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Innovation for Climate Change Mitigation

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# *International R&I collaboration on mitigation*

*Examples of international climate change mitigation research and innovation collaboration between the European Union and developing countries*

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The CARISMA Project started in February 2015 and received funding from the European Horizon 2020 programme of the EU under the Grant Agreement No. 642242. CARISMA intends, through effective stakeholder consultation and communication, to ensure a continuous coordination and assessment of climate change mitigation options and to benefit research and innovation efficiency, as well as international cooperation on research and innovation and technology transfer.



## Abstract

To keep global warming well below 2°C and reach a near-zero emission society, innovation in climate-related fields, as well as dissemination of findings will be needed. Innovation in low carbon and mitigation technologies is seen as a key contributor to achieving the ambitious greenhouse gas (GHG) reduction goals of countries outlined in the Paris agreement. Research collaboration on mitigation technology and innovation between developed and developing countries offers the opportunity for trust building, knowledge sharing and allows all parties to influence the decision-making process of technology development. This report aims at selecting collaboration initiatives from governments, industries and regions, each with different characteristics, in order to identify criteria for effective collaborations between the European Union and emerging countries.

The main finding of the analysis is that there is no unique pattern which could correspond to every good practice of collaborations. Depending on the scale and size of the project, the actors (regional, governmental or industrial) involved, the sector, and the type of activity (innovation, capacity building, knowledge sharing), optimal structures may vary.

We found that effective collaboration requires a well-defined strategy and offers well-identified benefits for stakeholders. An efficient monitoring system should also be implemented to enable incremental improvements. Public decision makers should implement policies which encourage collaborations. A combination of financial, fiscal incentives, or labelling could be examples of such policy matrix that may encourage collaborations. Industry members should understand that research collaborations could be opportunities both for growth and to mitigate their impact on climate.

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# 1 Introduction

The aim of this background report on research and innovation (R&I) collaboration initiatives in international climate change mitigation is to provide an illustrative mapping of R&I collaboration between industries, between governments, and initiated by regional organizations, involving EU Member States and emerging economies. Readers of this report will get a better understanding on the impact of R&I collaboration in the mitigation technology ecosystem and its contribution to mitigating global climate change as well as potential barriers hindering a successful collaboration.

Research and innovation initiatives have the potential to advance climate technology transfer across borders. This is the case regarding the uptake of climate technologies in developing countries, where the deployment of climate technologies can facilitate meeting countries' respective NDCs (National Determined Contributions) under the Paris Agreement (Ockwell et al., 2015). Collaborations between developed and developing countries, in particular technology transfer and capacity building, can function as a strong driver for decarbonisation (Dechezleprêtre, 2013). One indication of the growing importance of collaborations in climate change mitigation is the growing number of international collaborations on R&D programmes, which according to the OECD has doubled between 1996 and 2005. While mappings of efforts and initiatives are carried out under the UNFCCC and in previous research, a comprehensive overview of these initiatives is currently lacking and is needed to provide policy makers with key information to focus efforts on priority areas, avoid unnecessary duplication, and optimise resource utilisation.

The mapping will contribute to our understanding of how technology cooperation takes place at the moment, which technologies and types of cooperation dominate, and what are drivers that impact the depth and form of technology cooperation. It is furthermore meant to increase awareness on bilateral initiatives and to stress the increasing importance of the private sector involvement in collaborations. While EU programmes run by the European Commission are well-documented and relatively easily found, national bilateral initiatives by Member States are not widely known and difficult to identify. Having an insight into bilateral agreements could help to develop a better understanding of the overall European involvement in international R&I collaboration. This in turn will allow policy makers to increase the coordination and coherence of support actions and reinforce the policy diffusion and market creation for climate mitigation and adaptation technologies, improving synergies and avoiding unnecessary duplication.

This draft report is a combined result of three separate reports done on inter-industry initiatives, collaboration between governments and those between regions. Following a joint methodology section on selected criteria that guided our choice of initiatives, methodology a small section on appropriate target audiences for each collaboration category is presented. Section 4 through 6 each present between 8 to 12 project initiatives, followed by a summary table and case study projects. Section 7 concludes, and section 8 builds on that by offering a catalogue of questions which are intended to guide the discussion of the workshop.

# 2 Methods

## 2.1 Identification of initiatives

This report is by no means fully comprehensive. There is a large number of R&I initiatives, both within and amongst countries. A crucial task to give a view as comprehensive as possible is to define criteria that allow a selection of around 10 initiatives each in industry-industry, government-government and region-region collaborations, respectively. The following criteria were applied:

- Collaborations that are **large-scale** and **long-term** R&I initiatives in green technology, so-called 'flagship' projects (criterion applicable to all three categories)
- Collaborations with a significant **R&I component** engaging different relevant actors (criterion applicable to all three categories)
- Collaborations should comprise of **mutual technology cooperation**, meaning they comprise of actual technology development including a cross-sharing and cooperation in complementary expertise in related fields. This might be demonstrated e.g. via test projects (criterion applicable to all three categories).
- Collaborations that are of **high political relevance**. Research team looked for initiatives that were featured in relevant government agencies websites and often mentioned in press-releases and reports (criterion applicable mostly to government and regional initiatives).
- Furthermore, a **mutual business interest** with involvement of different stakeholders is a key criterion
- Collaborations with a high **variability in characteristics**, such as: number/type of actors, project duration, organisational configuration, etc. It appeared also important to select initiatives from various sectors, to illustrate that climate action is a cross-sectorial issue (mainly applicable for industry-to-industry collaborations).

Furthermore, **availability of relevant information** was a key criterion for the selection of initiatives in all three categories. The research teams visited project websites and contacted personnel identified as contact point in project descriptions. Only initiatives where sufficient information was available, either online or via telephone interviews, were selected for the mapping.

After the mapping was conducted, the next step was to select one to two initiatives per category on which a more in-depth case study was carried out.

## 2.2 Characterisation of the initiatives

After defining the above criteria, each research team carried out a mapping which led to the identification of some 10 R&I initiatives each. The taxonomy for the description of the initiatives mainly derives from the paper by Ockwell et al. (2015), with several variables to characterise R&I collaborations. The objective of this mapping (see Section 4 - 6) is to give an overview of the basic characteristics of these projects, namely i) actors involved ii) project duration iii) budget iv) organisational aspects v) technical focus and vi) outcomes. The team that looked at inter-industry initiatives also added two criteria: objectives of the initiative and whether there have been verified emission reductions or avoided emissions.

This section on government initiatives includes collaborations where partnering organisations from both countries involved are government authorities. This means that the EU country as well as the third country contact points are government ministries or agencies. Government initiatives are here defined via the source from which the funding for collaboration stems from. As the criteria described in the previous section also necessitates a multitude of different actors being present in project selected for mapping, the government-to-government nature of these collaborations, by no means excludes other organisations from contribution to cooperation. Many of the initiatives listed in this mapping include also business partners as well as academia, and to a lesser extent also NGO partners.

# 3 Types of initiatives

We selected from a large pool of collaboration initiatives about 30 projects to look at in more detail. The projects were categorised into government-by government initiatives if the initiatives were initiated and led by governments, industry-to-industry initiatives if the collaborations were led by private organisations focusing on one specific industry, and region-to-region initiatives if the collaborations covered different regions. Sometimes this classification is not absolute; there are projects that could potentially fit more than one category. In this case, we made a judgement about which category would fit best based on the project partners. A good example of projects that have elements of all three types of initiatives are the technology collaboration programme by the International Energy Agency (IEA). Technology Collaboration Programmes (TCPs) are independent, international groups of experts that enable governments and industries from around the world to lead programmes and projects on a wide range of energy technologies and related issues. TCPs currently cover topics related to efficient end-use (buildings, electricity, industry, transport), cleaner fossil fuels (emissions reduction, extraction, supply, transformation), renewable energy and hydrogen (technologies and policies for deployment). The 6000 experts in the TCPs work to advance the research, development and commercialisation of energy technologies. The scope and strategy of each TCP is in keeping with the IEA Shared Goals of energy security, environmental protection and economic growth, as well as engagement worldwide. Depending on the TCP, activities may include:

- basic and applied research, technology development and pilot plants
- technology assessment, feasibility studies, environmental impact studies, market analysis, policy implications
- information exchange of research results and programmes
- scientist exchanges
- databases, modelling and systems analysis
- experts' networks.

## 3.1 Government-to-government initiatives

These initiatives include projects that are funded through government channels. Government bodies may engage in R&I collaboration for a variety of reasons, among them goals of climate change mitigation, adaptation, capacity-building and technology transfer. Collaborations that include a climate goal may however also be implemented to advance other aims the actors may have. For industry members, collaborations could have other objectives than climate. There could also be opportunities, especially in the case of international collaborations, to increase firm reputation, create new market opportunities or secure a leading position on a market. For government officials active in the field, the report may provide a wider view of R&I collaboration being implemented.

For public decision-makers, the report may bring clarity to the complexity of international R&I collaboration and shed light where the gaps of technology cooperation may lie. Such a mapping will result in policy recommendations on the needs of future collaboration, featuring examples of how different national bodies across the EU cooperate with BRICS countries and Eastern European governments.

## 3.2 Industry-to-industry initiatives

The section mainly targets two targeted audiences: actors within the industry sector and public decision makers. For industry, collaborations could have other objectives than climate. They could also be opportunities, especially in the case of international collaborations, to increase firm reputation, create new market opportunities or secure a leading position on a market.

All sectors will have to innovate for mitigation and/or adaptation. In this report, private actors will find initiatives in various sectors. This could help understand the mechanisms of ongoing initiatives and could create incentives either to join existing collaborations or launch new research partnerships.

Public decision makers could as well be interested in this report. Collaborations – and innovation in a broader sense – should be encouraged. In this sense, a number of the selected initiatives produced policy recommendations, both on how to facilitate collaborations best, and also on how policy needs to address specific sectorial needs in order to allow for effective carbon reduction in these sectors.

## 3.3 Region-to-region initiatives

The section targets regional officials and representatives engaged in R&I project design for low carbon technologies, funding and collaboration. The regions we selected initiatives from were collaboration from the European Union on one side, and BRIC countries (Brazil, China, India) as well as Africa on the other. Supra-national government bodies as the EU usually start R&I initiatives as an outcome of policy directives on climate change mitigation, adaptation, capacity-building or transfer of technologies. Often, the initiatives are born out of joint agreements on tackling climate change mitigation. Transfer of knowledge, R&I&D, or capacity building is seen as a useful tool to reduce greenhouse gas (GHG) emissions at locations or in economic settings where it is most effective, as is the case in developing countries. Often the know-how or specific needs of the collaborating partner region or community is not known sufficiently, however, and therefore such regional collaborations often require the input from expert stakeholders that have knowledge of regional institutional settings to build a bridge between both collaboration partners.

This report intends to shed light on the current status-quo of international regional collaboration in R&D, and by doing so offer insight for the involved actors on the complexity of such initiatives, but also reflect on what works well and what needs to be improved upon.

# 4 Case studies

## 4.1 In-depth analysis of the CLIENT I initiative

### *Background*

The CLIENT I (Internationale Partnerschaften für nachhaltige Klimaschutz- und Umwelttechnologien und –dienstleistungen, eng: International partnerships for sustainable climate protection and environmental technologies and services) programme is part of the German government agencies "Research for Sustainability" (FONA) palette of tools to answer to challenges of climate change and its consequences. The programme was established in 2010 and runs until 2017.

The programme in particular supports start-up projects that fit the scope of addressing challenges in the fields of climate protection, resource use, land management, and water management. Research cooperation between businesses and universities is supported with the following third countries: Brazil, Russia, India, China, South Africa and Vietnam

As the mapping of the research in particular concentrates on emerging economies, the CLIENT programme fits this scope well. The project website lists in total 21 different projects that have been so far funded via the CLIENT programme.

### *Objectives of the initiative*

Through the CLIENT programme, FONA aims to provide answers via technology innovation and the creation of new networks. CLIENT provides funding for research and innovation by means of cross-country partnerships between universities and businesses aiming to advance innovation.

The programme provides funding in particular on four areas of sustainable development: i) climate change ii) resource use iii) land management and iv) water management.

### *Insights from involved actors*

As the CLIENT programme itself is a funding platform through which relevant projects can seek for funding, it is worthwhile here to look at the different manners in which projects have sought to implement the goals of the programme.

The CLIENT programme has e.g. funded a German-Vietnamese research collaboration (REMON, Real Time Monitoring of Urban Transport) in 2012 -2015, which aimed at reducing emissions and energy consumption in the traffic sector in Hanoi. This was done by implementing a real-time traffic information system, which monitored traffic and contributed to transport planning and urban planning.

The project collected raw traffic data with the help of GPS technology and geo-information which was used to inform the public on the current traffic situation street by street, helping therefore to control traffic flows. The data collection that was done also assists with long-term urban planning and traffic control. The project team consisted of partners in German and Vietnamese universities and research centres (such as Technische Universität Darmstadt, Institute for International Urban Research (InUrban) and Vietnamese-German Transport Research Centre (VGTRC)).

Another example of a CLIENT funded project can be found in Brazil where CLIENT funded the INTECRAL project in Rio de Janeiro. It is co-funded by German Federal Ministry of Education and Research (BMBF) via the CLIENT programme and the State Secretariat of Agriculture and Livestock Project Rio Rural (SEAPEC-PRR) in Brazil. The INTERCRAL project "supports small-scale farmers developing measures embedding a landscape/watershed framework to prevent and mitigate environmental risks and to protect and enhance forest ecosystems". More specifically the project uses brings forward technological solutions to the local agricultural production that may not have been available for farmers before. This is for example in small-scale sugarcane farming where the project provided brought forward technologies for their use.

### *Main achievements of the initiative*

The CLIENT programme has so far funded 21 different projects. As this programme is ending in 2017, a follow-up entitled CLIENT II has been established which has started in 2016.

All projects list their aims and objectives but so far little information has been found on the impacts the projects have had in economic, social and environmental terms. For example data on their ability to reduce GHG emissions in challenging to find. The Research team in continuing effort and conducting further research. For example the REMON project which finished in 2015, showcases it's results on its website. Among them are is the Traffic Viewer website available for the public to access traffic related information online. The service is also available via an app.

### *Limits and challenges*

Based on the results of the CARISMA workshop held in Amsterdam on 20 February 2017 and of an interview with a practitioner, it was found that it may be difficult to agree with the partner country on the exact scope of a project. In fact, while the donor country may see it as a capacity building exercise and a demonstration of new technologies, the recipient country may expect the full transfer of a mature technology. Other limitations concern the measurement of the possible impacts of such projects, due to a number of factors such as the lack of emission monitoring infrastructure in the recipient country, or the lack of follow-up of a project at the governmental level.

### *Policy implications*

The policy implications of CLIENT can be assessed at the level of the CLIENT programme itself, or at the level of local policy implications that have emerged as a result of projects funded by CLIENT.

For example, in the context of the REMON project, the project has brought forward policy recommendation to scale up the local solutions implemented in Hanoi to the whole city of Hanoi and next to other cities in Vietnam[1].

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[1] A. Sohr & E. Brockfeld (2015) *, From GPS data to valuable insights: Developing a traffic information system for Hanoi* http://www.remon-hanoi.net/sites/default/files/styles/medium/public/01_remon_dlr_from_gps_data_to_valuable_insights_2015-07.pdf.

Demonstration of CLIENT I programme's policy implications can be derived from the evolution between the CLIENT I and CLIENT II programme as the CLIENT II has a different scope form CLIENT I in terms of i) country coverage and ii) research areas.

## 4.2 In-depth analysis of the CNREC Initiative

In 2012, Chinese authorities from the China National Energy Administration (CNEA) officially opened the China National Renewable Energy Centre (CNREC) in close collaboration with the Danish Energy Agency(DEA). The aim of the CNREC is to take up Denmark's approach to the energy system and to learn from DEA's many years of experience with energy management based on long-term energy planning. Experts from the DEA work closely with CNREC staff on developing strategic energy policies, state-of-the-art methodologies and tools to encourage the use of renewable energy in the Chinese energy system. During the first three years of the Centre it has become one of the major sources for Chinese policy makers looking for expert advice and analysis on renewable energy.

The five-year long project "Boosting Renewable Energy as part of China's energy system revolution" was born out of the CNREC (together with the US NREL and the DEA) and aims to maximise renewable energy as a vital part of the future Chinese energy system, thereby enabling China to implement international best-practice solutions for the transformation of the energy system.

### *Objectives of the initiative*

The programme will give support to the CNEA China National Energy Administration regarding the decisions on the future targets for renewable energy and for coal reduction. It will address the most critical obstacles for the future development of renewable energy and develop a comprehensive look at the whole energy system. The programme focusses on R&I in distributed generation, power system flexibility and renewable energy friendly grids. This includes research on optimising demand side flexibility and promotion of storage technology as well as a partial switch from fossil fuel based combined-heat-power plants (CHP) to larger heat storages and decoupled power production through renewables.

### *Insights from involved actors*

Although the major funding aid for the programme comes from a London-based charity (Children's Investment Fund Foundation), the Danish government contributes as well. In terms of project coordination, it is actually the DEA's global cooperation programme that provides assistance to the Chinese centre. The DEA cooperates with governments of several emerging economies in order to contribute to their reduction of carbon emissions and to assist in their energy transition to become a low carbon economy. For China, focus of the DEA cooperation programme is mainly on research and innovation in thermal power flexibility (done jointly with the Chinese National Energy Administration). Through the Sino-Danish programme, the Chinese thermal power plant sector is engaged in a series of demonstration projects aiming at demonstrating increased operational flexibility as well as fuel flexibility through increased use of biomass. Another focal point is sharing experiences on energy efficiency, capacity building, pilot projects and policy development on energy efficiency strategies.

Boosting Renewable Energy (BRE) in China is one of such projects that falls under the umbrella of the DEA cooperation programmes. On the project's website (boostre.cnrec.org) several project examples and details are given from the Danish side as well as the Chinese. From their reporting, it becomes evident that a large part of the BRE programme is for Chinese energy sector authorities Chinese to learn from the transition the Danish power market has undergone since the 1970s as well as the transformation of the European power system. This includes the areas of efficient district heating, integration of wind and solar power to the power system network, and energy efficiency measures. The actors involved from the Danish side work closely with the CNEA (NEA) regarding decisions on future targets for renewable energy, address obstacles, and develop a comprehensive look at the whole energy system. Together they inform a Policy Committee which is anchored in the Chinese energy administration to implement and convert the findings into suitable energy policies.

### *Main achievements of the initiative*

Achievements and results of the BRE initiative are captured in an annual report, the "China Renewable Energy Outlook". As the BRE initiative has started only in 2015 and runs until 2019, the results so far are still in the making. However, notable German research institutes have declared to join the initiative in 2016 in order to participate in the research into transformation of the Chinese power sector. So far, a pilot plant for demonstrating thermal power flexibility has been launched in China (Jilin Province). The purpose of this is to test and research the potential for renewable energy absorption and power-heat contradiction. Based on preliminary research done in the first year of the initiative eventually 15 more pilot plants could be launched, concentrated in areas with prominent renewable energy absorption problems (Liaoning, Heilongjiang, Hebei, Inner Mongolia and Guangxi provinces). Once fully established, the pilot is expected to increase the peak capacity of co-generation units by 20% and minimum technical output by 40 -50%, reaching advanced international standards.

### *Limits and challenges*

Decisions in the chinese energy sector are taken in a top-down approach in which policies are formulated at the government level for the next five-year time and implemented at the state level through one of the seven electricity companies. This rather rigid process leaves little room for flexible implementation of pilot projects that have not previously been accepted at the government level. Project collaborators need to keep in mind that it is crucial to involve Chinese decision makers from all levels to guarantee a successful implementation. Another point is that the Chinese power grid network suffers from an investment gap between installed power capacity and distribution network. This gap is even more amplified in rural provinces and provinces in central China that are home to large industrial clusters and facilities and that cannot be provided sufficiently with RE (wind power from northern provinces for example) where large amounts of installed capacity in renewable energies cannot be connected to the grid yet. This leads to a general supply and demand mismatch of electricity in China. Actors seeking collaborations for low-carbon technologies in the Chinese electricity sector need to be aware that the impact (lowering GHG emissions compared to fossil-fuel technologies) of a technology is ultimately constrained by the transmission and distribution network in China. At the same time this offers opportunities for collaboration initiatives in the area of smart-grid technologies and integrated technology projects.

### *Policy implications*

China is an emerging economy with affluent mega-cities in states along the east and south-east region, heavy primary and secondary industry in generally poorly developed urban areas located in central and north China. The country is in dire need to control its GHG emissions as well other pollutants associated with energy extraction and electricity production because pollution and climate change related droughts are already becoming a real threat to Chinese economic development. For this reason alone, Chinese stakeholders are very interested to collaborate in research and innovation of climate mitigation technologies and there is a rich history of EU-China collaboration projects in climate change and technology development. Projects such as the CNREC discussed here, show that research groups at Chinese Universities are generally well linked with government driven innovation projects, and so international collaborators can take advantage of the well-developed domestic industry and academic research network. CCS technology for coal and gas fired power stations is the most financed technology by the European Union and China offers a huge market for applying CCS. Other mitigation technologies, especially those with a focus on demand side reduction (smart grid networks in cities for example) need to be added to the technology matrix in order to attempt a rebalance of supply and demand. This is where we see the biggest potential for effective future research and innovation collaboration potential.

## 4.3 In-depth analysis of the Cement Sustainability Initiative

### *Background*

The cement sector is one of the most emitting sectors in the world, with an estimated 5% of global GHG emissions coming from cement production, and 13% of the industry-related emissions (Figure 1). The main source of GHG emissions from this production is the fabrication of clinker.

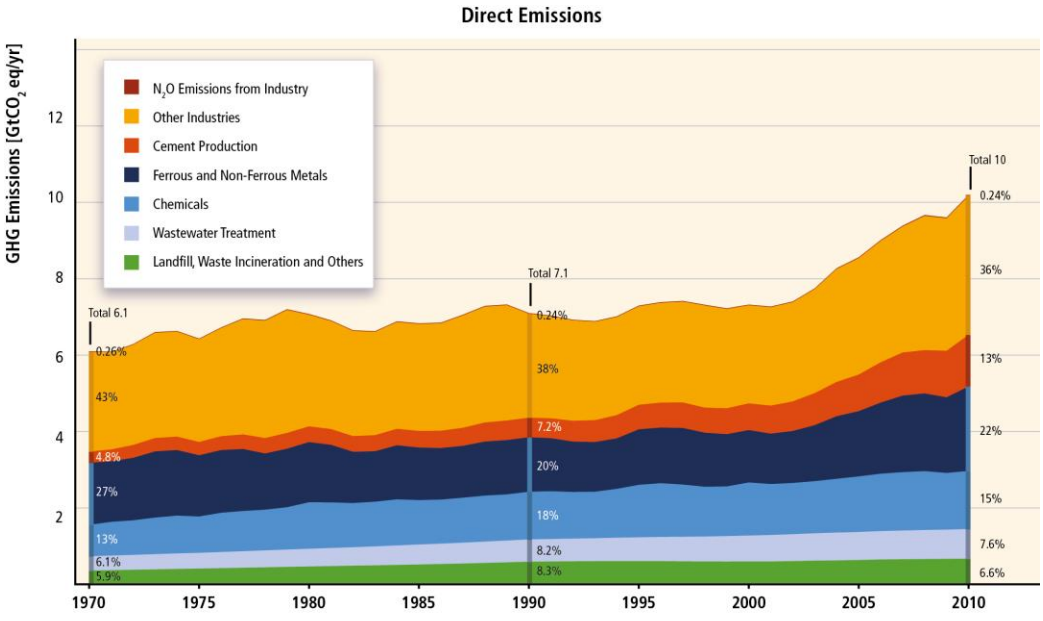


*Figure 1: Emissions from the industry sector. Source: IPCC 2014.*

Under the leadership of the WBCSD, in 1999, ten of the world's leading cement companies joined forces to pave the way for a more sustainable future for the cement sector. These companies came from the EU and other industrialised countries (Switzerland, Japan) but also from emerging and developing economies: Mexico, Brazil and Thailand.

The rationale of the initiative was the recognition that the cement sector had not been engaged in any of the three identified dimensions of sustainable development: society, economy and climate.

In addition to its founding members, companies joined the CSI since 2000, from all over the globe (China, Germany, Greece, India, Lebanon…). Today the Initiative gathers 22 members and 15 partners, accounting for approximately 30% of total emissions of the cement sector worldwide.

In 2015, as a preparation for the UNFCCC COP21 in Paris, CSI members participated to the WBCSD initiative "Low-Carbon Technology Partnership initiatives" (LCTPi). Gathering nine sectors in total (ranging from renewables to agriculture or carbon capture and storage), these LCTPis were initiatives to promote the role of the private sector in the struggle against climate change.

### *Objectives of the initiative*

The CSI has seven priority areas of research:

- health and safety
- climate protection
- fuels and materials
- GHG emissions reduction
- biodiversity
- water
- sustainable behaviours regarding cement production (including recycling)

Cement is composed mainly of clinker, a material with a significant carbon footprint. To reduce the emissions of the sector, companies have identified three core components: energy efficiency of furnace, switching to alternative fuel sources and reduce carbon intensity of the final product (especially by reducing the share of clinker).

The strategy of the CSI was clearly defined in their Agenda for Action in 2002. It sets objectives to be achieved by actors of the initiative individually but also common projects to be launched. The common projects involved developing protocols and guidelines for all of the sectors. Member firms then needed to incorporate these frameworks into their own strategies and report progress on implementation.

If the first objective of the CSI is to find solutions to reduce the potential detrimental impact of actions of member and partner companies, another important feature is to ensure dissemination of findings to any cement sector actor wishing to tackle climate change.

### *Insights from involved actors*

The initiative started by four companies who realized that cement companies are seen as only polluters and not as a provider of solutions to mitigate the climate change impact of

buildings and in an extended view of the urbanisation. The CSI was created to become the leading voice in the energy and climate global debate for the cement industry. Beyond members, the two partnerships with IEA and IFC were key to credibilize and to strengthen the initiative.

Climate change is one topic dealt with by the CSI among others, as mentioned below. CSI does not do R&I on its own, but provides a platform for members to launch collaborative R&I initiatives. In addition, CSI helps to link-up academic world with industry through partnerships with universities and research institutions.

### *Main achievements of the initiative*

The CSI published over 30 reports since 1999, including more than 10 guidelines in all the issues tackled by the initiative.

*Monitoring GHG emissions of the sector:* a flagship project of CSI is "getting numbers right" that aims to build a database tracking GHG emissions and energy performance of the cement sector in order to be used by companies themselves and also by public policy makers. Generally, company members have improved their MRV. For instance, the Sustainable Development Report of Lafarge (Lafarge 2014) presents that the major achievements of the company were the reduction of the share of clinker and the increase in the use of alternative fuels. This enabled a reduction of carbon intensity (measured as the quantity of $CO_2$ per ton of cement produced) of 26% between 1990 and 2014. It is difficult to tie these reductions to the involvement of Lafarge in the CSI, but it is probable that the improvements would have been less significant without this.

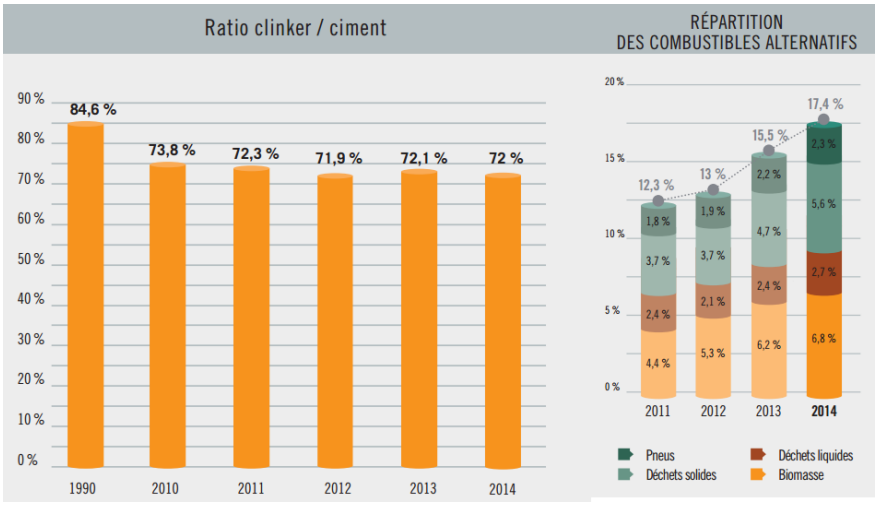


*Figure 2: Share of clinker in cement and use of alternative fuels. Source: Lafarge, 2014.*


*Figure 3: Carbon intensity reduction in the cement sector. Source: Lafarge, 2010.*

*Defining a cement technology roadmap*. CSI produces a cement technology roadmap to investigate what is needed from the industry in order to live-up to the Paris Agreement.

*Building a low-carbon technology partnership initiative for the cement sector*. CSI supports its members in the cement industry to do best they can to scale up GHG emissions reductions in the range of 20-25% in 2030.

*Developing capacities building for emerging countries*: CSI initiates a project with UNIDO to create Cement Sustainability Knowledge Center in emerging countries starting with China.

### *Limits and challenges*

Below the main limits and challenges are summarised:

- Profitability, as said in the first research paper produced by the initiative: "it is unrealistic to assume that cement companies will be willing or able to incur significant costs in addressing sustainability issues unless there is a clear business case for doing so - linked to business profitability" (Klee et al., 2000).
- Intellectual property: for dissemination purposes, intellectual property should not be enforced. However, without property rights there are fewer incentives to invest in R&D.
- Competition between companies members.
- International understanding, especially cultural reticence to unveil data
- Differences in regulations
- The lack of a well-defined global framework to provide economic incentives to encourage GHG emissions transfers between Parties under the Paris Agreement

### *Policy implications*

Most of the policy recommendations of CSI members were presented in the Cement LCTPi final report (WBCSD 2015). According to the document, the main recommendation is to

encourage predictable, objective, level-playing and stable GHG constraints. Given that the cement industry has an international supply chain (some cement products are exported) GHG mitigation policy development requires that players of the industry (mainly firms) come together internationally to discuss how to best sector-specific reduction policies. For European Union countries, it ought to be the government's role to facilitate such integrative, sector-specific policy making by implementing the EU policy recommendations on low carbon strategies into their national legislation.

Another important government's action would be to encourage disclosure of emissions data to gather industry-level emissions to develop an MRV (Monitoring – Reporting – Verification) capacity. The public record of the EU ETS is positive in this sense. The creation of databases would enable (public and private) actors identifying improvements, and then link these improvements with practices. Also, reduction policies could quantify real emissions reduction goals, and the database would help in verifying whether the policies were indeed effective or not.

CSI members urge governments to replace the inefficient Clean Development Mechanism. The objective would be to facilitate funding for energy-saving improvements (including energy efficiency). At the international level, the mechanism envisaged in the Article 6 of the Paris Agreement could be a solution. At the national level, another solution could be fiscal incentives.

Governments need to find solutions to avoid carbon leakage. Sectorial international policy coordination could be an answer.

Government action to give incentives to leave GHG emitting technologies should be encouraged. Financial incentives could be interesting. A carbon price is a good example of such mechanism to deter the use of such products. However, companies would prefer being rewarded for positive actions than being financially punished for environmentally detrimental behaviours. For instance, they call for financial or fiscal incentives for the use of alternative fuels. Avoided emissions should also be rewarded.

CSI members call for an international body to transfer competences to developing countries to build adaptation and resilience capacities.

## 4.4 In-depth analysis of the IEA agreement on Energy in Buildings and Communities

### *Background*

Approximately one fifth of global GHG emissions comes from non-industrial buildings, such as residential buildings, public or private offices, hospitals or schools (Figure 1). The main uses of energy in such buildings are heating, cooling, lighting and operations, contrary to industrial buildings where operations produce the largest amount of GHG. Concerned with the risk of climate change, many countries have issued national targets, aiming at reducing energy consumption of the building sector between 5 and 30% over the next decades.

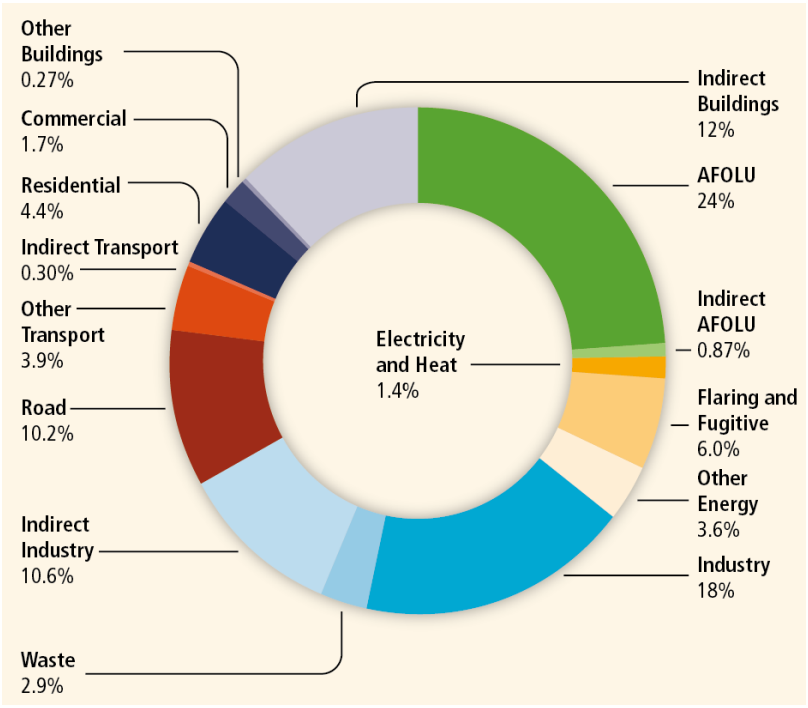


*Figure 4: Global emissions by sector. Source: IPCC, 2014.*

To meet this target, there is a strong need for research in technology and practices. International collaboration, with knowledge transfer, will have a key role to play. In recognition of this role, the International Energy Agency (IEA) established in 1977 an Implementing Agreement on Energy in Buildings and Communities. The Programme creates a channel for collaboration between national programmes and industries. Experts can share knowledge, build capacity and strengthen their networks. These research projects are also an opportunity for participants to identify barriers to the development of a low-carbon sector.

The EBC Programme gathers today 26 member countries from Europe, Americas, Asia and Oceania. Members come from governments or government organizations. The Secretariat is managed by the IEA.

### *Objectives of the initiative*

The strategy for the EBC Research Programme for the next years was defined in October 2013. This Strategic Plan[2] defines the strategy for the period 2014-2019. It defines the mission of the Programme as "to accelerate the transformation of the built environment towards more energy efficient and sustainable buildings and communities, by the development and dissemination of knowledge and technologies through international collaborative research and innovation."

The 2030 objective of the EBC programme is to have adoption of near-zero carbon emissions solutions in new buildings and communities, and numerous solutions have been

[2] Available online at: http://www.iea-ebc.org/fileadmin/user_upload/images/Pictures/EBC_Strategic_Plan_2014_19.pdf

identified to reduce the carbon footprint and energy consumption of existing sites. This objective applies for residential, commercial, office buildings and community systems.

There are also **2030 objectives for stakeholders**: energy end-users to be well aware of the issue of energy; businesses to be engaged in lifecycle components with prices linked to performance rather than technical capacities; new buildings produce and consume almost only renewable energy, etc.

To achieve these objectives, the research projects are divided in five (5) themes:

- Integrated planning and building design
- Building energy systems
- Building envelope
- Community scale methods
- Real building energy use

Most projects are proposed by members and other members choose whether or not to participate. The others are cost-shared, meaning that participants contribute funding to achieve common objectives.

The control of the Programme is managed by an Executive Committee which monitors all the different research projects and identifies areas in which new collaboration could be beneficial.

### *Main achievements of the initiative*

Every year the EBC Programme issues two reports (in June and November) reporting recent findings by research groups and intended to a large audience.

The Annual Report provides an overview of progress made by the EBC Programme, including summaries of new, ongoing and recently completed projects. It also includes an executive summary intended to policy decision makers.

In addition to these periodic publications, each project releases Project Summary Reports, which draw technical synthesis and make policy recommendations, and Project Reports which detail findings.

In total, the EBC Research Programme has issued since its beginning in 1977 more than one hundred (100) reports for over sixty (60) research programmes (called Annexes).

*GHG emissions*: the impact of a national policy on GHG emissions is difficult to fully grasp. For instance, in the residential sector, like the EBC programme, States set rules and fiscal incentives to invest in energy efficient products, but construction is managed by private actors of the sector. Therefore, monitoring of the impacts of the EBC collaboration is even more difficult than that of the CSI.

### *Limits and challenges*

If the mission of the Programme is "to accelerate the transformation of the built environment towards more energy efficient and sustainable buildings and communities, through international collaborative research and innovation", EBC programme has to

consider big differences in regulations between countries and in cultural aspects regarding building sector issues and challenges. In addition, EBC Programme currently depends strongly on the funding given out to projects, and this in turn depends on the policy signals set by governments. One major challenge is to gather countries around common issues to launch working group projects

### *Policy implications*

In the latest annual report (EBC 2016), EBC members called for standards and incentives to promote cost-effective and energy-effective available technologies in order to encourage governments to move forward with national measures and policies. In addition, in the context of the Paris Agreement objectives, EBC members drafted harmonized definitions for 'net-zero', 'near net-zero', in order to have a better understanding about their contributions to this Paris Agreement.

For one part, the challenge for policy makers in the field of energy and buildings is how to implement suitable low carbon policy recommendations by the IEA best into their national legislation. Germany, for example, has implemented a law as part of its "Energiewende" policy Directive in which older buildings are retrofitted with better insulation. Such policies may work in reality in Germany but in other countries there may be real constraints (old buildings that cannot be retrofitted, lack of personell capable of retrofitting etc). For such examples, it is important that policymakers consider the what is doable in each situation. The same goes for integrating research and innovation for low carbon technologies into the policy mix for the building sector. One of the things to keep in mind when supporting R&I is whether technology implementation is actually feasible at a large in a given country.

## 4.5 In-depth analysis of COACH Project

### *Background*

The COACH (Cooperation Action with China CCS-EU) project is part of the Sino-European Partnership for climate change, which officially started in 2005 with the signing of an agreement between the European Commission and the Chinese Ministry of Science and Technology to work closely on issues of climate change, and in particular to collaborate on research and development in the sphere of low carbon technology and efficient use of coal-fired power plants. The latter includes several research projects on carbon capture and storage technology, bundled under the "NZEC initiative' (near zero emission coal). COACH is one of two main projects of phase 1 within NZEC and ran between 2006 to 2010 with a budget of 2.5 million British pounds. We selected this project for an in depth-review because of the strong research and development focus that this project has, and because it is well documented. Several scientific publications and PowerPoint presentations from workshops function as outputs and document the lifetime of the project. Over the period of our years the project's R&D program was divided into 6 work packages, each with its own outputs.

### *CCS in China*

China's energy system faces many severe challenges, to mention a few:

- huge and fast increasing energy demand and limited supply capacity
- shortage of liquid fuel

- severe local and regional air pollution, especially from coal
- burning;
- huge clean and convenient fuel demand in rural and urbanizing areas; and
- enormous and fast increasing greenhouse gas emission

In order to face this challenge research and development into more efficient and clean coal-fired power generation has been plentiful in the last 15 years in China. Particularly, poly-generation via coal gasification is seen as a strategic and promising technology to address comprehensively the challenges. It inherits the virtues of integrated coal gasification combined cycle (IGCC) in terms of enhanced efficiency, diminishing conventional pollutants as well as trace metals. It is also expected that poly-generation may extend the range of applicable coal qualities that includes Sulphur-rich coals. Furthermore, by co-producing coal-derived synthetic fuels, poly-generation may also respond.

### *Objectives of the initiative*

The R&D focus is on coal gasification for appropriate polygeneration schemes with $CO_2$ capture and storage, the identification of reliable geological storage capabilities of $CO_2$ in China and a closer investigation on societal anchorage including legal regulatory and public issues. The objective of the COACH project is to lay the groundwork for implementing large-scale polygeneration energy facilities with options for coal-based electric power generation as well as production of hydrogen and synthetic fuels. For such facilities, CCS constitutes an inherent and decisive pre-requisite.

There are two technical directions of the COACH project, which include:

1. Coal gasification facilitating appropriate coal-based polygeneration schemes, refinement of products and export systems:
    a. Inventory of Chinese thermal power plants;
    b. Assessment of options for CCS including retrofit;
    c. Concept studies of coal-based plants including improved power cycles requiring a large-scale topping cycle based on gas turbines that operate on hydrogen-rich gaseous fuels;
    d. Polygeneration schemes with outputs like electricity, hydrogen and derived fuels (methanol, synthetic gasoline, diesel, etc.);
2. Identification of geological storage capabilities including large-scale use of CO2 in China for enhanced recovery of oil, natural gas and coal-bed methane (EOR/EGR/ECBM):
    a. Assessment of geological storage capacity of a selected basin;
    b. Mapping of geology and point emission sources;
    c. Generalised storage capacity assessment and site selection criteria.

These directions are basically pursued in a Chinese context, thus, with a strong emphasis on cost, fuel availability, and primary energy demand (i.e. efficiency). Generic and specific experience gained in European and Chinese research projects under topical areas that correspond to these directions are being extended – as appropriate – on firm strategic terms. Societal anchorage is another important aspect that is being indirectly covered via knowledge sharing and cross-cutting actions, especially with regards to legal and regulatory issues, including commercial aspects and other public relation issues.

### *Insights from involved actors*

Coach has had more than 20 group partners from R&D, oil and gas companies, manufacturers, service companies and SME's (12 from Europe, 8 from China). Due to time constraints, we have not yet been able to contact actors directly involved in the project, in order to question them and gather their direct insights from the project.

We were able, however, to work through a review report from Vincent et al. (2009) on the CCS storage options for the COACH project in the Bohai Basin, China (Shandong Province). This report offers an assessment of storage of storage potential in the Dagang oilfield complex, and investigation undertaken within COACH. The actors involved in this assessment, and those who wrote the review report, are scientists from Chinese, UK and Danish research institutes. The report is publicly available and referenced in the reference section. The research team concludes that within the Shandong province the greatest capacity for storage appears to lie in deep saline aquifer formations. They recommend that, that 'value-added' options through enhanced oil recovery in the Dagang oilfield complex or enhanced coal-bed methane recovery at Kailuan coalfield exist and should not be ignored when designing potential storage scenarios as these may offer a way to offset some of the initial outlay for CCS.

### *Main achievements of the initiative*

Kalaydjian et al. (2011) list and explain the main achievements of the COACH project. They list the following topics on which COACH made several impacts:

- *Knowledge Sharing & Capacity Building*: Besides setting up the official website, a survey of CCS activities was conducted and a school of CCS set up, that included training sessions and workshops and attracted about 80 Chinese and 30 European students.
- *Capture technologies*: The team defined and implemented a generic IGCC concept with $CO_2$ capture. They then compared it against a plain IGCC based system on the GreenGen Phase I system without $CO_2$ capture and benchmarked between a gas turbine with low calorific syngas and a turbine burning a hydrogen enriched gas mixture diluted with nitrogen. The $CO_2$ capture cost was found to amount to €22/t$CO_2$ whereas the cost of the avoided CO2 was a little bit higher amounting to €27/t$CO_2$.
- *Integration*: COACH project included some scenario designs for the option of a possible CCS demonstration project. The scenarios included the question of feasibility of capture, transport and storage of $CO_2$ from a IGCC power plant based in Tianjin to be stored in surrounding oilfields. Environmental risk and economic cost assessments were performed.

### *Limits and challenges*

CCS technology development and deployment currently depends strongly on the funding given out to projects, and this in turn depends on the policy signals set by governments. CCS is still far away from market penetration and lacks profitability at the current levels of carbon prices. There is also a visible trend of attempts to implement CCS in China and India while the main contribution to R&D remains in developed countries. This is not only because of the great potential for reducing carbon in these countries, but also because CCS is largely lacks social acceptance in Europe. It seems that research and innovation is not

the primary factor hindering a successful CCS implementation, but that more socio-economic hurdles need to be overcome.

### *Policy implications*

The COACH project is one of many CCS R&D projects that have been in operation throughout the last ten years. From a global, macro-policy perspective on climate change we see that CCS continues to be a crucial mitigation technology, and that without CCS the ambitious below 2degrees Celsius target will very likely be missed. Also, without CCS, the cost of reaching 450ppm CO2 eq. will be significantly higher (IPCC, 2014). At the moment, there is no fully commercialised CCS system installed yet, indicating there is little time left to have CCS ready and working by 2020 in China. But also, the importance of such joint R&D project as a leverage to speed up the feasibility process of emerging technologies enabling to move forward with climate policy objectives becomes obvious.

## 4.6 In-depth analysis of CAAST NET + Initiative

### *Background*

CAAST-Net Plus was conceived against the background of a global consensus that capacity in science and technology is essential to economic competitiveness, sustainable development and poverty reduction, and that improving the contribution of S&T to addressing common challenges through internationalization of research and innovation is a policy objective shared by Europe and Africa. The project strives to support and reinforce scientific and technological cooperation in research and innovation between Africa and Europe at both practical and policy levels.

### *Objectives of the initiative*

CAAST-NET has the following main objectives:

- To encourage new and diverse multi-stakeholder partnerships that, through research and innovation, tackle the global challenges of health, food security, and climate change that affect Europe and Africa.
- To enable better understanding between the public and private sector in Africa and Europe of the link between research and innovation, and to identify and share opportunities for cooperation through networking and communication.
- To facilitate exchanges that result in learning and that support formal policy dialogue for more effective research and innovation cooperation
- Strengthen bi-regional research and innovation cooperation in health, food security, and climate change through policy and situational analysis, and multi-stakeholder networking activities.
- Support informal and formal policy dialogue processes, and offer practical support to bi-regional research partnerships and networks to enable more effective cooperation.
- Disseminate key results effectively, and provide a multi-media platform for communication and interaction within relevant African and European research and innovation communities

### *Insights from involved actors*

There have been plenty of testimonies from project managers and stakeholders on the success of the CAAST-NET initiatives, as well as barriers and ways to improve the initiative.

### *Limits and challenges*

From interviews and testimonials we were able to extract the following challenges and limits: For one it was noted that there is a lack of 'outcome thinking' at the level of research project management, and on the part of the European Commission. There is undue focus on project outputs (as opposed to project outcomes) that are easy to document and report on. There is minimal questioning of the actual difference projects make. Also, there is minimal evidence of framework research projects generating knowledge that feeds directly into technology development or patents. This is largely due to low levels of private sector involvement in EU-Africa research collaborations. Too many workshops and seminars have not been fully taken advantage of by invited guests. Therefore, there is no need to set up another 'knowledge management' facility, online network, or portal, focus of CAAST-NET should be more on other networking opportunities. There is a general lack of follow-up studies to monitor longer-term outcomes of framework research projects that reflects the predominant focus of monitoring, reporting and evaluation on the strength of short-term project outputs. And finally, the unequal proportion of African to European project leaders can create unbalanced partnerships and threaten the effectiveness of bi-regional cooperation. Stimulate debate in relevant forums about the proper role and importance of understanding longer-term outcomes of EU-Africa research collaborations and how this could be built into the project design stage.

### *Policy implications*

The policy implications cited here stem largely from a response to the testimonials and follow-up on the limits and challenges discussed previously. For one, project organizers ought to stimulate debate on the role and importance of outcome thinking in Framework Project design, implementation and follow-up to influence projects being designed under Horizon 2020 and in other funding programming. This will hopefully drive the shift from output to outcome and impact thinking. Secondly, promote systematic collaboration with civil society and private business lobbying sectors that have expertise in advocating policy change in support of climate technology development and uptake. Third, rationalize and/or better coordinate existing data platforms in order for Africa-EU partnerships on research and innovation and climate change to 'speak with one voice'. These must be evidence-based processes — that is, informed by original EU-Africa research. EU-Africa research collaborations should seek to cooperate with a select few of the many networks and portals already in existence and that aim to inform the research-policy nexus**.** Explore and further develop financing and cooperation models, such as ERAfrica, which allows for more balanced partnership and cooperation.

# 5 Government-government collaborations

## 5.1 Descriptive account of initiatives

### *Sino-Danish Renewable Energy Development*

**Summary**

Running from 2009 until 2014, the Renewable Energy Development (RED) project has brought together Danish and Chinese actors in developing renewable energy. The programme was composed of two aspects: i) establishing the Chinese Centre for renewable energy, CNREC which opened in 2012 and ii) 12 research projects encouraging joint innovation and business cooperation renewable energy inter alia on offshore wind, biomass, bioethanol, solar cells, planning and integration of renewable energy. Partners from universities, private-sector businesses, public-sector organisations are involved in collaboration. Funding from the Danish government amounted to 100 million Danish Kroner.

**Outcomes**

*Under Component I*: Proposal on the creation of the Chinese Renewable Energy Centre; Sector strategies for wind, biomass and solar energy; Creation of a Renewable Energy Analysis and Information Centre. *Under Component II*: study on the Chinese RE market, identifying Sino-Danish co-operation opportunities; Four to five co-operation projects in research, development in aforementioned areas.

**Temporal scope**

2009 – 2014

**Technical focus**

Institutional capacity building and technology innovation for renewable energy development.

**Funding sources**

Funding via Danish state innovation fund launched by the Danish Trade and Investment Minister. In 2015-2019 the programme will continue and has acquired funding from the British Children's Investment Fund Foundation (CIFF).

**Organisational configuration**

Danish Energy Agency and National Energy Administration (China) as national executing agencies.

**For further information**

www.cnred.org

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### *UK Science & Innovation Network in India*

**Summary**

The UK Science and information network is part of the UK's Official Development Assistance (ODA). This includes climate mitigation support. One of its goals is to harness technology partnerships and investment to grow UK innovation capability.
The partnership with India is the Newton-

**Temporal scope**

The Newton Fund started in 2014 and is set to run until 2021 (renewable).

**Actors involved**

The Fund is being delivered by 15 UK delivery partners in collaboration with funders in 16 partnering countries.

**Technical focus**

Varies from project to project, e.g. Bio-

Bhabha Fund and Energy-Water-Food Nexus, which is one of the priorities in India. The institute funds researchers and inter alia supports them in commercialising their innovations by enabling researchers from India to develop business partnerships in the UK. Priority areas in the sphere of climate mitigation include Sustainable cities and Urbanisation and the Energy-Water-Food Nexus.

- **Outcomes**

The fund supports research projects, scholarships and training, as well as the commercialisation of technologies, such as energy-efficient water purifiers.

technological solutions for reducing industrial waste.

- **Funding sources**

The Newton funds has a budget of £735 million until 2015 by the UK ODA. There is no specific information on the share for India or the specific programmes.

- **Organisational configuration**

15 UK organisations (e.g. Innovate UK, Biotechnology & Biological Sciences Research Council (BBSRC), Engineering and Physical Sciences Research Council (EPSRC)) and Indian organisations (e.g. Department of Bio-Technology (DBT). The Indian departments of Technology are funding partners; An India Newton Team oversees the programme.

- **For further information**

www.newtonfund.ac.uk/about/about-partnering-countries/India/

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### *International Smart-Grids Action Network*

- **Summary**

Smart-grids are believed to be a solution for large GHG emissions cuts in the future by effectively managing demand.
The International Smart-Grid Action Network was launched by the IEA in 2010. This government-to-government collaboration enables advances in understanding and development of smart-grid technologies and practices. All countries report progress regularly, under coordination of the ISGAN. The integration of small-scale renewable power plants is also an issue tackle by the Network.

- **Outcomes**

18 publications.

- **Temporal scope**

2010 – present

- **Actors involved**

25 governments, with national teams composed of public and private sectors.

- **Technical focus**

Electric smart grids technologies.

- **Funding sources**

Member own funding

- **Organisational configuration**

Member research programmes

- **For further information**

www.iea-isgan.org

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### *Boosting RE in China*

- **Summary**

Running from 2015 until 2019, "Boosting RE as part of China's energy system revolution - CNREC" is the continuation of the Renewable Energy Development (RED) project. The partners are the Danish DEA, the Chinese National Renewable Energy Centre (CNREC) and the U.S. National Renewable Energy Laboratory (NREL). The program aims to boost the deployment of renewables in the Chinese energy system. It advises the China National Energy Administration regarding renewable energy development and coal reduction targets. It will analyse the whole energy system and address the obstacles to help the country develop a sustainable energy system that can be a model for the world.

- **Outcomes**

Developing a comprehensive scenario analysis to inform decision makers and boost the adoption of renewables.
Publish strategies and policy options to deploy renewables across the country.

- **Temporal scope**

2015 – 2019

- **Actors involved**
- **Technical focus**

National analysis and strategy to develop a plan for technology innovation in the area of renewable energy.

- **Funding sources**

CNREC has acquired $15,8 million funding from the British Children's Investment Fund Foundation (CIFF).

- **Organisational configuration**

The Energy Research Institute of China, NDRC, is the executing agency, in collaboration with the US National Renewable Energy Laboratory (NREL) and the Danish Energy Agency DEA).

- **For further information**

www.cnrec.org.cn

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### *Indonesian-Swedish Initiative for Sustainable Energy Solutions*

- **Summary**

The Indonesian-Swedish Initiative for Sustainable Energy Solutions (INSISTS) aims to promote knowledge exchange and strategic energy planning. It does so via research, innovation and pilot projects. The collaboration supports testing and developing of Swedish environmental technology solutions for the Indonesian market and for Indonesian investments in Swedish solutions.
The collaboration also includes a Business Accelerator Programme to act as a platform where companies from Sweden and Indonesia can meet aiming at business agreements that contribute to

- **Temporal scope**

2013 – ongoing

- **Actors involved**

Swedish Energy Agency and the National Energy Council of Indonesia. Universities, Research Institutes and Swedish and Indonesian businesses and cities are also involved.

- **Technical focus**

Development of the market for renewable energy and energy efficiency in Indonesia.

- **Funding sources**

Swedish Energy Agency.

the development of the market for renewable energy and energy efficiency in Indonesia.
The collaboration also includes the funding of research project "Deployment of Bioenergy in Indonesia" between Swedish KTH University and the Indonesian Gahdja Madha (UGM).

**Outcomes**

Two projects linked to the promotion of Swedish environmental technology exports. Increased trade.

**Organisational configuration**

Swedish Energy Agency and the National Energy Council of Indonesia are the national contact points.

**For further information**

www.energimyndigheten.se/forskning-och-innovation/internationalisering/indonesien/

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### *Indo-German Science & Technology Centre (IGSTC)*

**Summary**

The Indo-German Science & Technology Centre aims at facilitating institute – industry cross-border partnership through joint R&D efforts.
Although the scope of activities of the IGSTC is broader, it includes climate-related technologies. The IGSTC main objectives are: (1) facilitating the participation of industry in joint R&D projects, and assisting in mobilising the necessary resources, (2) promoting the dissemination of information on bilateral cooperation opportunities, (3) facilitating Indo-German collaborations in research and technology by promoting interaction among government, academia and industry, and (4) encouraging public-private partnerships (PPP) for innovation.

**Outcomes**

25 completed projects For a list, see:
www.igstc.org/IGSTC_ongoing_projects_1.pdf

**Temporal scope**

2010 – ongoing

**Actors involved**

Indian and German Government, academia and industry.

**Technical focus**

Manufacturing technology (including automotives); Energy and Environment; Health Research/Biotechnology; Information & Communication Technology; Advanced Materials & Nanotechnology; Chemical Process Technology etc.

**Funding sources**

The German and Indian governments provide Euro 2 million each year.

**Organisational configuration**

The Centre is guided by a Governing Body comprising representatives from both countries' Government, academia and industry.

**For further information**

www.igstc.org/about_us.html

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### *CLIENT*

**Summary**

The funding programme "CLIENT - International partnerships for sustainable climate protection and environmental technologies and services" promotes research, development and implementation of environmental and climate protection technologies.
The focus of the CLIENT programme is the promotion of demand-oriented R&I cooperation in the participating emerging and developing countries. It combines into one programme sustainable R&I solutions for concrete challenges which also include a commercial orientation, by opening up new market potentials for export-oriented, innovative German companies, in particular small and medium-sized enterprises (SMEs).
"CLIENT" does not only assist the partner countries, but also helps Germany fulfil its international commitments in the area of climate change. It also contributes, through the cooperative structure of the programme, to the strengthening the knowledge base and innovative capacity of German companies in both Germany and the partner countries.

**Outcomes**

21 listed projects: Brazil (2 projects), Chile (1), China (6), India (1), Russia (2), South Africa (3), Vietnam (6).

**Temporal scope**

2016 – 2023

**Actors involved**

German Federal Ministry of Education and Research. Partner countries: Brazil, Chile, China, India, Russia, South Africa and Vietnam).

**Technical focus**

Climate protection (e.g. emissions reductions, energy efficiency, adaptation); Resource use (e.g. production-integrated environmental protection, resource efficiency, raw material substitution, recycling); Land management (e.g. innovative land-use methods and adapted technologies and infrastructure); and Water management (e.g. energy- and consumption-optimised infrastructure).

**Funding sources**

German Federal Ministry of Education and Research for the German actors, and partner public authorities for their own actors.

**Organisational configuration**

Calls for collaborative research and development projects carried out by science, industry and other practitioners.

**For further information**

www.fona.de/de/client-internationale-partnerschaften-19705.html

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### *Geoforafri*

**Summary**

The project « Capacity building and access to earth observation data for monitoring forests in Africa » is a collaboration between the French Global Environment Facility and Southern African national (and regional) administrations in charge of forests.
The objective of the project is to facilitate the adoption of earth observation techniques and ensure the methodological and technological know-how within Central

**Temporal scope**

2012 – 2016

**Actors involved**

French Global Environment Facility (FFEM) and French Institut de Recherche pour le Développement (IRD), and national and regional Central and Western African administrations.

and Western African countries, to enable local institutions to carry out forest cover monitoring according to the international guidelines required to participate and benefit from the REDD+ mechanisms and funding. More specifically, the project aims at improving the use of Earth observation satellite data to measure and monitor environmental processes, on the basis of recognised and reliable measurement methods and guidelines information of the historical and current levels of GHG emissions issued from deforestation and forest degradation. This subsequently allows to define policies and actions to be implemented for reducing emissions, as well as the methods to be used for measuring emissions levels associated with future evolution of forest cover (MRV systems). The information is also used to help the implementation of investment programs (data and equipment), training and technical assistance, and support to research.

- **Outcomes**

27 financed projects. Research projects are listed here: www.geoforafri.org/index.php/composantes/projets-de-recherche

- **Technical focus**

Improving the use of Earth observation satellite data to measure and monitor environmental processes

- **Funding sources**

Fonds français pour l'environnement mondial, or French Global Environment Facility (FFEM). FFEM is a French public fund for the protection of the global environment in developing countries. The project offered funded 27 projects launched in 2013 and 2014.

- **Organisational configuration**

Collaboration between the French IRD and the University of Montpellier department of Spatial Observation for the Environment (UMR ESPACE-DEV), together with Central and Western African national agencies, ministries, universities, consultancies and NGOs - in response to call for projects.

- **For further information**

www.geoforafri.org

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### *Business with Impact*

- **Summary**

The Business with Impact (BEAM) programme has as a goal to advance the creation of new business opportunities in developing countries, with no restrictions on which developing countries the cooperation should take place with. Many of the projects tend to take place in emerging economies. The programme supports piloting, demonstration projects as well as development of new innovation. While the programme supports innovation in many fields, several funded projects deal with climate change aspects. That is the case for example with the "New Business Innovations for Sustainable Well-being" project, which partners with Mexico, Tanzania and India to generate new, sustainable business in developing countries, which in India focuses on

- **Temporal scope**

2015 – 2019

- **Actors involved**

Finnish Ministry of Foreign Affairs & Tekes (Finnish Funding Agency for Innovation), Universities, businesses, NGOs.

- **Technical focus**

General programme for funding innovation with the goal of "improving well-being in poorer countries".

- **Funding sources**

EUR 50 million, financed by Tekes and the Ministry for Foreign Affairs

- **Organisational configuration**

Companies, with the participation of

sustainable energy production. The "New Business Innovations for Sustainable Well-being" also carries out research via the Aalto University.

- **Outcomes**

Programme has started in 2015. No concrete outcomes listed yet.

NGOs, research organisations, and universities of applied sciences, can apply for funding via the programme with an online application done via TEKES.

- **For further information**

https://www.tekes.fi/en/programmes-and-services/tekes-programmes/beam--business-with-impact/

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### *IEA Bioenergy*

- **Summary**

The use of bioenergy could enable significant GHG emissions cuts, as well as improving energy security, particularly in rural areas.
Set up by the International Energy Agency in 1978, the IEA Bioenergy programme aims at improving cooperation and information exchange between countries which have national bioenergy research programmes. The Programme offers coordination between national R&I programme, and knowledge transfer opportunities. Though members all are government representatives, the programme aims at spreading information to the private and academic sectors, especially through the national programmes.

- **Outcomes**

200+ reports

- **Temporal scope**

1978 – present

- **Actors involved**

Government representatives from 22 member countries

- **Technical focus**

Bioenergy

- **Funding sources**

Collective funding

- **Organisational configuration**

Self-assembly

- **For further information**

www.ieabioenergy.com

## 5.2 Findings and recommendations from government-to-government initiatives

The section 4 of this report lists some of the main bilateral initiatives in the area of R&I collaboration on climate change mitigation and adaptation technologies between EU member states and third countries. This is important for future efforts to increase the coordination and coherence of support actions, improving synergies and avoiding unnecessary duplication. The selected bilateral collaborations with a strong research and innovation component were selected in response to: 1. The availability of information, and 2. the criteria listed in the introductory section.

The comparison of initiatives shows that those projects that fall under the general umbrella of government-led R&I initiatives can have very different objectives and modi operandi. Where the Sino-Danish programme focuses primarily on capacity building to create an independent authority for renewable energy, the Indonesian-Swedish one is principally aimed at testing and promoting given technologies. National and EU programmes, unless purely academic, tend to promote domestic technologies into new markets, a feature they do not share with multilateral approaches. While this motivation is understandable care must be taken that those reasons for collaboration do not clash with the goals of developing countries.

It was also found that there are no standard requirements at EU level for member states to present the initiatives, which are therefore to be found only at the national level, making the search and analysis complex to undertake. There is therefore no existing database of bilateral initiatives between EU member states and third countries, as well as no common definition of the scope of an R&I collaboration. When searching for published information in the different national ministries and agencies, it is possible to find numerous initiatives and bilateral agreements on research and capacity building. However, some are in the local language, making the search and analysis complex to undertake. There is often no information on the projects such collaboration agreements have funded, on the exact level of funding allocated, the results, as well as an assessment of the impacts of the individual projects.

Furthermore, the initiatives are also very heterogeneous in nature, and is it often difficult to understand the exact form and scope of the agreements. It is often unclear if the funding is offered to the partnering country, or if it funds only the activities of the domestic institutes involved in the project, while the host country must provide funding for its national representatives. Then, research agreements may have several objectives beyond R&I, and it is often difficult to understand from the descriptions provided the share of R&I, in contrast to technology transfer, capacity building or commercial promotion. In most cases capacity building is an important component, e.g. in Geoforafri or RED, while in the case for example of the CLIENT, INSISTS and Newton Fund the commercial aspect is also of relevance. Traditional R&I collaboration may thus be blurred with other objectives making it difficult to analyse the research component.

Due to the general character of the information provided, the quality and results of the projects cannot be easily ascertained. In some cases, there is an easy way to access information of the projects awarded and the funds provided. For the BEAM programme for example, the website gives a list of all projects financed, together with the funding provided and a short description, but the information on the project's results, the monitoring process and the outputs is not. Where actions have been financed to reduce emissions no data on the outcomes has been found. An analysis would require enquiring separately for each of the projects. Easy access to such information is important in view of achieving the European objectives of the Paris agreement and to have a full picture of the EU's efforts. This information has likely been gathered, as member states have their own evaluation procedures, but a greater level of transparency would be desirable.

The above conclusions lead us to provide a number of key recommendations, taking into account the limited influence of the EU on such programmes. The recommendations are:

- To develop a user-friendly tool for member states to register their initiatives in a common database. The rationale for the database is for interested parties to be able to find ongoing initiatives and facilitate collaboration and develop synergies.
- It is recommended to start with a database on a voluntary basis, and actively encourage its use. There are already a number of platforms for initiatives in other areas, such as the European Climate Adaptation Platform CLIMATE-Adapt, which provides a place to list initiatives, with the objective to help local authorities in EU member states to follow best practices and collaborate. Such a database would be valuable for many areas, not only R&D and climate mitigation policies.
- The database should be open and easy to use allowing the access of information to a larger audience, by providing information on projects in EU working languages. It could include search options by type of collaboration, area of research, technologies covered, geographical areas, outcomes (e.g. emission reductions) and documentation created. Past projects should be archived and remain accessible in order to enable new initiatives to learn from past results.
- A reflection into what constitutes a successful R&I programme: This could contribute to understanding which R&I actions by EU governments is impactful.
- Estimating the impact on GHG emissions and technology transfer: Policy-makers should encourage for R&I projects to estimate their long-term impact on GHG emissions and the advancement in technology transfer.
- Finding the mutual benefit: Better coordination and communication between the partners' government agencies and externally may help in developing projects more coherent with both parties' expectations. This may help achieving concrete objectives and lead to more viable follow-ups.
- Improving documentation and follow-up: A better follow-up of the projects at the government level (for example through a final webinar, workshop, movie or presentation, or simply through checklists) could improve the institutional memory, and allow for better possibilities to develop the next phases and link with other initiatives.

*Table 1: Summary of selected initiatives.*

| **Initiative** | Sino-Danish Renewable Energy Development | Boosting RE as part of China's energy system revolution | UK Science & Innovation Network in India | Indonesian-Swedish Initiative for Sustainable Energy Solutions | Indo-German Science & Technology Centre | CLINET I | Geoforafri | Business with Impact |
|---|---|---|---|---|---|---|---|---|
| **Actors involved** | | | | | | | | |
| *Public sector* | • | • | • | • | • | • | • | • |
| *Private sector* | • | • | | • | • | | | • |
| *Academia* | • | • | • | • | • | | • | • |
| **Temporal scope** | | | | | | | | |
| *One-off projects* | | | • | | • | | | |
| *Medium-term collaboration* | • | • | | • | • | • | • | • |
| *Long-term collaboration* | | | • | | | | | |
| **Organisational configuration** | | | | | | | | |
| *Self-assembly* | • | • | | • | • | • | • | • |
| *Competitive consortium* | | | | | | | • | |
| *Product development partnership* | | | | | | | • | • |
| *Network model* | | | | • | | | | • |
| *Open innovation* | | | | | | | | |
| *Member research programmes* | | | • | | | | | |
| **Funding sources** | | | | | | | | |
| *One member alone* | • | | • | • | | • | • | |
| *Member own funding* | | | | | | | | |
| *Collective funding* | | | | • | • | | | • |
| *External funding* | | • | | | | | | |
| **Objectives** | | | | | | | | |
| *Innovation* | • | • | • | • | • | • | • | • |
| *Best practices experiences* | | | | | • | | • | |
| *Technology transfer* | | | • | • | • | • | | • |
| *Knowledge transfer* | | | • | | • | • | • | • |
| *Financial transfer* | | | • | | | | | |
| *Capacity building* | • | • | • | • | • | • | • | • |
| *Policy recommendations* | • | • | | | | | • | |
| **Verified emissions reductions/avoided emissions** | | | | | | | | |

Source: Authors analysis

# 6 Industrial collaborations

## 6.1 Descriptive account of initiatives

### *Cement Sustainability Initiative*

- **Summary**

Launched in 1999, the Cement Sustainability Initiative is an initiative by 24 major companies of the cement sector (totalling about 30% of the world's production) to tackle the issue of a sustainable cement sector. The CSI is led by the World Business Council for Sustainable Development. The objective is to identify possible steps cement companies could make to progress towards a sustainable sector. Research areas include health, materials, GHG emissions monitoring and reduction.

- **Outcomes**

10+ reports

- **Temporal scope**

1999 – present

- **Actors involved**

24 private cement companies operating in about 100 countries in the world

- **Technical focus**

Mitigation from the entire life-cycle of cement.

- **Funding sources**

Member own funding and collective funding.

- **Organisational configuration**

Self-Assembly within the WBCSD.

- **For further information**

www.wbcsdcement.org

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### *Ukrainian-Danish Energy Centre*

- **Summary**

Realizing that the state of the energy sector in Ukraine was comparable to that of Denmark a few decades ago, both governments joined their efforts to reduce energy imports and consumption without negatively impact the economy. The Energy Centre, based in Kyiv (UKR) is a technical assistance of the Danish government to the Ukrainian administration. It serves as a platform to adapt to a Ukrainian context best practices from the Danish energy sector, including energy efficiency, renewables use or energy resource diversification.

- **Outcomes**

6 reports

- **Temporal scope**

2014 – 2017

- **Actors involved**

Danish Ministry of Foreign Affairs & Ukrainian Ministry of Energy and Coal Industry.

- **Technical focus**

Energy forecasting, MRV

- **Funding sources**

Ministry of Foreign Affairs of Denmark

- **Organisational configuration**

Self-assembly

- **For further information**

www.udec.org.ua/en

### *Consortium of International Agricultural Research*

- **Summary**

According to the FAO (2014), over 800 million people suffer from undernutrition. CGIAR is a global research partnership with the objective of reducing poverty, enhancing food security and improving natural resources by providing research on agricultural science and innovation. Founded in 1971 and administrated by the World Bank, the CGIAR is a consortium of 15 research centres, working in collaboration with partners from the public and private sectors.

- **Outcomes**

50+ reports

- **Temporal scope**

1971 – present

- **Actors involved**

Academia, in collaboration with public and private actors.

- **Technical focus**

Cross-cutting technology in agriculture.

- **Funding sources**

Member own funding.

- **Organisational configuration**

Network model.

- **For further information**

www.cgiar.org

### *Energy in Buildings and the Communities*

- **Summary**

The Energy in Buildings and the Communities Programme of the IEA is an international R&I collaboration between 22 member countries, from the public and private sectors, and from the academia. The main subjects of focus cover the main components of energy in buildings and community-scale building energy. Residential and industrial building energy use is responsible for one third of worldwide GHG emissions. The objective of the EBC programme is to reduce energy consumption between 5 and 30% over the next decades.

- **Outcomes**

55 completed projects with both technical reports and summary for decision makers.

- **Temporal scope**

1977 – Present

- **Actors involved**

Private, public and academic teams from 22 countries.

- **Technical focus**

Integration of energy-efficient and sustainable technologies into buildings and communities

- **Funding sources**

Member own funding

- **Organisational configuration**

Self-Assembly

- **For further information**

www.iea-ebc.org

### *Research Collaborative*

- **Summary**

Tracking "green" finance flows is a key monitoring process in the international effort to tackle climate change. The Research Collaborative programme is an OECD-led initiative which aims at tracking private climate finance. Specifically, this programme aims at identifying the private climate finance leveraged by investments in developing and emerging countries from OECD countries.
This is an open-network composed of government organizations, research institutes and finance institutions. The objective is to identify research priorities and gaps, and develop, test and evaluate methodological options to track climate-related finance flows.

- **Outcomes**

20 completed projects, 5 on-going

- **Temporal scope**

2013 – 2017

- **Actors involved**

Public, private and academic actors from 17 countries.

- **Technical focus**

Definition of acceptable MRV systems for private climate finance.

- **Funding sources**

Collective funding.

- **Organisational configuration**

Network model.

- **For further information**

www.oecd.org/env/researchcollaborative

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### *Beef Carbon*

- **Summary**

Emissions from livestock account for 18% of the world's GHG emissions. The first objective of the Beef Carbon project is better measuring GHG emissions from livestock through an observatory. Second, the project aims to develop and demonstrate new production practices with lower emission intensity. 170 farms have been identified to test these practices. The final objective is to set standards for emissions in the sector to reduce carbon footprint of French livestock by 15% in 10 years (or 120,000 tCO2). This could in turn result in definition of production standards in Europe, with the aim of reducing regional emissions from livestock.

- **Outcomes**

No outcome yet, but best practices experience and emission reductions expected.

- **Temporal scope**

2015 – 2025

- **Actors involved**

170 farms, actors from the public and the private sector.

- **Technical focus**

Emissions from livestock

- **Funding sources**

External (EU)

- **Organisational configuration**

Product development partnership

- **For further information**

www.interbev.fr/ressource/beef-carbon

### *Solar Power and Chemical Energy Systems*

- **Summary**

Solar energy can help deliver significant clean, sustainable energy worldwide. Developing renewable energy could also avoid having to build fossil fuel-burning power plants in developing countries where energy demand is expected to increase. The mission of the Solar PACES programme of the IEA is to facilitate technology development and deployment and energy partnerships to achieve cost-competitive solar technologies. Another pillar of the programme is the provision of recommendations for decision makers. The main technology focus is on Concentrated Solar Power (CSP) which uses sun-tracking mirrors to create high temperature for electricity production.

- **Outcomes**

10+ reports on technological issues

- **Temporal scope**

1997 – Present

- **Actors involved**

20 member countries, with representatives from the public, private and academic sectors

- **Technical focus**

Concentrated Solar Power technologies

- **Funding sources**

Collective funding

- **Organisational configuration**

Self-Assembly

- **For further information**

www.solarpaces.org

### *Low-Carbon Technology Partnership Initiative: Renewables*

- **Summary**

In order to stay under the 2°C limit, there is a strong need to decarbonise the energy sector. Developing renewable energy will be necessary to achieve this goal.
In 2015, in preparation of the Paris COP21, sixteen companies of the electricity sector gathered to develop business solutions to address this challenge. The final report urges policy makers to create a framework which consistently promotes the use and research for renewables, and to use carbon pricing as a tool to leverage the money to do so.

- **Outcomes**

Policy recommendations to enable R&I

- **Temporal scope**

2015

- **Actors involved**

16 companies from worldwide

- **Technical focus**

Renewables: technology and policy recommendations

- **Funding sources**

Collective funding

- **Organisational configuration**

Network model

- **For further information**

lctpi.wbcsd.org/portfolio-item/renewables

### *LCTPi: Low-Carbon Transport Fuels*

- **Summary**

Decarbonising the transport sector is essential to mitigate global warming well below 2°C. Low-carbon transport fuels have been recognized to have significant potential to achieve this goal.
In the lead-up to COP21, sixteen companies and professional associations gathered to share their vision on how to decarbonise the sector.
The final report describes technologies which are the most likely to be used in this decarbonisation effort and the policies which need to be implemented to encourage R&I initiatives in the sector.
Seven other sectors took the same LCTP initiatives, under the leadership of the WBCSD, but most were not followed through and did not produce results.

- **Outcomes**

Policy recommendations to enable R&I

- **Temporal scope**

2015

- **Actors involved**

16 companies from developed and emerging economies.

- **Technical focus**

Transport Fuels: technology and policy recommendations

- **Funding sources**

Collective funding

- **Organisational configuration**

Network model

- **For further information**

lctpi.wbcsd.org/portfolio-item/low-carbon-transport-fuels/

### *Vietnam-UK Co-development of 2050 Pathways Calculator*

- **Summary**

Department of Energy & Climate Change — MINISTRY OF INDUSTRY AND TRADE OF THE SOCIALIST REPUBLIC OF VIETNAM

The Vietnam 2050 Pathways Calculator is an online tool which predicts, in different sectorial trajectories, possible energy supply and demand pathways, and how they impact the country's GHG emissions. It was developed based on UK's own Pathways Calculator. The calculator draws on work from experts from both British and Vietnamese governments. The UK had previously helped other countries (China, India, South Africa, Japan and Thailand) develop their own Calculators.

- **Outcomes**

Product finalized

- **Temporal scope**

2014 – 2015

- **Actors involved**

UK Department of Energy and Climate Change and Viet Nam Ministry of Industry and Trade

- **Technical focus**

Emissions forecast in different sectors

- **Funding sources**

One member alone (UK government)

- **Organisational configuration**

Product Development Partnership

- **For further information**

Gov.uk

### *Global Methane Initiative*

- **Summary**


Methane has a greenhouse effect 200 times higher than carbon dioxide. Yet it is the only greenhouse gas which can be converted into fuel. Launched in 2004, the Global Methane Initiative is the world's largest international effort to target methane abatements, by both reducing emissions and promoting reuse of non-avoided methane as fuel. Technical subcommittees intend to assist countries project development in each member country in each of the covered sectors. It was estimated that between 2004 and 2015, the GMI could help achieve a reduction of 180 MtCO2eq.

- **Outcomes**

Numerous reports, regular workshops

- **Temporal scope**

2004 – Present

- **Actors involved**

More than 1,000 partners from public, private and academic sectors

- **Technical focus**

Recycling methane emissions into biogas

- **Funding sources**

Member own funding and external sources (financial institutions)

- **Organisational configuration**

Network model

- **For further information**

www.globalmethane.org/index.as

## 6.2 Findings and Recommendations from Industry-to-Industry initiatives

### *Cooperation justification*

To mitigate the impacts of climate change, there is a strong need for innovation in technologies and practices. This need is not country-specific, but requires a worldwide effort. This effort to mitigate climate change MUST include the private sector industries because of its global impact on GHG levels. Furthermore, some industry branches (energy and other heavy primary- or secondary industry sectors) have a disproportional high contribution to global emission levels, and it therefore makes sense to target them individually. Industries are usually well connected internationally, and firms often have their own research and development departments. In this respect they are well suited to be actively included international collaborations for research and innovation in low carbon

### *Criteria for good practices*

A start for recommendations for good practices of collaborations can be found in OECD guide on successful partnerships (OECD 2006). This report enables an adaptation of this paper to better fit to R&I collaborative initiatives in climate-related fields.

### *Governance/Structure*

According to San Martin-Rodriguez (2005), the main factor influencing the outcomes of collaborations is the interactions between actors. This includes willingness to collaborate, trust and communication.

The OECD report (2006) points out that collaborations should have autonomous bodies to help establish their identities. However, the present report illustrates that **the most adequate structure depends widely on context**. For instance, in the case of capacity-building collaborations, like the Viet Nam-UK collaboration, the collaboration needs to be incorporated within existing bodies (i.e. Ministries).

The role of different parties could also be a significant determinant of a collaboration's success. As illustrated in Figure 5 (which displays stakeholder role in the research chain in various sub-sectors of the cement sector), actors do not have the same role in every situation.[3] In terms of R&I collaborations, **there is no situation of "one fits all" for governments**. Each situation is specific.

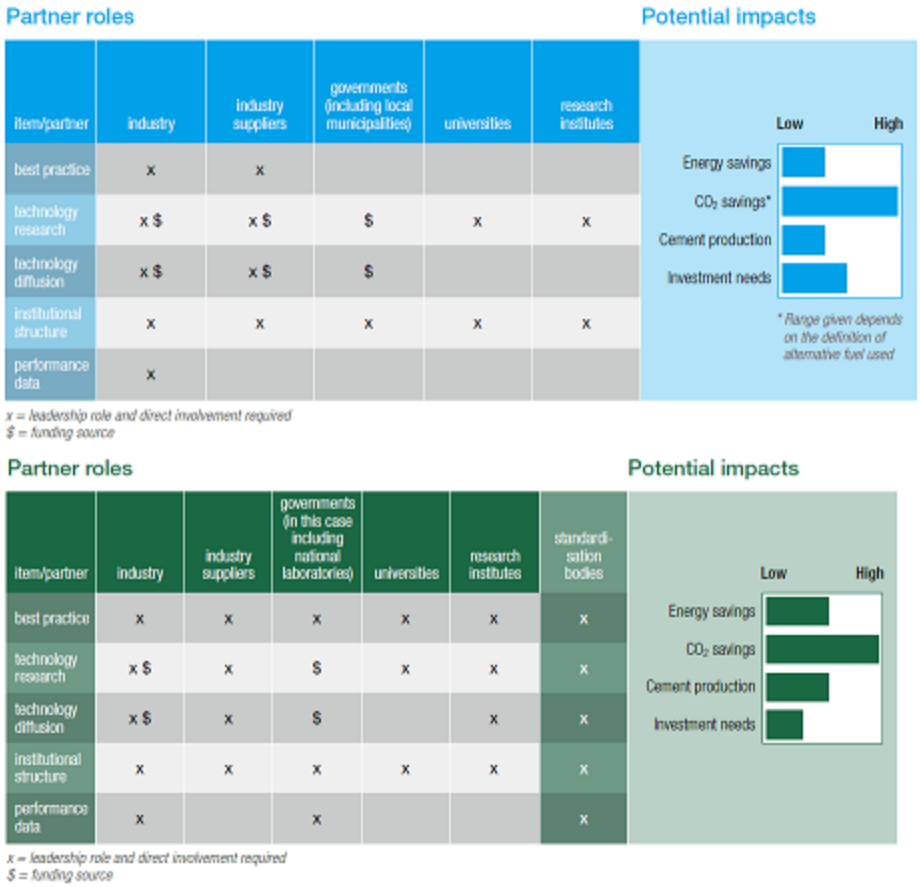


*Figure 5: Role of different stakeholders depending on the project. Source: WBCSD, 2015.*

[3] Figure 5 does not illustrate that there is also no such situation for companies either. However, it is not hard to imagine that depending on the sector or the technology, the role of the private sector could be modified.

### *Objectives and monitoring*

The definition of clear objectives and the identification of benefits are a critical process of the collaboration creation (Delman 2014). Without clarification, members could refrain from fully engaging in the collaboration.

More than objectives, **partnerships need to establish precise strategies** to work effectively and have a lasting effect (OECD 2006). In such strategy, each member's role must be clearly defined, and a strong commitment to fulfil these roles is necessary from all parties.

An important finding of this analysis was that currently, it is very difficult to verify the impacts of collaborations on results, especially on GHG emissions. This is why in Table 1, there is only a few projects for which there are verified emissions reductions.

Therefore, an **efficient monitoring process also needs to be implemented**. This process would create a form of "peer-pressure" between private actors, in the manner of that between states. However, an MRV (Monitoring Reporting and Verification) system similar to that used by the UNFCCC for countries (with territory-based monitoring) might not be the best solution for this process. Initiatives like that of the CSI to create standards for emission monitoring could be useful inputs to establish such a process.

The main issue for the development of an MRV process for R&I collaborations is the accounting of emissions. This is in fact a double issue. First, it is difficult to link directly innovation to GHG emission reductions. Second, it is possibly even more complicated differentiate GHG emissions reductions which are due to a collaboration from those which would have been made by the firm, had it not been engaged in the collaboration.

### *Number/Nature of members*

There is no universal optimal number of partners for an effective collaborative initiative. The optimal number and type of members could vary depending on the sector, the country(ies) involved or even within a sector on firms.

The member selection process needs to be handled carefully in order to maximise the potential for innovation production. According to the OECD, partners do not necessarily need to have different role, but their inputs in the relation should complement each other.

However, one significant claims of the OECD report (2006) is that partnerships where all members have the same goal would not work. However, in the case of climate-related R&I initiatives, the conclusion could be different. For instance, the case of the CSI is a good example of a lasting, efficient collaboration between companies which all desire to both ensure the sustainability of the sector and earn financial gains.

### *Financing*

One conclusion drawn from the analysis of selected initiatives is that one private company rarely (never in the cases in this report) support an entire collaboration on its own. The implication of a private firm in collaboration is either by collective funding for common projects or result sharing for its own research programmes. Cases of one party self-funding an entire collaboration is most likely to be involving the public sector, and be a case of

knowledge transfer and/or capacity building, like the case of the Ukrainian-Danish Energy Research Centre.

### *Recommendations for policy makers*

Many private actors engaged in collaborations **call for policies which encourage efforts** to reduce GHG emissions, behaviour change… Among the initiatives identified in this report, there is a call for policies to try to deter detrimental behaviours, like **carbon pricing, to be complemented with policies to reward low-carbon technologies or practices**. This is why members of the CSI called for policies to ensure that engaging in innovation activities, and in collaborative initiatives was profitable. Labelling (for instance through the ISO) could be a solution to categorize.

According to Glachant et al. (2013), optimal collaborations to be encouraged significantly differ depending on the country. For emerging countries, they find that the best strategy could be the implementation of local climate policies, such as carbon pricing, to encourage sectors to orientate their development towards green growth, and the strengthening of Intellectual Property Rights (IPR) to encourage investments in low-carbon technologies. However, for Least Developed Countries, the best solution would be technology transfer (through lower technological barriers, i.e. IPR) and capacity building, which are the most needed.

Differences in terms of legal structures could also refrain private sector actors to engage in R&I collaboration initiatives.

### *Recommendations for industry members*

As shown by Lee (2005), research collaborations can help increase the productivity of research (in the paper, in terms of publications). Thus, engaging in collaborative programmes could enable firms to develop new innovative products, meaning that **initiatives could create opportunities for profits**. Collaborations, especially international ones, could also enable companies to enter new markets, by working with local actors. This could again increase the companies' profits.

In addition to profit-oriented arguments, collaborations can help private actors to spread a message: companies individually calling for an action in a particular domain would capture significantly less attention than a coalition of firms. As such, collaborations could be **opportunities for the private sector to structure the political agenda**.

If collaborations can create low-carbon technologies or practices for its members to cut emissions, increase resilience, adapt technologies to climate change, etc., **dissemination to other actors** needs to be taken into account.

This raises the issue of **intellectual property rights**, especially for the private sector. If it is enforced, dissemination is made a lot more difficult. If not, there is a reduction of incentives to invest in R&D. IPR could also make difficult capacity building, especially for developing economies (Glachant 2013).

*Table 2: Summary of selected initiatives.*

| **Initiative** | Cement Sustainability Initiative | Ukrainian-Danish Energy Research Centre | Consortium of International Agricultural researchers | Energy in Buildings and Communities Programme | International Smart-grids Action Network | Research Collaborative | Global Forest Observations Initiative | Beef Carbon | IEA Bioenergy | Solar Power and Chemical Energy Systems | WBCSD LCTPi Renewables | WCBSD LCTPi Low-Carbon Transport fuels | Viet Nam - UK collaboration on development of pathways calculator | Global Methane Initiative | Energy Technologies Institute |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Actors involved** | | | | | | | | | | | | | | | |
| *Public sector* | | ● | ● | ● | ● | ● | | ● | ● | ● | | | ● | ● | ● |
| *Private sector* | ● | | ● | ● | | ● | | ● | | ● | ● | ● | | ● | ● |
| *Academia* | | | ● | ● | | ● | ● | | | ● | | | | ● | |
| **Temporal scope** | | | | | | | | | | | | | | | |
| *One-off projects* | | | | | | | | | | | ● | ● | ● | | |
| *Medium-term collaboration* | | ● | | | | ● | | ● | | | | | | | |
| *Long-term collaboration* | ● | | ● | ● | ● | | ● | | ● | ● | | | | ● | ● |
| **Organisational configuration** | | | | | | | | | | | | | | | |
| *Self-assembly* | ● | ● | | ● | | | | | ● | ● | | | | | ● |
| *Competitive consortium* | | | | | | | | | | | | | | | |
| *Product development partnership* | | | | | | | | ● | | | ● | ● | ● | | |
| *Network model* | | | ● | | | ● | | | | | | | | | |
| *Open innovation* | | | | | | | | | | | | | | | |
| *Member research programmes* | | | | | ● | | ● | | | | | | | ● | |
| **Funding sources** | | | | | | | | | | | | | | | |
| *One member alone* | | ● | | | | | | | | | | | ● | | ● |
| *Member own funding* | ● | | ● | ● | ● | ● | ● | | | | | | | ● | |
| *Collective funding* | ● | | | | ● | | | | ● | ● | ● | ● | | | |
| *External funding* | | | | | | ● | | ● | | | | | | ● | |
| **Objectives** | | | | | | | | | | | | | | | |
| *Innovation* | | | ● | ● | | ● | | ● | ● | ● | | | | ● | ● |
| *Best practices experiences* | ● | ● | ● | | | | | ● | ● | | ● | ● | | ● | ● |
| *Technology transfer* | | ● | ● | | ● | | ● | | | | | | ● | ● | |
| *Knowledge transfer* | ● | ● | | ● | ● | | ● | | | | ● | ● | ● | ● | |
| *Financial transfer* | | ● | | | | | | | | | | | ● | | |
| *Capacity building* | | ● | ● | | | | ● | | | | | | ● | ● | ● |
| *Policy recommendations* | ● | | | ● | ● | ● | | | | | ● | ● | | ● | ● |
| **Verified emissions reductions/avoided emissions** | ● | **NF** | **NF** | **NF** | **NF** | **NF** | **NF** | **NF** | **NF** | **NF** | **NF** | **NF** | **NF** | ● | **NF** |

# 7 Regional collaborations

## 7.1 Descriptive accounts of initiative

### *IEA Technology Cooperation Programmes*

**Summary**

One of the largest initiatives worldwide on energy technology collaboration, the IEA has currently 39 TCP's operating. The ultimate purpose is to create a flexible collaboration mechanism for both, IEA member and partner countries, as well as industry that has continued to enable innovation to respond to energy challenges. The focus lies on joint research, development and demonstration activities. The technology covered is renewable energy and hydrogen, as well as transport, buildings and electricity on the end-user side (including some fossil fuel ones that should not be qualified as mitigation). 80% of such TCP's are covered by research, 12% information sharing, with the rest being pilot and demonstration plants and field studies.

**Outcomes**

Linking research industry and policy is one of the main outcomes. Also, accelerated development and deployment of projects, harmonized standards and a strengthening of research capabilities.

**Temporal scope**

1975 - ongoing

**Technical focus**

End use projects in the buildings, electricity, industry and Transport sectors, Fossil fuels, Fusion Power and Renewable Energy

**Funding sources**

Each TCP is self -financed by the participants, either through financial or in-kind contributions. The participants themselves decide whether cost-sharing, task -sharing or a combination of both is most appropriate. In TCPs funded through a cost -sharing approach, each participant contributes to a common fund which can then be used to finance activities under the TCP's program of work. In TCPs funded through a task-sharing approach, each participant contributes resources in-kind (for example personnel or materials).

**Organisational configuration**

The IEA provides the framework for collaboration through TCP's, which is known as the IEA Framework for International Technology Cooperation It is a legal structure that is designed to simplify international co-operation between national entities, business and industry. It also includes important information about participation and reporting requirements.

**For further information**

www.iea.org/tcp

### *Carbon Sequestration Leadership Forum (CSLF)*

- **Summary**

The CLSLF is an initiative at the Ministerial-level with a focus on development of improved and cost-effect for CCS technology.
Goal, among others, is to identify key obstacles, potential areas of collaboration in R&D, resolve potential issues with intellectual property rights and to develop strategies that address public perception of CCS. Furthermore, the CSLF also promotes awareness and champions legal, regulatory, financial, and institutional environments conducive to such technologies

- **Outcomes**

Collaborative research on CCS with the result in demonstration projects along the capture, transport and storage pathway. Implementation of technological improvement.

- **Temporal scope**

2003 - ongoing

- **Actors involved**

European Commission and 24 partner countries.

- **Technical focus**

Carbon Capture and Storage

- **Funding sources**

Member countries

- **Organisational configuration**

Made up of its members, the CSLF has a policy group governing the overall framework and policies, the secretariat coordinating the communication among project members and a technical group reviewing the progress of the projects and offering recommendations to the policy group.

- **For further information**

www.cslforum.org/cslf

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### *International Partnership on the Hydrogen Economy*

- **Summary**

An international inter-governmental partnership whose objective is to facilitate and accelerate the transition to clean and efficient energy and mobility systems using fuel cells and hydrogen (FCH) technologies. It provides a forum for advancing policies, initiatives, codes, and standards to accelerate the cost-effective transition to the use of FCH in the economy.

- **Outcomes**

PHE aims to facilitate active sharing of information among its members and help facilitate international research, development, demonstration, and commercial utilization activities related to fuel cells and hydrogen (FCH) technologies primarily in order to accelerate market penetration of the technology and to allow early adoption and their supporting

- **Temporal scope**

2003 – ongoing

- **Actors involved**

European Commission, India, China, USA, South Africa, Japan, Korea, Russia, Norway, Canada, Brazil, Australia.

- **Technical focus**

Fuel Cell and Hydrogen Technology

- **Funding sources**

EU and IPHS Members

- **Organisational configuration**

Formation of the IPHE was facilitated by the US Department of Energy and Dept. of Transport and is now managed evenly between its current 18 partners and members,

infrastructure. The Forum for advanced policies, the introduction and initiatives for common codes and standards aim to result in a cost-effective transition in the use of FCHs in the economy, which furthermore ought to enhance the security and efficiency of energy systems, address environmental objectives and grow the economy.

- **For further information**

www.iphe.net

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### *The EU - Brazilian cooperation in Science and Technology*

- **Summary**

BBICE is an international cooperation project funded under FP7. The ultimate aim is support of bilateral cooperation in Science and Technology and Innovation. Although the funding is targeted at a broad spectrum of projects in various sectors, there is prioritized category of "Science and Technology in context of sustainable growth" listed as research project types. Past projects have included material re-use, bio-, biomethane and hydrogen research, energy and energy security.

- **Outcomes**

A strengthening of EU-Brazilian partnership in Science and technology. Travel grants for researchers, facilitation of research links.

- **Temporal scope**

2012 - ongoing

- **Actors involved**

EU Member State countries and Brazil

- **Technical focus**

Biofuels, biomethane, energy and hydrogen research

- **Funding sources**

FP7

- **Organisational configuration**

Bilateral partnership with several academic and stakeholder involvement from EU and Brazil

- **For further information**

www.b-bice-plus.eu and ec.europa.eu/research/iscp/pdf/projects/leaflet_B%20BICE_08.2014.pdf

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### *Network for the Advancement of Sub-Saharan Africa-EU Science and Technology Cooperation (CAAST-NET +)*

- **Summary**

The cooperation has been developed against the background of an emerging global consensus that capacity building in S&T is essential not only to economic competitiveness, but also to sustainable development and poverty reduction. In Africa, a growing number of governments

- **Temporal scope**

2016 – 2020

- **Actors involved**

EU and Sub-Saharan African Countries

- **Technical focus**

Low carbon, sustainable and efficient

are prioritizing S&T as a key sector of their national and regional growth and development programs. As a consequence, there is an increasingly important focus on S&T under the Europe-Africa cooperation program. The Network funds research and innovation in various science and technology projects but includes sustainable development (agriculture), and climate change research.

- **Outcomes**

CAAST-Net Plus delivers on: (1) Informing the bi-regional policy dialogue for mutual learning and awareness; (2) Building support for coordinated and innovative approaches to bilateral funding of bi-regional cooperation around global challenges; and (3) Brokering the public-private relationship to foster improved uptake and translation of bi-regional research partnership outputs into innovative technologies, good and services.

agriculture, climate change research in Africa.

- **Funding sources**

FP7

- **Organisational configuration**

Initiative by the EU, but operation now with several international Ministries, Scientific Networks and Universities.

- **For further information**

www.caast-net-plus.org

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### *Near Zero Emissions Coal Initiative (NZEC)*

- **Summary**

The EU-China Partnership on Climate Change, agreed in 2005, is designed i.e. to strengthen practical cooperation on the development, deployment and transfer of clean fossil fuels technologies, to improve energy efficiency and to achieve a low carbon economy. In this respect the EU and China have developed a project with the aim of developing and demonstrating advanced near-zero emission coal (NZEC) technology through carbon dioxide capture and storage (CCS). This technology will allow for the capture of CO2 emissions from coal-fired power plants and its subsequent storage underground, for example in exploited oil or gas fields or in sealed geological strata, thereby avoiding CO2 emissions into the atmosphere.

- **Outcomes**

Pilot demonstration of a commercial scale of a CCS plant at the end of Phase 3.

- **Temporal scope**

2005 - ongoing

- **Actors involved**

EU-China

- **Technical focus**

Carbon Capture and Storage

- **Funding sources**

Partially funded by European Union (other contributors: China and the UK)

- **Organisational configuration**

EU and partnerships with China

- **For further information**

ec.europa.eu/clima/dossiers/nzee

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### *Promoting Low Emission Urban Development Strategies in Emerging Economy Countries (Urban LEDS)*

**Summary**

Objective of the initiative is to enhance the transition to low emission urban development by cooperating with local governments in Brazil, India, Indonesia and South Africa on implementing methodological frameworks on low carbon strategies (all sectors of urban planning and development). The cooperation includes help in 1) capacity building, 2) resources and tools, 3) technical and financial solutions and 4) global networking. In terms of technical support an integrated approach is taken, meaning support on policy, regulatory, governance, capacity building, awareness raising and stakeholder engagement. Main purpose of the cooperation is a help in implementation of the greenClimatecity methodology as well as technical assistance (for example on the LED project)

**Outcomes**

Establishment of sufficient capacities in local urban communities for low carbon and sustainable development of cities. Projects ought to support national plans for climate change mitigation.

**Temporal scope**

2012 - ongoing

**Actors involved**

EU, Brazil, China, India, Indonesia, South Africa

**Technical focus**

Technical solutions on sustainable urban development

**Funding sources**

European Commission offers financial assistance

**Organisational configuration**

EC, UN Habitat, and local governments of sustainability are promoting projects which are jointly implemented with local political management committees, stakeholder groups and a local climate team

**For further information**

urbanleds.iclei.org

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### *Global Climate Change Alliance (GCCA)*

**Summary**

GCCA aims to strengthen the dialogue and cooperation between the EU and developing countries on climate change. Where possible, it seeks to help developing countries and LDC's to achieve millennium development goals and to mitigate climate change. Two main supporting pillars: 1) a platform for dialogue and shared experience and 2) technical and financial support. Part of the technical support encompasses advice on sector based mitigation strategies. Also, and on more concrete terms the partners help in low carbon solutions, disaster risk management and strategic assistance to adaptation. Since 2012, 65 so called technical missions have been conducted

**Temporal scope**

2009 - ongoing

**Actors involved**

EU and 38 developing countries

**Technical focus**

Low carbon technology implementation across various sectors. Help in developing national strategies and adaptation plans

**Funding sources**

75% EU budget, the rest split between EU MS participation and EDF.

that aimed at knowledge sharing and build-up of regional partnerships

- **Outcomes**

The GCCA is seen as long-term initiative with an ongoing exchange of technical an policy support. The policy dialogue is supported by Conferences and workshops. The technical support ought to result in national and regional programmes on low carbon development.

- **Organisational configuration**

Established in 2007 by the European Union, it is now a broad network with 38 partner countries and several EU-, and non-EU partner organisations.

- **For further information**

http://www.gcca.eu/technical-and-financial-support/intra-acp-technical-assistance

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### *COACH Project*

- **Summary**

Coach project aims to establish broad cooperation between China and the EU in the field of CCS. Includes preparation for implementation in China of large-scale polygeneration energy facilities with options for coal based electric power generation as well as production of hydrogen and synthetic fuels. For these facilities, $CO_2$ capture and geological storage (including use for enhanced oil or gas recovery) constitute an inherent and decisive prerequisite.

- **Outcomes**

Advance in making carbon capture and storage feasible.

- **Temporal scope**

2006 - 2010

- **Actors involved**

EU MS and China

- **Technical focus**

Carbon Capture and Storage technology

- **Funding sources**

EU

- **Organisational configuration**

EU and public and private partners in and outside China (industry as well as government)

- **For further information**

www.co2-coach.com

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### *Global Forest Observations Initiative*

- **Summary**

Established in 2010 by the Group of Earth Observations to replace the Forest Carbon Tracking programme, the Global Forest Observations Initiative aims at coordinating and assisting national programmes for Forest Monitoring and Carbon Tracking systems.
Among the five components undertaken by the GFOI, the R&D plan is aims at

- **Temporal scope**

2014 – Present

- **Actors involved**

19 Research centres

- **Technical focus**

Forest spatial observation

- **Funding sources**

identifying priority areas where research is lacking to achieve the goals set by the initiative, including forest degradation or mapping of particular forest types. As of 2016, the R&D component gathers 19 research centres worldwide.

- **Outcomes**

10+ reports, regular expert meetings

Member own funding

- **Organisational configuration**

Network model

- **For further information**

www.gfoi.org

## 7.2 Findings and recommendations of region-to-region initiatives

We have listed and examined various regional initiatives on R&I in climate change mitigation, of which most are joint EU initiatives with either Brazil, China or India. These are summarised in table 3. Some collaborations also are in form of a global network, or focus on a continent and least developed countries (Africa).

In section 9 of this report, we also attempted to present a diverse selection of regional initiatives, not only in geographical coverage but also in terms of technology coverage and industry sectors. It was noticed that as a tendency inter-regional EU projects primarily deal with energy and electricity type projects at a large scale (for example CCS, low-carbon electricity generation and efficiency improvements in China versus bio-fuel, bio-methane and waste to energy-type generation in Brazil). They seem to either develop those technologies further that are already established in the global technology market, or intend to focus innovative technologies that are currently pushed strongly by international macro-policy, such as CCS. Needs-based development of those technologies that Ockwell et al. (2015) describe as having local climate development gains seem to be of secondary importance. Furthermore, such initiatives have the clearly stated goal to cut global GHG emissions as they are often incepted within global climate agreements between the EU and partnering regions, so we conclude that this is why GHG emissions reduction is given so much weight as opposed to other positive benefits that could potentially result out of the collaborations (adaptation, poverty reduction, educational measures of local communities).

Global alliance and partnership-type projects instead tend to cover a more diverse set of technologies for R&I, different topics and projects of different scale and size. They tend to engage more with local stakeholders and communities in order to define the needs for mitigation technology of the developing country and then adapt technology R&I accordingly. The GCCA and the CAAST-NET+ are examples of very diverse initiatives that offer a broad spectrum in technology R&I, capacity building, training or help in designing national- and regional frameworks for climate change mitigation as well as adaptation.

While such collaborations with a broad scope seem to have the intention of making a strong positive impact in developing countries, they also are often more difficult to trace and understand for anyone interested, such as for us researchers. Websites tend to be less informative on details over the nature of the projects, such as how exactly technology research and innovation is incorporated and followed through. Alliance-type collaborations also seem to stress to a lesser degree the pure R&I component, compared to the inter-regional initiatives between the EU and China, and instead focus a lot on capacity building,

training and education of local policy makers, which strictly speaking does not fit the scope we had set entirely.

Therefore, when evaluating more regional collaboration initiatives in the future, we suggest to add to the descriptive characterisation of projects an analysis of drivers and on the motivation for initiating such collaborations. A clearer definition of benefits of these collaborations ought to cover the actors (who benefits: both partners, only one), the type of benefits (adaptation/mitigation, financial, set-up of R&D infrastructure, IPR transfer, other co-benefits) a temporal scale (short-term and long-term), but also if there is an authority set in place who supervises and controls these developments. Such clear analysis of drivers and benefits of projects is currently hard to find from the information provided on the project websites.

It is expected that international collaboration in R&I for low carbon technology will intensify and increase over the next years. Beyond the idea of a publicly accessible database on current and past projects, we recommend working out clear guidelines on project collaboration design with a detailed analysis /statement on benefits for each partner.

*Table 3: Summary of selected initiatives.*

| **Initiative** | IEA Technology Cooperation Programmes | Carbon Sequestration Leadership Forum | International Partnership on the hydrogen economy | The EU-Brazilian Cooperation in Science and Technology | Network for the Advancement of Sub-Saharan Africa-EU Science and Technology Cooperation | Near Zero Carbon Initiative | Promoting Low Emission Urban Development Strategies in Emerging Economy Countries | Global Climate Change Alliance | COACH Project |
|---|---|---|---|---|---|---|---|---|---|
| **Actors involved** | | | | | | | | | |
| *Public sector* | x | x | x | x | x | x | X | x | x |
| *Private sector* | x | | | x | x | x | x | x | x |
| *Academia* | | | | x | x | x | | x | x |
| **Temporal scope** | | | | | | | | | |
| *One-off projects* | | | | | | | | | x |
| *Medium-term collaboration* | | | | x | | x | X | | |
| *Long-term collaboration* | x | x | x | | x | | | x | |
| **Organisational configuration** | | | | | | | | | |
| *Self-assembly* | | | | | | | | | |
| *Competitive consortium* | | | | | | | | | |
| *Product development partnership* | | | | | | | | | |
| *Network model* | x | x | | x | x | x | x | x | x |
| *Open innovation* | | | | | | | | | |
| *Member research programmes* | | | x | | x | x | | x | |
| **Funding sources** | | | | | | | | | |
| *One member alone* | | | | | | | | | |
| *Member own funding* | x | x | x | | | x | | x | x |
| *Collective funding* | x | | | | | | | | |
| *External funding* | x | | | x | x | x | x | x | x |
| **Objectives** | | | | | | | | | |
| *Innovation* | x | x | | | x | x | x | x | |
| *Best practices experiences* | | | | | | | | | |
| *Technology transfer* | x | | x | x | | x | | x | x |
| *Knowledge transfer* | x | x | x | x | | x | x | x | x |
| *Financial transfer* | x | | | | | | | | |
| *Capacity building* | x | x | | x | x | x | x | x | x |
| *Policy recommendations* | **x** | x | | x | x | | | | |
| **Verified emissions reductions/avoided emissions** | | | | | | | | | |

Source: Authors analysis

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