CARISMA

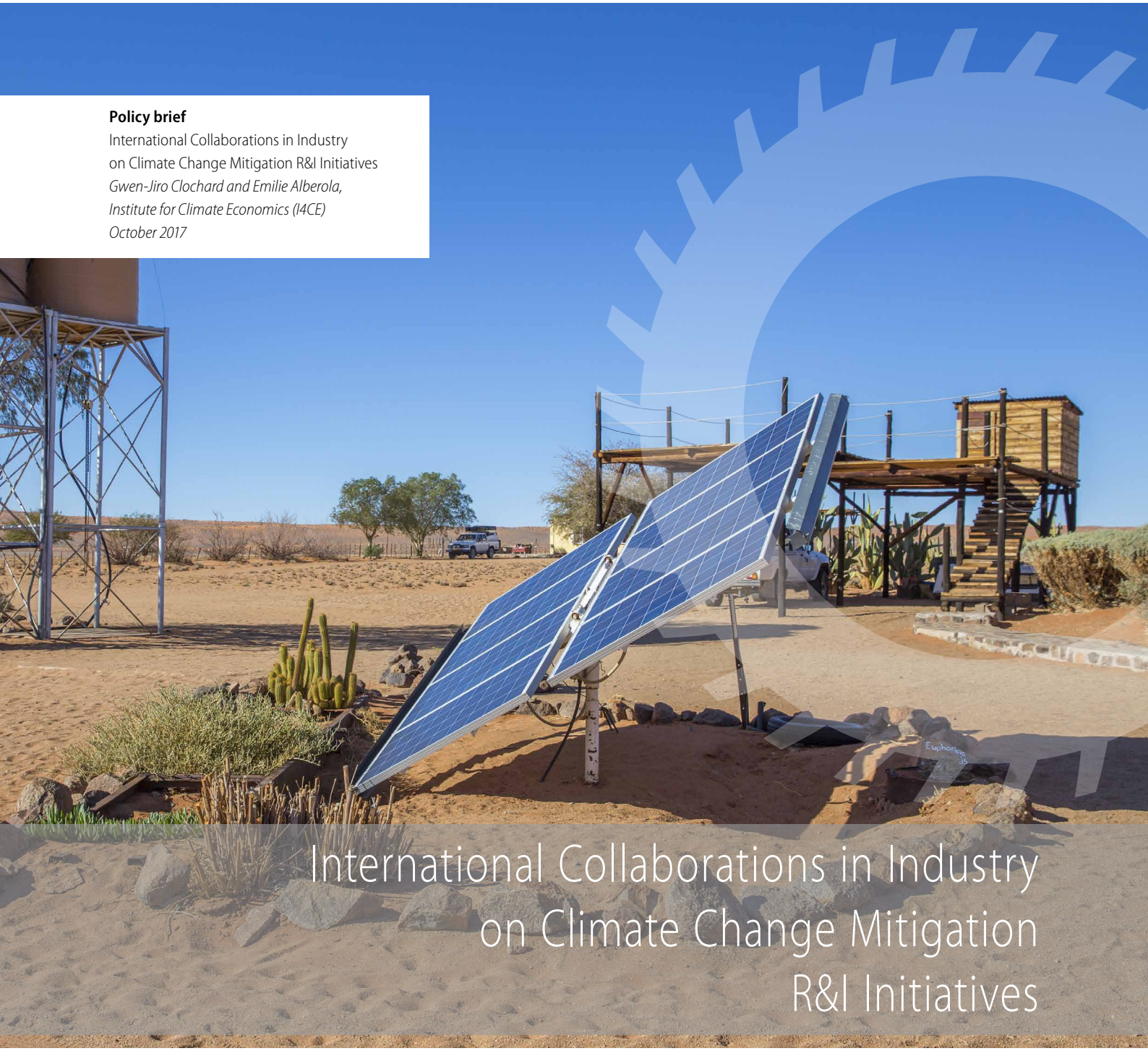
Innovation for Climate Change Mitigation

Policy brief

International Collaborations in Industry on Climate Change Mitigation R&I Initiatives

Gwen-Jiro Clochard and Emilie Alberola, Institute for Climate Economics (I4CE)

October 2017



International Collaborations in Industry on Climate Change Mitigation R&I Initiatives

The CARISMA Project receives funding from the European Horizon 2020 programme of the EU under the Grant Agreement No. 642242.

Summary for decision-makers

As international collaborative research and innovation (R&I) initiatives have the potential to advance climate change mitigation technology transfer across borders, in particular in developing countries, some industries have developed various international R&I collaborative initiatives to facilitate deployment of low-carbon technologies and practices.

In the CARISMA project, such initiatives were mapped in a background report, and discussed in a workshop involving stakeholders from government, industry, academia, and international organisations. The main conclusion of the mapping is that these collaborations can be widely different in form, governance, duration, or funding, and a one-size-fits-all approach for stimulating such R&I cooperation on mitigation does not exist: the optimal policy framework varies depending on sector and on actions. However, R&I collaboration for climate between industries needs to be encouraged by a coherent and long-term policy framework.

This Policy Brief summarises general lessons and identifies 8 recommendations for stimulating international collaborations on R&I among industries for policy makers and for industry:

1. Supporting low-carbon innovation and technology development with appropriate policies
2. Facilitating the building of the international platforms as knowledge communities
3. Easing the access of collaboration members to fund R&I activities
4. Transforming climate burden into business opportunities and developing the spirit of collaboration
5. Among members of R&I collaboration, being clear on roles and interactions of each member, on expected output (during the project) and impact (beyond the project)
6. Helping to structure the political agenda on innovation and international approaches
7. Monitoring outcomes and impacts of the R&I initiative with performance indicators
8. Sharing knowledge and best practices of R&I initiatives through promotion, capacity building, and international business platforms.

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.

Introduction

International research and innovation (R&I)[1] initiatives have the potential to advance technology transfer across borders, in particular in developing countries and emerging economies. This is an opportunity for technology-exporting countries. Industry actors in these countries have implemented various programmes to facilitate R&I on climate change mitigation aiming to foster deployment of climate technologies abroad.

The ambitious climate goal spelled out in the Paris Agreement to limit warming to "well below 2°C" (and strive for 1.5°C) necessitates globally scaled-up, real-world implementation of low-greenhouse gas (GHG) technology and innovation, particularly in the production and in the use of energy, which generates around two-thirds of global GHG emissions. Greater ambition than is embodied in the current national determined contributions (NDC) submitted by countries is needed (Rogelj et al., 2016). International cooperation between countries can significantly reduce climate change mitigation costs and allow a higher ambition (World Bank, 2016).

Recent years have seen considerable growth in the number and variety of international cooperation initiatives seeking to foster the innovation and the deployment of low-GHG energy technologies with the growing place of climate change issues in the international policy agenda. This trend includes new cross-cutting technology initiatives, new technology- and sector-specific initiatives, and an increased focus on international energy technology collaboration within existing multilateral entities that have wider economic or political mandates (IEA, 2014).

For industry members, collaborations are likely to also have other objectives than climate. These could include opportunities to increase firm reputation, create new market opportunities, or secure a leading position in a market. In addition, the higher the need for interdisciplinary cross-border and cross-sector research, the less a single company has the capability to innovate successfully on its own. Therefore, companies increasingly look for partners with complementary expertise to obtain access to different technologies and knowledge quickly (OECD, 2017a). Joining efforts on R&I with technological complementarities, similar strategic interests, and mitigation problem solving are other important motives for international collaborations.

[1] R&I means Research that aims at developing a project and Innovation meaning to create the enabling conditions for its deployment in the market and diffusion to commercial application.

This policy brief aims to give guidance to industry- and government-based decision makers on how to stimulate and facilitate this industry-level international R&I cooperation on climate change mitigation. The results are based on the background report "Mapping and Analysis of Industry-sector specific climate change mitigation research and innovation initiatives"[2] , produced in the CARISMA project by Radboud University, CEPS and I4CE which lists over 30 initiatives. This CARISMA mapping, which scoped selected initiatives initiated by industry sectors, contributes to earlier mappings of efforts and initiatives such as those carried out under the UNFCCC. **A comprehensive overview of these initiatives will probably never be achieved** because of the decentralised and uncoordinated nature of R&I cooperation, as well as confidentiality issues. Our inventory in the mapping report therefore also necessarily is incomplete.

This policy brief also includes recommendations based on input from stakeholders as voiced during a CARISMA workshop "research and innovation collaboration on climate change mitigation technologies between Europe and emerging economies", in Amsterdam on 20 February 2017, and interviews with practitioners.

2 Context of climate change mitigation R&I initiatives

A climate-friendly development pathway that includes innovation support is needed to build the foundation for inclusive growth into the second half of this century and mitigating risks of climate change. This is the key message of the latest report of OECD (2017b) published on the topic "Investing in Climate, Investing in Growth". The OECD demonstrates that combining ambitious climate action with pro-growth economic reforms coupled with strong green innovation would boost GDP growth from 2.1% to 3.1% for the G20 economies on average in 2050.

At the same time, moving towards a below-2°C scenario by 2050 and maintain global growth will require intensive efforts in R&I from public and private actors. This is in line with the Paris Agreement, which underlines the importance of both national and international collaborations on R&I initiatives as fundamental pillars of climate change mitigation[3]. In emerging or developing economies, the deployment of the most advanced and appropriate low-carbon technologies faces several issues additional to those in developed countries, including, but not limited to, a lack of initial capacities and barriers to information or to intellectual property (Chin and Grossman 1990, Helpman 1993). International R&I collaboration could function as a double-edged sword; developing and emerging countries increase their technological and innovative capacity, while developed countries can create new markets for their technologies.

Furthermore, several emerging economies, China in particular, have become significant actors in the global innovation system. R&I activities, including international cooperation, play a key role in the take-off of emerging economies such as China, India and South Korea. The speedy growth of information and communication technologies can offer many opportunities by helping developing countries and their private sector overcome barriers to knowledge transfer and technology uptake.

As underlined by the International Energy Agency in its Technology Collaboration Programme report, collaborations between countries accelerate outcomes on innovative technologies to the collective benefit of all members (IEA 2016). **According to OECD (2015), international collaboration on research programmes has doubled between 1996 and 2005, accounting for about 20% of scientific publications.**

Encouraging the development of R&I collaboration initiatives in climate change mitigation requires a credible low-carbon policy framework that would emerge mostly from the alignment of all policies with climate objectives. At the domestic level, existing policy frameworks, developed over decades to support fossil-fuel-based economic growth, can inadvertently weaken the low-GHG investment signal provided for instance by carbon pricing policies (OECD, 2011). Potential misalignments can be identified in many policy areas, including R&I in fossil fuels.

Carbon pricing policies can only significantly steer industry towards low-carbon innovation if prices are high or if revenues can be used for supporting innovative technologies. Pricing carbon can help drive innovation in technologies and business models that can reduce carbon emissions and promote resource efficiency, and thus boost productivity improvements (Stiglitz & Stern, 2017). However, where carbon price policies exist, their impact on low-carbon R&D and innovation investments is often limited and indirect. Indeed, current carbon pricing policies, in particular the EU Emissions Trading System (EU ETS), lead to marginal short and long-term impacts on low-carbon R&D and innovation investments due to a combination of low carbon prices and a lack of political confidence in a continuous and strong increase of prices. Furthermore, carbon pricing can have indirect impacts when revenues generated by auctioning are used especially for financing R&I. In Europe, the EU ETS supports innovative carbon capture and storage (CCS) and renewable energy projects between 2013 and 2020 though a dedicated financing fund named NER 300[4]. These carbon pricing policies need to be complemented by other targeted measures such as specific investment incentives, regulations and standards, information policies, and measures aimed at low-carbon innovation. However, the interactions between policies need to be carefully assessed[5].

[2] http://carisma-project.eu/Portals/0/Documents/CARSIMA%20Working%20Document%205_May%202017_Intl%20RD%20collaboration%20mitigation.pdf
[3] See UNFCCC: http://unfccc.int/ttclear/negotiations/decisions.html
[4] NER 300 is so called because it is funded from the sale of 300 million emission allowances from the New Entrants' Reserve (NER) set up for the third phase of the EU emissions trading system (EU ETS between 2013 and 2020). NER 300 is one of the world's largest funding programmes for innovative low-carbon energy demonstration projects. The programme is conceived as a catalyst for the demonstration of carbon capture and storage (CCS) and innovative renewable energy (RES) technologies on a commercial scale within the European Union.
[5] For more information about interactions between policies, see Fujiwara (2016), Van der Gaast and al. (2016), OECD (2011), Gloaguen and Alberola (2013), IETA (2015) or , Jalard and al. (2015)

3 Lessons and challenges identified

This policy brief is based on the preliminary mapping of a limited number of industry R&I initiatives. With the collected data from desk review, an experts' workshop and interviews we can identify a number of issues and general recommendations. These could be developed in potential further research on a more extensive sample of such initiatives.

Two examples of international collaboration led by industry are in Box 1. The full set can be found in Lindner et al. (2017).

We identify four key areas of recommendations on:

(1) the policy context to stimulate R&I **collaboration motivation** between stakeholders, in particular industry
(2) the **definition of clear objectives** of collaboration and their monitoring,
(3) the structure and **governance** of R&I climate collaboration initiatives, and
(4) on **financing and valorisation of their benefits.**

On these four issues, specific recommendations can be addressed to public policy makers (governments) and to private actors (industry members).

Box 1. Two illustrative examples of international collaborations-in industry in climate R&I initiatives

The Cement Sustainability Initiative (CSI)
http://www.wbcsdcement.org

> *Actors involved:*
21 private companies of the cement sector, operating in about 100 countries in the world.

> *Main objectives:*
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)

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

1. Monitoring GHG emissions of the sector
2. Defining a cement technology roadmap.
3. Building a low-carbon technology partnership initiative for the cement sector.
4. Developing capacities building for emerging countries

The Energy in Buildings and Communities Initiative (EBC)
http://www.iea-ebc.org

> *Actors involved:*
Private, public and academic teams from 22 countries

> *Main objectives:*
The mission of the programme is 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 to have been identified to reduce the carbon footprint and energy consumption of existing sites. This objective applies for residential, commercial, office buildings and community systems.

To achieve these objectives, the research projects are divided in five 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.

3.1 The policy context to stimulate R&I cooperation motivation

To mitigate the impacts of climate change, there is a need for innovation in technologies and practices that must stimulate the private sector industries because of their global impact on GHG levels. Some industry branches (energy and other energy-intensive industry sectors) have a disproportionately high contribution to global emission levels, and their differences require policymakers to target them by sector. Industries are usually well suited to be active drivers of international collaborations for R&I in low-GHG technologies: they are connected internationally, often have their own research and development departments to support their innovation activities.

According to Edwards-Schachter et al. (2013), motives for international collaborations between industry members on R&I, can be summarised in five categories: (1) Access to new knowledge and joint technological development; (2) Access to new markets; (3) Sharing risks and reducing costs; (4) Search for R&D complementarities and technical assistance (capacity complementarity); (5) Improvements to technological and innovation competency (learning). Policy makers should encourage R&I collaborations because it could help deliver significant climate benefits and co-benefits for health, wealth, food security and improved livelihoods. However, **the effort must not be government-alone; the private and academic sectors need to be involved.** With the view to technology learning, governments are relatively active during R&D stages, while the private sector plays a more dominant role during deployment and diffusion.

R&I in general holds economic and financial risks, and for climate change mitigation it faces particular challenges due to high political uncertainties. Collaborations create additional risks by introducing uncertainty about partners' intentions, commitment, and efforts. These high business and collaboration risks inherent in collaborative initiatives on climate change mitigation need to be balanced by reliable policies that will create and sustain the economic benefits.

Consequently, **clear policy signals are essential for industry-led R&I in climate change mitigation, as it is needed to guide the transformation of technologies and business models for a low-GHG economy.** Indeed, developing climate-compatible growth and business models requires countries' policy makers to implement policies and reforms that support low-emission R&D development and innovation investments, backed up with efficient and effective climate policies and enhanced incentives for innovation. Credible policies are needed to enable industries to develop their own low-carbon strategy and to identify perspectives of their current business in a net-zero emission world and of R&D and innovation opportunities.

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 orient 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.

At the international level, R&I collaboration initiatives can be stimulated also by the international climate regime. Technology cooperation has featured in UNFCCC COP decisions since the start of the Convention (UNFCCC, 2010). A key milestone was the establishment in 2010 of the Technology Mechanism (TM), comprising the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN). CTCN fosters collaboration within a network that includes private sector entities and provides technical assistance to developing countries. The system of Technology Needs Assessments and Technology Action Plans includes the identification of particular needs and projects that can be the focus of industrial collaborations.

More recently, technology is mentioned explicitly in Article 10 of the Paris Agreement (De Coninck & Sagar, 2017), which establishes a technology framework to provide overarching guidance to the work of the TM and emphasises the needs of developing countries for support.

The UNFCCC Paris Agreement also opens up an additional pathway and possible incentive for R&I cooperation initiatives. The Agreement recognises in its Article 6 that voluntary international cooperation approaches can be a pillar of climate action to allow for higher ambition in their mitigation and adaptation actions and to promote sustainable development and environmental integrity. This Article 6 enables countries to collaborate on carrying out measures in their NDC, in line with emissions trading experience. This can provide a nice policy context for business-level cooperation. Article 6.4 proposes a new mechanism, still under negotiation, that could be built on the experience Clean Development Mechanism (CDM) of the Kyoto Protocol with some useful reforms, and specifically mentioning participation by private entities. This could advance the movement already visible in the CDM towards acknowledging and quantifying emission reductions due to policies and programmes, which could include technology cooperation. Article 6.8 sketches out a framework for non-market approaches aimed inter alia at enhancing private sector participation in the implementation of NDCs. These non-market approaches could be collaborative sectorial platforms for sharing experiences and practices stimulating low-carbon innovation or for treating projects such as technology transfer and capacity building. The CARISMA list of industrial collaborations includes examples where a developed country assisted a developing country. However, multi-partner groupings of governments, non-state actors and private entities could arrange their collaborations as a non-market approach to assist in the implementation of NDCs.

Each of these approaches offers a way for emission reductions achieved by cooperation between parties, and particularly between developed and developing countries to be recognised in some way within the framework of the NDCs. For example, one country investing in emission reduction on the territory of another country could have this investment accounted for under its own NDC. The key questions, similar to the case of CDM project and programme collaboration, are the robustness of attribution of emissions reductions to particular cooperation initiatives and arrangements, and the accounting framework that will be applied to NDCs.

This framework is one of the main subjects of post-Paris UNFCCC negotiations. Making Article 6 operational will also require a lot of technical and political work and rules, modalities and procedures, which are currently under discussion between Parties. It is to be hoped that, even if the expected mitigation consequences of cooperation programmes cannot be included in tonne-for-tonne NDC accounting, or must be

prudentially discounted, the NDC system will offer a platform where those who offer and fund technology collaborations can achieve recognition for their efforts.

Lastly, in carbon pricing policy design, effective trade treatment may not only reduce the ('carbon leakage[6]') downside of pricing carbon in energy-intensive sectors, but, as with the current WTO negotiations on environmental goods, could accelerate the international diffusion of climate-friendly products and services (Grubb and al, 2015). By creating opportunities to increase profitability through the reduction of GHG emissions, the future crediting mechanism developed under the Paris Agreement in the future could also support innovation and incentivise the generation of new ideas and solutions in an international cooperative approach.

3.2 R&I cooperation objectives and monitoring of outcomes[7]

The definition of clear objectives and the identification of benefits are a critical process of establishing collaboration on research and innovation (Delman, 2014). The most frequent objectives of R&I international collaboration initiatives analysed are building networks of experts and stakeholders, facilitating knowledge transfer and good practices such as capacity building and awareness-raising efforts. A much smaller number of initiatives engage in systematic and comprehensive policy or market analysis. Some initiatives prioritise policy dialogue until targeting high-level policy dialogue with Ministries and high-level policy makers. In order to achieve these objectives and benefits, **partnerships need to establish precise strategies** to work effectively and have a lasting effect (OECD, 2006). In such a strategy, each member's role must be clearly defined, and a strong commitment to fulfil these roles is necessary from all parties. Moreover, fulfilment of these roles needs to be monitored in order to measure the impact of actions.

With respect to the latter, an important finding of the mapping in our analysis is that **it is very difficult to verify the impacts of collaborations on results,** especially on GHG emissions. Few partnerships demonstrated that their members have verified GHG emission reductions generated by projects.

Therefore, **an efficient monitoring process also needs to be implemented to identify progress made by members according to collaboration objectives.** This process would create a form of "peer-pressure" between members. Initiatives such as the Cement Sustainability Initiative (CSI) (see Box 1) to create standards for emission monitoring could be useful inputs to establish such a process. Apart from administrative burden, the main issue for the development of a monitoring process for R&I collaborations on climate change mitigation is the accounting of emissions reduced or avoided thanks to the collaboration. 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 to differentiate GHG emission 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.

3.3 Governance and institutional basis

Most R&I international collaboration initiatives analysed were established without a strong formal legal status and the most recent ones were founded on a political declaration or non-legally binding terms of reference. Many are managed by a small secretariat, often hosted by existing entities (often the larger member). The advantage of such a light institutional structure is to be quickly formed in response to policy and strategic priorities. However, the main disadvantage of such non-legally binding initiatives is to face a lack of commitment by members, in particular regarding contribution to financing.

Furthermore, most of the R&I international collaboration initiatives analysed were not established as stand-alone entities but under wider umbrella initiatives or directly linked with existing platforms the collaboration could be incorporated within existing bodies.

Therefore, **the most adequate structure depends on context.** In terms of R&I collaborations, **there is no situation of "one fits all". Each situation is specific.** The main factor influencing the outcomes of collaborations is the interaction between actors.

Similarly, there is no universally optimal number of partners for an effective collaborative initiative, as this could vary depending on the sector, the country(ies) involved or even within a sector or firms, or whether a history of cooperation already exists. The member selection process needs to be handled carefully in order to maximise the potential for innovation.

Partners do not necessarily need to have different roles, but their inputs in the cooperation should complement each other. In this sense, one significant claim of the OECD report (2006) is that all members can subscribe to the same overall goal, but that each partner can have different motivations (mitigation to enter new markets, mitigation to create employment, etc. The case of the CSIis a good example of an effective collaboration between companies which all desire to both ensure the sustainability of the sector and earn financial gains.

To facilitate international collaboration, a well-developed system to protect and enforce IPR can stimulate technology diffusion by providing secure channels for sharing expertise. By contrast, ineffective intellectual property rights regimes, in particular inadequate enforcement, can dissuade foreign companies from licensing their technologies by fear of competitors using them without authorisation. Additionally, inadequate IPR systems often discourage foreign subsidiaries from increasing the scale of their R&D activities. Lastly, the existence of IPR does not appear to impede technology transfer to developing countries. In fact, most environmental innovation comes from incremental improvements to existing off-patent technologies. Even where these incremental innovations are patented – usually in only a few jurisdictions – there is sufficient room in the market for competing technologies.

[6] Carbon leakage refers to the situation that may occur if, for reasons of costs related to climate policies, businesses were to transfer production to other countries with laxer emission constraints. This could lead to an increase in their total emissions. The risk of carbon leakage may be higher in certain energy-intensive industries.

[7] Output and outcome can be distinguished as following: output can directly be measured, but outcome is a result of a project to be seen beyond the project, which is more difficult to measure.

3.4 Financing

In none of the R&I initiatives selected for our analysis did a single private company support an entire collaboration on its own. **The participation of a private firm in collaboration is always by collective funding for common projects.** Cases of one party self-funding an entire collaboration are mainly those involving the public sector and this is the case of knowledge transfer and/or capacity building, such as the Ukrainian-Danish Energy Research Centre.

R&I collaborations can be supported by financing coming from dedicated innovation or climate funds, private or publics. Under the UNFCCC, the Green Climate Find (GCF) is dedicated to fund a wide spectrum of climate technology projects and programmes submitted by accredited entities, including potentially R&I activities and projects to help countries tackle challenges faced in the early stages of the technology development cycle.

In addition, the GCF can provide two specific types of support. Firstly, a business incubation and financial support facility are to be set to enable the deployment of viable and new technologies in developing countries. This Private Sector Facility could potentially play an important role in this area by attracting venture capital and angel investors to deploy their capital in developing countries. Secondly, a capacity-building programme/request for proposals for developing countries to enhance endogenous capacities related to climate technologies, more focus on knowledge sharing and learning through various capacity-building activities (the "readiness" programme). It would provide an allocation for agreed activities, as well as modalities for providing such support, including the types of entities that may apply for funding, the minimum results, or expected outcomes[8].

In Europe, several EU-funded programmes are dedicated to climate change mitigation such as Climate KIC (Knowledge and Innovation Communities) that has been created in 2010 by the European Institute of Innovation and Technology (EIT). This Climate KIC is the largest public-private innovation partnership focused on climate change, consisting of dynamic companies, the best academic institutions and the public sector providing funding.

4 Recommendations

4.1 Recommendations for policy makers

As demonstrated for 'traditional' R&D activities, public policy can intervene at any stage of the R&I for climate change mitigation cycle to stimulate innovation, including to accelerate the diffusion of innovations, through international collaborations. In R&I activities, governmental support can be most important in the form of research budget, which could decrease in the deployment and diffusion stages when private sector takes over[9].

Different innovations and technologies require different levels and kinds of support at the various stages of the innovation chain. For instance, the kind of policy intervention that might successfully accelerate the deployment of a technology near commercialisation, like concentrating solar thermal power, will be very different from that required by technologies just emerging from the laboratory, such as advanced biofuels from algae. However, each stage of the innovation chain for clean energy technologies may not be equally conducive to international collaborations.

One way to stimulate low-GHG technology and market innovation is to give an economic signal by putting a price on GHG emissions, in whatever form. Many private actors engaged in collaborations call for policies that encourage efforts to reduce GHG emissions and to change behaviour. Among the initiatives identified in the background report (Lindner et al. 2017), there is a call for policies to try to deter detrimental behaviours. Such policies should be complemented with policies to reward R&I in low-carbon technologies or practices. This is why members of the CSI (see Box 1) called for policies to ensure that engaging in innovation activities and in collaborative initiatives is profitable.

"Key takeaway points for policy makers."

(1) **Supporting private sector in innovation and low-GHG technology development with appropriate policies** that consider the level of market competition, the level of technology maturity and the scale of private actors. Large R&I projects are important but stimulating smaller R&I projects can be also a priority to accelerate innovation.

(2) **Facilitating the building of the emergence of regional and international platforms as knowledge and informative communities** that centralise all R&I initiatives whatever technologies, sectors or countries on which members could register and promote their initiatives, their objectives and their best practices. **Those initiatives are more efficient in dissemination or policy dialogue when linked with existing international complementary initiatives or organisations.**

(3) **Financing R&I collaboration initiatives:** facilitating the access to climate mitigation dedicated funds (specific R&D funds or innovation support facilities), or the valorisation of GHG emissions reductions generated by low-GHG options developed in cooperative R&I initiatives, by designing international crediting mechanisms for potential transfers between stakeholders willing to achieve their GHG objectives. This could be made part of the GCF.

[8] https://www.greenclimate.fund/documents/20182/409835/GCF_B.14_02_-_Support_for_facilitating_access_to_environmentally_sound_technologies_and_for_collaborative_research_and_development.pdf/410006c7-c3f6-4abc-96fe-cfa9280994e0

[9] "This problem is also known as the 'Valley of Death" that applies to all types of technologies and start-up growth enterprises - including eco-innovations, when risks associated with early-stage (unproven and proven technologies) and middle-stage (pre-commercial) technologies are by private investors seen as too risky, and often public policies do not still provide funds (Edwards and Murphy 2003).

4.2 Recommendations for industry actors

For industry actors, international collaborations on climate change mitigation R&I activities can be motivated by low-GHG objectives but also by others ones beyond climate. Indeed, they can help: increase the access to new knowledge, to new markets share risks and reduce costs; and improve R&D complementarities, competency and technical assistance. In addition, collaborations can help private actors to structure the climate policy agenda with governments: companies individually calling for an action in a particular domain would capture significantly less attention than a coalition of firms.

"Key takeaway points for industry members".

(1) **Transforming climate burden into business opportunities:** developing the spirit of collaboration R&I initiatives on low-carbon technologies and practices to facilitate the emergence of innovation, new markets, and technologies.
(2) **Objective and members:** the objective of the collaborative initiative needs to be clearly defined by its members and a mutual benefit identified. In the project design stage, be clear about roles and interactions among members, expected output (during the project) and impact (beyond the project). Initiatives with large members, companies and organisations have a strong potential of effectiveness but developing also networks with smaller partners or members could have a stronger impact on innovation.
(3) **Communicating needs for supportive policies to governments** by helping to structure the political agenda on innovation and international approaches. Clearer climate change mitigation pathways will help industries anticipate, plan for and communicate the structural consequences of the transition away from their GHG-intensive activities portfolio and also to draft their decarbonisation strategy and low-carbon roadmap detailing their business model shift and encouraging R&I collaborative initiatives.
(4) **Monitoring outcomes** and impacts of the R&I initiative **by developing tools and indicators** of progress and benefits according to defined objectives without disclosing sensitive information.
(5) **Sharing knowledge and best practices of R&I initiatives** through promotion, capacity building, and sectoral, regional and international business platforms (CTCN, etc.)

References

Chin, J.C., Grossman, G., (1990). Intellectual property rights and North–South trade. In: Jones, R.W., Krueger, A. (Eds.), The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin. Blackwell, Cambridge, MA

De Coninck, H., & A. Sagar (2017). Chapter 15: Technology Development and Transfer (Article 10). In: The Paris Agreement on Climate Change. Analysis and Commentary. Edited by Daniel Klein, María Pía Carazo, Meinhard Doelle, Jane Bulmer, and Andrew Higham. Oxford University Press: Oxford, UK.

Delman, J. (2014) "The Danish RED and China National Renewable energy Centre: Report from the final Technical Review Mission", Renewable Energy Development, November 2014

Edwards-Schachter, M.; Castro-Martínez, E.; Sánchez-Barrioluengo, M.; Anlló, G.; Fernández-De-Lucio, I. (2013), "Motives for international cooperation on R&D and innovation: empirical evidence from Argentinean and Spanish firms", International Journal of Technology Management, Vol. 62, Nos. 2/3/4, 2013

EBC (2016), "EBC Annual Report 2015", IEA: Paris, France. http://www.iea-ebc.org/fileadmin/user_upload/docs/AR/EBC_Annual_Report_2015.pdf

Fujiwara, N. (2016), "Policy interaction between the EU Emissions Trading System and the Renewable Energy Directive", CARISMA Working Document No. 2, October 2016 https://europa.eu/capacity4dev/file/56759/download?token=0DUsvmVv

Glachant, M., DamiDen Dussaux, Y. Ménière, A. Dechezleprêtre (2013), "Promoting the International Transfer of Low-Carbon Technologies: Evidence and Policy Challenges", French Centre for Policy Making, October 2013 http://personal.lse.ac.uk/dechezle/Promoting_the_international_transfer_of_low_carbon_techs.pdf

Gloaguen, O. and E. Alberola (2013), "Assessing the factors behind CO2 emissions changes over the phases 1 and 2 of the EU ETS: an econometric analysis", CDC Climat Research, Working Paper No. 2013-15, October 2013 http://www.cdcclimat.com/IMG/pdf/13-10_cdc_climat_r_wp_13-15_assessing_the_factors_behing_co2_emissions_changes.pdf

Grubb, M., H. de Coninck & Ambuj D. Sagar (2015) From Lima to Paris, Part 2: Injecting Ambition, Climate Policy, 15(4): 413-416.

Helpman, E., (1993). Innovation, imitation, and intellectual property rights. Econometrica 61, 1247 – 1280

IETA (2015), "Overlapping Policies with the EU ETS", July 2015. http://www.ieta.org/resources/EU/IETA_overlapping_policies_with_the_EU_ETA.pdf

IEA (2014), "Mapping Multilateral Collaboration on Low-Carbon Energy Technologies", OECD/IEA: Paris, France. https://www.iea.org/publications/insights/insightpublications/MappingMultilateralCollaboration_FINAL.pdf

IEA (2016), "Technology Collaboration Programmes: Highlights and Outcomes", OECD/IEA: Paris, France. http://www.iea.org/publications/freepublications/publication/TechnologyCollaborationProgrammes.pdf

Jalard, M., L. Dahan, E. Alberola (2015), "The EU ETS emissions reduction target and interactions with other energy and climate policies", COPEC Report Chapter 1, I4CE/Enerdata, November 2015 https://www.i4ce.org/wp-core/wp-content/uploads/2015/11/rapport-i4ce-BAT.pdf

Lindner, S., E. Alberola, M. Alessi, A. Behrens, G-J Clochard, H. de Coninck, K. Tuokko (2017), "International R&I collaboration on mitigation: Examples of international climate change mitigation research and innovation collaboration between the European Union and developing countries", CARISMA Working Document no. 5, May 2017 http://carisma-project.eu/Portals/0/Documents/CARSIMA%20Working%20Document%205_May%202017_Intl%20RD%20collaboration%20mitigation.pdf

OECD (2006), "Successful partnerships: A Guide", OECD LEED Forum on Partnerships and Local Governance, Vienna, Austria, January 2006 https://www.oecd.org/cfe/leed/36279186.pdf

OECD (2011), "Interactions between Emission Trading Systems and other Overlapping Policy Instruments", General Distribution Document, Environment Directorate, OECD, Paris. http://www.oecd.org/env/tools-evaluation/Interactions%20between%20Emission%20Trading%20Systems%20and%20Other%20Overlapping%20Policy%20Instruments.pdf

OECD (2015), "OECD Science, Technology and Industry Scoreboard 2015: Innovation for growth and society", OECD Publishing, Paris OECD (2015), "OECD Science, Technology and Industry Scoreboard 2015: Innovation for growth and society", OECD Publishing, Paris

OECD (2017a), "The links between global value chains and global innovation networks: An exploration", OECD Science, Technology and Industry Policy Papers, No. 37, OECD Publishing, Paris https://ideas.repec.org/p/oec/stiaac/37-en.html

OECD (2017b), "Investing in Climate, Investing in Growth", prepared by the OECD in the context of the German G20 presidency, OECD Publishing, Paris, May 2017. https://www.oecd.org/environment/cc/g20-climate/synthesis-investing-in-climate-investing-in-growth.pdf

Rogelj et al., (2016), "Paris Agreement climate proposals need a boost to keep warming well below 2 °C", Nature, 534, 631–639 (30 June 2016) doi:10.1038/nature18307 http://www.nature.com/nature/journal/v534/n7609/full/nature18307.html?foxtrotcallback=true

Stiglitz J & N Stern (2017), Report of the High-Level Commission on Carbon Prices, Carbon Pricing Leadership Coalition, World Bank, May 2017. https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/59244eed17bffc0ac256cf16/1495551740633/CarbonPricing_Final_May29.pdf

UNFCCC (2010) "Report on options to facilitate collaborative technology research and development", Note by the Chair of the Expert Group on Technology Transfer. UNFCCC http://unfccc.int/resource/docs/2010/sbsta/eng/inf11.pdf

Van der Gaast, W., G-J Clochard, E. Alberola, A. Türk, N. Fujiwara, N.A-Spyridaki (2016), "Effects of interactions between EU Climate and Energy Policies", CARISMA Working Document No. 3, November 2016. http://carisma-project.eu/Portals/0/Documents/CARISMA%20Working%20Document%203%20-%20Policy%20Interactions.pdf

World Bank, (2016), "State and Trends of Carbon pricing" report, October 2016, Washington D.C. http://documents.worldbank.org/curated/en/598811476464765822/pdf/109157-REVISED-PUBLIC-wb-report-2016-complete-161214-cc2015-screen.pdf

WBCSD (2015) "Low-Carbon Technology Partnerships initiatives, Cement: Final Report" http://lctpi.wbcsd.org/wp-content/uploads/2016/03/LCTPi-Cement-Report.pdf