suggesting the **need for longer-term engagement**. This emphasizes the importance of ensuring continuity in follow-up activities, such as with the subsequent AfriAlliance and DOWN2EARTH projects.

19 The activities of AfriAlliance are organized into 10 demand-driven action groups: Arid African Alluvial Aquifers for Agriculture; Upscaling the Potential of Water Harvesting Across Africa; Integrated Water Resource Management and Ethics; Efficient and Innovative Small-Scale Irrigation; Sustainable Intensification for Resilience and Food Security; Tailor-Made Socio Economic Approaches for Integrated Water Management in Rural to Urban Driven Mutations;Scaling of Citizen Science based Water Resource Monitoring; Planning for Drought in Semi-Arid Africa; Mara Water and Wetlands Watch; and African Alliance for Water Stewardship Action Group.

20 See https://cordis.europa.eu/project/id/869550.

21 The developed protocol involves guidance on answering four key questions ("What is the science available?", "What are the societal capacities?", "How can science be translated into policy?" and "How can society benefit from the forecast?"), with the research conducted in the DEWFORA project helping to answer each one.

5.4.4. Identified good practices

On the basis of the above-mentioned lessons learned, the following good practices have been identified that may benefit other initiatives:

- **Matching the time horizon and organization of the initiative with the nature of the collaborative RD&D activity**: for example, continued political commitment may require long-term high-level legal frameworks; the development of specific tools and protocols by multiple partners is more suited to a short- to medium-term project-based mode of organization; while collaborative RD&D initiatives with longer-term goals like knowledge transfer and capacity-building require continuity through long-term institutional arrangements and embedding in local actors and institutions;

- **Incorporating a variety of knowledge sources**, including from collaborative RD&D partners with expertise in different (but relevant) knowledge domains, intended users of developed technologies, and local and traditional knowledge sources;

- Designing consortia for collaborative RD&D initiatives **to include participants representing the entire technology cycle**: in this case, this includes not only actors who are focused on developing the forecasting and warning system, but also those focused on data collection, intermediaries for knowledge dissemination, and users of the generated knowledge and solutions;

- Extensive **testing of developed technologies and tools in diverse contexts** to understand and address challenges related to their replicability and scalability.

5.5. CGIAR

5.5.1. Key characteristics

Focus	Mitigation/adaptation	Mitigation and adaptation (not climate-specific)
	Technology cycle stage	Research to commercialization
	Sector	Agriculture (food)
	Geographical scope	Global, triangular
	Geographical participation	Global
Organization	Type of collaboration	Plurilateral network
	Actors	National government agencies, industry and research institutes
Budget	Between 2011 and 2020, on average about USD 500 million annually in contributions from national governments, multilateral organizations and private foundations	

5.5.2. The initiative

CGIAR (previously the Consultative Group on International Agricultural Research) was established in 1971 with the **objective** of growing agricultural productivity, reducing poverty and achieving environmental sustainability. (Renkow and Byerlee, 2010). It started in the early 1970s with 7 international agricultural research centres (IARCs). Currently its core **organization** consists of 15 IARCs spread all over the world (see figure 5) as locations of collaborative agricultural research, working across five broad themes and employing some 8,000 people. A key characteristic of the centres is that each centre has its own crop or sector focus, and that they are connected to the geographical region in which they are located. The objectives of CGIAR, as well as the task allocation and focus of the centres, have varied over time (see table 7), as has the number of centres. However, one of the consistent threads through the decades of CGIAR's existence is that its IARCs have played a significant role in building capabilities in agricultural innovation in their respective regions.

In June 2020, CGIAR announced a "fundamental reform", which included renaming itself as One-CGIAR, and **reorganizing** itself by consolidating the 15 IARCs.[22] Because this was a recent announcement of which the consequences cannot yet be evaluated, this case study will discuss CGIAR before the reform. However, it is worth noting that climate change was mentioned as one of the global threats (next to biodiversity and coronavirus disease 2019) that have led CGIAR to decide that a model with greater collaboration was needed to help to enable the necessary transformation of the food system (CGIAR, 2020).

22 See https://www.weltohnehunger.org/full-article/cgiar.html.

Figure 5: CGIAR International agricultural research centres

Source: https://ciat.cgiar.org/ar18/cgiar/

CGIAR builds on a long history of international centres for agricultural research. The Rockefeller and Ford Foundations are often credited with the institutional innovation of international, **problem-oriented research** centres with **longer-term funding** in 1960. They, in turn, built on developments that started after the First World War, in particular with the United States Department of Agriculture and the Food and Agriculture Organization of the United Nations. (Byerlee and Lynam, 2020) This went from sharing of materials and research results to aligning research plans, to uniform testing and pooling resources into one coordinated programme in the United States Department of Agriculture. The value of this new R&D cooperation model was acknowledged by the Food and Agriculture Organization of the United Nations, which with the United States helped to establish the spread of knowledge and practice in post-war Europe for growing maize and wheat in the 1950s. Initiated in India and spread throughout South and South-East Asia, a similar process took place for rice. Partly parallel to those crops, and partly to other crops, developments took place in Latin America, in particular Mexico and Colombia, and in Africa. The Rockefeller and Ford Foundations funded the research centres that formed the early IARCs, but a different governance model was needed to upscale the collaboration and expand to different crops and regions. Eventually this culminated in the formation of CGIAR, which pioneered a long-term funding model combined with problem-oriented research and a flexible design of its IARCs.

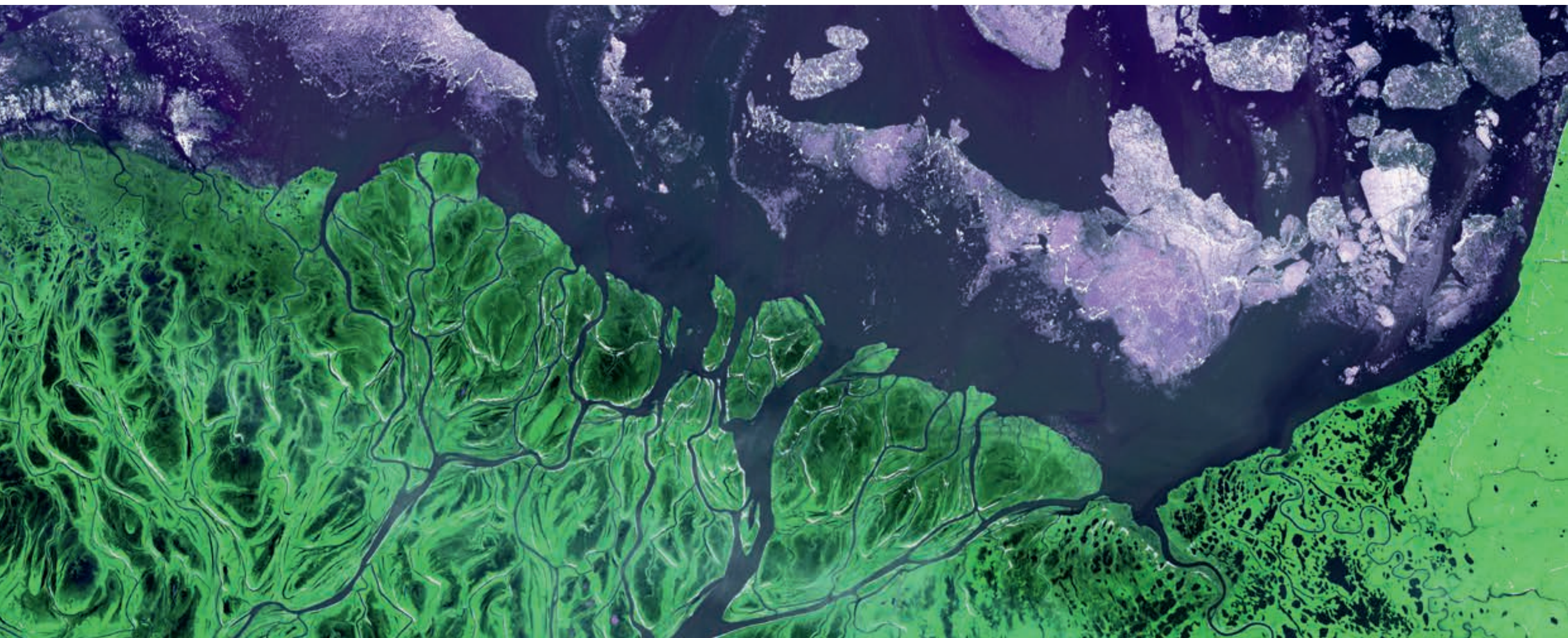


Table 7: International agricultural research centres in CGIAR, their entry into CGIAR and locations

Center	Location	Year of entry into CGIR	Mandate and/or commodity	Regional focus
Africa Rice Center (formerly Warda)	Benin	1975	Rice	Sub-Saharan Africa
Bioversity Inernational (formerly IPGRI)	Italy	1974	Plant genetic resources	Global
CIAT – International Center for Tropical Agriculture	Colombia	1971	*Phaseolus* beans, cassava	Global
CIFOR - Center for International Forestry Research	Indonesia	1993	Sustainable forestry mgmt	Global
CIMMYT - International Maize and Wheat Improvement Center	Mexico	1971	Maize, wheat	Global
CIP – International Potato Center	Peru	1973	Potatoes, sweet potatoes, other root crops	Global
ICARDA – International Center for Agricultural Research in the Dry Areas	Syria	1975	Barley, lentils, fava beans, wheat, chickpeas	Middle-East, North-Africa
ICRISAT - International Crops Research Institute for the Semi-Arid Tropics	India	1972	Sorghum, millets, pigeonpeas, chickpeas, ground nuts	Semi-arid tropics (Asia and Africa primarily)
IFPRI - International Food Policy Research Institute	USA	1980	Policy	Global
IITA - International Institute of Tropical Agriculture	Nigeria	1971	Cassava, maize, cowpeas, yams, soybeans, bananas, plantains	Africa
ILRI - International Livestock Research Institute	Kenya	1995*	Livestock	Global (emphasis on Africa)
IRRI - International Rice Research Institute	Philippines	1971	Rice	Global
IWMI - International Water Management Institute	Sri Lanka	1991	Irrigation, water mgmt.	Global
ICRAF - World Agroforestry Centre	Kenya	1991	Agroforestry, multi-purpose trees	Global
WorldFish Center (formerly ICLARM)	Malaysia	1992	Aquatic resources management	Global

Source: Renkow and Byerlee, 2010

The **activities** of CGIAR span the full RD&D cycle, ranging from basic research to the commercialization of new technologies and practices. Moreover, they include data collection and sharing, socioeconomic studies spanning all scientific disciplines, and interaction with stakeholders in partnerships. For example, its Research Program on Climate Change, Agriculture and Food Security includes not only adaptation and mitigation but also aspects such as gender and sustainable development. Its activities include the development of technologies and practices for climate-smart agriculture and analyses of low-emission development pathways at the global and developing country level, using tools such as participatory evaluation and trials with smallholders.

The **focus** of CGIAR has changed over time. As the **private sector** claimed a larger role in the agricultural R&D landscape, (Pardey et al., 2016) CGIAR had to find new niches. With agricultural productivity growing and becoming less of a concern from a technological point of view, questions around integration of agriculture with sustainable development, **adaptation to climate change** and other environmental pressures, the **mitigation of greenhouse gas emissions** of agriculture and food production, and how to improve livelihoods for low-income farming communities have gained prominence over the past two decades. This newer focus is most prominent in the above-mentioned Research Program on Climate Change, Agriculture and Food Security, but it also plays a role in other CGIAR programmes, such as the Research Program on Policies, Institutions and Markets.

The current CGIAR **budget** is based on the CGIAR Trust Fund contributions in three windows:[23]

- Portfolio investments support CGIAR as a whole, and are agreed by the funders collectively;
- Programme investments are individual funders' contributions to a component of the overall CGIAR portfolio, which is agreed by the funders collectively;
- Project investments are individual funders' contributions to CGIAR activities defined by the funders themselves, often in collaboration with partners external to CGIAR.

Over the past decade, of the total USD 4.7 billion in contributions, about one third went to portfolio investments, a little under one fifth to programme investments and roughly half to project investments, which are defined by the funders, often in collaboration with partners. The funders are a group of 40 (mainly developed) countries, multilateral banks and organizations, and private foundations. The largest contribution is from the United States, followed by the Bill & Melinda Gates Foundation.

In terms of **outcomes**, CGIAR is attributed with considerable successes in impactful agricultural innovations, especially in the early decades of its existence. About one third of agricultural yield growth in developing countries between 1965 and 1998 can be attributed to CGIAR crop genetic improvement (Renkow and Byerlee, 2010). Although the 'green revolution' was already under way when CGIAR was established, the international R&D cooperation that led to CGIAR was an important part of the basis for the vast improvement of agricultural productivity in the developing world, arguably reducing the incidence of famine significantly (Byerlee and Lynam, 2020).

5.5.3. Key success factors and lessons learned

International collaboration on RD&D in **international, regionally contextualized centres** is the core success factor of CGIAR. This started even before CGIAR was founded but could be upscaled and expanded through the formation of the **umbrella organization** of CGIAR, an institutional innovation that has had no rival since in any other sector. CGIAR allowed for the expansion of funding from private foundations to public institutions, which enabled a doubling of the total budget for the IARCs. It provided exactly the efficiency, knowledge exchange and coordination needed in a then highly fragmented global agricultural research field.

CGIAR and its IARCs have shown **flexibility in the context of changing circumstances**, although this has not been without challenges. Progress in genetic research and advancing innovation systems in several major economies have allowed private actors to reap the 'easy' benefits in terms of RD&D that quickly led to market-ready products. CGIAR, with its mission of "substitute for weaknesses in national research programmes" and "building national capacity" has thus faced greater difficulties in running projects with concrete results (Mazzucato, 2013) and demonstrating the impact of its activities. The more complex, less product-focused challenges[24] that the agricultural sector faced related to natural resource management in the 1980s and 1990s, broader societal issues and multidisciplinarity, and currently the Sustainable Development Goals, demand new models for CGIAR. This has spurred the search for new research structures. (Byerlee and Lynam, 2020) The relationship between climate change (adaptation and mitigation) and agriculture is no exception to this. Climate change is a major reason for CGIAR to embark on the One-CGIAR reform, which aims to speed up the response and learning on solutions by "deploying scientific innovations faster, at a larger scale and at reduced cost".

CGIAR and its individual IARCs have been the subject of **academic investigation** over the years. In addition, an element of CGIAR that has contributed to its success is the establishment in the 1990s of the Standing Panel on Impact Assessment, which focused on developing and promoting ex post impact assessment for crop genetic improvement research, natural resource management and policy analysis. Having such an **independent impact assessment** unit with scientific autonomy has helped to improve research effectiveness and efficiency.

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23 See https://www.cgiar.org/funders/trust-fund/trust-fund-contributions-dashboard/.

24 So-called 'wicked problems' – problems that are hard to solve because of incomplete, contradictory, and changing requirements that are often difficult to pinpoint. The very complex interdependencies mean that attempts to solve one aspect of a problem may reveal or even create problems elsewhere.

5.5.4. Identified good practices

On the basis of the above-mentioned lessons learned, the following good practices have been identified that may benefit other initiatives:

- **Establishing problem-focused research centres** allows for the accumulation of specialized knowledge and specialist capabilities in the specific crop or issue;
- **Embedding the IARCs in specific regions** contributed to capacity-building in those regions. Normally this happens in institutions in developed countries, and developing country researchers need to leave their countries to find the best research facilities. It is unique that the opposite succeeded with CGIAR: some of the world-leading agricultural research was done in developing country contexts;
- **Following a mixed funding model** in three windows (portfolio, programme and project) enabled core funding to CGIAR and its institutes, enabling basic research infrastructure, and allowed funders to indicate and fund their own preferences in the project funding window;
- **Conducting evaluations and impact assessments through an independent, dedicated body** can provide credible information transparently and allows for academic reflection and research;
- Having a centralized leadership structure that showed **flexibility** in the context of a changing agricultural research landscape has allowed a large organization like CGIAR to adapt to global trends in technologies and challenges. Currently, with the transition to One-CGIAR, the organization is trying to respond to major global threats such as climate change.

5.6. Joint Initiative on Research and Innovation

5.6.1. Key characteristics

Focus	Mitigation/adaptation	Not climate-specific, covers mitigation and adaptation
	Technology cycle stage	Research and development financing
	Sector	Cross-cutting
	Geographical scope	International/Regional (bi-regional); North–South, South–South
	Geographical participation	European Union, Latin American and Caribbean States, small island developing States
Organization	Type of collaboration	Plurilateral platform
	Actors	Governments, government implementing agencies, research and educational organizations, industry, small and medium-sized enterprises
Budget	ERANET LAC project	EUR 2.9 million in total (2013–2017) from FP7
	Joint calls for tenders	EUR 37.5 million in total (2013–2018)
	Joint Initiative and Research	Unknown

5.6.2. The initiative

The EU and the Latin American and Caribbean States (EU-CELAC) established a strategic partnership at the first EU-CELAC Summit in 1999, in which the Community of Latin American and Caribbean States (CELAC) is the EU's official counterpart for the region-to-region partnership and summit process. The framework of the partnership commits to working "in an inclusive manner and on equal terms for both regions" on the issues covered by the biregional declarations and action plans (EU-CELAC, 2015; European Commission, 2018).[25]

The 2010 Action Plan established the Joint Initiative on Research and Innovation (JIRI) with the **objective** of promoting a "regular bi-regional dialogue on Research & Innovation" between the EU and the Latin American and Caribbean States. The **focus** of the cooperation has been on common challenges such as **climate change** and biodiversity, bioeconomy, energy, health and ICT covered in five thematic working groups, co-chaired by representatives from both regions. The broad scope and the **organization** of the cooperation allows each participating country to pursue activities in line with its national priorities, including, where applicable, its **NDC, NAP and TNA**. JIRI is implemented through Senior Officials Meetings with EU-LAC representatives aiming at consolidating EU-LAC cooperation by "updating common priorities, encouraging mutual policy learning and ensuring the proper implementation and effectiveness of cooperation instruments through biannual Action Plans".[26]

The main **achievements** of JIRI include the following:

- A consolidated science and technology biregional dialogue through the working groups that identify concrete areas for thematic cooperation;[27]
- The establishment of a common research area with three 'pillars': mobility of researchers, access to research infrastructure and jointly addressing common challenges;
- The launch of the EU-funded ERANet-LAC project, with the aim of supporting the political process of implementing JIRI. The project started in 2013, bringing together 17 funding agencies from Europe and CELAC, co-funding calls for joint research projects. The project consortium consisted of partners from 18 countries, of which 8 were from Latin America and Caribbean countries. So far, a total of EUR 36.5 million in project funding has been allocated;

25 It also refers to "major international conferences, summits and special sessions on issues of worldwide concern, including particularly the Third International Conference on Financing for Development and the Post-2015 Development Agenda to deliver an outcome combining poverty eradication, and sustainable development; and COP21" (EU-CELAC 2015 Summit Political Declaration "A partnership for the next generation").

26 See https://eeas.europa.eu/headquarters/headquarters-homepage_en/13042/EU-CELAC%20relations.

27 Since 2016 there is also a cross-cutting working group on research infrastructure, with the aim of "facilitating multilateral initiatives leading to a better use and development of research infrastructures amongst the two regions". Its activities so far have mostly comprised meetings and policy workshops.

- The establishment of the EU-CELAC Interest Group to take over the role of the ERANet-LAC project consortium at the end of the project in 2017. The group consists of 28 funding agencies from Latin America, the Caribbean and Europe that wish to collaborate in biregional science, technology and innovation (STI), and the implementation of the common research area through joint actions;

- The establishment of the EU-CELAC Platform, an information and communication website for funding agencies, universities, research centres, enterprises and individuals interested in the biregional cooperation on research and innovation. It also serves as a meeting point of the EU-CELAC Interest Group. The platform is supported and maintained by the Spanish Foundation for Science and Technology.

The ERANet-LAC project and the subsequent EU-CELAC Interest Group so far have organized four annual calls for proposals between 2013 and 2018 (see table 8 for details). In total, 335 proposals were submitted, of which 271 were deemed eligible for funding and 64 were actually funded, for a total budget of EUR 36.5 million (20% of total requests for funding for all proposals). Success rates ranged across topics, from 14% for biodiversity projects and 30% for energy projects (both in share of projects funded and share in budget funded). **Climate change** is not identified as a separate topic area, but cuts across all other areas.[28] Funded projects comprise various types of activities, ranging from developing joint knowledge platforms to performing research on new materials, laboratory testing and piloting of (combinations of) technologies.[29]

Table 8: Number and budget of proposals funded from 2013 to 2018

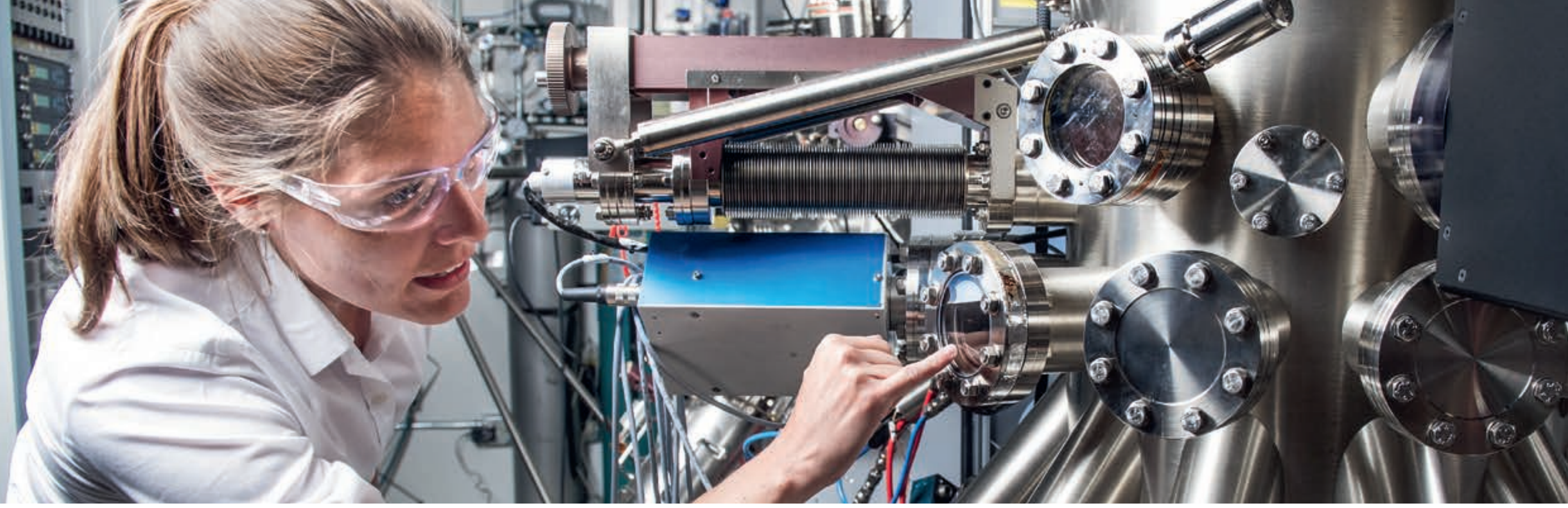
Scope[30]	Proposals requested/ eligible	Proposals funded	Budget funded (requested) (EUR millions)
All	335/271	64	36.5 (186.4)
Health	122/99	29	16.2 (70.1)
Energy	27/24	8	4.9 (15.7)
Bioeconomy	78/64	14	7.3 (40.0)
Biodiversity	83/64	12	5.2 (37.4)
Information and communication technologies	25/20	6	2.9 (13.2)

Source: https://www.eucelac-platform.eu/

28 For example, '"ICT" includes projects on disaster preparedness and sustainable transport in smart cities, and "biodiversity" those on the impacts of climate change on fish or on biodiversity management and the use of microalgae for industrial purposes.

29 Typical examples include "Transnational cooperation for development of a solution for saving energy and water in small near coast facilities using simple devices harnessing the ocean energy" and "Amazonian fishes and climate change" (developing geographical information system tools and impact scenarios to help developing regional conservation programmes).

30 Statistics do not identify climate change as a separate area.



Of the **funding**, 68% originated from Europe and 32% from Latin America and Caribbean countries. **Participating actors** were mostly from "higher education" (52% of the total number of participants), "researchers" (42%), but industry (2%), small and medium-sized enterprises (2%) and "other" groups (3%) also participated. [31] The organization and activities of the funding agencies builds on the national contact points (NCPs), national structures established and financed by governments of EU member States and States associated to the EU framework funding programmes (i.e. FP7, Horizon 2020).[32] NCPs provide local personalized support. The organization of such an NCP system can vary greatly between countries, ranging from a highly centralized approach to decentralized networks, with actors potentially involving government ministries to universities, research centres and special agencies to private consulting companies. The Latin American and Caribbean countries established the LAC NCP Network, which has been in operation since 2017. This comprises 28 countries in the region, including 10 small island

developing States.[33]

5.6.3. Key success factors and lessons learned

An important contributor to JIRI's achievements is that it is part of a long-term cooperation between the regions covering a broad scope with **high-level political commitment** and involvement, combined with **practical and technical implementation** (Sánchez, 2018). Structural processes, with regular meetings, an overarching framework and co-chairing from both regions at all levels have resulted in real **joint ownership**. This has been concretized by involving a large community of stakeholders in individual projects through the joint funding calls, which also facilitates matching of the joint activities with each country's own needs and existing RD&D (and funding) infrastructure.[34] So, while the programme does not make a specific link to countries' **NDCs** or **TNAs**, the programme set-up facilitates directing the activities to be in line with their priorities.

JIRI has shown the ability to move from more traditional North–South support to a form of cooperation that is more North–South–South focused, transitioning from a biregional collaboration to a multilateral network. Or, as formulated at an OECD workshop on new EU development cooperation strategies in Latin America and the Caribbean: "the EU-Latin America relationship is moving from a *traditional* cooperation model toward a strengthened ***peer learning*** model, where the will to share experiences and to learn from innovations appears to be more decisive than the funds".[35] As concluded in an earlier case study of EU-CELAC (Leijten, 2019), this shows how the development or strengthening of institutions can initially be the objective of collaborative programmes, to subsequently become drivers for further collaboration at a later stage.

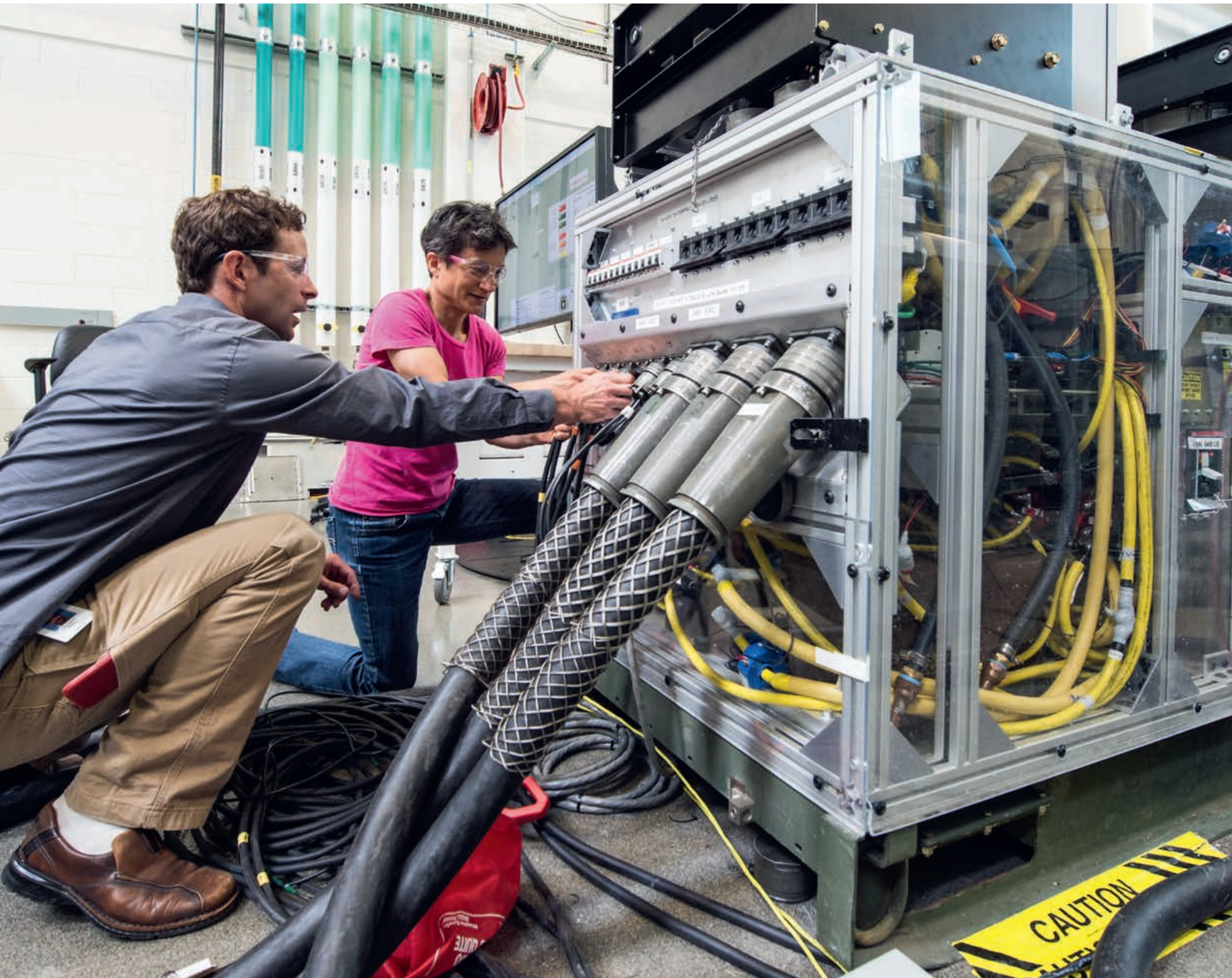
In this context, JIRI and the joint calls for tender have the advantage of being able to combine **countries in different development stages**, also within LAC. Countries with less advanced STI infrastructures can then learn by doing, learning not only from EU partners, but also from more experienced countries within the region. This was also an explicit objective of the ERANet-LAC project.[36] The project consortium itself

31 The EU-CELAC platform, available at https://www.eucelac-platform.eu/.
32 See https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/support/ncp.
33 One additional small island developing State, Barbados, was one of the consortium partners in the ERANet-LAC project.
34 This is also in line with the EU Smart Specialisation Strategy of 2012, with considerations on clustering in regional innovation ecosystems, in which the regional presence of a wide range of interrelated innovation actors are important factors for growth.
35 See http://www.oecd.org/dev/dev-week-eu-development-cooperation-strategies-latin-america-caribbeans.htm.
36 ERANet-LAC project Final Report Summary, 2018, available at https://cordis.europa.eu/project/id/609484/reporting.

included science agencies, councils or ministries from Argentina, Brazil, Chile, Mexico, Panama, Peru, Uruguay and Barbados, with available funding used to implement activities also in countries outside the consortium such as Guatemala, Colombia, the Plurinational State of Bolivia and the Bolivarian Republic of Venezuela, as well as **small island developing States**, such as Jamaica, Dominican Republic and Cuba.[31] This set-up also allows for a large scope (many countries) as well as a phased **scale-up**, when countries have built up sufficient capacities and infrastructures to initiate and coordinate STI projects themselves.

The ERANet-LAC project was also designed with the **sustainability** of the initiative in mind (Leijten, J. 2019). The 18 consortium members, together with 11 non-partner funding organizations established the EU-CELAC Interest Group to organize future joint actions. The project also established the EU-CELAC platform as an information platform for the funding agencies, as well as tools for finding cooperation partners and online submission of proposals. The third call for tenders, which took place in December 2017, was the Interest Group's first pilot joint call, with the participation of 23 funding organizations from 21 countries.

In principle the above approach is **replicable** to other countries and regions, especially as the approach on the EU side is based on its long-term views and strategies in terms of international cooperation, supporting sustainable development in the broad sense, as well as supporting STI within Europe and abroad, and the opportunities provided by participation in the EU structural funding programmes (i.e. FP7, Horizon 2020). It would require on the side of the cooperating region the political intention as well as the institutions, processes and infrastructure for regional coordination and integration. This could be limited to a selected number of countries that can lead regional STI developments and support the development of capabilities and infrastructure in other countries in the region.



5.6.4. Identified good practices

On the basis of the above-mentioned lessons learned, the following good practices have been identified that may benefit other initiatives:

- **Embedding the RD&D collaborative initiative in a broader, long-term cooperation**, connecting high-level political processes and commitment with implementation processes and institutions at the technical level as part of an overarching framework and strategy;

- **Ensuring equal partnerships and joint ownership** through the organization of structural processes and approaches, such as through (1) co-chairing by both partners at all levels and (2) the inclusion of organizations from both regions in the activities in different roles, especially at the strategic level (such as setting objectives and priorities) and in funding activities;

- **Engaging a large number and variety of countries** in the programme, with the possibility of selecting participants in specific projects and in different roles, allowing both flexibility to match activities with national needs and capacities and twinning higher-capacity and lower-capacity countries and partners to facilitate mutual learning and capacity-building;

- **Building on existing structures and processes** for supporting STI as far as possible, including science councils and funding agencies;

- **Designing initiatives for sustainability**, that is, if initial support and funding for an initiative is limited in time, ensuring that during that period more structural entities, processes and funding sources are identified and set up to keep the initiative active and effective beyond that period.

5.7. Ibero-American Programme on Science and Technology for Development

5.7.1. Key characteristics

Focus	Mitigation/adaptation	Not climate-specific, covers mitigation and adaptation
	Technology cycle stage	Research, development and demonstration to commercialization
	Sector	Cross-cutting
	Geographical scope	International, regional, country; North-South, South-South
	Geographical participation	Spain, Portugal and 19 Spanish and Portuguese-speaking Latin America and Caribbean countries
Organization	Type of collaboration	Plurilateral platform
	Actors	Governments, government implementing agencies, research and educational organizations, industry, small and medium-sized enterprises
Budget	Programme	USD 5–20 million per year
	Individual projects funded in programme	Maximum USD 250,000 per year for a maximum of four years
	Thematic networks	Maximum USD 30,000 per year

5.7.2. The initiative

The Ibero-American Programme on Science and Technology for Development (CYTED) was created in 1984 by 21 Spanish- and Portuguese-speaking countries in Europe and Latin America, with the **objective** of contributing to the "harmonious development of the Ibero-American region through cooperation mechanisms that seek scientific and technological results, transferable to production systems and social policies".[37] Since 1995 CYTED has been formally included in the cooperation programmes of the Ibero-American Summit of Heads of State and Government. CYTED acts as a bridge for interregional cooperation in science and technology between Europe and Latin America. Its **specific goals** are:

- Encouraging the integration of the Ibero-American Scientific and Technological Community, promoting an agenda of shared priorities for the region;
- Strengthening the technological development capacity of Ibero-American countries through the promotion of joint scientific research, the transfer of knowledge and techniques, and the exchange of scientists and technologists among R&D and innovation groups in the member countries;
- Promoting the participation of business sectors from member countries interested in innovation processes, in accordance with the research and technological developments of the Ibero-American Scientific and Technological Community.

The CYTED programme **organization** uses a decentralized model, building on the national organizations for science and technology of the 21 participating countries. The political decision-making body of the CYTED programme is the General Assembly, and the General Secretariat is its management body. Each national organization for science and technology is responsible for managing the programme in its own country and is represented in CYTED's administration bodies. The programme's activities are funded from the budgets of the national organizations for science and technology, with additional funding from the Inter-ministerial Commission for Science and Technology of Spain, the Spanish Agency for International Development Cooperation and some other volunteer contributions by different countries.[37]

37 See http://www.cyted.org/.

The CYTED programme currently has eight thematic areas, priority areas for the Ibero-American region as established by the General Assembly:

- Agrofood – solving food security problems and increasing the added value of products from agriculture, fishing and aquaculture;
- Health – improving health conditions in areas related to infectious diseases, public health and epidemiology, medical biotechnology, chronic and degenerative diseases, and medicines;[38]
- Industrial development – addressing issues related to raw materials use, material and product design efficiency, waste and related socioeconomic and environmental impacts;
- Sustainable development – responsibly managing natural and cultural resources, food, health, biodiversity, environment and clean energy resources;
- ICT – reducing the gap between developed and developing countries caused by increased use of ICT;
- Science and society – making science more accessible and encouraging the involvement of Ibero-American citizens in scientific and technological advances;
- Energy – promoting universal access to energy services through increased energy savings and diversification of energy sources, including renewable energy and new energy carriers;
- Business incubator – increasing the competitiveness of national industries through access to new technologies and innovation and international markets and funds.

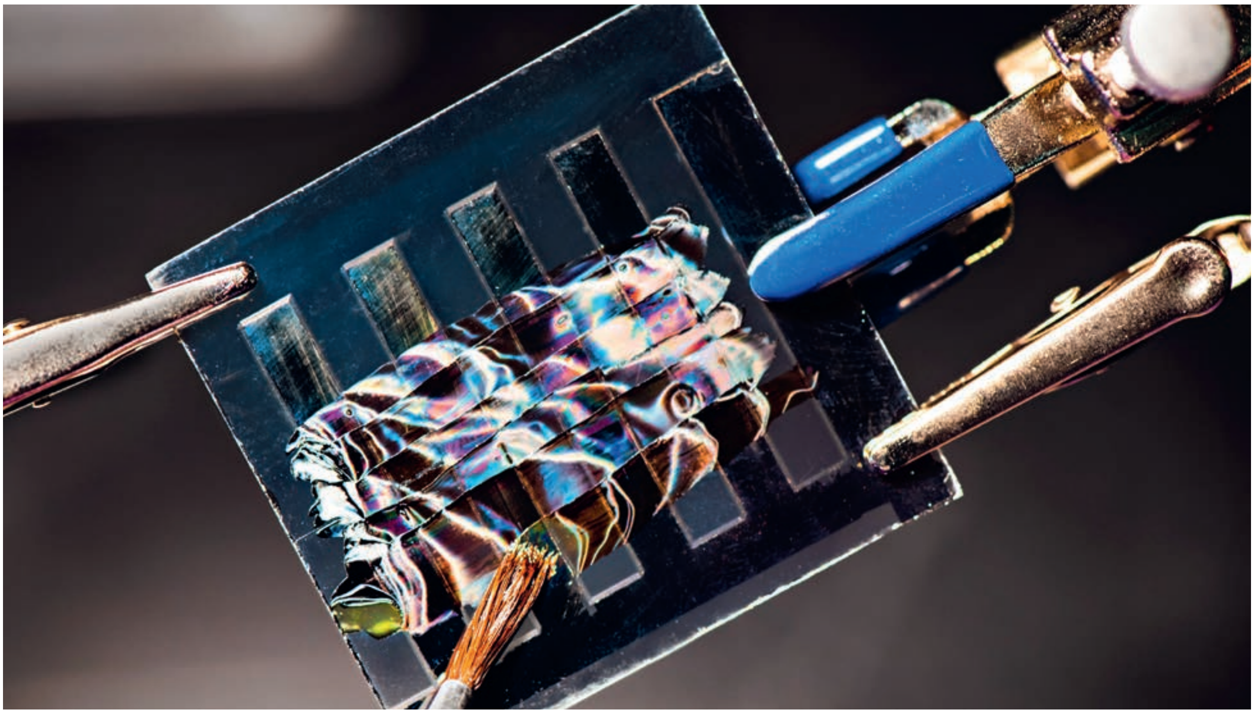
38 Medicines include biomedicine, technologies for health and wellbeing, biotechnology, fundamental biology, pharmaceutical fine chemicals and traditional medicine.

Climate change is not a separate thematic area, but both the sustainable development and energy thematic areas cover substantial mitigation activities (renewable energy, energy savings, recycling, etc.). Adaptation activities are also covered under sustainable development.[39] Examples include a project that promotes adaptation to climate change through the analysis of the biodiversity and ecosystems of coral reefs, seagrasses and mangroves in active collaboration with production activities.

Each year, CYTED launches a **call for proposals** to carry out actions in the above-mentioned thematic areas. Each of the areas has an Area Manager who leads a committee in charge of analysing the regional needs in that area and designing a proposal for action based on those needs. The Area Manager and the other committee members are appointed by the General Secretariat, aiming for a balance between different professional profiles and countries. The Area Committee's role is to establish the scientific-technological guidelines for the calls, collaborate in the evaluation of the proposals, monitor ongoing actions and promote the CYTED programme and its activities.

The programme's funding model is based on co-funding. A large part of the overall **budget** of USD 5–20 million per year[40] is provided by the Spanish Government (originally at least 50%), while other countries' contributions depend on their socioeconomic conditions. The maximum amount of financial support available for each project is USD 250,000 per year, for a maximum of four years (EU, 2014). While the **type of activities** funded has varied somewhat over the years, the 2020 call for proposals lists the following:

- Thematic networks: associations of R&D groups of public or private entities in member countries, with scientific or technological activities in one of the thematic areas with the objective of exchanging knowledge between R&D groups and enhancing cooperation;
- Projects in strategic issues: research and technological development projects between groups in different member countries that are financed both with CYTED funds and with external contributions through their national organizations for science and technology;
- Scholarships for entrepreneurs: opportunities for companies in the incubation period within Ibero-American science parks to access new markets and develop their business on an international scale;
- CYTED forums: meetings between Ibero-American businesses and researchers to address specialized topics to promote technology innovation, transfer and cooperation projects.



39 See http://www.cyted.org/en/node/4799 and http://www.cyted.org/en/node/4801 and http://www.cyted.org/en/node/4800.
40 See https://stip.oecd.org/stip/policy-initiatives/2017%2Fdata%2FpolicyInitiatives%2F15252.

The thematic networks aim to promote among its members stable and continued scientific interactions; mutual interest exchanges of scientific and technical knowledge; synergistic enhancement and coordination of its R&D lines; exchanges and mobility of research staff; training of human resources; technical and methodological training; preparation of proposals for research and innovation projects; and technological diffusion and transfer actions between different groups or entities, provided they are technically, economically and commercially viable.[40]

The **results** of the programme include the generation of strategic RD&D projects involving companies and experts who access important international funds from the CYTED programme. The **beneficiaries** of CYTED financing instruments can be universities, R&D centres and innovative corporations in member countries. Since 1984, more than 28,000 Ibero-American entrepreneurs, researchers and experts in priority areas of knowledge have participated in the programme. From 2005 to 2016 more than 22,300 researchers and 877 companies from all the CYTED member countries participated in the funded thematic networks, of which 73 were still operational in 2018, comprising more than 5,000 researchers from 1070 groups and 180 companies.

CYTED has also been a member of the ERANet-LAC project since its inception and has played a major role in the implementation of the public calls for research projects implemented as part of that project (see JIRI case study above).

5.7.3. Key success factors and lessons learned

While CYTED was originally focused on the promotion of scientific research through cooperation among researchers from universities and public R&D centres, over time it evolved towards the **increased participation of companies** and final users, as well as the promotion of public–private partnerships. This was done through the adoption of different instruments and evaluation criteria that are more in line with the needs and capabilities of private companies and final users. This is a development seen as part of the national STI systems and policies in the member countries to address increasingly complex problems, taking into account advances in new technologies, environmental challenges and the need for social inclusion (EU-LAC, 2018). The more recent thematic area of technology based incubators is one example of such a new instrument. It promotes collaboration and innovation among companies and research centres or higher education institutions to increase the competitiveness of national industries in the member countries. Through such collaboration, entrepreneurs gain access to international markets and funds, as well as to new technologies and innovation. Company participation is a requirement for "IBEROEKA" certification of strategic innovation projects, which provides priority access to financing mechanisms for innovation.[41] The cooperation, however, seems to be more focused on the later stages of the R&D cycle

41 See http://www.cyted.org/en/node/4803.

(incubation, innovation) and the dissemination of technologies, and less so on the earlier stages of joint RD&D of new technologies.

The type, scale and design of the actions funded and programme orientation and management were also revised to achieve **a better balance in the participation of member countries**. While Spain originally was the main funder as well as the lead country in terms of proposals submitted and awarded, the contribution of Latin America and Caribbean countries has significantly increased over time. From 2005 to 2012, a total of 84 of the 217 funded projects were coordinated by Spain, while a small number of Latin American and Caribbean countries also coordinated a substantial number of projects: Argentina (26), Brazil (21), Cuba (19), Mexico (14) and Columbia (13). Most of the other countries coordinated only one project. The geographical participation varies across thematic areas.In 2018, scientific teams of all countries had participated in actions in each area.[42] The number of researchers per country varied between nearly 100 for some of the Central American and Caribbean countries, and over 1,000 in Argentina, Colombia, Cuba, Mexico and Spain (European Commission, 2018).

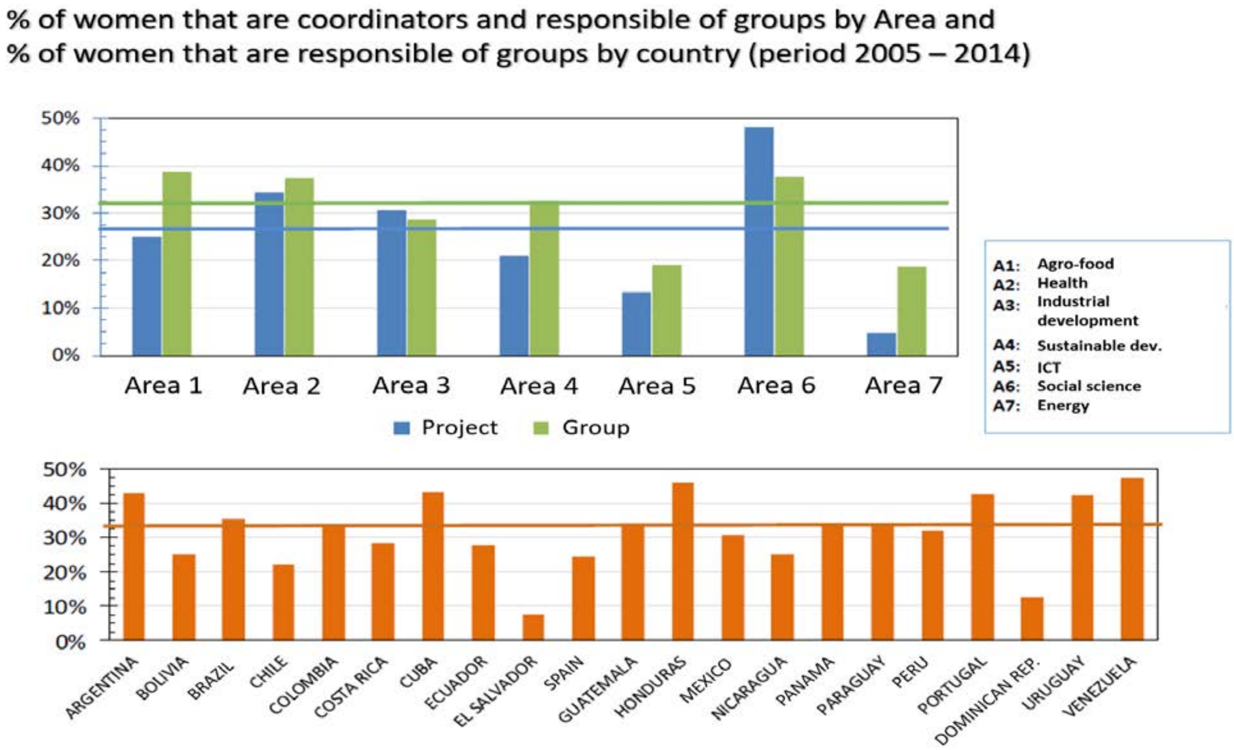
The programme's co-funding model leads to increased **ownership** of the programme and its implemented actions among the country members, also contributing to the programme's **sustainability**. The increased diversity in country participation as mentioned above also resulted in a broader funding base, with more countries providing financial resources to fund the call for proposals, especially in the recently launched "Projects on strategic issues" calls.[48] This is especially important as the available funding from Spain has been under pressure for a number of years, posing risks for the programme's sustainability.**Error! Bookmark not defined.**[7]

42 Except for area 5 "Information technology and communication", where Honduras was not involved.

A strong characteristic of CYTED is the way it uses the thematic networks to build long-term, **sustainable** cooperation that can include a diverse set of countries, with different capabilities and needs in different roles, facilitating **upscaling** and learning-by-doing among countries in different stages of development. Together with the calls for action based on the needs assessments carried out by the thematic area committees, this also facilitates matching proposals and implemented actions to **country needs**. So, while the programme does not explicitly link to countries' **NDCs** or **TNAs**, the programme set-up and implementation facilitates directing the activities to be in line with their priorities.

While it is unclear whether the programme has specific design elements to promote **gender** balance, it does track the degree to which women have a coordinating role within groups and projects as part of one of its networks.[43] Figure 5 shows that this varies across thematic areas and countries, but is generally relatively high, between 20 and 50%. For thematic areas on ICT and energy the share is lower.[44]

Figure 5: Participation of women in CYTED: share of women as project coordinators or group leaders per thematic area and per country



Source: translated from http://www.cyted.org/sites/default/files/2.-%20Indicadores%20Acciones%202005-2014.pdf.

5.7.4. Identified good practices

On the basis of the above-mentioned lessons learned, the following good practices have been identified that may benefit other initiatives:

- **Embedding the RD&D collaborative initiative in a broader, long-term cooperation**, with high-level political commitment, as part of an overarching framework and strategy;
- **Incorporating the needs assessment in the programme design** by identifying (and regularly updating) thematic areas in line with member country priorities and establishing calls for funding

43 The Network for Science and Technology Indicators – Ibero-American and Inter-American – was adopted by the CYTED programme as an Ibero-American network and by the Organization of American States as an Inter-American network. It has also organized workshops on science and technology indicators with a gender focus. See http://www.ricyt.org/en/

44 See https://bit.ly/3ns6hnS.

proposals based on dedicated needs assessments for each thematic area carried out by committees specific to each thematic area;

- **Ensuring joint ownership** through the organization of structural processes and approaches, such as representation in decision-making bodies, joint identification of needs, and formulation of calls for proposals and proposal evaluation, and through co-funding by member countries;
- **Engaging a large number and variety of countries and parties** in the programme, with selections of those participating in specific activities in different roles, allowing both flexibility to match activities with national needs and capacities and twinning higher-capacity with lower-capacity countries and partners to facilitate mutual learning and capacity-building;
- **Building on existing structures and processes** for supporting STI as far as possible, including the national science and technology policy bodies;
- **Constantly evaluating and adapting the programme**'s design, instruments and topic areas to reflect broader socioeconomic and technological developments and needs in the member countries;
- **Using long-term thematic networks** covering multiple types of actions and participating countries and organizations, that can expand over time to scale up and cover more countries and evolving needs.

5.8. The Asian Food and Agriculture Cooperation Initiative

5.8.1. Key characteristics

Focus	Mitigation/adaptation	Not climate-specific, but covering adaptation activities
	Technology cycle stage	R&D to commercialization
	Sector	Agriculture
	Geographical scope	Regional, South–South, triangular
	Geographical participation	Asia-Pacific
Organization	Type of collaboration	Multilateral network
	Actors	National government agencies and research institutes from Bangladesh, Bhutan, Cambodia, Indonesia, Kyrgyzstan, Lao People's Democratic Republic, Mongolia, Myanmar, Nepal, Philippines, Republic of Korea, Sri Lanka, Thailand, and Viet Nam
Budget	Depending on the specific project	

5.8.2. The initiative

The Asian Food and Agriculture Cooperation Initiative (AFACI) is an intergovernmental and multilateral cooperation initiative that aims to improve food production and support sustainable agriculture in Asian countries by conducting joint R&D and sharing knowledge on agricultural technology.[45] It was officially inaugurated in November 2009 in Seoul, Republic of Korea, with its secretariat based in the International Technology Cooperation Center of the Rural Development Administration in Jeoniu, Republic of Korea.[46] As at 2020, AFACI had 14 member countries and five partner institutions.[47]

45 See http://www.afaci.org/main.

46 Since then, the Rural Development Administration has also set up cooperation with 12 member countries in Latin America through the Korea-Latin America Food and Agriculture Cooperation Initiative and 19 member countries in Africa through the Korea-Africa Food and Agriculture Cooperation Initiative; they are collectively known as "the 3FACIs".

47 The partner institutions include the Food and Fertilizer Technology Center, Biodiversity International, the World Vegetable Center, the International Rice Research Institute, the Asia-Pacific Islands Rural Advisory Services Network and the International Livestock Research Institute.

AFACI aims to achieve the following five **goals**:

- Sharing of knowledge related to agricultural technologies among member countries;
- Facilitating cooperation among member countries for agricultural technology innovation;
- Human resource network building through the AFACI website;
- Providing a platform to develop a common strategy to promote sustainable agriculture in the Asian region;
- Actively participating in the international community's efforts to promote agricultural development in the Asian region.

By working towards these goals, AFACI aims to contribute to the Sustainable Development Goals on zero hunger, climate action and establishing partnerships for the goals (Goals 2, 13 and 17, respectively).

Member countries identify priority issues and research projects in meetings of the General Assembly, which is assisted by the Secretariat and Science and Technology Advisory Board. In addition, partner government organizations within the member countries (typically ministries and public research institutes related to the agriculture sector) are responsible for country-specific project design and implementation. Core **funding** for AFACI and its research projects is provided by the Korean Rural Development Administration, with funding for personnel and further voluntary contributions provided by the member countries (AFACI, 2010).

Each of the projects falls under one of five themes: basic technology, food crops, horticulture, animal science and extension. Based on the scope of participation from members, research projects are designated as pan-Asian projects, regional projects or country projects. The duration of all projects is three years, with the possibility of extension depending on the result of **monitoring and evaluation**. In addition, AFACI conducts joint workshops, training and expert consultations at least once a year for disseminating knowledge from ongoing projects, knowledge exchange and capacity-building.

As at July 2020, AFACI had completed 15 projects and had 5 ongoing projects. Although **climate change adaptation** is not a core focus of AFACI, several of its projects are directly or indirectly related to increasing climate resilience among its member countries, developing technologies and building capacity for climate change adaptation in the agriculture sector. One prominent example is the Agro-meteorological Information for Adaptation to Climate Change project (2012–2015) with participation from 11 member countries.[48] The objectives of the project were to:

- Collect local agrometeorological data such as air temperature, precipitation and solar radiation, in all participating countries;
- Analyse regional agrometeorological variation and classify agroclimatic zones;
- Use of basic agrometeorological data to develop useful metrics such as drought index, growing degree days, and crop period;

48 Bangladesh, Cambodia, Indonesia, Lao People's Democratic Republic, Mongolia, Nepal, Philippines, Republic of Korea, Sri Lanka, Thailand, and Viet Nam.

- Improvecapacity-building for maintaining and managing an automatic weather system. (AFACI, 2015)

The main **achievements** of AFACI include the following:

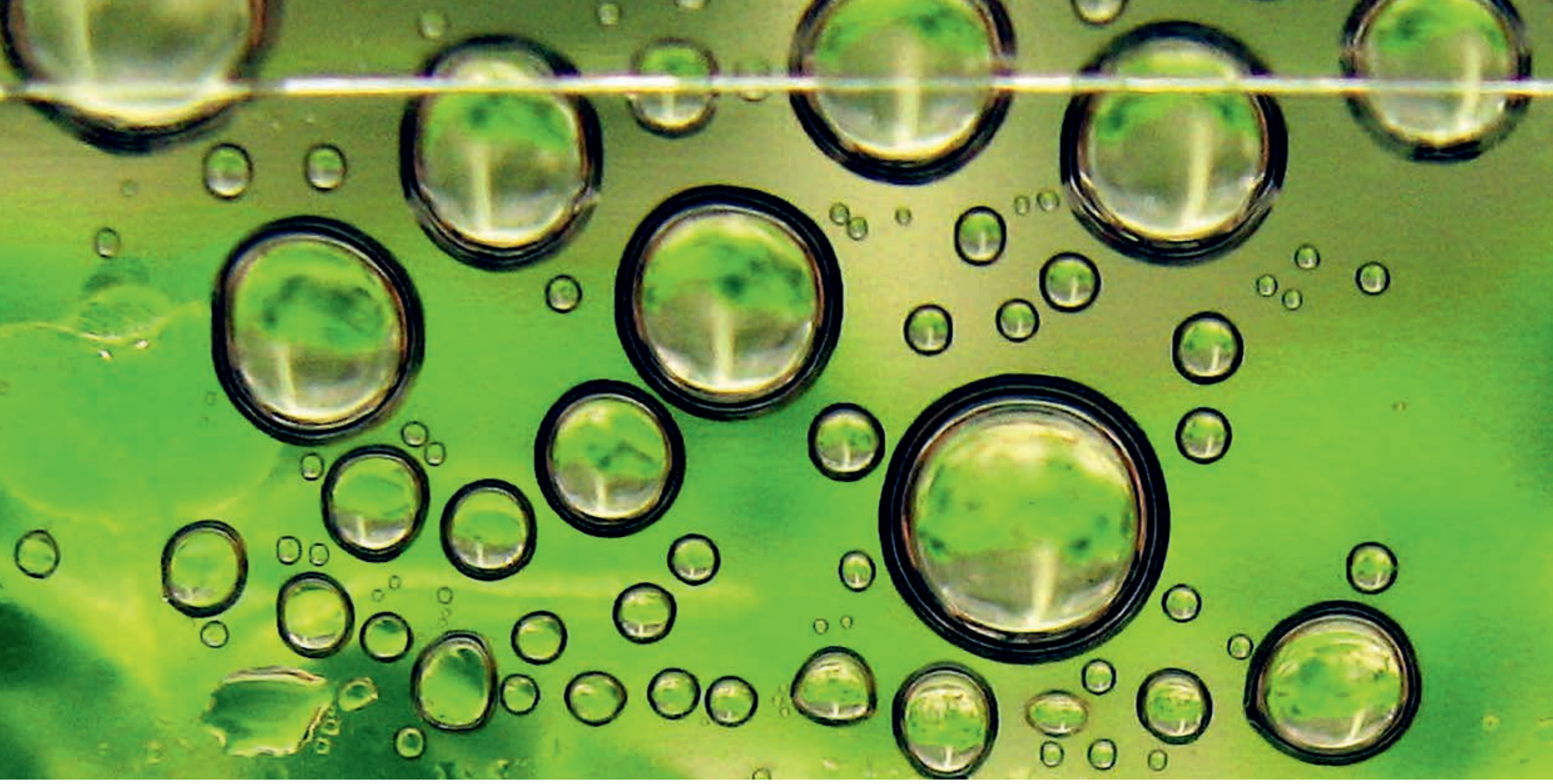
- Establishment of a platform in the form of the AFACI General Assembly for the member countries to develop national, regional and pan-Asian research priorities in agricultural technology;
- Establishment of long-term partnerships with member countries through their respective ministries and public research institutes for agriculture to ensure the uptake of research projects in national agricultural and economic policies;
- Establishment of data collection, management, exchange and dissemination systems in member countries for agrometeorological data, migratory disease and insect occurrence, plant genetic resources and livestock genetic resources;
- Development of technologies (and related manuals, books, training and/or certification programmes) for improved postharvest handling, organic vegetable production, agricultural produce safety, virus-free seed potato production and mechanization for cassava harvesting;
- Establishment of programmes of knowledge exchange through increased international mobility of researchers and practitioners for training visits, expert visits and workshops. [49]

5.8.3. Key success factors and lessons learned

The achievements of AFACI can be attributed to several factors related to the design of its institutions and processes.

First, the way research priorities are defined and projects executed has allowed member countries to pursue **common goals while allowing for flexibility in a multilateral setting**. AFACI uses a bottom-up,

49 See https://bit.ly/3slgGUV.



member-driven approach in setting (and updating) strategic priorities and goals for RD&D projects in its General Assembly meetings, which are held once every three years. Thus, the research subjects **reflect existing challenges and emerging needs** of member countries.

Second, while the overall programme design provides guidelines for the high-level approach to be taken to achieve its goals, the member countries operationalize it in a way they judge to be best suited to their **national (and subnational) needs and capacities**. For example, in the context of the Agrometeorological Information for Adaptation to Climate Change project, Thailand had a relatively well-developed network of 119 meteorological stations, and thus it could focus on data interpolation and analysis. In contrast, the Philippines chose to focus on the installation of a network of 100 agrometeorological stations throughout the country as a major component of the project.

Third, direct **engagement of members' national stakeholders** (ministries, public research institutes and training institutes) provided a direct linkage for the outputs of the RD&D projects to be institutionalized and/or taken up in national agricultural and RD&D policies, thus enabling **scaling up** and long-term **sustainability** of the research outcomes. For example, the Asian Network for Sustainable Organic Farming Technology and Good Agricultural Practices projects provided direct inputs to Bhutan's national-level 2019 Vision of Organic Agriculture, as well as one of its "mega-projects" to support organic farming and good agricultural practices (about USD 15 million). In addition, 13 member countries have established standards for the production and certification of organic products.

Finally, AFACI conducts **periodic assessments of the effectiveness, sustainability and impact of implemented projects** to identify potential areas for long-term development of the initiative as a whole. A study conducted by the Global Agro Network in 2020 aimed to understand the status of AFACI projects, to analyse the performance of AFACI by project and by country, and to identify policy recommendations for its future development (AFACI, 2020). It recommended that AFACI:

- Strengthen its networks for information by organizing them around specific programmes, rather than simply creating networks of countries for knowledge-sharing in general;
- Position itself as an initiative to strengthen the capacity of agricultural technology development in developing countries, rather than merely implementing RD&D projects;
- Serve as a platform for scaling up RD&D initiatives globally by establishing cooperation projects with international organizations and donor countries beyond AFACI;
- Increase the focus of RD&D projects by organizing them based on their focus in the value chain;
- Extend the scope of its partnerships and activities to also include the private sector, to jointly study commercialization of agricultural technologies.

5.8.4. Identified good practices

On the basis of the above-mentioned lessons learned, the following good practices have been identified that may benefit other initiatives:

- Using a **bottom-up, member-driven approach in setting strategic priorities** and common goals for individual RD&D projects;
- Giving discretion to member countries to **adapt the measures required to achieve common goals** so as to ensure their suitability to **context-specific needs and capacities**;
- Engaging with policymakers, public research institutes and/or training institutes as participants or audiences for projects with the goal of **institutionalizing and ensuring the long-term sustainability** of RD&D processes;
- **Periodically assessing the goals, design, impact and sustainability of RD&D projects** and programmes to ensure their continued relevance to member countries' (and broader societal) needs.

6. GOOD PRACTICES AND LESSONS LEARNED

This section synthesizes the cases in the previous section into nine good practices and lessons learned. The clearest and most coherent characteristics that seem to have served the initiatives well include those set out below.

1. High-level support/buy-in: many of the programmes analysed have benefited from high-level buy-in and support, both in the initiation phase and for longer-term continuity. This serves different purposes: it ensures that the programmes are appropriately resourced and enhances the level of engagement by the key actors involved in designing, supporting and participating in the programme. In addition, it enhances the sustainability of the programme, linking the programme's focus to the policy and/or political priorities of participating countries or regions. In the case of CYTED, for example, the initiative was embedded in an existing, long-term process of the Ibero-American Summit of Heads of State and Government process; in MI, it was initiated by Heads of State on the margins of the twenty-first session of the Conference of the Parties, but again very much aligned to the broad priorities of the participating countries. High-level commitment needs to be accompanied by joint ownership from the beginning, and joint funding based on equal partnership as well as structural pragmatic implementation processes.

2. Joint ownership and funding, and equal partnership: being fully involved from the earliest stages of decision-making gives a sense of ownership to the participants in the initiative and also enhances the potential of the R&D output being utilized since this is driven by, and incorporates, locally identified objectives (such as the NDCs). This approach was an important factor in JCERDC and also in the IEA TCPs. The joint selection of areas for collaborative RD&D that suits the needs and priorities of partner countries enhances the chance of success. In JIRI, such a process helped to ensure that all participants benefited from the collaborative work, although the eventual specific nature and scope of engagement may vary from country to country.

For creating joint ownership, joint funding of the initiatives' activities is also key, that is, not only North–South funding. This is, for example, the case in JIRI and CYTED, where the developing country regions (increasingly) contribute funding for the joint research activities through their national funding agencies. One aspect that helped to establish strong joint ownership in JIRI is the requirement that all working groups and meetings be co-chaired by a representative from each region, ensuring an equal partnership. Ownership is also enhanced when the initiative has the flexibility to match activities with the diverse set of national priorities, needs and capacities. Here, for instance, CYTED has shown an increased share of funding coming from Latin American and Caribbean countries (rather than Spain) over time.

3. Broad participation and stakeholder engagement: involvement of stakeholders from academia, research institutions, the private sector, funding organizations and policymaking from the earliest stages of the programme to get inputs regarding its direction and design can help to enhance programme effectiveness. At the same time, sensitization of potential participants to the opportunities offered by the planned programme is also useful for enhancing their engagement – JCERDC, for example, held outreach workshops explicitly to discuss upcoming project calls with potential participants. In the case of DEWFORA, the participation of a range of actors from various backgrounds allowed the marshalling of a diversity of knowledge sources, including local knowledge systems.

Since private sector participation can significantly help with bringing technologies to market (while also helping to raise additional resources), many of the cases analysed make particular efforts to enhance private sector participation. However, although various initiatives have made a special effort to engage with the private sector, its involvement in most initiatives is limited in the early stages of the technology cycle addressed here. If private companies are involved, it is often more in the incubation, commercialization and dissemination phase.

In the case of CYTED, for example, participation in the programme helps entrepreneurs to gain access to international technologies, funds and markets, but they were only sparingly involved in the initiative's design. In the case of MI, where enhancing private sector participation is a key goal, many of the member countries have put in place programmes to enable this. India, for example, has allocated funds specifically to promote collaboration between innovators from other MI countries and Indian institutions in support of the ICs.

Initiatives also benefit from broad participation in terms of the number and type of countries participating. This allows for increasing peer learning (South–South) and developing capacities in less technologically advanced countries that take more complex roles and activities at a later stage, as shown in CGIAR. This also allows further alignment with national priorities, needs and capabilities, as they develop over time.

4. Alignment with national priorities, needs and capabilities: alignment with national priorities, needs and capabilities is crucial for the ownership, impact and long-term sustainability of the initiative. The **joint priority setting** mentioned above for JCERDC is one way to support such alignment. CYTED explicitly incorporated needs assessments in the programme design by identifying (and regularly updating) thematic areas in line with member country priorities and establishing calls for funding RD&D proposals based on that. In some of the multi-country, multi-initiative platforms and networks, countries have had the flexibility to choose the activities to participate in, which they do on the basis of alignment to their national interests and capabilities. In the case of MI, for example, different countries participated in different IC. In the case of AFACI, different member countries operationalized their participation in specific projects in a manner commensurate with their national (and subnational) needs and capacities. This kind of **flexibility** allows the continued engagement of countries with the collaborative effort without having to take on obligations that are misaligned with their interests. CYTED uses its thematic networks to build long-term, sustainable cooperation that can include a diverse set of countries with different capabilities and needs. Such a **diversity** of participation can also facilitate upscaling and learning across countries in different stages of development.

5. Alignment of the design of the initiative with the requirements of the technology and its context: the case studies show that there is great diversity in the type of collaboration that initiatives have used to undertake joint RD&D, ranging from bilateral projects to RD&D consortia (with different levels of participation by industry) to platform or network approaches. Within the IEA TCPs, for example, each programme was tailored around the nature and needs of the relevant technology or sector. In the case of MI, which also covered a range of technologies, the choice of collaboration drew on expert input since this was seen as dependent on the nature of the technology and the kind of scientific/technological opportunities that it offered. MI has an analytical unit (AJR) that supports programme design. Accordingly, the timescales and resource provision can vary greatly.

6. Suitable governance and management processes of initiatives: governance structures and management processes for overseeing the initiatives require due attention. A governance structure that involves all key partners allows for transparent and inclusive representation of all partners' interests and is commonly adopted by most of the initiatives examined. There is often a differentiation between the governance of the overall initiative itself and the governance of specific RD&D activities being undertaken. In the former, participating countries' or organizations' interests tend to be represented by their own representative, while the latter is organized so as to achieve the scientific or technical objectives by those partners with an interest in the particular topic. In other words, large initiatives often require a multi-level governance system, appropriate and specifically designed to meet the challenge at hand. An example here is JCERDC, where the centre itself has a different governance structure from the individual virtual entities for each of the topic areas that have been set up as consortia, and the IEA TCPs, which all have different memberships. This can also be reflected in the funding structure, as in CGIAR, where funders can choose whether to fund all of CGIAR, specific centres or programmes, or specific projects.

The effectiveness of R&D programmes also hinges on appropriate management support. In many cases, this has been provided through existing science and technology organizations that have the appropriate infrastructure and experience rather than the establishment of an altogether new structure. This might work in developed countries, with relatively well-funded research institutions, but in developing countries, where funding for RD&D is extremely sparse, and researchers are overstretched, such management support may be particularly challenging. Hence, it is recommended that provisions be made to ensure that participants from developing countries, especially the least developed countries, are enabled to participate.

7. Structured review and continual adjustment: this is a key element of all successful programmes to ensure that the activities are on track and the programme is moving towards achieving its objectives. This includes developing clear assessment criteria, conducting periodic reviews, and refining programme elements, if needed. Some of the larger programmes, such as CGIAR and MI, have established units (Standing Panel on Impact Assessment and Analysis and Joint Research sub-groups, respectively) that are assigned responsibility for this function from the earliest stages, although such an investment is really only possible for large programmes. Still, it does highlight the importance of treating review and assessment as a core element of the overall effort.

Many of the long-term institutionalized programmes analysed here also undertake periodic examination of various elements of their RD&D efforts ranging from the goals to design to impact to sustainability to ensure their continued relevance to member countries' (and broader societal) needs. Here, CYTED is a good example of a programme that has constantly evaluated and adapted its design, instruments and topic areas to reflect broader socioeconomic and technological developments and needs in the member countries. Although the IEA TCP as a whole has not changed in its design, it allowed for enough flexibility to let the individual TCPs evolve over time. CGIAR has reinvented itself several times over its almost 50-year history and is currently undergoing another reorientation.

8. Design for long-term sustainability: in some cases, there has been an explicit effort towards ensuring long-term sustainability. In cases such as JIRI, CYTED, CGIAR and MI, the institutionalization of the efforts over time provides sustainability (backed by deep and sustained commitment by funding and/or policy entities). The TCPs leverage the IEA's long-established track record of promoting information exchange and cooperation in the area of energy among OECD member countries, which could subsequently be expanded to affiliate developing countries. Especially in cases where funding for an initiative is limited in time or uncertain, it is important to ensure that structural entities, processes and funding sources are identified and set up to keep the initiative active and effective. The ERANet-LAC project, launched under JIRI to issue calls for joint RD&D proposals, established the EU-CELAC Interest Group to take over the role of the project's consortium at the end of the project. The third call for tenders under JIRI was the Interest Group's first pilot joint call.

9. Combine technological hardware RD&D with software and orgware activities: while there are many international collaborations on climate technology RD&D, only a limited number of initiatives are active in the early technology cycle, that is, engaged in actual RD&D on hardware technologies. Of those that are, most provide funding for joint RD&D activities, rather than conducting joint RD&D themselves. Exceptions are some of the IEA TCPs and CGIAR, which has its own RD&D centres. Most international initiatives that claim to focus on RD&D actually undertake RD&D strategizing, policy dialogues, information-sharing and capacity-building. These activities can be seen as a good practice when they are implemented *alongside* (hardware) technological RD&D. Technological RD&D can benefit from, for example, standards and policies that can play an important role in facilitating the diffusion of the technology early on. A broader perspective may also mean incorporating secondary but key objectives into the programme such as training and capacity-building for the continuation or expansion of RD&D activities in the future. This helps to ensure that, as RD&D progresses and technologies come closer to real-world application, other elements of the deployment system are already in place to ensure a smooth and rapid uptake of those technologies.

7. CONCLUSIONS AND RECOMMENDATIONS

This compilation discusses eight international RD&D collaborations in the field of climate change technology of varying sizes and scopes, reflecting different aims and histories, and representing different sectors in both adaptation and mitigation. Some initiatives have been running for decades, while others are much more recent. While this coverage is only a subset of all international collaborative RD&D initiatives that were identified in the initial mapping, this set provided considerable breadth in time, geography, governance structures and sectors. A general and important observation is that many joint RD&D initiatives are not climate-specific, that is, they have a broader scope, which includes (energy and) climate change-related topics, and there are relatively few initiatives that address climate change adaptation.

The previous section identified **nine good practices and lessons learned** that could be replicated in other locations and future initiatives: (1) high-level political buy-in; (2) joint ownership and funding, and equal partnership; (3) broad participation and stakeholder engagement from the beginning; (4) alignment with national priorities, needs and capabilities; (5) alignment of the initiative's design with the technology and its context; (6) suitable governance and management processes of initiatives; (7) structured evaluation and continual adjustment; (8) design for long-term sustainability; and (9) combination of technological hardware RD&D with software and orgware activities.

The analysis does not allow for the identification of specific good practices regarding the **form of cooperation**. Very generally speaking (with limited empirical basis), the bilateral project-oriented approach seems suitable for a one-off bounded collaborative effort with a focus on engaging with specific issues, or as part of a programmatic arrangement that supports a set of projects (with some thematic commonality) over time. The pluri- or multilateral consortium approach, involving a number of participating organizations, is more suitable for a more complex but usually time-bound research effort where different consortium members will have complementary skills. A network-based approach also requires coordination across network members to ensure that all the members are aligned in relationship to overall objectives of the network, as is the case of CGIAR. A network approach is a longer-term arrangement where independent organizations engage in information exchange or programmes and projects. Finally, the platform approach is shallower in terms of cooperation and works best for a broad and long-term arrangement where very different actors may be interested or involved in different aspects of the platform's activities.

From these good practices, five key recommendations are set out below.

1. Strengthen assessments and learning on successful collaborative RD&D initiatives: while some of the collaborative RD&D initiatives do have internal assessment processes, evaluation by third-party assessment is less common. It is noted that each of the initiatives analysed was declared a success. And while activities have demonstrably been implemented in each case, structured (i.e. using predefined criteria) and regular independent evaluations are only conducted with CGIAR. Other initiatives have had one-off independent evaluations, some of which are not public. Carrying out and publishing such assessments is, however, critical for improving the understanding of factors that contribute to initiatives' success and failure. Such understanding will be useful not only for the development of follow-on initiatives but also for the development of new initiatives by other agencies. It is therefore recommended that the costs for such evaluations should be considered as part of the initiative's budget from the start. It is also noted that evaluations of individual initiatives can mainly address questions such as whether the initiative's stated objectives are met and whether improvements are necessary and feasible. Broader conclusions regarding what formats or approaches are the most effective way to collaborate on joint RD&D can only be learned from evaluations that cut across multiple initiatives. Additional lessons could also be learned from the evaluation of failed collaboration initiatives. Both could be relevant areas for further research. Universities could play a role in this.

2. Facilitate flexible and evolving participation of countries in line with national needs and capacities: in designing initiatives, it should be recognized that different countries and stakeholders have different needs, priorities and capabilities. Aside from dedicated knowledge-sharing and capacity-building activities, active collaboration in joint RD&D activities provides an especially effective way of learning-by-doing from peers and building up in-country capabilities. Needs assessments used in setting scope and objectives of initiatives and their activities and projects would support this gradual build-up of capabilities and facilitate countries and stakeholders evolving to more advanced roles and responsibilities in the collaboration.

3. Pay particular attention to the "how" of private sector-participation: the participation of the private sector is generally recognized as being crucial to the translation of RD&D into market deployment and many collaborative RD&D initiatives do promote the participation of industry. But greater attention needs to be paid to the nature of the private sector participation to ensure that the results of the collaborative work do lead to application and real-world outcomes. For firms, this may require providing incentives such as, for example, follow-on grants for particularly promising candidates or ensuring close connection between collaborative RD&D initiatives and incubators. Another field of private sector involvement is through the financial sector. Increasingly, financial institutions, from commercial banks to institutional investors, implement environment, social and governance provisions in their portfolios, with a focus on long-term societal benefits of investments. Interactions with private investors are rarely sought in collaborative technological RD&D and could be explored further to mutual benefit.

4. Enhance collaborative technological RD&D and put it in a broader context: the mapping of international RD&D collaborations yielded many initiatives that claim to focus on RD&D but do not include any hardware technological component. Clearly, more attention needs to be paid to scientists and engineers working together on advancing technological knowledge and application needs to advance climate technologies but also to build capacity globally, which happens most fruitfully through problem-solving collaboration. However, advancing collaborative RD&D needs the technology hardware as well as the software and orgware. Application of technology requires having in place a large number of facilitating activities and efforts that support advancement of the hardware technology. These include policies to create early markets and to support broader deployment, standards to provide broad acceptability of the technology by firms while also promoting performance specifications that are likely to enhance utility to users, market research to understand the commercial potential of the technology and user characteristics, facilitated linkages with global supply chains, and training of appropriate workforce. Paying attention to these ecosystem-level factors even as RD&D progresses will help to increase both the probability of commercial application and the speed with which it happens.

5. Make specific capacity-building arrangements to enable equal and more productive partnerships with developing countries: local engagement with developing countries and capacity-building are crucial elements of developing country participation. For effective international RD&D collaboration, all engaged researchers need to be able to cooperate as equal partners. But this may sometimes be a challenge, given the relatively weaker innovation systems and funding of academics and researchers in many developing countries. All initiatives that have achieved meaningful developing country participation have supported local capacity development in some form while also promoting local ownership.

In conclusion: the broader aim of international RD&D collaboration in the context of the Paris Agreement is to enable every region and country to develop the capabilities to find their own path towards a low-emission, climate-resilient society and economy. This compilation suggests that such collaboration can indeed be successful and effective, but the design and implementation of the collaborative RD&D initiatives need careful attention, need to be systemic and need to support capability building globally. This would help such initiatives to better contribute to the overarching goal of strengthening climate innovation across the world to address the urgent global climate challenge.

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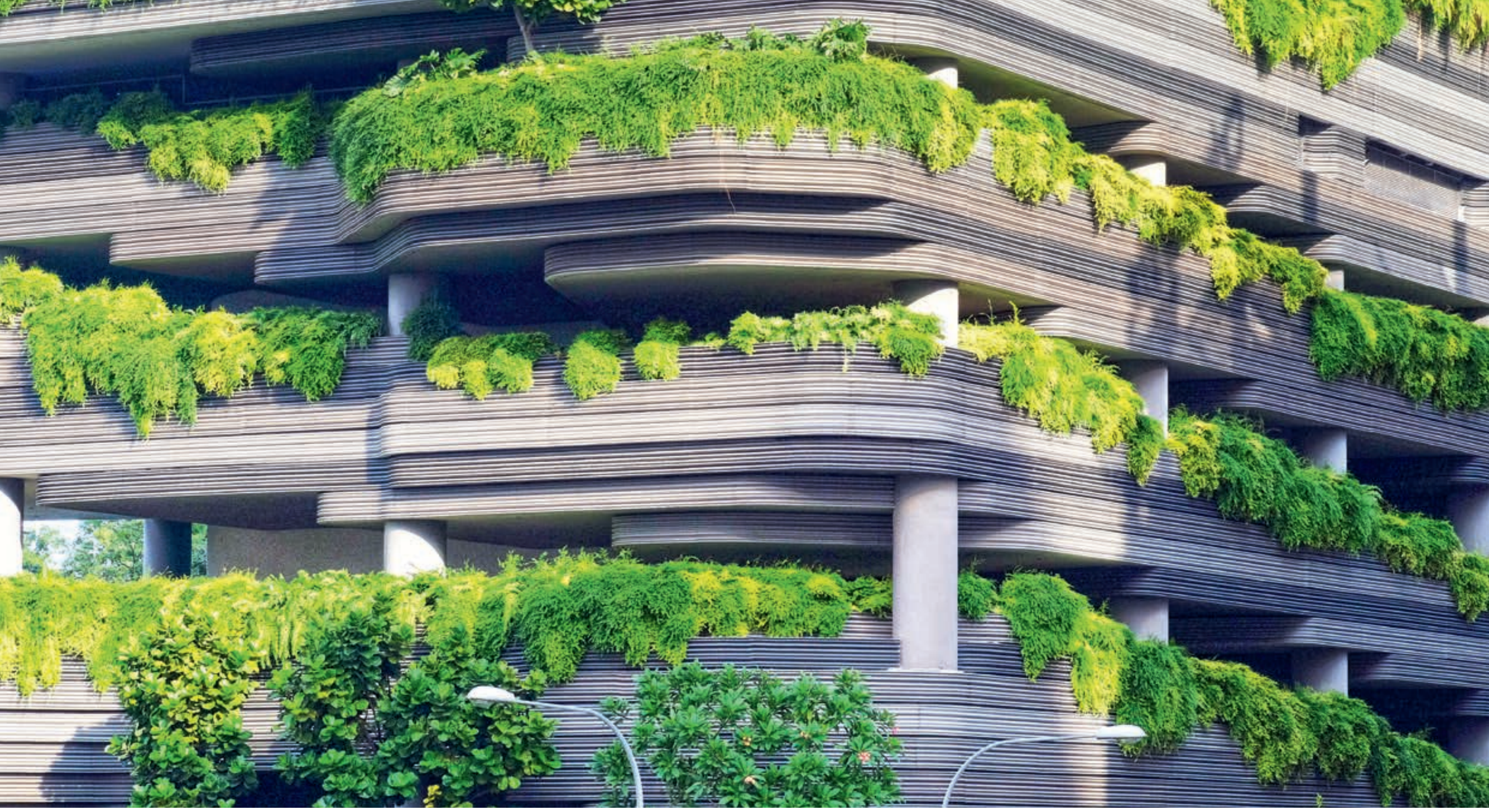

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About the Technology Executive Committee

The Technology Executive Committee is the policy component of the Technology Mechanism, which was established by the Conference of the Parties in 2010 to facilitate the implementation of enhanced action on climate technology development and transfer. Along with the other component of the Technology Mechanism, the Climate Technology Centre and Network, the committee is mandated to facilitate the effective implementation of the Technology Mechanism.

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